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RESEARCH ARTICLE
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BACTERIOLOGICAL PROFILE OF WOUND INFECTIONS AND THEIR ANTIMICROBIAL SUSCEPTIBILITY PATTERN FROM CLINICAL SAMPLES IN A TERTIARY CARE HOSPITAL

Tamma Saisashank Reddy[1], Dr. M. Shabnum[2*]

[1.]3rd MBBS Student, Katuri Medical College & Hospital, Guntur
[2 *]Professor, Department of Microbiology, Katuri Medical College & Hospital, Guntur

***Corresponding Author:** M. Shabnum
[*]Professor, Department of Microbiology, Katuri Medical College & Hospital, Guntur

Abstract:
Introduction: Wound infections are frequently attributed to several bacterial pathogens like Staphylococcus aureus, Pseudomonas aeruginosa and members of Enterobacteriaceae family. With emergence of MRSA, ESBL producers and Carbapenem Resistance Producers, antibiotics have become indispensable in treating the infections making surveillance of changing prevalent microorganisms along with their antibiotic susceptibility patterns a need of the hour.
Objective: This study was aimed to isolate bacteria from wound infections and detect their antibiotic susceptibility pattern.
Methodology: A total of 100 samples from wounds were processed and Antibiotic susceptibility pattern was tested by Kirby Bauer Disc Diffusion method. ESBL production was tested by a combined disc diffusion assay, Carbapenem Resistance was tested using Meropenem discs and MRSA were detected using Cefoxitin disc.
Results: Culture positivity was 86% with predominant isolate being Pseudomonas aeruginosa (23.4%) followed by Staphylococcus aureus (21.2%) and Klebsiella species (17%). ESBL producers were 23.40% of the isolates, 51.06% isolates being Carbapenem Resistant and 19.19% being MRSA.
Conclusion: Regular surveillance, strict implementation of infection control practices and antibiotic policy added with root cause analysis of wound infections can reduce the burden of antibiotic resistance.

Keywords: Wound Infections, Antibiotic Resistance, Extended Spectrum Beta Lactamase (ESBL), Carbapenem Resistance, MRSA

INTRODUCTION

The skin represents a defence barrier against the colonization of pathogens. The disruption of the normal anatomical structure by surgical operations or by chemical, physical, mechanical and thermal events, with an alteration of skin functions, results in a wound.[1] Skin when exposed to injuries, scratches and in contact with the external environment, there is loss of integrity and the added moisture acts as a nutritive environment for the microorganisms to colonize and proliferate delaying the healing process.[2, 3, 4, 5]. Skin and soft tissue infections contribute to higher rates of morbidity and mortality affecting the quality of life.[2, 6]

Wounds are divided into two categories: Acute and Chronic. Acute wounds like cuts, burns, abrasions and surgical wounds heal through the regular phases of wound repair.[6] Chronic wounds can

be exacerbated by predisposing factors like advancing age, obesity, metabolic disorders like Diabetes mellitus, immunosuppression, poor nutrition. Leg & foot ulcers, pressure sores as a consequence of impaired arterial supply or venous drainage are hypoxic, leading to necrosis and cell death, making it ideal for the wound microflora to proliferate.[5]

In the initial stage of the infection process, most common causative organisms involved are Staphylococcus aureus, Streptococcus pyogenes. When chronic wound is developed, gram negative organisms like Escherichia coli, Pseudomonas aeruginosa, Acinetobacter species, Proteus species play a role.[2, 7, 8] The risk of surgical wound infection is 1-5% of post operative wound infections in case of clean surgeries and 27% risk in dirty procedures and can have a polymicrobial etiology.[5, 9] Fungi like Candida species, Aspergillus fumigatus also play a role due to their widespread nature and even as part of normal flora.[10]

The polymicrobial wound infections will add up the chances of not only genotypic resistance, but also phenotypic resistance or antimicrobial tolerance.[11, 12]

There is a need for careful and up to date monitoring of the changing trends of the pathogens and the identification of antimicrobials to which they are susceptible for initiating effective pathogen specific treatment and combating antimicrobial resistance at the same time reducing the patient morbidity and mortality.[12] The study was aimed to isolate bacteria from wound infections and detect their antibiotic susceptibility pattern.

METHODOLOGY

Ethical Consideration: Institutional Ethical Clearance was obtained prior to the study.
Source of Clinical Samples: Clinical samples from wound infections (Swab, Pus, Abscess fluid, Tissue) received in the Microbiology laboratory for culture and sensitivity testing
Study Design: Prospective study over a period of 2 months.
Sample Size: 100 samples
Inclusion Criteria: Samples from wound infection
Exclusion Criteria: Samples not from wound infection

Method:

Isolation of bacteria from wound infections:

- Clinical samples from wound infections received by the Microbiology laboratory for culture and sensitivity testing were inoculated on Nutrient agar, Blood agar and Mac Conkey agar. The culture plates were incubated at 37°C for 24–48 hours. Once the growth is obtained, bacteria were isolated based on morphology and gram stain

Detection of the antibiotic susceptibility pattern:

- Identification and Antibiotic susceptibility tests were performed by Kirby Bauer Disc Diffusion Method based on Clinical and Laboratory Standards Institute (CLSI) guidelines.
- The following antibiotics were tested for Antibiotic Susceptibility Testing for Gram Negative Bacilli
  - Enterobacteriaceae: Ceftazidime, Cefoxitin, Ciprofloxacin, Gentamicin, Amikacin, Piperacillin / Tazobactam, Imipenem, Meropenem, Cotrimoxazole,
  - Non – Fermenters: Ceftazidime, Cefoxitin, Ciprofloxacin, Gentamicin, Amikacin, Piperacillin / Tazobactam, Imipenem, Meropenem, Tobramycin, Aztreonam
- The following antibiotics were tested for Antibiotic Susceptibility Testing for Gram Positive Cocci:
  - Penicillin, Cefoxitin, Ceftriaxone, Ciprofloxacin, Clindamycin, Erythromycin, Gentamicin, Amikacin, Cotrimoxazole, Linezolid

Detection of ESBL production:

- Isolates resistant to Ceftazidime (inhibition zone <17mm) by Disc Diffusion method were considered as potential ESBL producers and tested further

- The Ceftazidime resistant strains were tested for ESBL production by a combined disc diffusion assay using Ceftazidime disc and Ceftazidime / Clavulanic acid disc
- The zone diameter difference of >5 mm around the Ceftazidime / Clavulanic acid disc in comparison to the zone size of the Ceftazidime disc, was confirmed as ESBL producer.

Detection of Carbapenem Resistance:

- Isolates resistant to Imipenem and Meropenem (inhibition zone <19mm) by Disc Diffusion method were considered Carbapenem Resistant Strains

Detection of MRSA:

- Isolates resistant to cefoxitin with zone of inhibition <19mm by Disc Diffusion Method were reported as MRSA

RESULTS

Fig No 1. Culture Positivity

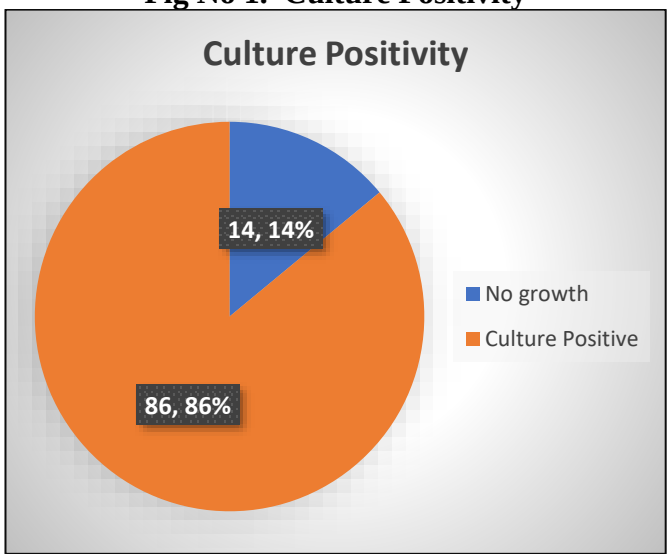


Table No. 1: Sample wise organism isolation

Samples with	Number (%)
Single organism isolated	77 (89.53%)
Polymicrobial isolated	9 (10.46%)
Total	86 (100%)

Fig No. 2: Gender Distribution of Culture Positive Samples

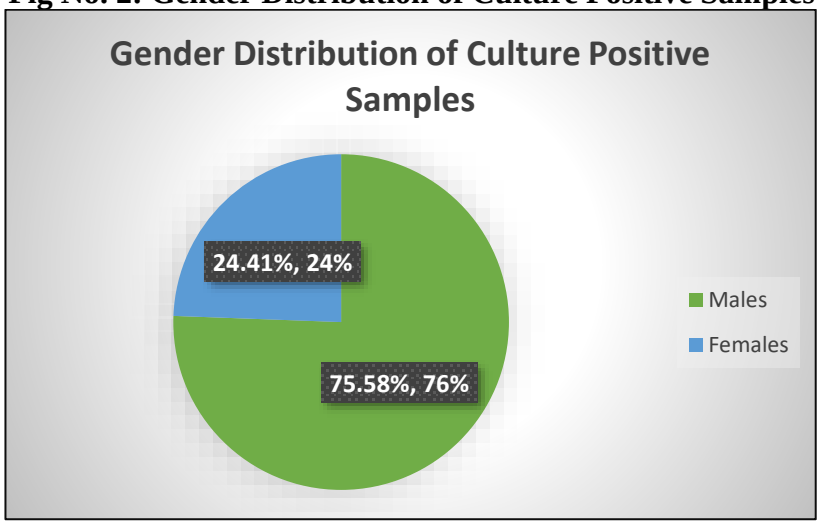


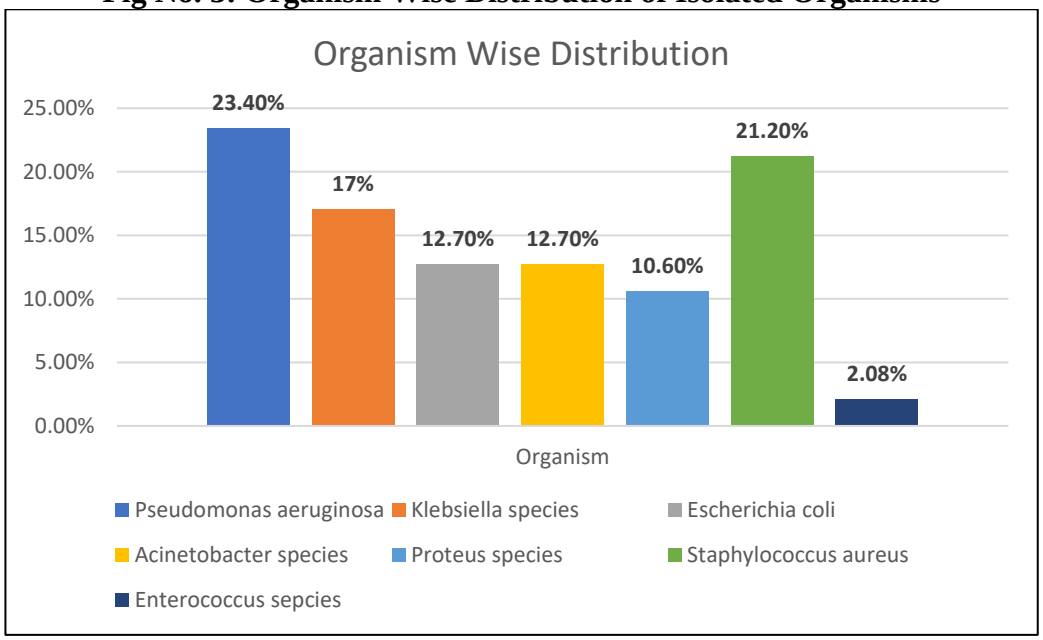
Table No. 2: Age Distribution of Culture Positive Samples

Age (in years) Distribution	Number (%)
<1 – 20	8 (9.30%)
21 – 40	24 (27.90%)
41 – 60	28 (32.55%)
61 – 80	24 (27.90%)
81 - 100	2 (2.30%)
Total	86 (100%)

Table No. 3: Department Wise Distribution of Samples

Department	Number (%)
General Surgery	50 (50%)
ENT	24 (24%)
Orthopedics	6 (6%)
Urology	6 (6%)
ICU / Stepdown	6 (6%)
Dermatology	2 (2%)
General medicine	2 (2%)
Cardiothoracic and vascular surgery (CTVS)	2 (2%)
Pediatrics	2 (2%)
Total	100 (100%)

Fig No. 3: Organism Wise Distribution of Isolated Organisms



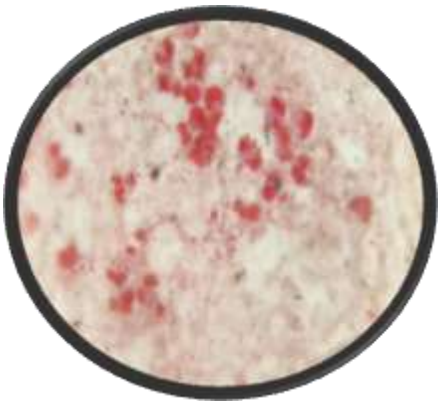


Fig 4: Pus cells with Gram Negative Bacilli

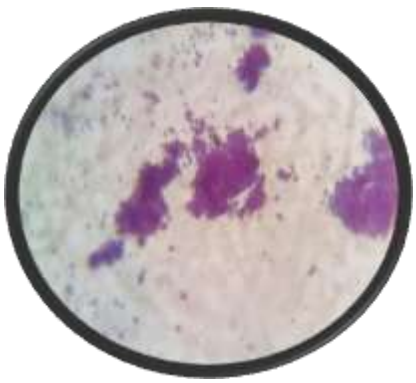


Fig 5: Gram Positive Cocci

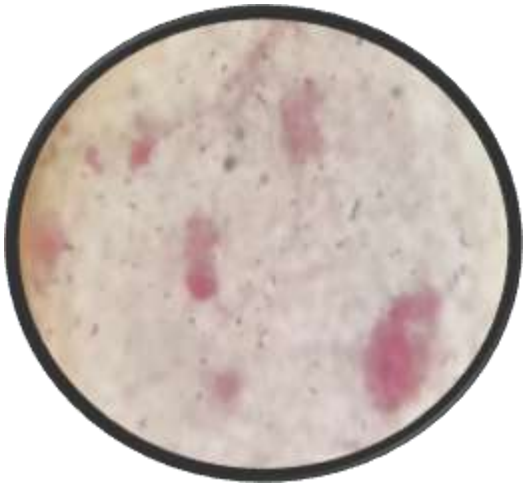


Fig 6: Pus cells with Gram Negative Bacilli and Gram Positive Cocci

Fig 7: Beta Hemolytic colonies on Blood agar

Fig 8: Lactose Fermenting Colonies (Mucoid - *Klebsiella pneumoniae*)

Fig 9: Lactose Fermenting Colonies (*Escherichia coli)*

Fig 10: Green colored colonies on Nutrient Agar (*Pseudomonas aeruginosa*)

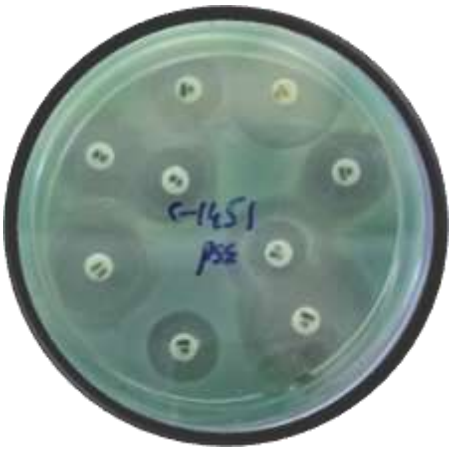


Fig 11: Antibiotic Susceptibility Testing

Table No. 4: Antibiotic Susceptibility Pattern of Gram-Negative Isolates

Antibiotics	Escherichia coli (n=12)	Klebsiella species (n=16)	Pseudomonas aeruginosa (n=22)	Acinetobacter species (n=12)	Proteus vulgaris (n=10)
Ceftazidime	2 (16.6%)	10 (62.5%)	10 (45.4%)	4 (33.3%)	4 (40%)
Cefoxitin	0 (0%)	2 (12.5%)	0 (0%)	2 (16.6%)	0 (0%)
Ciprofloxacin	6 (50%)	12 (75%)	14 (63.6%)	8 (66.6%)	10 (100%)
Gentamicin	6 (50%)	6 (37.5%)	8 (36.3%)	2 (16.6%)	6 (60%)
Amikacin	4 (33.33%)	2 (12.5%)	6 (27.2%)	2 (16.6%)	4 (40%)
Piperacillin / Tazobactam	4 (33.33%)	4 (25%)	18 (81.8%)	10 (83.3%)	8 (80%)
Imipenem	2 (16.6%)	4 (25%)	10 (45.4%)	8 (66.6%)	2 (20%)
Meropenem	4 (33.33%)	0 (0%)	2 (9.09%)	4 (33.33%)	4 (40%)
Cotrimoxazole	6 (50%)	8 (50%)	2 (9.09%)	6 (50%)	10 (100%)
Tobramycin	NA	NA	16 (72.7%)	NA	NA
Aztreonam	NA	NA	6 (27.2%)	NA	NA

Table No. 5: Antibiotic Susceptibility Pattern of Gram-Positive Isolates

Antibiotics	Staphylococcus aureus (n=20)	Enterococcus species (n=2)
Penicillin	2 (10%)	0 (0%)
Cefoxitin	2 (10%)	NA
Ciprofloxacin	8 (40%)	0 (0%)
Cotrimoxazole	12 (60%)	NA
Gentamicin	8 (40%)	NA
High level gentamicin	NA	0 (0%)
Amikacin	4 (20%)	0 (0%)
Erythromycin	0 (0%)	NA
Clindamycin	8 (40%)	NA
Linezolid	14 (70%)	NA
Teicoplanin	NA	0 (0%)
Vancomycin	NA	2 (100%)

Fig No 12: ESBL producers, Carbapenem Resistant and MRSA isolates Distribution among isolated organisms

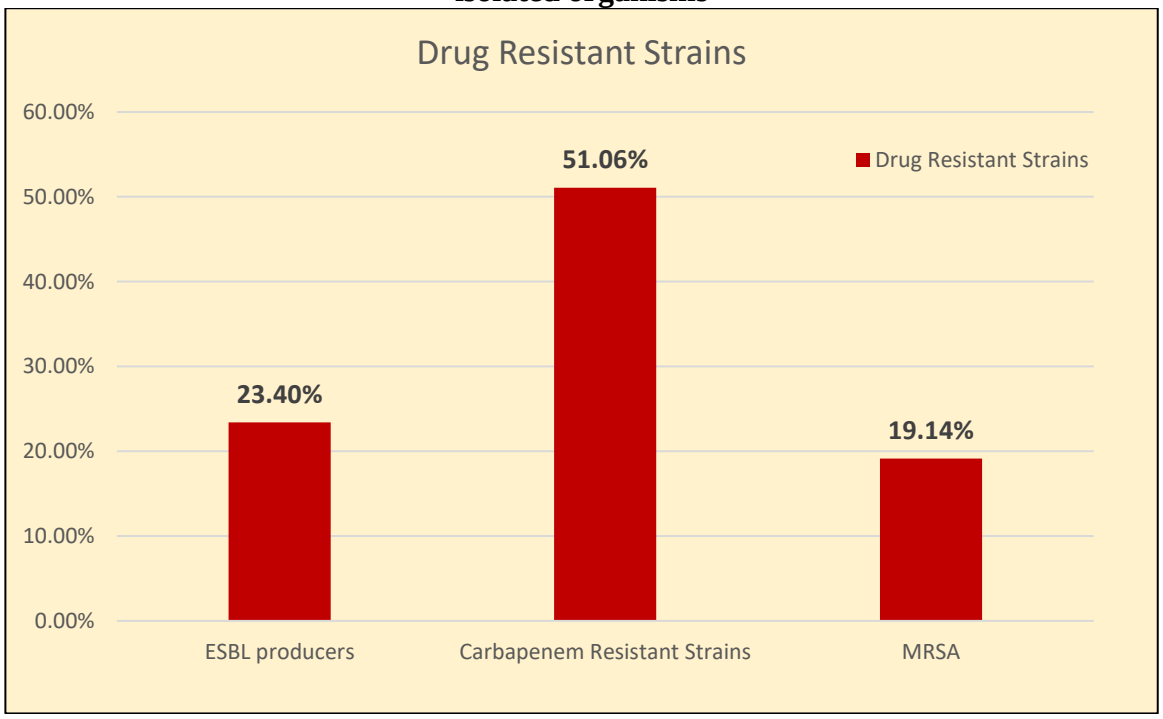
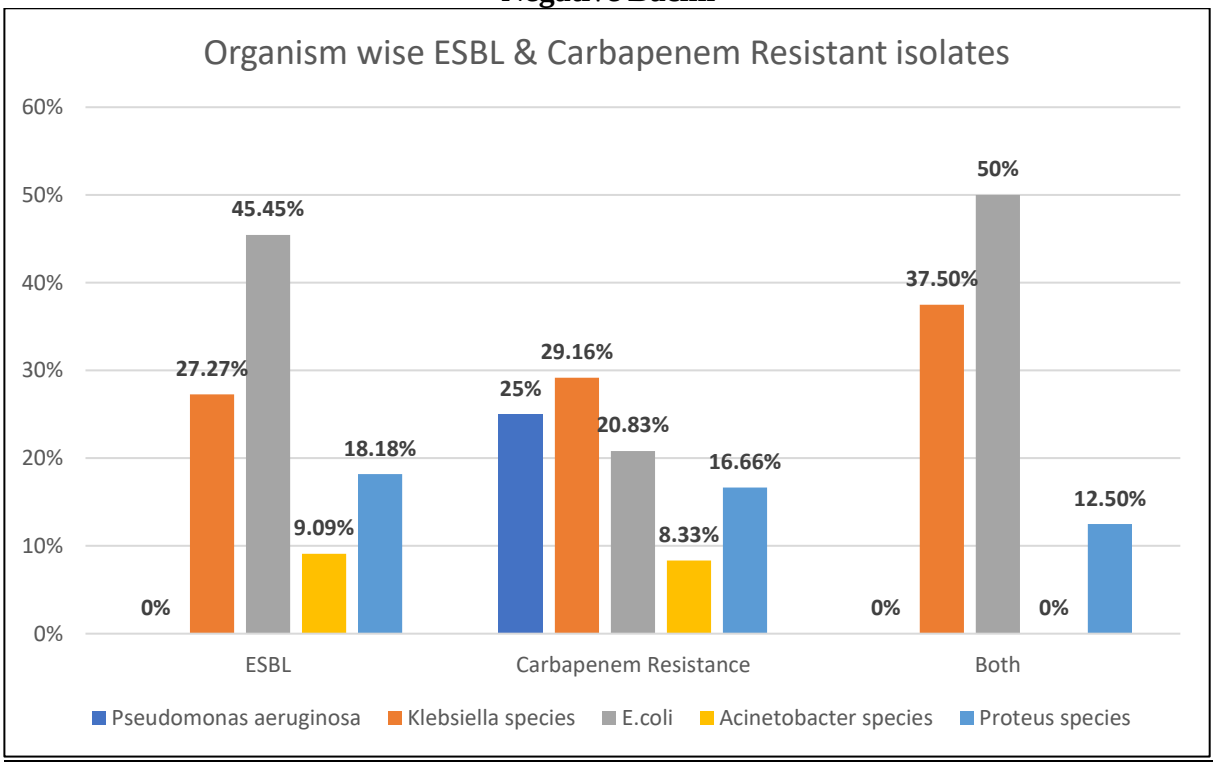


Fig No 13: Organism wise ESBL & Carbapenem Resistant isolates Distribution among Gram Negative Bacilli



DISCUSSION

The present study was carried out in the Department of Microbiology over a period of 2 months. Among the 100 samples received, 86 samples showed culture positivity (86%) and 14 samples showed no growth (14%). Similar culture positive rates were reported by Abdu et al[13] (83.03%), Aynalem Mohammed et al[14] (83.9%)

Among the 86 culture positive samples, 77 samples (89.53%) isolated single organism and 9 (10.46%) samples isolated more than 1 organism with a total of 94 isolates. Similar results of isolation were reported by Puca et al[15] as single organism (75.3%) and polymicrobial infection as 24.7%. Similar polymicrobial growth was observed by Aynalem Mohammed et al[14] (18.3%).

There was a male preponderance (75.59%) among the culture positive samples similar to Abdu et al (56.15%). Of the 86 culture positive samples, maximum was among the age group 41 – 60 years (32.55%), followed by 21 – 40 & 61 – 80 years (27.90%). This might be supported by the fact that males are more predisposed to trauma due to their occupations like riders, farming, industry supported by the most isolated organisms were from ages 41 – 60 years which is the working population as also mentioned by Abdu et al[13].

Various samples were received like pus, discharge from wound infection, debrided tissue from a wound infection, pus from abscess, cyst, ulcer, drain site discharge, swab from cellulitis Maximum samples received from the Department of General Surgery (50%), followed ENT (24%), Orthopedics, Urology, ICU & Stepdown (6%).

Among the 94 isolates, among the Gram-negative bacilli, Pseudomonas aeruginosa was most commonly isolated organism (23.4%) followed by Klebsiella species (17%) and Escherichia coli & Acinetobacter species (12.7%). Among the Gram-positive isolates maximum isolates were Staphylococcus aureus (21.2%). M. M. Alam et al[16] also reported Pseudomonas aeruginosa as the most commonly isolated organism among Gram negative bacilli (27.1%), followed by Escherichia coli (26.2%) and Klebsiella (14.9%) similar to our study, and Staphylococcus aureus as the most commonly isolated organism among Gram positive organisms (75.9%) (35.99% among all isolates) similar to our study. Similar findings were reported by Abdu et al[26] with Pseudomonas aeruginosa being the most predominant organisms (17.07%), followed by Escherichia coli (11.58%) and

Klebsiella pneumoniae (10.37%). Ahmed A. Al – Naqshbandi et al[17] also reported gram negative isolates as the predominant organisms isolated from wounds similar to our study. Ahmed A. Al – Naqshbandi et al[17] reported Staphylococcus aureus as the most commonly isolated Gram - positive organism (23.94%) similar to our study.

On the contrary, M. E. Abalaka et al[18] reported Staphylococcus aureus as the most commonly isolated organism (35%) followed by Pseudomonas aeruginosa (26.7%). On the contrary M. E. Abalaka et al[18] reported Escherichia coli as least occurring organism (3.3%) while our study reports Enterococcus species as the least occurring organism (2.08%). The Extracellular adherence protein (Eap) of Staphylococcus aureus plays a key role in delayed wound healing blocking angiogenesis and slowing the inflammatory response as reported by Abalaka et al[18].

In this study, Escherichia coli showed maximum susceptibility to Ciprofloxacin, Gentamicin and Cotrimoxazole (50%), least sensitivity was shown for Ceftazidime and Imipenem (16.6%). No susceptibility was shown for Cefoxitin (0%). Klebsiella species showed maximum sensitivity to Ciprofloxacin (75%), followed by Ceftazidime (62.5%) and Cotrimoxazole (50%). Lower sensitivity was observed towards Piperacillin / Tazobactam and Imipenem (25%). Least susceptibility was shown to Cefoxitin, Amikacin (12.5%). No isolate showed susceptibility to Meropenem (0%). Similar susceptibility patterns towards Cephalosporins (40%) and ciprofloxacin (30 – 50%) were reported by Afroz et al[19], Esebelahie, N. O et al [20](Ciprofloxacin 58.95%, Gentamicin 32.5%. Aynalem et al[14] also reported most of the Escherichia coli isolates showing susceptibility to gentamicin (87.5%), Chloramphenicol (75%) and ciprofloxacin (62.5%) and Klebsiella species showing susceptibility to gentamicin (70.6%), followed by cephalosporins (47.1%).

Acinetobacter species showed maximum susceptibility to Piperacillin / Tazobactam (83.3%) followed by Ciprofloxacin, Imipenem (66.6%) and Cotrimoxazole (50%). Lower susceptibility rates were observed towards Ceftazidime and Meropenem (33.33%) followed by Cefoxitin, Gentamicin, Amikacin (16.6%). Proteus vulgaris showed maximum susceptibility to Ciprofloxacin and Cotrimoxazole (100%), followed by Piperacillin / Tazobactam (80%), followed by Gentamicin (60%). Lower susceptibility was observed towards Ceftazidime, Amikacin and Meropenem (40%). Least susceptibility was shown to Imipenem (20%) and no sensitivity towards Cefoxitin (0%). Alam et al[16] reported that piperacillin / tazobactam and carbapenems had a better activity against Proteus and low resistance against carbapenems contrary to our study.

Pseudomonas aeruginosa showed highest susceptibility towards Piperacillin / Tazobactam (81.8%), followed by Tobramycin (72.7%), Ciprofloxacin (63.6%). Lower susceptibility rates were observed for Ceftazidime and Imipenem (45.4%), followed by Gentamicin (36.3%), Aztreonam and Amikacin (27.2%). Least susceptibility was observed towards Meropenem and Cotrimoxazole (0.09%). High susceptibility to Piperacillin / Tazobactam corroborates the reported study by Abdu et al[13] (96.43%) and Amoran O. E et al[21]. Fluoroquinolones and Gentamicin were more effective in this study which correlates with Esebelahie, N. O et al[20]. The findings by Aynalem et al[14] reported sensitivity to Aminoglycosides similar to the findings of this study.

Among the 20 Staphylococcus aureus isolates, maximum susceptibility was observed to Linezolid (70%), followed by Cotrimoxazole (60%), Ciprofloxacin, Gentamicin and Clindamycin (40%), Amikacin (20%). Least susceptibility was observed against Penicillin & Cefoxitin (10%) and Erythromycin (0%). Similar high susceptibility to linezolid was reported by Alam et al (99%)[16]. No Vancomycin resistant Enterococci were observed in this study similar to the findings reported by Alam et al[16].

Among the 94 isolates, 23.40% (22) isolates are ESBL producers, 51.06% isolates (48) are Carbapenem Resistant isolates and 19.14% (18) are MRSA. Alam et al[16] reported 34.16% MRSA isolates in their study correlating with such numbers in our study. Higher rates of MRSA were reported by Aynalem et al[14] (76.9%).

Among the 22 ESBL producers, 45.45% (10) were Escherichia coli, 27.27% (6) isolates were Klebsiella species, 18.18% (4) isolates were Proteus species and 9.09% (2) isolates were Acinetobacter species. Roopashree et al[22] reported majority of the ESBL producers were Escherichia

coli (50.90%) followed by Klebsiella pneumoniae (18.18%) similar to the ESBL producers isolates from our study.

Among the Carbapenem resistant isolates, 29.16% (14) isolates were Klebsiella species, 25% (12) were Pseudomonas aeruginosa, 20.83% (10) isolates were Escherichia coli, 16.66% (8) were Acinetobacter species and 8.33% (4) were Proteus species. Roopashree et al[22] reported higher rates of Carbapenem resistance among Pseudomonas aeruginosa followed by Acinetobacter species, Escherichia coli and Klebsiella species contrary to our study.

The difference in antibiogram could be due to the difference in the bacterial strains among the population, difference in the infection control measures, variation in the wounds and surgical techniques.

Of the 16 isolates which were both ESBL producers and Carbapenem Resistant, 50% (8) were Escherichia coli, 37.50% (6) were Klebsiella species and 12.5% were Proteus species. Such alarming multidrug resistance among gram negative bacilli is limiting the treatment options for the patients. Carbapenems are a reliable set of drugs for treating bacterial infections, and such emerging resistance patterns raises the issue of major public health concern. Such changing trends have to be frequently monitored so that the right antibiotic can be given to the patient for better patient care and reducing morbidity and mortality.

CONCLUSION:

Cost effective and simple methods for diagnosis can be incorporated in routine laboratory for improving clinical management of the patients suffering from infections caused by drug resistant organisms. Increasing proportion of antibiotic resistance is implicating persistence of drug-resistant infections leading to higher morbidity and mortality posing a serious health threat rendering treatment to such infections a high challenge. Timely reporting of drug-resistant strains will help in preventing the spread of multidrug resistance isolates. Regular surveillance with root cause analysis of all wound infections, strict adherence to hospital antibiotic policy, implementing strict infection control practices must be considered to reduce the wound infection rates and also reduce the burden of antibiotic resistance.

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AUTHORS CONTRIBUTIONS:

Tamma Saisashank Reddy worked as principal investigator and contributed to the drafting the proposal, conducting the research, collect the data. M. Shabnum worked as a coinvestigator and played key role in acquiring the approval for the study, reviewing the content, analyzing the data and its interpretation, drafting the manuscript and preparing for its publication. All authors have read and approved the final manuscript.

COMPETING INTERESTS:

None

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REFERENCES

1. Maillard, J.Y; Kampf, G; Cooper, R. Antimicrobial stewardship of antiseptics that are pertinent to wounds: The need for a united approach. JAC Antimicrob. Resist. 2021, 3, dlab027
2. Simões, D, Miguel, S.P, Ribeiro, M.P, Coutinho, P, Mendonça, A.G, Correia, I.J. Recent advances on antimicrobial wound dressing: A review. Eur. J. Pharm. Biopharm. 2018, 127, 130–141

3. Van Koppen, C.J, Hartmann, R.W. Advances in the treatment of chronic wounds: A patent review. Expert Opin. Ther. Pat. 2015, 8, 931–937.
4. Negut, I, Grumezescu, V, Grumezescu, A.M. Treatment Strategies for Infected Wounds. Molecules 2018, 9, 2392
5. Bowler P, Durden B, Armstrong D. Wound Microbiology and Associated Approaches to Wound Management. *Clin Microbiol Rev*. 2001;14(2):244–269.
6. Pallavali, R.R, Degati, V.L, Lomada, D, Reddy, M.C, Durbaka, V.R.P. Isolation and in vitro evaluation of bacteriophages against MDR-bacterial isolates from septic wound infections. PLoS ONE 2017, 12, e0179245.
7. Gupta N, Gautam V, Saini S, et al. Prevalence of multi drug resistant organism in wound infection. *J Infect Dis Antimicrobial Agent*. 2002; 19:111–117.
8. 9.Esebelahie NO, Esebelahie FO, Omoregie R. Aerobic bacterial isolates from wound infection. *Afr J Cln Exper Microbial*. 2013;14(3):155–159.
9. Nichols,R.L. 1998. Postoperative infections in the age of drug resistant Gram Positive bacteria. Am. J. Med. 104: 11S-16S
10. Kalan L, Loesche M, Hodkinson BP, Heilmann K, Ruthel G, Gardner SE, et al. Redefining the Chronic- Wound Microbiome: Fungal Communities Are Prevalent, Dynamic, and Associated with Delayed Healing. mBio. 2016; 7: 5
11. Ntirenganya C, Manzi O, Muvunyi CM, Ogbuagu O. High prevalence of antimicrobial resistance among common bacterial isolates in a tertiary healthcare facility in Rwanda. Am J Trop Med Hyg 2015; 92: 865–70. https://doi.org/10.4269/ajtmh.14-0607 PMID: 25646259
12. Puca,V, Marulli R.Z, Grande R, Vitale I, Niro A, Molinaro G, Prezioso S, Muraro R, Di Giovanni P. Microbial Species Isolated from Infected Wounds and Antimicrobial Resistance Analysis: Data Emerging from a Three Yeat Retrospective Study. Antibiotics 2021; 10: 1162. https://doi.org/10.3390/antibiotics10101162
13. Abdu A.B, Egbagba J, Fente B.G. Identification and antimicrobial susceptibility profile of bacterial pathogens isolated from wound infections in a tertiary hospital, Bayelsa, South southern, Nigeria. Trop J Path Micro 2019; 5(12): 966 – 975. doi: 10.17511/jopm.2019.il2.01
14. Aynalem Mohammed, Mengistu Endris Seid, Teklay Gebrecherkos, Moges Tiruneh, Feleke Moges, "Bacterial Isolates and Their Antimicrobial Susceptibility Patterns of Wound Infections among Inpatients and Outpatients Attending the University of Gondar Referral Hospital, Northwest Ethiopia", *International Journal of Microbiology*. 2017. Vol. 2017: 1 - 10. https://doi.org/10.1155/2017/8953829 . Article ID 8953829
15. Puca, V.; Marulli, R.Z.; Grande, R.; Vitale, I.; Niro, A.; Molinaro, G.; Prezioso, S.; Muraro, R.; Di Giovanni, P. Microbial Species Isolated from Infected Wounds and Antimicrobial Resistance Analysis: Data Emerging from a Three-Years Retrospective Study. Antibiotics 2021, 10, 1162. https://doi.org/10.3390/antibiotics10101162
16. Alam et al: Mohammad Morshad Alam, Md Nazrul Islam, Mohammad Delwer Hossain Hawlader, Shakil Ahmed, Abrar Wahab, Muzahidul Islam, KM Roshed Uddin, Ahmed Hossain. Prevalence of multidrug resistance bacterial isolates from infected wound patients in Dhaka, Bangladesh: A cross-sectional study. International Journal of Surgery Open. 2021; 28: 56-62. https://doi.org/10.1016/j.ijso.2020.12.010
17. Al-Naqshbandi AA, Hassan HA, Chawsheen MA, Abdul Qader HH. Categorization of Bacterial Pathogens Present in Infected Wounds and their Antibiotic Resistance Profile Recovered from Patients Attending Rizgary Hospital-Erbil. ARO [Internet]. 2021. 9(2):64-0. Available from: https://aro.koyauniversity.org/index.php/aro/article/view/864
18. Abalaka M.E, T.B Saidu and F. Attah, 2022. Isolation, identification and characterization of bacteria isolated from wound sepsis from patients in a secondary medical care facility in Nigeria. J. Med. Sci. 22: 103 – 106
19. Afroz S, Sarkar D, Khatun K, Khan TM, Paul S. Bacterial pathogens in wound infection and their antimicrobial susceptibility pattern in a medical college hospital, in Dhaka, Bangladesh. Int

J Res Med Sci. 2020 May. 8(6):2105-9. Available from: https://www.msjonline.org/index.php/ijrms/article/view/8014

20. Esebelahie, N.O, Newton – Esebelahie, F.O, Omoregie R. Aerobic bacterial isolates from infected wounds. Afr. J. Cln. Exper. Microbiol. 14(3):155 – 159. Doi:10.4314/ajcem.v14i3.6
21. Amoran OE, Sogebi AO, Fatugase OM. Rates and risk factors associated with surgical site infections in a tertiary care centre in South Western Nigeria. Int J Trop Dis Health. 2013; 26(3): 25 – 36. doi: 10.4103/npmj.npmj_72_19
22. Roopashree S, A G Prathab, Sandeep T. Bacteriological profile and antibiotic susceptibility patterns of wound infections in a tertiary care hospital in South India. Indian Journal of Microbiology Research 2021; 8(1): 76 – 85. https://doi.org/10.18231/j.ijmr.2021.016