Medicine

Research

TRENDS IN BACTERIOLOGICAL PROFILE AND ANTIBIOGRAM OF MEDICAL WARD IN TERTIARY CARE HOSPITAL OF JAMMU AND KASHMIR

Shujat Gul[1], Asifa Ali[2], Irfan Gul[3], Muzzamil Ahmad Andrabi[4], Hardeep Singh[5], Mohammed Abdul Nayeem[6]

[1]Assistant Professor, Department of Medicine, MMIMS&R, Ambala, Haryana, India.
[2]Lecturer, Department of Gynaecology & obstetrics, Government Medical College, Srinagar, Jammu and Kashmir, India.
[3]Assistant Professor, Department of Medicine, Government Medical College, Anantnag, Jammu and Kashmir, India.
[4]DM Nephrology, Scholar IPGMR, Kolkata, West Bengal, India.
[5]Professor, Department of Medicine, Government Medical College, Srinagar, Jammu and Kashmir, India.
[5]Resident Student, Shadan Institute of Medical Science, Hyderabad Telangana, India

Received : 19/10/2022
Received in revised form : 16/11/2022
Accepted : 28/11/2022

Keywords:
Bacteriological Profile, Antibiogram, Medical Ward, Tertiary Care.

Corresponding Author:
Dr. Irfan Gul,
Email:irfanbeigh33@gmail.com
ORCID: 0000-0002-4344-7633

DOI: 10.47009/jamp.2022.4.5.147

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2022; 4 (5); 707-711

Abstract

Background: This study identified bacteriological profile, determined their antibiotic susceptibility patterns, and guide the treatment for patients who were admitted with sepsis. **Materials and Methods:** Observational (cross-sectional) study conducted among adult subjects admitted to General Medical (GM) and High Dependency (HD) wards of SMHS hospital Srinagar with a suspected diagnosis of sepsis. **Result:** Gram-positive infection (53.7%) was more common than gram negative infection (45.1%) and fungal organisms (1.2%). In GM wards among gram positive organisms the most common was Staph aureus 40 (34.2%), Enterococcus 13 (11.1%), CONS 10 (8.5%) and others. Among gram negative organisms, E coli was most common 23 (19.7%), Klebsiella species 11 (9.4%), Pseudomonas 6 (5.1%). In HD wards among gram positive most common organism isolated was Staph (19.9%), CONS 6 (13.3%), Enterococcus 5 (11.1%) & Streptococcus pneumonia 1(2.2%). And gram-negative organisms most common organisms isolated were E Coli 9 (20.0%) Acinetobacter 7 (15.6%), Pseudomonas 4 (8.9%). Out of all Staphylococcus aureus isolates, 59.1% were methicillin resistant (MRSA). Among the gram-positive organisms, maximum number of isolates were resistant to Benzyl penicillin and Ampicillin (76.2%) Amoxicillin clavulanate (72.7%) and Erythromycin (72.7%). Among gram-negative organisms, maximum resistance was with Ampicillin and amoxicillin clavulanate (76.1%) ceftriaxone (65.3%). Tigecycline, colistin, minocycline and polymyxin B showed 100% sensitivity. **Conclusion:** Overall, there was a high prevalence of infection with highly resistant organisms to the most commonly used antibiotics. Hence, timely investigation of infection and regular surveillance of antimicrobial resistance pattern is important to reduce morbidity, mortality and to prevent development of super bugs.

INTRODUCTION

Sepsis is a complication caused by the body's overwhelming and life-threatening response to infections which can lead to tissue damage, organ failure and death. It is difficult to predict, diagnose and treat.[1] Data suggest that sepsis contributes to about 30 % to 50% of all in-hospital deaths in the USA.[2] Gram-negative bacteria are the major pathogen in the patient with sepsis but since 1987 until 2000, Gram-positive bacteria have been the major cause of sepsis with an increasing rate of 26.3%.[3] The Sepsis Occurrence in Acutely ill Patients (SOAP) study reported an almost equal prevalence of Gram-positive and Gram-negative bacterial infections among patients with sepsis,[4] although Gram-positive bacterial infections might now be more common than Gram negative.[5] Sepsis and septic shock are associated with high mortality and substantial morbidity. More than 25–30% of patients with sepsis die from the condition, with

ISSN (O): 2687-5365; ISSN (P): 2753-6556

hospital mortality for septic shock approaching 40–60%.[6] Studies demonstrated that the appropriateness of antibiotic therapy in septic patients can reduce the mortality rate.[7] It shows the importance of antibiotics selection in septic patients, therefore a systematic approach of antibiotic selection is needed by considering the location of infection sources, the common pathogen that develops to sepsis, and the local pattern of antibiotic sensitivity.[8] Empirical use of antibiotics is based on experience with a particular clinical entity and guided by the clinical presentation and local resistance pattern. Diverse studies have confirmed that the prompt institution of empirical antimicrobial therapy active against the causative pathogen is lifesaving in patients with severe sepsis.[9] Inappropriate empiric antibiotic therapy can be detrimental to the health of the patient. It can lead to increased morbidity and mortality and can also increase bacterial resistance. [10]

Every hour delay in treatment of sepsis increases mortality by 7%.[11] A Study from North India done at SKIMS, Srinagar Kashmir from 2012 to 2014, it was found that frequencies of Gram-positive and Gram-negative bacteria were 16.83% with yeast recovered in 5.78% of the specimens. Acinetobacter spp and K. pneumoniae were the most common Gram-negative bacteria and Staph aureus the most common Gram-positive one. High level resistance to all the antimicrobials was seen; with Acinetobacter spp being the most multidrug-resistant GNB isolated in the ICU setting. ESBL production was highest in K. pneumoniae isolates (77.1%). Methicillin resistance was seen in 95% of S. aureus and 91% of coagulase negative staphylococci (CoNS) isolates with vancomycin resistance seen in 46% of enterococcal isolates.[12]

Objective of Study

To Evaluate the Bacteriological Profile and antibiogram of Septicemic patients admitted to General and High dependency medical wards of SMHS hospital Srinagar J&K from 2017 to 2019. So as to guide in most appropriate treatment.

MATERIALS AND METHODS

This was an observational (cross-sectional) study conducted in the General (GM) and High Dependency (HD) medical wards of SMHS hospital Srinagar. All adult subjects (≥18 years) admitted to GM and HD wards of SMHS with a suspected diagnosis of sepsis according to surviving sepsis campaign 2012, were included in this study.

Sepsis is defined according to surviving sepsis campaign (2012) as the presence (probable or documented) of infection together with systemic manifestations of infection. [13]

Sample Collection

Samples of Blood, Urine, Pus and Sputum were collected as appropriate using standard collection practices. [14]

5 to 10 ml of blood was withdrawn from a single site of the patient. Inoculated culture bottles were immediately sent to the microbiology laboratory, [14] depending on choice and financial status of patient conventional or BACT/ALERT cultures were sent.

Samples were preferentially collected before starting antimicrobial therapy and were considered for processing and culture sensitivity testing as soon as possible, based on standard.

Laboratory methods of Microbiology at SMHS Hospital.

Identification of Organism

Preliminary identification of bacterial isolates on solid culture media was done based on colonial morphology, Gram staining characteristics and bench top test of catalase test, oxidase test and coagulase test etc. [15]

Bacterial isolates obtained on culture were confirmed by:

A. Conventional biochemical tests as per standard methods.
B. VITEK-2 compact automated (Biomerieux inc) detects by means of computations involving the software contained in the VITEK 2 ID/AST microbial detection system. [15]

Antibiotic Susceptibility Testing

Antimicrobial susceptibility testing was performed using: Clinical and Laboratory Standards Institute (CLSI) guidelines 2016. [16] Antimicrobial sensitivities were interpreted as per CLSI guidelines 2016 software. [16]

Statistical Methods

The recorded data was compiled and entered in a spreadsheet (Microsoft Excel) and then exported to data editor of SPSS Version 20.0 (SPSS Inc., Chicago, Illinois, USA). Continuous variables were expressed as Mean±S.D. and categorical variables were summarized as frequencies and percentages. Graphically the data was presented by bar and pie diagrams. Student's independent t-test was employed for comparing continuous variables. Chi-square test or Fisher's exact test, whichever appropriate, was applied for comparing categorical variables. A "P-value" of less than 0.05 was considered statistically significant.

RESULTS

In GM wards and HD wards age of patients ranged from 19 to 80 and most of patients were >60 years of age with mean age was 51.7+15.1 years in GM and mean age of 55+16.7 years in HD ward "P-value" (0.28)

Out of Total 153 patients, 76 (49.7%) were male and in GM wards 56 (50.9%) patients were male while in HD wards 20 (46.5%) were male "P-value" (0.62) 1290 samples from 1125 patients were taken out of which 960 samples from 845 patients were sent from

ISSN (O): 2687-5365; ISSN (P): 2753-6556

GM wards (74.4%) and 330 culture samples from 280 patients from HD wards (25.6%).162 samples were positive, 117 (12.18%) from GM wards, and 45 (13.6%) from HD wards.

Table 1 showing organism isolated from cultures in general and high dependency medical wards during our study. In HD wards among gram positive most common organism isolated was Staph aureus 9 (20.0%) {MSSA 2 (4.5%), MRSA 6 (13.6%), VRSA 1 (2.3%)} followed by CONS 6 (13.3%), Enterococcus 5 (11.1%) & Streptococcus pneumonia 1(2.2%). Among gram-negative organisms most common organisms isolated were E Coli 9 (20.0%) followed by Acinetobacter 7 (15.6%), Pseudomonas 4 (8.9%), Klebsiella 3 (6.7%) and Burkholderia 1 (2.2%). In GM wards among gram positive organisms the most common was Staph aureus 40 (34.2%) {(MRSA 23 (19.7%), MSSA 17 (14.5%)} followed by Enterococcus 13 (11.1%), CONS 10 (8.5%) and Streptococcus pneumonia 3 (2.6%). Among gram negative organisms, E coli was most common 23 (19.7%) followed by Klebsiella species 11 (9.4%), Pseudomonas 6 (5.1%), Salmonella typhi 5 (4.3%) and Acinetobacter baumanii 4 (3.4%). Two (1.7%) cultures grew Mucor species.

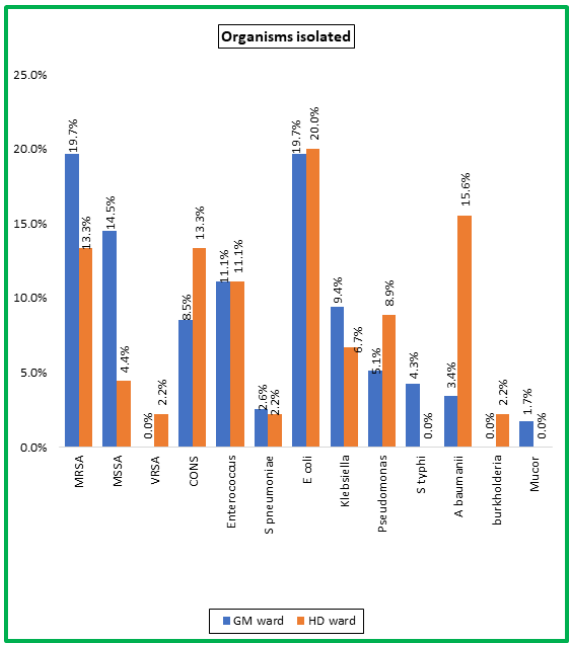

Table 1: Organisms Isolated in study subjects

	GM Wards	HD Wards	Total	Percentage
Gram positive bacteria	66	21	87	53.7%
Gram negative bacteria	49	24	73	45.10%
Fungal	2	0	2	1.2%
Total	117	45	162	100%

Table 2: Sensitivity Pattern of Gram-Positive Bacteria in GM Wards

Drug	MSSA	MRSA	CONS	Enterococcus	S.Pneumonia	Total Senstive %
Cefoxitin	100.0%	0.00%	60.0%	NA	NA	46.0%
Benzyl Penicillin	29.4%	NA	50.0%	15.4%	0.0%	28.6%
Amoxyclav	NA	NA	NA	38.5%	0.0%	31.3%
Ceftriaxone	47.1%	NA	NA	NA	33.3%	45.0%
Amikacin	45.5%	46.2%	60.0%	NA	0.0%	43.8%
Gentamycin	64.7%	80.0%	50.0%	53.8%	100.0%	67.7%
Ciprofloxacin	41.2%	30.0%	50.0%	40.0%	100.0%	46.6%
Tigecycline	100.0%	100.0%	100.0%	100.0%	NA	100.0%
Vancomycin	100.0%	100.0%	100.0%	100.0%	NA	100.0%
Linezolid	100.0%	100.0%	100.0%	100.0%	NA	100.0%
Teicoplanin	100.0%	100.0%	100.0%	NA	NA	100.0%
Daptomycin	100.0%	100.0%	77.8%	NA	NA	95.0%
Rifampicin	82.4%	75.0%	60.0%	NA	NA	74.4%
Clindamycin	60.0%	68.4%	30.0%	NA	NA	56.8%

Range of sensitivity for Gram Positive in GM wards is from 28.6% to 100%. Only 28.6% of total Gram-positive isolates were sensitive to benzyl penicillin. 100% sensitivity was observed for vancomycin, linezolid, teicoplanin and tigecycline followed by daptomycin 95.0%, nitrofurantoin 78.8%, rifampicin 74.4% and gentamycin 67.7%. Range of sensitivity for Gram Positive organisms in HD wards is from 14.3% to 100%. Sensitivity of 14.3% for benzyl penicillin while 100% sensitivity for daptomycin and tigecycline.

Table 3: Sensitivity Pattern of Gram-Positive Bacteria in HD Wards

Drug	Staph aureus	CONS	Enterococcus	S. Pneumonia	Total Sent
Cefoxitin	22.2%	33.3%	NA	NA	26.7%
Benzyl Penicillin	22.2%	16.7%	0.0%	NA	14.3%
Amoxyclav	NA	NA	20.0%	0.0%	16.7%
Ceftriaxone	22.2%	NA	NA	0.0%	20.0%
Amikacin	33.3%	50.0%	NA	100.0%	43.8%
Gentamycin	50.0%	50.0%	50.0%	0.0%	47.6%
Ciprofloxacin	22.2%	66.7%	60.0%	100.0%	47.6%
Tigecycline	100.0%	100.0%	60.0%	NA	100.0%
Vancomycin	88.9%	85.7%	100.0%	NA	90.9%
Linezolid	88.9%	66.7%	100.0%	NA	85.7%

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Teicoplanin	100.0%	83.3%	NA	NA	93.3%
Daptomycin	100.0%	100.0%	NA	NA	100.0%
Rifampicin	55.6%	60.0%	NA	NA	57.1%
Clindamycin	20.0%	16.7%	NA	NA	22.2%

Table 4: Sensitivity Pattern of Gram-Negative Organisms

Drug	E Coli		Klebsiella		Pseudo-monas		Acineto-bacter		Burkholderia		S. Typhi		Total Sensitivity	
	HD	GM	HD	GM	HD	GM	HD	GM	HD	GM	HD	GM	HD	GM
Ampicillin	22.20%	21.70%	NA	NA	0.00%	33.30%	NA	NA	0.00%	NA	NA	40.00%	15.40%	24.10%
Amoxyclav	22.20%	30.40%	0.00%	20.00%	NA	NA	NA	NA	0.00%	NA	NA	NA	15.40%	27.30%
PipTaz	55.60%	65.20%	33.30%	63.60%	50%	66.70%	42.90%	50.00%	0.00%	NA	NA	60.00%	45.80%	68.30%
Ceftriaxone	11.10%	43.50%	0.00%	54.50%	0.00%	33.30%	28.60%	25.00%	0.00%	NA	NA	50.00%	13.60%	43.20%
Cefepime	55.60%	66.70%	50.00%	70.00%	25.00%	75.00%	57.10%	75.00%	0.00%	NA	NA	80%	52.40%	68.60%
Cefoperazone	NA	NA	NA	NA	25.00%	66.70%	28.60%	66.70%	0.00%	NA	NA	NA	27.30%	66.70%
Ceftazidime	33.30%	60.00%	33.30%	66.70%	50.00%	50.00%	28.60%	NA	100%	NA	NA	75.00%	37.50%	62.50%
Imipenem	66.70%	72.20%	66.70%	81.80%	75.00%	83.30%	57.10%	100.00%	100%	NA	NA	100.00%	62.50%	78.90%
Meropenem	55.60%	88.90%	66.70%	100.00%	100.00%	83.30%	28.60%	100.00%	100%	NA	NA	100.00%	65.20%	92.10%
Amikacin	44.40%	60.90%	0.00%	54.50%	50.00%	66.70%	42.90%	50.00%	100%	NA	NA	40.00%	43.50%	61.90%
Gentamycin	55.60%	66.70%	33.30%	54.50%	50.00%	75.00%	50.00%	50.00%	0.00%	NA	NA	60.00%	52.40%	65.60%
Levofloxacin	33.30%	52.20%	33.30%	63.60%	25.00%	66.70%	28.60%	50.00%	0.00%	NA	NA	40.00%	33.30%	59.50%
Ciprofloxacin	44.40%	42.10%	66.70%	55.60%	50.00%	66.70%	57.10%	75.00%	0.00%	NA	NA	60.00%	50.00%	52.60%
Nitrofurantoin	71.40%	88.90%	66.70%	72.70%	NA	NA	NA	NA	0.00%	NA	NA	50.00%	70.00%	82.80%
Aztreonem	33.30%	69.60%	33.30%	70.00%	50.00%	66.70%	37.50%	75.00%	100%	NA	NA	100%	39.10%	69.80%
Tigecycline	NA	NA	NA	NA	NA	NA	85.70%	NA	100%	NA	NA	NA	100.00%	NA
Colistin	NA	NA	NA	NA	100.00%	100.00%	100.00%	100.00%	100%	NA	NA	100%	100.00%	100.00%

Range of sensitivity for GNB in GM wards is from 24.1% to 100%. Sensitivity of 24.1% for ampicillin while 100% sensitivity for colistin followed by meropenem 92.1%, nitrofurantoin 82.8% and imipenem 78.9%. Range of sensitivity for GNB in HD wards is from 13.6% to 100%. Sensitivity of 13.6% for cefuroxime and ceftriaxone while 100% sensitivity for tigecycline and colistin.

DISCUSSION

With limited data on infection causing organism in developing countries this study was undertaken to detect the bacteriological profile and sensitivity pattern of infections in septicemic patients in a tertiary care hospital so as to guide in making choice for empirical treatment. In our study we analyzed the spectrum of sepsis in patients admitted in GM wards and HD wards. A total of 153 patients with culture proven sepsis were included in this study. 110 patients were included from GM wards and 43 patients were included from HD wards. Sepsis was found to be significantly higher in older patients as compared to younger patients both in GM wards and HD wards and was overall more common in women (50.3%) than men (49.7%). Overall gram-positive infection (53.7%) was more common than gram negative infection (45.1%). 1.2% cultures positive for fungal organisms. In GM wards gram positive infection (56.4%) was more common followed by gram negative (41.9%) and fungal (1.7%) infection. In HD wards gram negative isolates (53.3%) were more common than gram positive (46.7%). The most common organism isolated was Staphylococcus aureus in 30.25% cultures followed by E. coli in 19.75%

Out of all Staphylococcus aureus isolates, 59.18% were methicillin resistant (MRSA). This was probably because of indiscriminate and empirical use of broad-spectrum antibiotics before approaching health care.

Resistance in gram positive bacteria ranged from 0% to 76.2% and 0% to 75.6% for gram negative bacteria. Among the gram-positive organisms, maximum number of isolates were resistant to Benzyl penicillin and Ampicillin (76.2%) followed by Amoxycillin clavunate (72.7%) and Erythromycin (72.7%). Tigecycline was the most effective drug with sensitivity of 100% followed by Teicoplanin (98.3%), vancomycin (97.6%), Linezolid (96.3%)

ISSN (O): 2687-5365; ISSN (P): 2753-6556

and Rifampicin (70.2%). Staphylococcus aureus was found highly sensitive to Tigecycline, Teicoplanin, Daptomycin (100%) followed by Vancomycin (97.9%) and Linezolid (97.8%).

Among the gram-negative organisms, maximum resistance was seen with Ampicillin and Amoxicillin clavunate (76.1%) followed by ceftriaxone (65.3%). Tigecycline, colistin, minocycline and polymyxin-B showed 100% sensitivity. Meropenem was found 83.3% sensitive for GNB.

Our results indicated that Tigecycline, Colistin, Minocycline, Polymyxin B, carbapenems, nitrofurantoin, piperacillin and gentamycin have good activity against gram negative bacteria and Tigecycline, Teicoplanin, Daptomycin, Vancomycin and Linezolid are highly active against gram positive organisms, though indiscriminate use should be avoided. Therefore, it is advisable to continuously evaluate the sensitivity-resistance pattern of isolates in each region to use antibiotics rationally.

Among Aminoglycosides, gentamycin was found to be more sensitive in both gram positive (62.7%) and gram negative (60.3%) infections as compared to amikacin (43.8% & 55.1%), probably because of indiscriminate use of amikacin in clinical practice.

Our study shows that Gram positive bacteria were largely resistant to Penicillin's, Cephalosporins, Erythromycin and Fluoroquinolones.

Tigecycline, Vancomycin, Teicoplanin, Linezolid and Daptomycin were the most effective drugs against Gram positive bacterial infections. In addition, Rifampicin and Gentamycin were also effective for Gram positive bacterial infection. Clindamycin and Gentamycin demonstrated good activity against Gram positive bacteria in GM wards as compared to HD wards.

Carbapenems, Polymyxins, Tigecycline and Minocycline were the most effective drugs against gram negative organisms. Nitrofurantoin, Cotrimoxazole, Aztreonam and Gentamycin also showed good efficacy. Piperacillin and Cefepime were also effective although other Penicillin's and Cephalosporins were largely ineffective. Aztreonam and Aminoglycosides showed better efficacy in GM wards as compared to high dependency wards.

Overall, there was a high prevalence of infection with highly resistant organisms to the most commonly used antibiotics. Hence, timely investigation of infection and regular surveillance of antimicrobial resistance pattern is important to reduce morbidity, mortality and to prevent development of super bugs.

CONCLUSION

In Kashmir, there is scant data on isolates causing infections and their antimicrobial susceptibility patterns in sepsis patients. Therefore, this present study was undertaken to detect the bacteriological profile and sensitivity pattern of infections in septicaemic patients in a tertiary care hospital so as to guide in making choice for empirical treatment

Overall, there was a high prevalence of infection with highly resistant organisms to the most commonly used antibiotics. Hence, timely investigation of infection, regular surveillance of antimicrobial resistance pattern and avoiding erratic use of antibiotics is important to reduce morbidity, mortality and to prevent development of super bugs.

REFERENCES

1. Rittirsch D, Flierl MA, Ward PA.et al. Harmful molecular mechanisms in sepsis. Nat Rev Immunol. 2008;8(10):776-87. doi: 10.1038/nri2402.
2. Liu V, Escobar GJ, Greene JD, Soule J, Whippy A, Angus DC, et al. Hospital deaths in patients with sepsis from 2 independent cohorts. JAMA. 2014;312(1):90-2. doi: 10.1001/jama.2014.5804.
3. Martin GS, Mannino DM, Eaton S, Moss M.et al. The epidemiology of sepsis in the United States from 1979 through 2000. N Engl J Med. 2003;348(16):1546-54. doi: 10.1056/NEJMoa022139.
4. Vincent JL, Sakr Y, Sprung CL, Ranieri VM, Reinhart K, Gerlach H, et al. Sepsis in European intensive care units: results of the SOAP study. Crit Care Med. 2006;34(2):344-53. doi: 10.1097/01.ccm.0000194725.48928.3a.
5. Vincent JL, Marshall JC, Namendys-Silva SA, François B, Martin-Loeches I, Lipman J, et al. Assessment of the worldwide burden of critical illness: the intensive care over nations (ICON) audit. Lancet Respir Med. 2014;2(5):380-6. doi: 10.1016/S2213-2600(14)70061-X.
6. ProCESS Investigators, Yealy DM, Kellum JA, Huang DT, Barnato AE, Weissfeld LA, et al. A randomized trial of protocol-based care for early septic shock. N Engl J Med. 2014;370(18):1683-93. doi: 10.1056/NEJMoa1401602.
7. Nathwani D.et al. Major sepsis study confirms back to basics approach. J R Coll Physicians Edinb. 2014;44(2):133. doi: 10.4997/JRCPE.2014.210.
8. Poddar B. Protocol-based care for early septic shock. Natl Med J India. 2014;27(5):267-8.
9. Beshah D, Desta A, Belay G, Abebe T, Gebreselasie S, Sisay Tessema T. Antimicrobial Resistance and Associated Risk Factors of Gram-Negative Bacterial Bloodstream Infections in Tikur Anbessa Specialized Hospital, Addis Ababa. Infect Drug Resist. 2022;15:5043-5059. doi: 10.2147/IDR.S371654.
10. Goldmann DA, Weinstein RA, Wenzel RP, Tablan OC, Duma RJ, Gaynes RP, et al. Strategies to prevent and control the emergence and spread of antimicrobial-resistant microorganisms in hospitals: a challenge to hospital leadership. JAMA. 1996;275(3):234-40.
11. Cecconi M, Evans L, Levy M, Rhodes ,et al. Sepsis and septic shock. Lancet. 2018;392(10141):75-87. doi: 10.1016/S0140-6736(18)30696-2.
12. Bassetti M, Righi E, Carnelutti A.et al. Bloodstream infections in the Intensive Care Unit. Virulence. 2016;7(3):267-79. doi: 10.1080/21505594.2015.1134072.
13. Dellinger RP, Levy MM, Rhodes A, Annane D, Gerlach H, Opal SM, et al. Surviving sepsis campaign: international guidelines for management of severe sepsis and septic shock: 2012. Crit Care Med. 2013;41(2):580-637. doi: 10.1097/CCM.0b013e31827e83af.
14. Charlton CL, Babady E, Ginocchio CC, Hatchette TF, Jerris RC, Li Y, et al. Practical Guidance for Clinical Microbiology Laboratories: Viruses Causing Acute Respiratory Tract Infections. Clin Microbiol Rev. 2018;32(1):e00042-18. doi: 10.1128/CMR.00042-18.
15. Meltzer AS. Medical Laboratory Manual for Tropical Countries. Vol. II. CMAJ. 1986;134(12):1378.
16. Humphries R, Bobenchik AM, Hindler JA,et al. Overview of Changes to the Clinical and Laboratory Standards Institute Performance Standards for Antimicrobial Susceptibility Testing, M100, 31st Edition. J Clin Microbiol. 2021;59(12):e0021321. doi: 10.1128/JCM.00213-21.

ISSN (O): 2687-5365; ISSN (P): 2753-6556