Bacteriological Profile and Antimicrobial Resistance of Wound Isolates at Nepalgunj Medical College Teaching Hospital: A Cross-Sectional Study

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ABSTRACT

Introduction: Wound infections are a common cause of morbidity and are increasingly complicated by multidrug-resistant organisms. **Aims:** To determine the bacteriological profile and antimicrobial susceptibility patterns of aerobic isolates from wound infection samples. **Methods:** An analytical cross-sectional study was conducted at Nepalgunj Medical College Teaching Hospital from June 2025 to March 2026. Pus/wound swabs collected from patients with clinically suspected infections across various departments were processed for aerobic culture. Isolates were identified by standard biochemical tests, and antimicrobial susceptibility testing was performed using the modified Kirby-Bauer disc diffusion method in accordance with latest Clinical Laboratory Standards Institute guidelines. Multidrug resistance was defined as resistance to at least three different antibiotic classes. **Results:** A total of 410 patients were enrolled, yielding 203 bacterial isolates. *Staphylococcus aureus* was the most common isolate (23.2%), followed by *Klebsiella pneumoniae* (21.2%), *Escherichia coli* (14.8%), and *Pseudomonas spp*. (13.8%). Overall, 99.5% of isolates were multi drug resistant, with 94.6% resistant to five or more antibiotic classes. Methicillin resistance was identified in 83.0% of *S. aureus*. Gram-negative isolates showed near-complete resistance to third-generation cephalosporins. While meropenem and polymyxin B retained activity against most Enterobacteriaceae, colistin resistance was high in *Pseudomonas* spp. (96.4%) and *Citrobacter* spp. (100%). Vancomycin remained 100% effective against Gram-positive cocci. **Conclusion:** This study highlights a critical prevalence of Multidrug-Resistant pathogens in pus and wound infections, primarily Methicillin-resistant Staphylococcus aureus and extensively drug-resistant Gram-negative bacilli. With conventional and last-resort antibiotics losing efficacy, therapeutic options are severely limited. Implementing routine surveillance, local antibiograms, and robust antimicrobial stewardship is essential.

Keywords: Antimicrobial resistance; Antibiogram; Multidrug resistance; Methicillin-resistant; *Staphylococcus aureus*; Nepal; Wound infection

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INTRODUCTION

Wound infections represent a significant global health burden, contributing to prolonged hospitalization, increased healthcare expenditure, and substantial morbidity and mortality.[1–3] The disruption of skin integrity creates a favorable environment for microbial colonization.[4,5] In recent decades, the emergence and spread of multidrug-resistant (MDR) organisms, including methicillin-resistant *Staphylococcus aureus* (MRSA), extended-spectrum β-lactamase (ESBL)-producing Enterobacteriaceae, and carbapenem-resistant *Pseudomonas aeruginosa*, have severely limited therapeutic options.[6–8]

In low- and middle-income countries, the situation is critical due to limited infection control infrastructure, high antimicrobial consumption, and a lack of routine surveillance.[9,10] In Nepal, several studies have documented the bacteriological profile of wound infections, with culture positivity rates ranging from 59% to 62%.[11,12] These reports show a predominance of S. aureus and Gram-negative bacilli such as *Klebsiella pneumoniae, Escherichia coli*, and *Pseudomonas spp*., accompanied by alarming levels of MDR.[13–15] However, most available data originate from the capital or eastern regions, and there is a paucity of information from western Nepal, where healthcare resources and prescribing patterns may differ.

Nepalgunj Medical College Teaching Hospital (NGMCTH) is a tertiary care center serving the western, mid-western, and far-western regions of Nepal as well as neighboring parts of India. The local bacteriological profile and antimicrobial susceptibility patterns of wound infections in this setting have not been previously described which is essential for guiding empirical therapy, and establishing a baseline for infection control interventions. Therefore, this study was conducted to determine the bacteriological profile and antimicrobial susceptibility patterns of bacteria isolated from wound samples at NGMCTH.

METHODS

An analytical cross-sectional study was conducted at the Department of Microbiology, Nepalgunj Medical College Teaching Hospital, Kohalpur, Banke, Nepal, from June 2025 to March 2026. The hospital is a tertiary care center serving western, mid-western, and far-western Nepal, as well as neighboring parts of India. All patients aged >14 years with clinically suspected wound infection (purulent discharge, serous or seropurulent discharge with signs of inflammation, warmth, erythema, induration, tenderness, pain, and raised local temperature) from any department (surgery, orthopedics, obstetrics/gynecology, etc.) were eligible. Patients with suture abscesses or wounds with cellulitis but no active discharge were excluded. The institutional review board of NGMC approved the study protocol [65/081-082 dated June 2025]. Informed consent (written and verbal) was obtained from all patients.

A consecutive sampling method was used. The sample size was calculated using the formula:

$n = z^2 \times p \times (1-p) / e^2$

where z = 1.96 (95% confidence level), p =0.59 (estimated culture positivity rate from Rai et al 2017)[11], and e = 0.05 (5% margin of error). The calculated sample size was 372. After adding 10% for potential unlabeled, mishandled, or inadequate-quality specimens, the final estimated sample size was 409. However, a total of 410 participants were enrolled during the study period. Using sterile cotton swabs, two pus/wound swabs were collected aseptically from each patient. Gram-stained preparations were made from one swab for provisional diagnosis. The second swab was inoculated on 5% sheep blood agar and MacConkey agar plates and incubated at 37°C for 48 hours before being reported as sterile. Growth on culture plates was identified by colony characteristics and standard biochemical tests.[16,17] Antimicrobial sensitivity testing (AST) was performed using the modified Kirby-Bauer disc diffusion method on Mueller-Hinton agar, and results were interpreted according to the Clinical Laboratory Standards Institute (CLSI) guidelines (2023). Methicillin resistance was detected using cefoxitin (30 µg) as a surrogate marker. *Staphylococcus aureus* (ATCC 25923), *Escherichia coli* (ATCC 25922), and *Pseudomonas aeruginosa* (ATCC 27853) were used as control strains for AST.[18]

The Kirby-Bauer disc diffusion method was used to study the Antibiotic susceptibility pattern of the bacterial isolates according to the Clinical Laboratory Standards Institute (CLSI) guidelines. However, for colistin and polymyxin B, CLSI recommends broth microdilution (BMD) as the reference standard, as disc diffusion is unreliable due to poor agar diffusion. In this study, susceptibility to colistin and polymyxin B was assessed using disc diffusion as an exploratory measure.[19,20] 0.5 McFarland standard suspension from isolated bacterial colonies was used for antimicrobial susceptibility testing (AST). Antimicrobial Susceptibility testing was interpreted per standard protocol by measuring the inhibition zone diameter around the discs and reported as sensitive, intermediate, or resistant.[21–23] The antibiotics disc and concentration which were used for both gram-positive and gram-negative aerobic bacteria were as follows: penicillin (P) 10 units, erythromycin (E) 15 µg, cefoxitin (CX) 30 µg, Clindamycin (CD) 2 µg, cotrimoxazole (COT) 5 µg, linezolid (LZ) 30 µg, high-level gentamicin (HLS) 120µg, vancomycin (VA) 30 µg, ceftriaxone (CTR) 30 µg, ampicillin (AMP) 10µg, cefuroxime (CXM) 30µg, ceftazidime (CAZ) 30 µg, cefotaxime (CTX) 30 µg. *Acinetobacter, Klebsiella, Escherichia coli, Citrobacter*, and *Enterobacter species* were screened for extended-spectrum beta-lactamase (ESBL) production according to the CLSI guidelines using ceftazidime (30 µg), cefotaxime (30 µg), and ceftriaxone (30 µg).[24] The organisms showing reduced susceptibility to at least one of these antibiotics, with a zone of inhibition on Mueller-Hinton agar for ceftazidime ≤22 mm ≤25mm, were considered potential ESBL-producing organisms and selected for a phenotypic confirmatory test for ESBL.[25] Multidrug resistance (MDR) was defined as acquired non-susceptibility to at least one agent in three or more antimicrobial categories, per the joint expert proposal from the European Center for Disease Prevention and Control (ECDC) and the Centers for Disease Control and Prevention (CDC). Additionally, isolates resistant to five or more antimicrobial classes were categorized as having 'severe resistance' (≥R5) to reflect the exceptionally high burden of resistance observed in this setting.[26]

Statistical Analysis

Data were entered and analyzed using Statistical Package for the Social Sciences (SPSS) software version 25.0 for Windows (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize demographic characteristics, culture positivity rates, bacterial isolates, and antimicrobial susceptibility patterns. Categorical variables were presented as frequencies and percentages. Associations between categorical variables were assessed using the Chi-square test. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 410 participants were enrolled, of which 226 (55.1%) were male and 184 (44.9%) were female. The overall mean age was 43.2 ±15.8 years (males 44.4±14.9, females 41.6±16.7). The most represented age group was 21–40 years (159, 38.8%), followed by 41–60 years (130, 31.7%). Among females, the highest proportion was observed in the 21–40 years age group (87; 47.3% of all females), whereas among males, the highest proportion was observed in the 41–60 years age group (80; 35.4% of all males). A chi-square test was performed to assess whether the age-group distribution differed significantly between male and female participants. The analysis revealed a statistically significant association between age group and gender (χ^2=10.14, df=3, p=0.017), indicating a younger age distribution among female participants compared to males (Table I).

Age group Age(yrs)	Gender Male (n)	Female (n)	Total (n) %
<20	22	15	37 (9)
21-40	72	87	159 (38.8)
41-60	80	50	130 (31.7)
>60	52	32	84 (20.5)
Total	226 (55.1%)	184 (44.9%)	410 (100)
(χ^2 = 10.14, df = 3, p = 0.017			

Table I: Demographic Distribution of Study Participants by Age and Gender (N=410)

A total of 203 bacterial isolates were recovered from 410 pus/wound samples (culture positivity rate: 49.5%). Of these, 120 (59.1%) were from males and 83 (40.9%) from females. *Staphylococcus aureus* was the most common isolate (47, 23.2%) and the only major pathogen more frequent in females (26 vs. 21). Gram-negative isolates (*Klebsiella pneumoniae, Escherichia coli*, *Pseudomonas spp*.) were more common in males. The largest number of isolates was observed in the 21–40 years age group (73, 36.0%), followed by the 41–60 years age group (59, 29.1%). Chi-square tests showed no significant association between isolate type and sex (χ^2=10.40, p=0.319) or age group (χ^2=34.62, p=0.149), indicating that the microbiological profile was independent of these demographic variables (Table II).

Bacterial isolates	Sex		Age in years				
	Male (n)	Female (n)	<20 yrs	21-40 yrs	41-60 yrs	>60 yrs	Total n (%)
S. aureus	21	26	6	19	14	8	47 (23.2)
K pneumoniae	25	18	3	14	15	11	43 (21.2)
E. coli	20	10	3	11	9	7	30 (14.8)
Pseudomonas spp.	21	7	2	11	9	6	28 (13.8)
Proteus spp.	10	6	0	3	4	9	16 (7.9)
Citrobacter spp.	7	6	0	5	6	2	13 (6.4)
Enterococcus spp.	6	1	0	3	0	4	7 (3.4)
Streptococcus pyogenes	4	3	2	1	1	3	7 (3.4)
CONS	3	3	2	2	0	2	6 (3)
NFGNB	3	3	0	4	1	1	6 (3)
Total	120	83	19	73	59	53	203 (100)
(χ^2 = 10.40, df = 9, p = 0.319)			(χ^2 = 34.62, df = 27, p = 0.149)				

CONS= Coagulase negative Staphylococci, NFGNB = Non-fermenting Gram-negative bacilli

Table II: Distribution of Bacterial Isolates According to Sex and Age Group (n = 203)

Vancomycin and chloramphenicol showed 100% susceptibility across all species. Linezolid and doxycycline also demonstrated good activity, with susceptibility of 80.8% and 74.5% in *S. aureus*, respectively. Methicillin resistance (cefoxitin-resistant) was observed in 83.0% of *S. aureus* (MRSA) and 83.3% of coagulase-negative *staphylococci*. Penicillin resistance was nearly universal (97.9–100%). Resistance to erythromycin, cotrimoxazole, and gentamicin was high (83–100% in most species. Cephalosporins (ceftriaxone) showed limited utility, with resistance rates exceeding 60% across all isolates (Table III).

Antimicrobials	*S. aureus* (n=47) S / R	CONS (n=6) S / R	*Enterococcus spp.* (n=7) S / R	Str. pyogenes (n=7) S / R
Vancomycin	47 (100) / 0	6 (100) / 0	7 (100) / 0	7 (100) / 0
Chloramphenicol	47 (100) / 0	6 (100) / 0	—	—
Linezolid	38 (80.8) / 9	4 (66.7) / 2	5 (71.4) / 2	6 (85.7) / 1
Doxycycline	35 (74.5) / 12	4 (66.7) / 2	5 (71.4) / 2	7 (100) / 0
Cefoxitin	8 (17.0) / 39	1 (16.7) / 5	0 / 7 (100)	1 (14.3) / 6
Amikacin	26 (55.3) / 21	3 (50.0) / 3	1 (14.3) / 6	2 (28.6) / 5
Clindamycin	22 (46.8) / 25	2 (33.3) / 4	1 (14.3) / 6	—
Amoxyclav	20 (42.5) / 27	3 (50.0) / 3	1 (14.3) / 6	3 (42.9) / 4
Ceftriaxone	18 (38.3) / 29	4 (66.7) / 2	2 (28.6) / 5	4 (57.1) / 3
Gentamicin	13 (27.7) / 34	3 (50.0) / 3	1 (14.3) / 6	3 (42.9) / 4
Ciprofloxacin	12 (25.5) / 35	3 (50.0) / 3	3 (42.9) / 4	3 (42.9) / 4
Erythromycin	8 (17.0) / 39	2 (33.3) / 4	1 (14.3) / 6	0 / 7 (100)
Cotrimoxazole	5 (10.6) / 42	5 (83.3) / 1	1 (14.3) / 6	0 / 7 (100)
Penicillin	1 (2.1) / 46	0 / 6 (100)	0 / 7 (100)	0 / 7 (100)

Amoxy/Clav – Amoxycillin / Clavulanic acid

Table III: Antimicrobial susceptibility pattern of Gram-positive cocci isolates (n=67)

Meropenem and polymyxin B were the most effective agents, with susceptibility rates of 81–94% and 93–100%, respectively, except for *Citrobacter spp.* (0% to polymyxin B). Due to methodological limitations, these values are not reliable for clinical decision-making. Piperacillin/tazobactam demonstrated moderate efficacy (77–93% susceptibility). Doxycycline showed promising activity against *Citrobacter spp*. (84.6%) and *E. coli* (80.0%). Resistance to cephalosporins (cefotaxime, ceftriaxone, cefepime) was near-universal (90–100% in most species). Amikacin (46–67% susceptibility) was more active than gentamicin (8–57%). Fluoroquinolone resistance exceeded 50% in *K. pneumoniae* and *E. coli* (Table IV).

Antimicrobial	*K. pneumoniae* (43)	*E. coli* (30)	*Pseudomonas spp.* (28)	*Proteus spp.* (16)	*Citrobacter spp.* (13)	NFGNB (6)
Meropenem	35 (81.4)	27 (90.0)	25 (89.3)	15 (93.7)	7 (53.8)	3 (50.0)
Pip/Tazo	33 (76.7)	25 (83.3)	26 (92.8)	15 (93.7)	9 (69.2)	4 (66.7)
Polymyxin B	42 (97.7)	30 (100)	26 (92.8)	16 (100)	0 (0.0)	—
Colistin	43 (100)	30 (100)	1 (3.6)	16 (100)	0 (0.0)	6 (100)
Doxycycline	31 (72.1)	24 (80.0)	18 (64.3)	7 (43.7)	11 (84.6)	2 (33.3)
Amikacin	22 (51.1)	20 (66.7)	13 (46.4)	8 (50.0)	6 (46.1)	0 (0.0)
Levofloxacin	20 (46.5)	14 (46.7)	19 (67.8)	9 (56.2)	4 (30.8)	0 (0.0)
Gentamicin	20 (46.5)	17 (56.7)	13 (46.4)	8 (50.0)	1 (7.7)	1 (16.7)
Ciprofloxacin	18 (41.9)	13 (43.3)	13 (46.4)	6 (37.5)	4 (30.8)	0 (0.0)
Amoxy/Clav	16 (37.2)	12 (40.0)	3 (10.7)	4 (25.0)	3 (23.1)	0 (0.0)
Cotrimoxazole	9 (20.9)	14 (46.7)	9 (32.1)	4 (25.0)	2 (15.4)	2 (33.3)
Ceftazidime	9 (20.9)	19 (63.3)	2 (7.1)	2 (12.5)	1 (7.7)	—
Ceftriaxone	13 (30.2)	9 (30.0)	8 (28.6)	7 (43.7)	1 (7.7)	6 (100)
Cefepime	4 (9.3)	6 (20.0)	4 (14.3)	1 (6.2)	1 (7.7)	0 (0.0)
Ampicillin	1 (2.3)	4 (13.3)	6 (21.4)	2 (12.5)	0 (0.0)	1 (16.7)
Cefuroxime	0 (0.0)	1 (3.3)	2 (7.1)	2 (12.5)	0 (0.0)	0 (0.0)

Pip/Tazo – Piperacillin / Tazobactam, Amoxy/Clav – Amoxycillin / Clavulanic acid, Amp/Sulbac – Ampicillin / Sulbactam; Colistin and polymyxin B susceptibility tested by disc diffusion, which is not CLSI-recommended. Results may overestimate resistance; broth microdilution confirmation is required

Table IV: Antimicrobial susceptibility pattern of Gram-negative isolates (n=136)

Overall, 99.5% (202/203) of isolates were MDR, and 94.6% (192/203) were resistant to five or more antimicrobial classes (≥R5). Only one isolate (*E. coli*) was susceptible to all tested classes (R0). MDR rates were 100% for *S. aureus, K. pneumoniae, P. aeruginosa, Proteus spp., Citrobacter spp*., and several others. Notably, 100% of *Acinetobacter* spp., *Citrobacter* spp.,

Enterococcus faecalis, Proteus spp., P. aeruginosa, and Str. pyogenes isolates were in the most severe resistance category (≥R5) (Table V).

Organism	R0	R1	R2	R3	R4	≥R5	Total	MDR
Acinetobacter spp.	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	6 (100.0)	6 (100)	6 (100.0)
Citrobacter spp.	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	13 (100.0)	13 (100)	13 (100.0)
E. coli	1 (3.3)	0 (0.0)	0 (0.0)	0 (0.0)	4 (13.3)	25 (83.3)	30 (100)	29 (96.7)
Enterococcus faecalis	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	7 (100.0)	7 (100)	7 (100.0)
Klebsiella pneumoniae	0 (0.0)	0 (0.0)	1 (2.3)	1 (2.3)	2 (4.7)	39 (90.7)	43 (100)	43 (100.0)
Proteus spp.	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	16 (100.0)	16 (100)	16 (100.0)
Pseudomonas aeruginosa	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	28 (100.0)	28 (100)	28 (100.0)
S. aureus	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (2.1)	46 (97.9)	47 (100)	47 (100.0)
CONS	0 (0.0)	0 (0.0)	0 (0.0)	1 (16.7)	0 (0.0)	5 (83.3)	6 (100)	6 (100.0)
Streptococcus pyogenes	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	7 (100.0)	7 (100)	7 (100.0)
Total	1 (0.5)	0 (0.0)	1 (0.5)	2 (1.0)	7 (3.4)	192 (94.6)	203 (100)	202 (99.5)

Table V: Multiple Drug Resistance Patterns of Bacterial Isolates

DISCUSSION

The present study provides a detailed analysis of the bacteriological profile and antimicrobial resistance patterns among pus/wound isolates from a tertiary care hospital in western Nepal. The findings reveal an alarmingly high burden of multidrug-resistant (MDR) organisms, with nearly all isolates (99.5%) resistant to three or more antibiotic classes and 94.6% resistant to five or more classes. These rates are exceptionally high compared to regional averages and pose a critical threat to effective wound infection management.

The culture positivity rate was 49.5% (203/410), which is lower than the 59–62% rates reported in similar Nepalese studies focusing on pus and wound samples.[11,12] This discrepancy may stem from differences in patient selection criteria, prior antibiotic administration, or variations in sampling techniques. Nevertheless, wound infections in this setting remain predominantly bacterial, and empirical antibiotic therapy should be guided by local susceptibility data. The male predominance (55.1%) and the highest infection frequency in the 21–40 years age group (38.8%) align with previous studies from Nepal and India, likely reflecting higher exposure to trauma, surgery, and healthcare settings in this demographic.[13,14]

Staphylococcus aureus was the most common isolate (23.2%), followed by *Klebsiella pneumoniae* (21.2%), *Escherichia coli* (14.8%), and *Pseudomonas spp*. (13.8%). This distribution is consistent with findings from other tertiary care centers in Nepal and South Asia, where Gram positive cocci and Enterobacteriaceae co dominate wound infections.[11–15] The proportion of *K. pneumoniae* in our study (21.2%) is higher than that reported in some regional studies (10–15%). This difference may reflect local variations in antibiotic pressure, infection control practices, or patient demographics.

The methicillin resistance rate among *S. aureus* (MRSA) was 83.0%, far exceeding the 15–42% range typically reported in low and middle-income countries.[9,10,27] This rate is also notably higher than the 57.9% MRSA prevalence reported in a separate study from a hospital in Chitwan, Nepal.[28] This suggests widespread overuse of β-lactam antibiotics and inadequate infection-control measures. Encouragingly, vancomycin and linezolid retained excellent activity (100% and 80.8% susceptibility, respectively), but their unrestricted use risks further resistance. Chloramphenicol also showed 100% susceptibility, though its clinical utility is limited by toxicity concerns.

Among Gram negative bacilli, resistance to third generation cephalosporins (ceftriaxone, cefotaxime) was nearly universal (70–100% resistance), strongly suggesting widespread ESBL production. This is consistent with regional trends, where ESBL rates among *Enterobacteriaceae* often exceed 50–70%.[29,30] Carbapenems (meropenem) and polymyxin B remained effective against most *K. pneumoniae* and *E. coli* (81–100% susceptibility). However, the detection of colistin resistance in 96.4% of *Pseudomonas spp*. and 100% of *Citrobacter spp.* is extremely concerning, as colistin is a last line agent. Such high colistin resistance is unusual and may be driven by irrational use in vet-

erinary or human medicine.[31] Piperacillin/tazobactam showed moderate activity (77–93% susceptibility), while amikacin was more effective than gentamicin (50–67% vs. 7–57%). Fluoroquinolone resistance exceeded 50% in *K. pneumoniae* and *E. coli*, making these agents unreliable for empirical therapy.

The MDR rate of 99.5% in this study is exceptionally high compared to regional averages of 40–70% reported in similar settings.[6,9,10] For comparison, a 2018 study from Kathmandu reported an MDR rate of 48% among wound isolates, and a 2022 study from eastern Nepal found an MDR rate of 64% among surgical site infections.[12,14] Our finding of 94.6% of isolates resistant to ≥5 antibiotic classes underscore the severity of the resistance crisis in western Nepal. Possible explanations for these extraordinary MDR rates include unregulated antibiotic access, as over-the-counter availability and self-medication are common in Nepal; prolonged hospital stays, with many patients referred from peripheral centers after receiving multiple antibiotic courses; weak antimicrobial stewardship, as no formal antibiotic use guidelines or restriction policies existed at our hospital during the study period; and inadequate infection control, leading to high rates of cross-transmission of resistant clones.

A comparison with regional data reveals striking differences. Our culture positivity rate (49.5%) was lower than the 59–62% range reported in Nepal[11,12] while our MRSA rate (83.0%) was roughly three times higher than the regional average of 15–42%.[9,10,31] The overall MDR rate (99.5%) far exceeded the 40–70% range documented in similar settings[6,9,10] and colistin resistance in Pseudomonas (96.4%) was dramatically higher than the 5–15% reported regionally.[31] The exceptionally high resistance rates (99.5% MDR, 83% MRSA) are likely driven by unregulated over-the-counter antibiotic access, prior empirical therapy before sampling, absence of an antimicrobial stewardship program, prolonged hospital stays, weak infection control infrastructure, and lack of a local antibiogram. Furthermore, veterinary colistin use may contribute to apparent colistin resistance, though disc diffusion overestimation is a major factor.[32,33]

LIMITATIONS

This study has several limitations. It is a single-center study, so findings may not be generalizable to other regions or community settings. Anaerobic bacteria were not cultured, potentially leading to an underestimation of the true microbial diversity of wound infections. A major methodological limitation is that colistin and polymyxin B susceptibility were tested by disc diffusion rather than the gold-standard broth microdilution method. CLSI does not recommend disc diffusion for colistin because it frequently yields false-positive resistance results. Therefore, the high colistin resistance rates reported (96.4% in *Pseudomonas spp*., 100% in *Citrobacter spp*.) are likely overestimates and should not be used to guide clinical therapy without confirmatory BMD testing. Molecular characterization of resistance mechanisms (e.g., mecA, ESBL genes, mcr genes) was not performed, limiting our ability to confirm the genetic basis of observed resistance. Finally, clinical outcome data (e.g., treatment success, mortality) were not collected, so the direct impact of these resistance patterns on patient outcomes remains unknown. Despite these limitations, the study provides a robust baseline to guide empirical therapy and inform future surveillance efforts.

CONCLUSION

This study demonstrates an exceptionally high burden of multidrug resistant bacteria among pus/wound isolates at a tertiary care hospital in western Nepal. *Staphylococcus aureus* and Gram-negative bacilli, particularly *Klebsiella pneumoniae*, predominate, with methicillin resistance in 83.0% of S. aureus (MRSA) and near-universal resistance to third-generation cephalosporins among *Enterobacteriaceae*. Alarmingly, 99.5% of isolates are multidrug resistant, and emerging colistin resistance in *Pseudomonas* and *Citrobacter* species threatens the last line of defense. The limited efficacy of conventional oral antibiotics leaves few options for empirical outpatient therapy. At the same time, the detection of resistance to last resort agents signals a potential crisis in inpatient wound infection management. Routine microbiological surveillance, development of institution specific antibiograms, and implementation of antimicrobial stewardship programs are urgently needed. Strengthening infection prevention and control measures, including hand hygiene, environmental cleaning, and isolation of resistant cases, is equally critical. Without immediate and sustained intervention, the continued spread of multidrug resistant organisms will render routine treatment of wound infections increasingly ineffective.

REFERENCES

1. Ban KA, Minei JP, Laronga C, et al. American College of Surgeons and Surgical Infection Society: surgical site infection guidelines, 2016 update. J Am Coll Surg. 2017;224(1):59-74.

2. Zimlichman E, Henderson D, Tamir O, et al. Health care–associated infections: a meta-analysis of costs and financial impact on the US health care system. JAMA Intern Med. 2013;173(22):2039-46.

3. Text T. Global Guidelines for the Prevention of Surgical Site Infection. World Health Organization. Published online 2018. Accessed March 27, 2026. https://www.ncbi.nlm.nih.gov/books/NBK536404/

4. Bowler PG, Duerden BI, Armstrong DG. Wound microbiology and associated approaches to wound management. Clin Microbiol Rev. 2001;14(2):244-69. doi:10.1128/CMR.14.2.244-269.2001

5. Al-Waili NS, Salom K, Al-Ghamdi AA. Honey for wound healing, ulcers, and burns; data supporting its use in clinical practice. Sc W J. 2011;11:766-87. doi:10.1100/tsw.2011.78

6. WHO. Antimicrobial resistance. Global report on surveillance. World Health Organization. 2014;61(3):12-28. doi:10.1007/s13312-014-0374-3

7. Gelaw A, Gebre SS, Tiruneh M, Fentie M. Antimicrobial susceptibility patterns of bacterial isolates from patients with postoperative surgical site infection, health professionals and environmental samples at a tertiary level hospital, North West Ethiopia. Int J Pharm Sci Rev Res. 2013;3(1):1-9.

8. Amare B, Abdurrahman Z, Moges B, et al. Postoperative surgical site bacterial infections and drug susceptibility patterns at Gondar University Teaching Hospital, Northwest Ethiopia. J Bacteriol Parasitol. 2011;2(8):1000126.

9. Okeke IN, Aboderin OA, Byarugaba DK, Ojo KK, Opintan JA. Growing problem of multidrug-resistant enteric pathogens in Africa. Emerg Infect Dis. 2007;13(11):1640-1646. doi:10.3201/eid1311.070674

10. Ayukekbong JA, Ntemgwa M, Atabe AN. The threat of antimicrobial resistance in developing countries: causes and control strategies. Antimicrob Resist Infect Control. 2017;6(1). doi:10.1186/s13756-017-0208-x

11. Rai S, Yadav UN, Pant ND, et al. Bacteriological Profile and Antimicrobial Susceptibility Patterns of Bacteria Isolated from Pus/Wound Swab Samples from Children Attending a Tertiary Care Hospital in Kathmandu, Nepal. Int J Microbiol. 2017;2017. doi:10.1155/2017/2529085

12. Upreti N, Rayamajhee B, Sherchan SP, Choudhari MK, Banjara MR. Prevalence of methicillin resistant Staphylococcus aureus, multidrug resistant and extended spectrum β-lactamase producing gram negative bacilli causing wound infections at a tertiary care hospital of Nepal. Antimicrob Resist Infect Control. 2018;7(1). doi:10.1186/s13756-018-0408-z

13. Ghimire P, Shrestha BB, Karki OB, Timilsina B, Neupane A, Bhandari A. Postoperative surgical site infections in the department of general surgery of a tertiary care centre: a descriptive cross-sectional study. JNMA. 2022;60(249):439-43

14. Yadav KR, Shrestha K, Shah R, Yadav B, Rijal S, Kumar P. Study of Aerobic Bacteria from Surgical Site Infection and their Antibiotic Susceptibility Pattern at a Tertiary Care Centre in Eastern Nepal. Journal of Nobel Medical College. 2024;13(1):60-65.

15. Shrestha S, Wenju P, Shrestha R, Karmacharya RM. Incidence and risk factors of surgical site infections in Kathmandu university hospital, Kavre, Nepal. KUMJ. 2016;14(54):107-111.

16. Forbes BA, Sahm DF, Weissfeld AS. Diagnostic Microbiology. Mosby St Louis; 2007.

17. Lapage SP. Biochemical tests for identification of medical bacteria. J Clin Pathol. 1976;29(10):958.

18. Weinstein MP, Lewis JS. The clinical and laboratory standards institute subcommittee on antimicrobial susceptibility testing: background, organization, functions, and processes. J Clin Microbiol. 2020;58(3):e01864-19.

19. Soni M, Chaurasia D, Pakhare AP, Kapoor G. Comparative Accuracy Analysis of the In Vitro Activity of Colistin Against Multidrug-Resistant (MDR) Non-Fermenters Using Broth Microdilution, Disk Elution, and Agar Dilution. Cureus. 2025;17(6):e85256. doi:10.7759/CUREUS.85256

20. Bakthavatchalam YD, Veeraraghavan B. Challenges, Issues and Warnings from CLSI and EUCAST Working Group on Polymyxin Susceptibility Testing. J Clin Diagn Res. 2017;11(8):DL03. doi:10.7860/JCDR/2017/27182.10375

21. Amare B, Abdurrahman Z, Moges B, et al. Postoperative surgical site bacterial infections and drug susceptibility patterns at Gondar University Teaching Hospital, Northwest Ethiopia. J Bacteriol Parasitol. 2011;2(8):1000126.

22. Dessie W, Mulugeta G, Fentaw S, Mihret A, Hassen M, Abebe E. Pattern of Bacterial Pathogens and Their Susceptibility Isolated from Surgical Site Infections at Selected Referral Hospitals, Addis Ababa, Ethiopia. Int J Microbiol. 2016;(1):2418902. doi:10.1155/2016/2418902

23. Jain AK, Patidar H, Nayak V, Agrawal R. Prevalence, risk factors and microbial profile of surgical site infection after cesarean section in a tertiary care center in western India. J Pure Appl Microbiol. 2022;16(1):700-707.

24. Wayne PA. Clinical and laboratory standards institute (CLSI). Performance standards for antimicrobial susceptibility testing. informational supplement M100. Clinical and Laboratory Standards Institute. Preprint posted online 2019.

25. Jenkins SG, Schuetz AN. Current concepts in laboratory testing to guide antimicrobial therapy. In: Mayo Clinic Proceedings. Vol 87. Elsevier; 2012:290-308.

26. Magiorakos AP, Srinivasan A, Carey RB, et al. Multidrug-resistant, extensively drug-resistant and pandrug-resistant bacteria: an international expert proposal for interim standard definitions for acquired resistance. Clinical Microbiology and Infection. 2012;18(3):268-281. doi:10.1111/J.1469-0691.2011.03570.X

27. Shrestha LB, Syangtan G, Basnet A, Acharya KP, Chand AB, Pokhrel K. Methicillin-resistant Staphylococcus aureus in Nepal. JNMA J Nepal Med Assoc. 2021;59(237):518. doi:10.31729/JNMA.6251

28. Adhikari R, Kshetri B, Sharma KN, et al. Prevalence of Methicillin-Resistant Staphylococcus aureus Isolated from Clinical Samples at Narayani Samudayik Hospital, Chitwan, Nepal. Tribhuvan University Journal of Microbiology. 2020;7:37-42. doi:10.3126/TUJM.V7I0.33794

29. Shyaula M, Khadka C, Dawadi P, Banjara MR. Systematic Review and Meta-analysis on Extended-Spectrum β-lactamases Producing Klebsiella pneumoniae in Nepal. Microbiol Insights. 2023;16:11786361221145180. doi:10.1177/11786361221145179

30. Shakya P, Shrestha D, Maharjan E, Sharma VK, Paudyal R. ESBL Production Among E. coli and Klebsiella spp. Causing Urinary Tract Infection: A Hospital Based Study. Open Microbiol J. 2017;11(1):23-30. doi:10.2174/1874285801711010023

31. Amatya R, Barakoti A, Rai JR, Subedi A. Colistin Resistance among Human Clinical Isolates from a Tertiary Care Hospital in Nepal. Kathmandu University Medical Journal. 2021;19(3):294-300.

32. Amatya R, Barakoti A, Rai J, Medical ASKU, 2021 undefined. Colistin Resistance among Human Clinical Isolates from a Tertiary Care Hospital in Nepal. nepjol.infoR Amatya, A Barakoti, JR Rai, A SubediKathmandu University Medical Journal, 2021•nepjol.info. Accessed May 22, 2026. https://nepjol.info/index.php/KUMJ/article/view/49701

33. Khanal S, Pharmd A, Trotter AB, et al. Challenges and opportunities in the implementation of an antimicrobial stewardship program in Nepal. cambridge.org. Published online 2023. doi:10.1017/ash.2022.359