

ORIGINAL ARTICLE - PUBLIC HEALTH

ANTIMICROBIAL RESISTANT PATTERN IN DISTRICT PUBLIC HEALTH LABORATORIES IN TAMILNADU – A RETROSPECTIVE STUDY

*Avudai Selvi Rathinasamy ⁽¹⁾, Amudha A ⁽¹⁾, Sankarmani Ramasamy Mathivanan ⁽¹⁾,
Sudhakar Thangarasu ⁽¹⁾, Srikumaran P ⁽²⁾, M.Anitha Jose ⁽¹⁾, Suresh Jothi kumar S ⁽¹⁾,
Satheesh M ⁽¹⁾, Palani Sampath ⁽¹⁾, Vadivelan P ⁽¹⁾, Somasundharam A ⁽¹⁾, Selvavinayagam T S ⁽¹⁾*

(1) Directorate of Public Health and Preventive Medicine

(2) Government Stanley Medical College, Chennai, Tamilnadu

Abstract

BACKGROUND : The evidence of rising multidrug-resistant organisms requires implementation of effective stewardship programs to control Anti-Microbial Resistance (AMR). But this has to be informed by evidence-based knowledge of local antimicrobial resistance patterns. The aim of this study is to establish the prevalence of common pathogenic microbes including their antimicrobial susceptibility patterns and distribution in Tamilnadu. Globally the emergence of antibiotic resistance and limited availability of treatment options present an increasing challenge for the management of bacterial infections worldwide. Recently the incidence of bacterial infections has risen, and the lack of available treatment options against some Multi-drug-resistant (MDR) strains is alarming. Infections caused by MDR organisms are associated with high morbidity and mortality. Hence, careful adherence to infection control and infection treatment guidelines helps to improve patient outcome and reduce the antibiotic usage.

METHODOLOGY : It is a retrospective secondary data analysis. Data collected from October 2022 to March 2023 from the culture & sensitivity records of various clinical isolates at all District Public Health Laboratories in Tamilnadu performing culture and sensitivity and the data was received in excel sheet in a fixed format.

RESULTS : A total of 400 positive culture were included in this study, out of which E.coli (31%), Staphylococcus.sp (26%), Klebsiella.sp (22%), Pseudomonas.sp (10%), Proteus.sp (5%), Acinetobacter.sp (2%) were isolated. Maximum resistance was observed with commonly used first line antimicrobials such as co-trimoxazole, ampicillin, amoxycylav, fluoroquinolones, and third generation cephalosporins. Least resistant or highly sensitive were amikacin, meropenem, imipenem & cefaperazone sulbactam among the gram-negative bacteria. Macrolides, clindamycin, vancomycin & linezolid were the most sensitive antimicrobials against the gram-positive bacteria. Out of 102 Staphylococcus aureus, 53% were resistant to ceftiofime which implies there were Methicillin-resistant Staphylococcus aureus (MRSA)

CONCLUSION : The microbial culture and sensitivity for a clinical sample are essential before starting antimicrobial therapy. To prevent the rising trend of AMR, rational use of antibiotics, prescribing appropriate antibiotics after conducting culture and sensitivity, Preventive measures and health policies should be implemented to prevent the spread of infection caused by these pathogens.

KEYWORD : Antimicrobial resistance, Bacterial isolates, Antibiotic susceptibility

INTRODUCTION

Antibiotics plays major role in modern medicine. Antibiotic resistance is a worldwide public health problem and it is a threat to mankind.¹ The burden of infectious disease is highest in India and recent reports showed the inappropriate and irrational use of antimicrobial agents against the diseases led to increase in the development of antimicrobial resistance (AMR).² AMR is said to be the primary cause of death for both hospitalized and non-hospitalized patients in both developed and developing nations if proper control and prevention measures are not implemented. An average of 1 lakh deaths are attributed to AMR each year.³

The primary cause of infections in human is bacteria.⁶ As the infection due to Gram negative bacteria is more prevalent than Gram positive bacteria, infection control practices and new antimicrobial development have primarily targeted mainly for gram negative organisms.^{12,13,14,15} The treatment of

any bacterial infection requires the appropriate prescription and administration of antibiotics.^{4,5}

Antimicrobial agents are classified into different groups based on the mechanism of action, which are inhibition of bacterial cell wall synthesis, depolarisation of the cell membrane, inhibition of protein synthesis and inhibition nucleic acid synthesis. With this wide range of mechanism of action we would have controlled the microorganisms and protected the population from morbidity and mortality due to bacterial infection, but due to improper antibiotic usage lead to the drug resistance. The contributing factor for development

Please Scan this QR Code to



View this Article Online

Article ID: 2023:03:04:05

Corresponding Author : Amudha A

e-mail: amudhavincent@gmail.com

of antimicrobial resistance is improper prescription of antimicrobial agents, such as the prescription of broad-spectrum antibiotics during the initial stage of infection and treating the patients with intrinsically resistant antibiotics.¹¹

The WHO-endorsed global action plan on antimicrobial resistance (AMR) states that it is critical to increase global knowledge of AMR through research and monitoring initiatives.^{7,8,9} AMR monitoring is essential and offers a number of advantages such as giving information on the rate of bacterial resistance, assisting in the selection of suitable antibiotics and thereby lowering the AMR rate¹⁰ a decline in the number of hospital admissions and medical expenses, and a drop in the death rate.

This study evaluated the antimicrobial susceptibility pattern of important pathogenic bacteria isolated from District Public Health Laboratories in Tamilnadu. Based on the results of various cultures of microbial specimens, the data can be used as a reference for pathogen identification and selection of empirical antibiotic therapy in our setup.

METHODOLOGY

This is a retrospective study, secondary data analysis. It was carried out at all District Public Health Laboratories, Tamilnadu performing culture and sensitivity. The study duration was six months (October 2022- March 2023). The data were collected retrospectively from records maintained at the laboratory. All infectious patients for whom the antimicrobial susceptibility tests have been performed and the reports found to be positive were included in the study. Any case having negative culture or incomplete data and mixed bacterial growth were excluded. A well-structured data collection form was used to collect the data. Antimicrobial susceptibility reports were analysed for the specimen used, the pathogen identified, sensitivity, and resistance pattern, Kirby-Bauer disc diffusion method was used to test the antimicrobial sensitivity of organisms. The data obtained were analysed using Microsoft excel.

RESULTS

A total of about 1089 clinical samples were cultured, out of which 400 (36.7%) samples showed significant bacterial growth and exhibited resistance to either single or multiple antibiotics. Remaining samples either had no bacterial growth or insignificant bacterial growth.

Out of the total 1089 samples, 678 were female and 411 were male patients, 237 & 163 shown significant growth. (Figure 1) Culture positive were predominant among 21-30 age group.

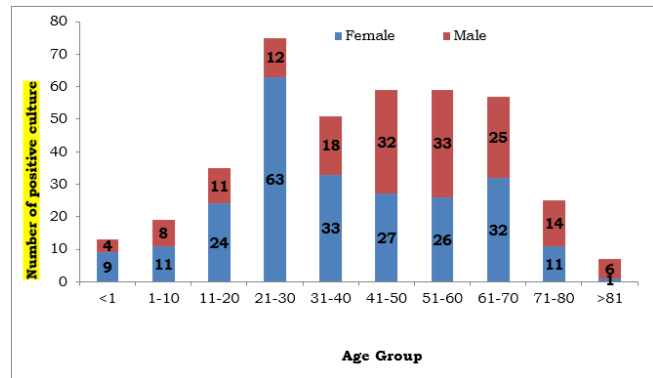


Figure 1: Age & Gender Distribution (n=400)

In this study, the results were discussed for this 400 isolates. The sample distribution of this study was 176 pus, 147 were urine, 44 were sputum, and 17 were blood. Rest other specimens like vaginal, throat, wound and eye swab, catheter tip, ET aspirate, pleural fluid & stool were less than 10. (Figure 2)

There are about 32 District Public Health Laboratories catering all the districts of Tamilnadu, of which data is obtained from those DPHLs performing culture and sensitivity profile. Table 1: shows the district wise distribution of bacterial isolates.

Table 1: District wise isolation of organism

Organism	Chennai	Coimbatore	Dindigul	Erode	Kannur	Kannur	Madurai	Nagapattinam	Pudukottai	Ramanipet	Salem	Sivaganga	Tenkasi	Thuraiyur	Thiruvananthapuram	Thiruvannamalai	Thiruvannamalai	Thiruvannamalai	Thoothukudi	Total	
<i>E. coli</i>	1	7	24	11	13	1	1	2	1	19	1	5	20	8	3	8	122				122
<i>Staphylococcus.sp</i>		9	12	13	1	2	1	12	5	22	12	4	8	1	102						102
<i>Klebsiella.sp</i>	1	4	27	5	15	1	1	5	2	4	14	3	4	2	87						87
<i>Pseudomonas.sp</i>	1	7	1	3	2	2	6	3	9	3	1	3	1	3	39						39
<i>Proteus.sp</i>		4	5					4	1			3		1	2	20					20
<i>Acinetobacter.sp</i>	1		4	2	1			1							9						9
<i>Enterococcus.sp</i>				1				1	1				3		1	1	8				8
<i>Citrobacter.sp</i>				1					1		1				2		4				4
<i>Enterobacter.sp</i>												1			3		4				4
<i>Streptococcus.sp</i>					2								1				3				3
<i>Salmonella.sp</i>											1						1				1
<i>Shigella.sp</i>																			1		1
Total	3	16	76	32	47	2	5	2	49	13	33	59	22	1	22	18	400				400

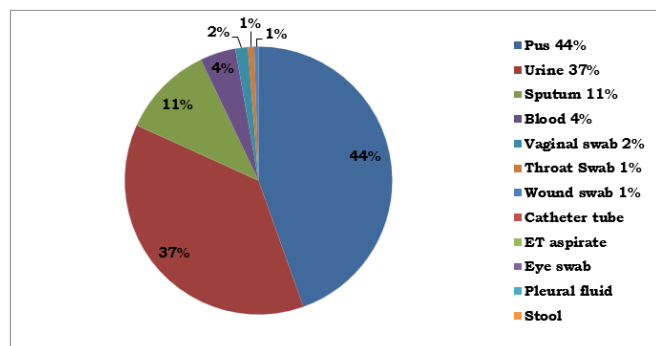


Figure 2: Distribution of Clinical sample

Bacteria isolated from various samples were E.coli, Staphylococcus aureus, Klebsiella, Pseudomonas, Proteus, Acinetobacter, Enterococcus, Citrobacter, Streptococcus, salmonella

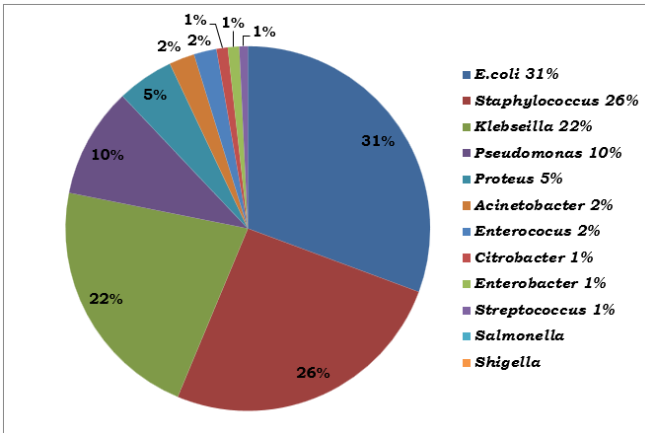


Figure 3: Distribution of Bacterial Isolates

E.coli was the most common organism isolated with a total of 122 (31%) Out of the 122, E. coli were isolated from 85 urine, 31 pus aspirate, 3 from blood. A total of 102 (26%) Staphylococcus aureus were isolated, 65 from pus swabs, 15 from urine, 7 from sputum. Klebsiella isolates were a total of 87 (22%). They were isolated from various samples such as pus/wound swabs (36), urine 25, sputum 24 and blood (2).

About 39 (10%) isolates of Pseudomonas were isolated from wound/pus swabs (20) and urine samples (8), sputum (7). Proteus, (5%) was isolated 13 each from Pus /wound swab and 6 from urine. 9 (2%) Acinetobacter isolates were from pus/wound swabs, sputum and blood. Citrobacter (4) and Enterobacter (4) were isolated from the urine sample, Sputum and pus. (Table 1)

Table 2: Distribution of clinical sample & bacteria isolated

Organism	Blood	Catheter Tip	ET aspirate	Ocular swab	Pleural fluid	Pus	Sputum	Stool	Throat Swab	Urine	Vaginal swab	Wound swab	No of Isolates
E.coli	3	1				31				85	2		122
Staphylococcus				1	1	65	7			15	4	2	102
Klebsiella	2					36	24			25			87
Pseudomonas			1			20	7		1				39
Proteus	1					13							20
Acinetobacter	2					3	3			1			9
Enterococci						4	1			3			8
Citrobacter						3				1			4
Enterobacter							2		1	1			4
Streptococcus						1			1	1			3
Salmonella										1			1
Shigella								1					1
Total	17	1	1	1	1	176	44	1	3	147	6	2	400

This analysis focused mainly on GLASS priority organisms (16) i.e.E.coli, S. aureus, Klebsiella and Acinetobacter. E.coli were tested on commonly used antibiotics, as shown in the stacked Bar graph in Figure 4. We noted that E.coli showed resistant to ampicillin, Cefazolin, Norfloxacin and

3rd generation cephalosporins. E.coli isolates shows resistant to Ceftriaxone (46%) & ceftazidime (56%), it implies that these E.coli can be ESBL producers. 6% and 9% isolates shows resistance to Imipenem and Meropenem which can be a Carbapenemase producers (Superbug). It is suggested that these antibiotics have almost exhausted their utility for this microbe.

Figure 5: details the antimicrobial susceptibility profiles of S. aureus, the listed antibiotic discs used in the laboratory. S. aureus highly underscores its resistance profiles to give a high light for Methicillin-Resistant Staphylococcus aureus (MRSA), Cefoxitin is surrogate marker for MRSA, in this study about 53% of the S. aureus shows resistant and interestingly all isolates shows sensitive to Vancomycin and 13% were resistant to Linezolid.

Klebsiella.sp were Intrinsic resistant to Ampicillin, resistant to Ceftriaxone (47%) & ceftazidime (45%), it can be ESBL producers. Only 17% were carbapenemase producers. (Figure 6), Acinetobacter.sp shows 33% resistant to Ceftazidime and Piperaciline tazobactam. 29% shows resistant to

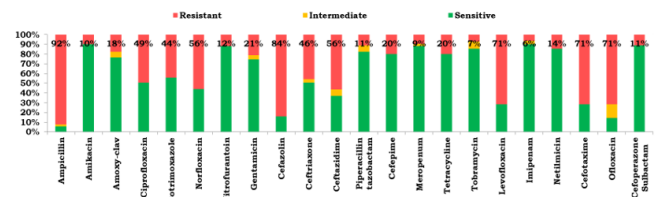


Figure 4: Antibiogram of E.coli: (n= 122)

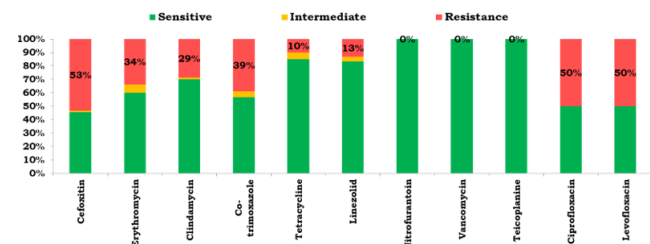


Figure 5: Antibiogram of Staphylococcus aureus. (n=102)

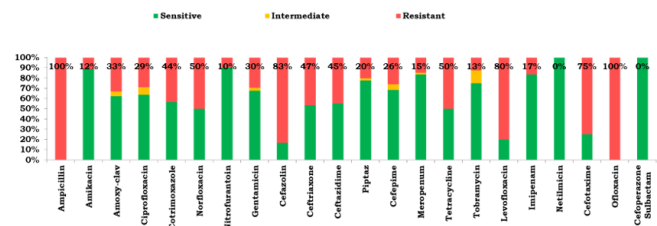


Figure 6: Antibiogram of Klebsiella pneumoniae: (n= 87)

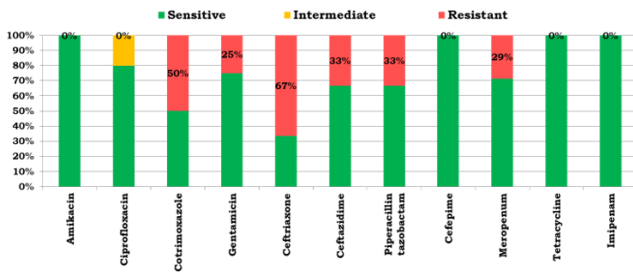


Figure 7: Antibiogram of *Acinetobacter.sp.* (n=9)

DISCUSSION

In the last few decades, antibiotic resistance has become a major problem in the health sector. It is a challenging issue to combat infectious diseases and complications with rising antibiotic resistance. It also results in a rise in morbidity and mortality, in addition to the increased out of pocket expenditure.

In our study, the number of samples that yielded significant bacterial growth is 36.7% which was lesser than other studies conducted in China¹⁷ and other studies conducted in India.^{18,19,20} This probably could be due to samples collected in the primary health centre, which is different from other studies conducted at tertiary care centres and also duration of the study is only 6months. But another study conducted at Gujarat showed 35% significant growth.²⁵

The number of clinical samples was higher among the age group 21-30, which is identical to the study in Uganda²¹ and in the systematic review involving multiple countries.²² Similarly the number of samples was more in female gender which is identical to most studies related to AMR.²³

Among the isolates in our study, the most common pathogen with resistance was observed in *E.coli* followed by *Staphylococcus.sp* and *Klebsiella.sp*. The observation of this study is similar to the findings from studies conducted in New Delhi²⁶ and other systematic reviews.²² There was a slight change in the top three organisms in the study conducted in Tamilnadu were *Klebsiella* was the common pathogen with resistance.²⁴

The maximum number of pathogen was isolated from pus sample followed by urine, sputum and blood and this finding was comparable to the studies conducted in Namakkam²⁴ and Pondicherry. In a tertiary care set up clinical sample such as tracheal aspirate, blood, ET tip would have been more number, but in our set up swab from wound, urine and sputum is higher.

Highest proportion of resistance in *E.coli* was found with Ampicillin followed by fluoroquinolones, and first and third-generation cephalosporins, It is similar to a study in

Europe²⁸ while maximum sensitivity was found with imipenem, tobramycin, meropenem and piperacillin-tazobactam. The finding from our study was comparable with other study conducted at Bangalore²⁷ except for the study conducted in Karnataka¹⁹ where the sensitivity pattern was different from our study with Tobramycin. This may be due to treating any infection with antibiotics, were patient fails to take the full course of antibiotics.

When observing the sensitivity pattern of *S.aureus*, 53% were Methicillin-resistant *S.aureus*. *S.aureus* has better sensitivity to other anti-microbials. The finding from our study is identical to the other studies conducted in Assam.²⁸ Sensitivity of ciprofloxacin is comparatively higher when compared with other antibiotics.

On observing the resistant pattern of *Klebsiella.sp*, the resistance is higher with ampicillin, 1st 2nd and 3rd generation Cephalosporins and Fluoroquinolones, in a study at Gujarat²⁵ the resistant pattern for cephalosporins was higher (71%) and sensitivity was observed with avibactam, Netilmicin, Amikacin and Nitrofurantoin in our study.

Acinetobacter.sp has good sensitivity for amikacin, Imipenem, tetracycline, 4th generation cephalosporins and fluoroquinolones when compared with other drugs. This finding was identical to the findings from other studies except for the sensitivity of Imipenem and amikacin. This difference in sensitivity pattern in our study is because the samples were collected from the primary health centre rather than tertiary care institutions where Health care-associated infections are high mainly due to Multi drug resistant organisms. The proportion of beta-lactamase producers was comparatively lesser probably due to the same reason.

CONCLUSION

In this study drug-resistant organisms were isolated from 400 samples which were mostly from pus samples. Gram-negative organisms like *E.coli*, *Klebsiella.sp*, and gram-positive *Staphylococcus aureus* were isolated in higher numbers. All the pathogens were found to be resistant to more than 2-3 antibiotics. Even though the study is carried out at the primary health centre level the resistant pattern is quite alarming. This may be due to the overuse of antibiotics and extensive usage of antibiotics in veterinary medicine usage. In our study most of the isolates show resistance to ampicillin, which is the preliminary antibiotic prescribed at every Primary Health Centre in our community, hence it is the right time to check antibiogram at the community level and to implement escalation strategies and improve antibiotic prescription to treat infections and protect the community from unnecessary an-

tibiotic usage and combat antibiotic resistance.

To prevent the rising trend of AMR, rational use of antibiotics, prescribing appropriate antibiotics after conducting culture and sensitivity, Preventive measures, and health policies should be implemented to prevent the spread of infection caused by these pathogens.

REFERENCE

1. World Health Organisation (WHO), WAAW: World Antibiotic Awareness Week, 2018, available from: <https://www.who.int/Campaigns/world-antibiotic-awareness-week/world-Antibioticawareness-week-2018>.
2. Travasso C. India draws a red line under antibiotic misuse. *BMJ* 2016;352:i1202. DOI: 10.1136/bmj.i1202.
3. Fahrenkamp-Uppenbrink J. Countering antibiotic resistance. *Science*.2015;347(6226):1109–1111.
4. Maraki S, Mantadakis E, Mavromanolaki VE, Kofteridis DP, Samonis G. A 5-year surveillance study on antimicrobial resistance of *Acinetobacter baumannii* clinical isolates from a tertiary Greek hospital. *J Infect Chemother*. 2016;48(3):190–198. doi:10.3947/ic.2016.48.3.190
5. Aslam B. Antibiotic resistance: a rundown of a global crisis. *Infect Drug Resist*. 2018;11:1645–1658. doi:10.2147/IDR.S173867.
6. Maleki DT, Ghalavand Z, Laabei M, et al. Molecular analysis of accessory gene regulator functionality and virulence genes in *Staphylococcus aureus* derived from pediatric wound infections. *Infect Genet Evol*.2019;73:255–260. doi:10.1016/j.meegid.2019.05.013
7. Tsutsui A, Suzuki S. Japan nosocomial infections surveillance (JANIS): a model of sustainable national antimicrobial resistance surveillance based on hospital diagnostic microbiology laboratories. *BMC Health Serv Res*. 2018;18(1):799. doi:10.1186/s12913-018-3604-x
8. Organization WH. Global action plan on antimicrobial resistance. Available from: <https://www.who.int/antimicrobial-resistance/globalaction-plan/en/>
9. Organization WH. Global antimicrobial resistance surveillance system (GLASS) report: early implementation 2017–2018. Available from: <http://www.who.int/drugresistance/surveillance/GLASSmeeting/en/>
10. Li L, Dai J-X, Xu L, et al. Antimicrobial resistance and pathogen distribution in hospitalized burn patients: a multi-center study in Southeast China. *Medicine*. 2018;97:34.
11. Yu VL (2011) Guidelines for hospital-acquired pneumonia and health-care-associated pneumonia: a vulnerability, a pitfall, and a fatal flaw. *Lancet Infect Dis* 11: 248–252.
12. Prabaker K, Weinstein RA. Trends in antimicrobial resistance in intensive care units in the United States. *Curr Opin Crit Care* 2011;17(5):472–479. DOI: 10.1097/MCC.0b013e32834a4b03.
13. de Kraker ME, Davey PG, Grundmann H, BURDEN study group. Mortality and hospital stay associated with resistant *Staphylococcus aureus* and *Escherichia coli* bacteraemia: estimating the burden of antibiotic resistance in Europe. *PLoS Med* 2011;8(10):e1001104. DOI: 10.1371/journal.pmed.1001104.
14. Sader HS, Flamm RK, Jones RN. Tigecycline activity tested against antimicrobial resistant surveillance subsets of clinical bacteria collected worldwide (2011). *Diagn Microbiol Infect Dis* 2013;76(2): 217–221. DOI: 10.1016/j.diagmicrobio.2013.02.009.
15. Bouchillon SK, Badal RE, Hoban DJ, Hawser SP. Antimicrobial susceptibility of inpatient urinary tract isolates of gram-negative bacilli in the United States: results from the study for monitoring antimicrobial resistance trends (SMART) program: 2009–2011. *Clin Ther* 2013;35(6):872–877. DOI: 10.1016/j.clinthera.2013.03.022.
16. Veeraraghavan B, Walia K. Antimicrobial susceptibility profile & resistance mechanisms of Global Antimicrobial Resistance Surveillance System (GLASS) priority pathogens from India. *Indian J Med Res*. 2019 Feb;149(2):87–96. doi: 10.4103/ijmr.IJMR_214_18. Erratum in: *Indian J Med Res*. 2019 Mar;149(3):432. PMID: 31219073; PMCID: PMC6563747.
17. Qu J, Huang Y, Lv X. Crisis of Antimicrobial Resistance in China: Now and the Future. *Front Microbiol*. 2019 Sep 27;10:2240. doi: 10.3389/fmicb.2019.02240. PMID: 31611863; PMCID: PMC6777638.
18. Savanur SS, Gururaj H. Study of Antibiotic Sensitivity and

Resistance Pattern of Bacterial Isolates in Intensive Care Unit Setup of a Tertiary Care Hospital. *Indian J Crit Care Med* 2019;23(12):547-555.

19. Chakraverti TK, Tripathi PC. Pattern of antibiotic susceptibility of common isolates in ICU of a tertiary care hospital: 2 years study. *Int J Clin Biomed Res* 2015;1(2):79-86.

20. Mogasale, V.V., Saldanha, P., Pai, V. et al. A descriptive analysis of antimicrobial resistance patterns of WHO priority pathogens isolated in children from a tertiary care hospital in India. *Sci Rep* 11, 5116 (2021). <https://doi.org/10.1038/s41598-021-84293-8>.

21. Mugerwa I, Nabadda SN, Midega J, Guma C, Kalyesubula S, Muwonge A. Antimicrobial Resistance Situational Analysis 2019-2020: Design and Performance for Human Health Surveillance in Uganda. *Trop Med Infect Dis*. 2021 Sep 29;6(4):178. doi: 10.3390/tropicalmed6040178. PMID: 34698282; PMCID: PMC8544686.

22. Tadesse, B.T., Ashley, E.A., Ongarello, S. et al. Antimicrobial resistance in Africa: a systematic review. *BMC Infect Dis* 17, 616 (2017). <https://doi.org/10.1186/s12879-017-2713-1>.

23. Saravanan R, Raveendaran V. Antimicrobial resistance pattern in a tertiary care hospital: An observational study. *J Basic Clin Pharma* 2013;4:56-63.

24. Rangapriya m*, alina lorance, anisha merin varghese, arshi hanif, aruna s study on antimicrobial resistance pattern in a tertiary care hospital – an Observational retrospective study, *Asian J Pharm Clin Res*, Vol 14, Issue 11, 2021, 69-75

25. Shethia, F. K., Suryawanshi, M. V., Anand, I. S. (2021). Prevalence of Antimicrobial Resistance Pattern in Tertiary Care Hospital: A Prospective Observational Study. *International Journal for Pharmaceutical Research Scholars*, 10(2);01 – 17

26. Kaur, N., Sharma, S., Malhotra, S., Madan, P., & Hans, C. (2014). Urinary tract infection: aetiology and antimicrobial resistance pattern in infants from a tertiary care hospital in northern India. *Journal of clinical and diagnostic research: JCDR*, 8(10), DC01.

27. Asima Banu et al., Extraintestinal infections due to E.coli: An emerging issue. *Journal of Clinical and Diagnostic Research*. 2011;June;5(3): 486-490

28. Russo TA, Johnson JR. Medical and economic impact of extraintestinal infections due to Escherichia coli: focus on an increasingly important endemic problem. *Microbes Infect* 2003;5:449-456.

28. Das PP, Nath R, Choudhury G, Sarmah A, Bora P. Trends in Antimicrobial Resistance in a Tertiary Care Hospital of Assam, India. *J Pure Appl Microbiol*. 2023;17(3):1591-1604. doi: 10.22207/JPAM.17.3.20