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Antimicrobial Sensitivity of Bacterial Species Isolated from Blood, Respiratory and Pus Samples

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ABSTRACT

Background: Antimicrobial resistance (AMR) will result in the deaths of 10 million people per year by 2050 unless action is taken to prevent this emerging crisis. To develop effective therapeutic strategies to fight infections caused by drug-resistant bacteria, it is critical to monitor the trend in the evolving resistance pattern over time.

Objective: The present study deals with the assessment of microbial profiles of blood, respiratory as well as pus samples and their antimicrobial sensitivity against commonly used antimicrobial drugs in a tertiary healthcare setting.

Materials and Methods: Between January and June 2023, blood, respiratory, and pus samples were obtained from both the outpatient and inpatient departments and transferred to the microbiological laboratory for further investigation. All samples were tested in appropriate culture conditions, and pure bacterial isolates were evaluated for antimicrobial sensitivity to a variety of antimicrobial medicines.

Results: A total of 84% of samples were collected from the IPD while the rest were collected from the OPD of different departments. In respiratory and blood samples, *Klebsiella* and *Salmonella* Spp., respectively, were recorded as the dominant microbial isolates. The antimicrobial sensitivity pattern analysis of respiratory samples revealed that *Klebsilla* spp. and *pseudomonas* have maximum sensitivity against imipenem, while *Candida* spp. showed higher sensitivity against fluconazole and *Gram-positive cocci* showed good sensitivity against linezolid. Moreover, in blood samples, *Salmonella* Spp. was found sensitive to all tested drugs, on the other hand, *Pseudomonas* spp. showed good sensitivity against piperacillin/tazobactam while *E. coli* had maximum sensitivity to ertapenem. In the case of *Gram-Positive Cocci*, vancomycin was found as the most sensitive drug. In pus sample analysis, *E. coli* was found the dominant bacterial isolate followed by methicillin-resistant *Staphylococcus aureus* and *Pseudomonas* spp., methicillin resistant staph aureus(MRSA). in both IPD samples while in the case of OPD isolates, *Pseudomonas* spp. was dominated. In the case of *E. coli*, imipenem has higher sensitivity in both IPD and OPD isolates. *Pseudomonas* spp. were found to have good sensitivity for ceftazidime. *Gram-Positive Cocci*, was only recorded from IPD samples with maximum sensitivity against vancomycin

Conclusion: The increasing trend of resistance has serious consequences for humans, hence, to detect changes in sensitivity patterns, regular surveillance of IPD, OPD (if possible) and ICU should be conducted by infection control doctors and nurses working in close collaboration at regular intervals.

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Introduction

The modern era of antibiotics began with Sir Alexander Fleming's discovery of penicillin in 1928, which transformed medicine and society, saved lives, and increased life expectancy to what it is today. Antibiotics' surprising effectiveness gave rise to the euphoric but false belief that they could successfully control all infectious diseases. Unfortunately, overuse, misuse, and underuse of antibiotics over the past few decades have led to the rapid emergence and spread of bacterial strains that are resistant to almost all therapeutically effective antibiotics [1]. Antimicrobial resistance (AMR) will result in the deaths of 10 million people per year by 2050 unless action is taken to prevent this emerging crisis [2]. Therefore, it is crucial to keep an eye on the AMR rates for clinically significant pathogens in different parts of the world. To develop effective therapeutic strategies to fight infections caused by drug-resistant bacteria, it is critical to monitor the trend in the evolving resistance pattern over time. To track AMR globally, several sizable surveillance studies are being carried out. Studies have shown that Asian nations have a significant AMR burden [3].

In India, the infectious disease burden is highest in the world, and the inappropriate and illogical use of antimicrobial drugs against these infections has increased antimicrobial resistance development. According to the government of India's' scoping report on antimicrobial resistance in India (2017), more than 70% of isolates of *Escherichia coli*, *Klebsiella pneumoniae*, and *Acinetobacter baumannii*, as well as nearly half of all *Pseudomonas aeruginosa*, were resistant to fluoroquinolones and third generation cephalosporins. Although resistance to the treatment combination piperacillin-tazobactum was still 35% for E. coli and P. aeruginosa, the existence of numerous resistance genes, including carbapenemases, rendered *K. pneumoniae* resistant to the drug combination [4]. To overcome these challenges and improve the outcome of major infections in hospital settings, hospital resistance patterns must be monitored [5]. However, India's participation in worldwide AMR studies is insignificant. As a result, data are scarce on the incidence rates and true burden of AMR in India [3]. Therefore, the present study was carried out to find the microbial profile of respiratory and blood samples as well as their antimicrobial sensitivity pattern that provides a detailed insight that can provide a baseline to develop guidelines for better utilization of antimicrobial therapy.

Methodology

In this study, clinically relevant samples namely blood,respiratory and pus were collected from January to June 2023 from the both outpatient department (OPD) and the inpatient department (IPD) patients from SSB heart and multispeciality hospital-Faridabad. Then all samples were transferred to the microbiology laboratory. All samples were subjected to pure isolation of microbial isolated in specific culture media by following standard operating procedures. Then pure bacterial isolates were evaluated for antimicrobial sensitivity patterns by Vitek 2 and interpretation was made based on guidelines published by the Clinical and Laboratory Standards Institute [6]. Antimicrobial drugs namely cefixime, ceftazidime, ceftriaxone, ciprofloxacin, ertapenem, fosfomycin, gentamicin, amikacin, amoxyclav, imipenem, nalidixic acid, nitrofurantoin, norfloxacin, ofloxacine, pipratezobectum, tigecycline, trimethoprim/sulbactam were used in this study.

Results

A total of 84% of samples were collected from IPD while the rest were collected from the OPD of different departments (Figure 1).

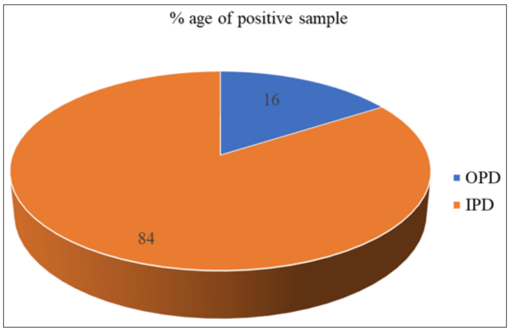

Figure 1: Percentage of IPD and OPD Samples

All clinically relevant samples namely pus, respiratory and blood revealed that samples from IPD had higher number as compared to OPD samples (figure 2).

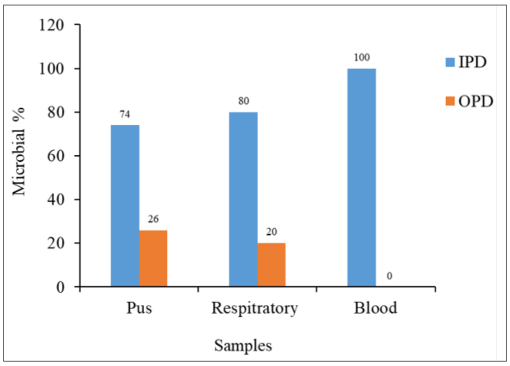

Figure 2: Percentage of different clinical samples from OPD and IPD

Respiratory Sample Analysis

Respiratory sample analysis revealed both IPD and OPD samples were dominated by the *Klebsiella* spp followed by *E. coli* while *Acinetobacter* spp, and MRSA were only observed in IPD (Figure 3).

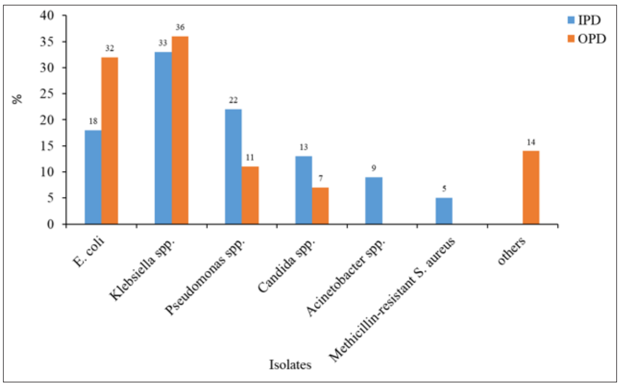

Figure 3: Microbial colonization pattern in respiratory samples from IPD and OPD

ssssIn the case of *Klebsilla* spp. from respiratory samples, all drugs were found to have less than 50% sensitivity in both IPD and OPD samples while *Klebsilla* spp. form OPD samples had 45 % sensitivity against imipenem and meropenem.. (Figure 4).

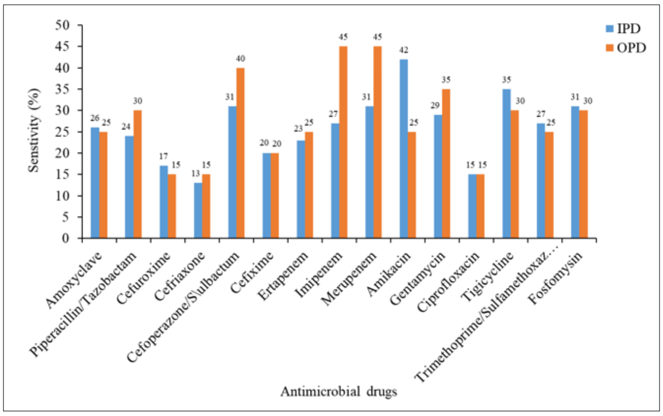

Figure 4: Antibacterial sensitivity for *Klebsilla* spp. isolated from IPD and OPD respiratory samples

In the case of *E. coli*, both IPD and OPD isolates were found to have similar patterns for all antimicrobial drugs (Figure 5).

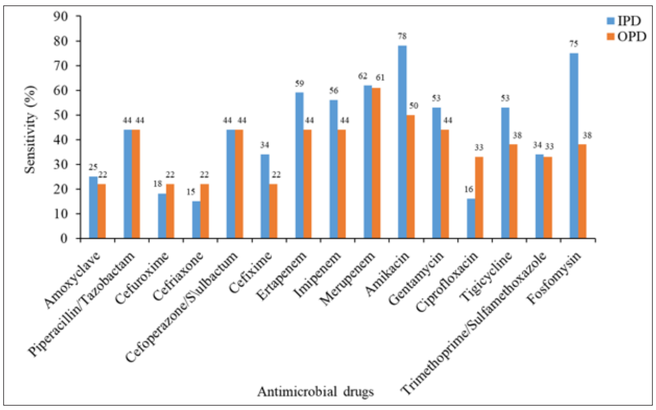

Figure 5: Antibacterial sensitivity for *E. coli* isolated from IPD and OPD respiratory samples

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In IPD sample, *Pseudomonas* spp. showed maximum sensitivity against imipenem (60%) followed by meropenem(54%) gentamicin (54%) and ciprofloxacin (52%). In case of OPD, *Pseudomonas* spp. had higher sensitivity against gentamicin and meropenem, (Figure 6).

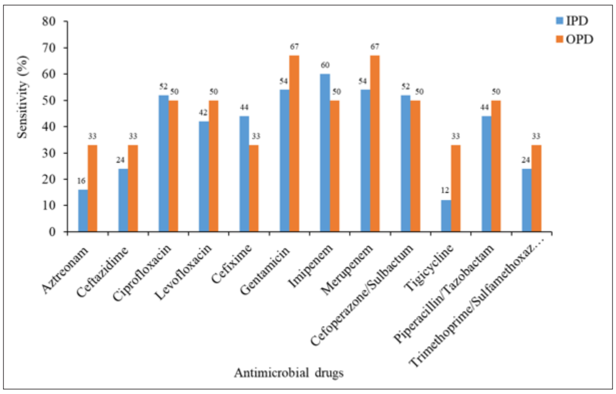

Figure 6: Antibacterial Sensitivity Pattern of *Pseudomonas* spp

Candida spp. showed maximum sensitivity against fluconazole, caspofungin, micafungin, and flucytosine. (Figure 7).

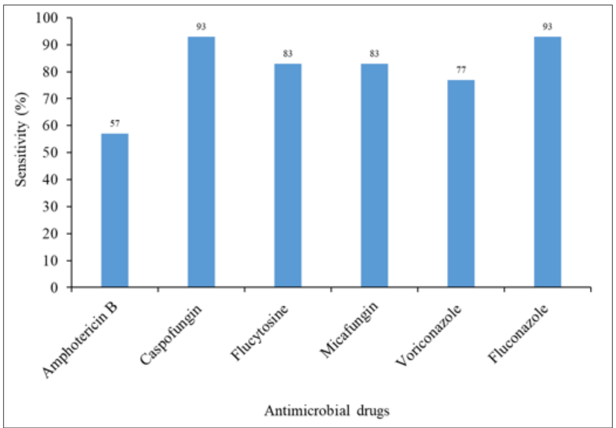

Figure 7: Antibacterial sensitivity pattern Candida spp

In the respiratory sample, Gram-positive cocci isolates showed good sensitivity against linezolid, vancomycin, and ciprofloxacin; all drugs showed good sensitivity patterns except erythromycin is the least sensitive drug (Figure 8).

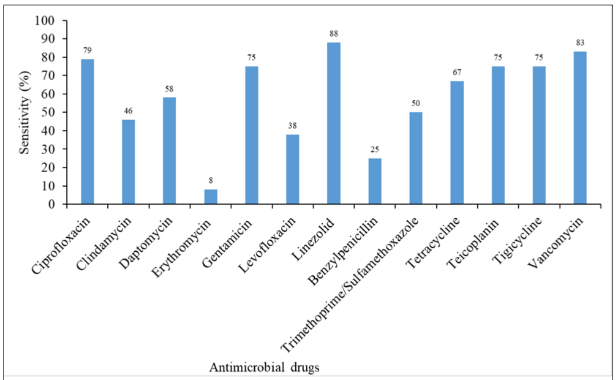

Figure 8: Antibacterial sensitivity pattern of Gram-positive cocci

Blood analysis

In Blood samples, *Salmonella* Spp. was found the dominant bacterial isolate followed by Coagulase-negative *staphylococci* and *E. coli* i.e., 38% and 23%, respectively, in IPD samples (Figure 9).

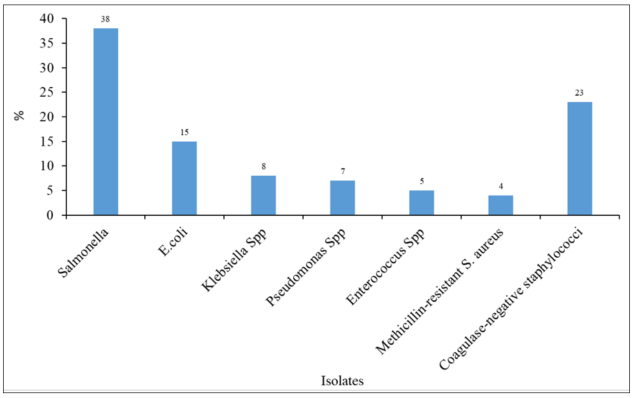

Figure 9: Microbial colonization pattern in blood samples

In the case of *Salmonella* spp., all drugs were found to have more than 80% except cefuroxime (Figure 10).

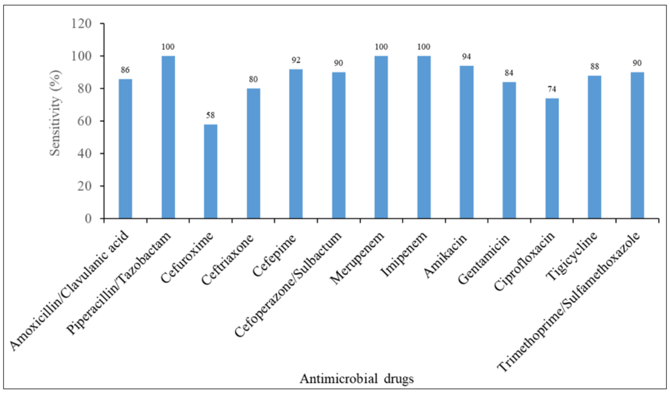

Figure 10: Antibacterial sensitivity for *Salmonella* spp. isolated from blood samples

In the case of *Pseudomonas* spp., IPD isolates showed a good sensitivity pattern for all drugs; out of which piperacillin/tazobactam, imipenem and meropenem have maximum sensitivity (Figure 11).

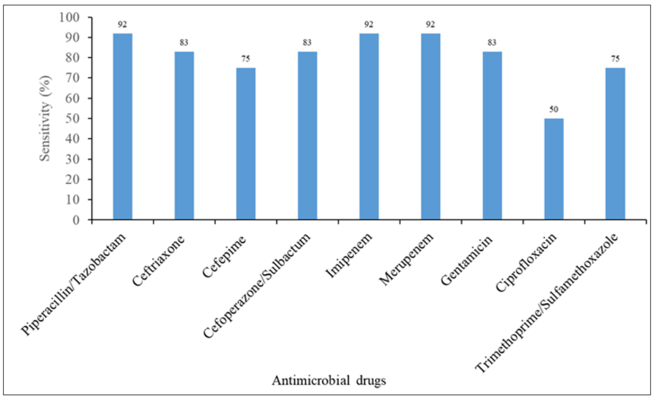

Figure 11: Antibacterial sensitivity for *Pseudomonas* spp. isolated from blood samples.

In the case of *E. coli*, maximum sensitivity was recorded against ertapenem (Figure 12).

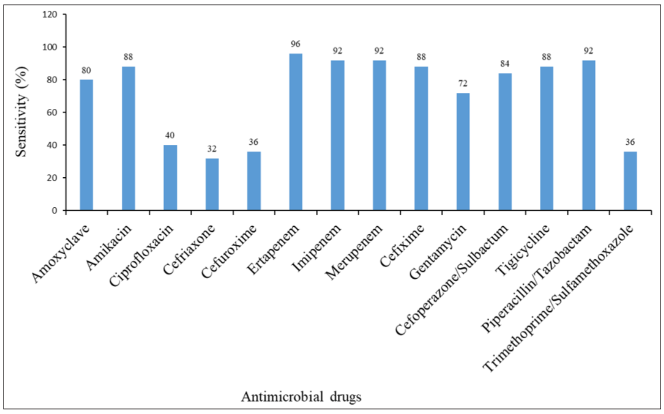

Figure 12: Antibacterial sensitivity for *E. coli* isolated from blood samples

In the case of *Gram-Positive Cocci*, IPD isolates showed different patterns for different antimicrobial drugs. Moreover, vancomycin was found as the most sensitive drug followed by tigecycline and linezolid, respectively (Figure 13).

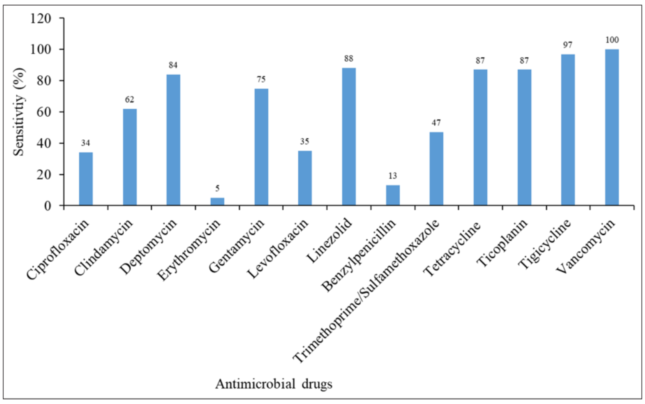

Figure 13: Antibacterial sensitivity for *gram positive cocci* isolated from blood samples

Pus Analysis

In pus samples, *E. coli* was found the dominant bacterial isolate followed by methicillin-resistant *Staphylococcus aureus* and *Pseudomonas* spp. Methicillin resistant staph aureus(MRSA). in both IPD samples. In case of OPD isolates, *Pseudomonas* spp. was observed as the dominant microbial species followed by *E. coli* and *S. aureus*. Moreover, *Klebsiella* spp. and *Acinetobacter* spp. were only isolated from pus samples collected from IPD samples (Figure 14).

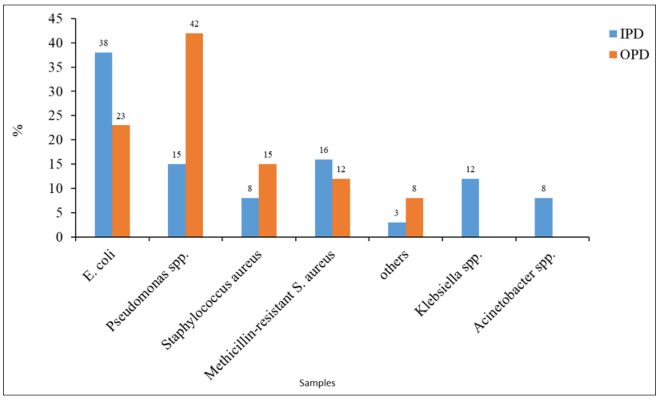

Figure 14: Microbial colonisation pattern in pus samples from IPD and OPD

In case of E. coli spp., all drugs were found to have almost similar sensitivity pattern (Figure 15).

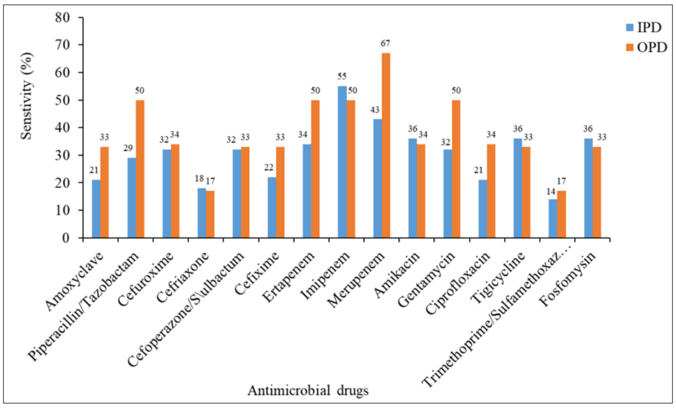

Figure 15: Antibacterial sensitivity for *E. coli* spp. isolated from IPD and OPD pus samples.

In case of *Pseudomonas* spp., IPD isolates showed less sensitivity for all drugs than OPD isolates. OPD isolates were found to have good sensitivity for ceftazidime, cefixime followed by gentamicin and meropenem. Moreover, colistin showed no sensitivity in both IPD and OPD samples (Figure 16).

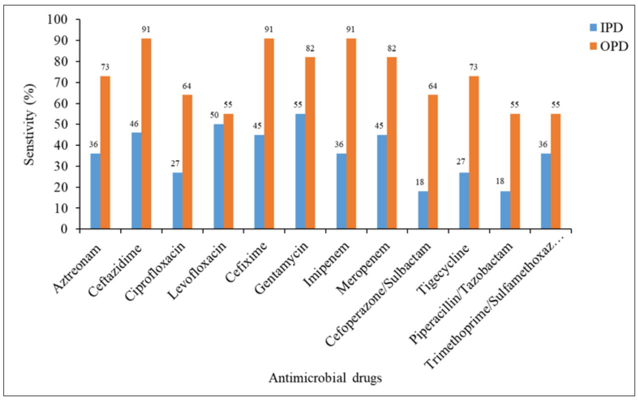

Figure 16: Antibacterial sensitivity for *Pseudomonas* spp. isolated from IPD and OPD pus samples

In case of Gram-Positive *Cocci*, maximum sensitivity was recorded against vancomycin followed by linezolid and tigecycline (Figure 17).

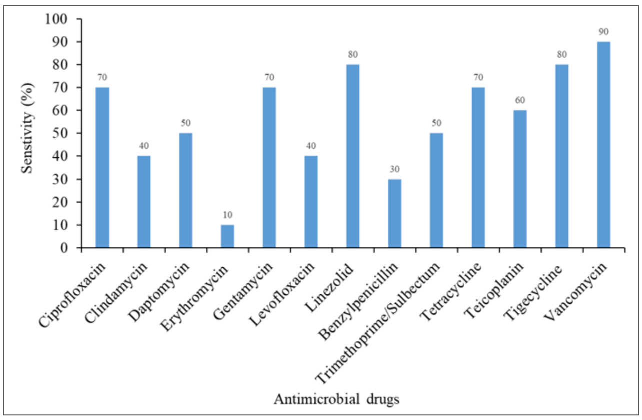

Figure 17: Antibacterial sensitivity for *Gram-Positive Cocci* isolated from IPD and OPD pus samples

Discussion

In the case of respiratory sample analysis, the pattern of pathogens isolated from both IPD and OPD samples revealed that all patients may have suffered from the acute lower respiratory tract infection and a similar observation was also reported by an Indian tertiary care center in 2020 [7]. This study supports the report of Simoes et al, which suggests that factors such as overpopulation, poor nutritional status, low birth weight, and smoking habits are commonly responsible for acute lower respiratory tract infections [8]. Further, the present study observed that *Klebsiella* spp. was the predominant bacterial isolate from the respiratory samples and similar observations were documented from the different healthcare settings of the world [7-11].

Furthermore, *Klebsilla* spp. found to be sensitive against imipenem and meropenem while no sensitivity was recorded for colistin. Imipenem was also recorded as sensitive to *Klebsilla* spp in various studied [12-13]. *Pseudomonas* spp. also showed maximum sensitivity against imipenem and followed the observation of Chinnnusamy et al [14]. *Candida* spp. showed maximum sensitivity against fluconazole. According to Bitew et al., fluconazole is still the drug of choice against *Candida* infections [15]. Gram-positive cocci isolates showed good sensitivity against linezolid which is considered the most powerful drug of choice in healthcare settings even in intensive care settings. However, several studies showed contradictory observations which might be due to the antimicrobial treatment started before the microbiological analysis and the results were significantly influenced by the method of specimen collection, transportation, processing and standard care policies of healthcare settings.

In Blood samples, *Salmonella* Spp. was found the dominant bacterial isolate followed by Coagulase-negative *staphylococci* and *E. coli* in IPD samples. In the case of *Salmonella* spp., all drugs were found sensitive except cefuroxime. Similar resistance to cefuroxime was reported from India, Nigeria, the UAE, and Germany [16-18]. On the other hand, *Pseudomonas* spp. showed good sensitivity against piperacillin/tazobactam, imipenem and meropenem. Similar results were also observed in different healthcare settings [19-20]. *E. coli* had maximum sensitivity to ertapenem and similar results were also reported previously [21] while Sobur et al., reported ertapenem as resistance against *E. coli* [21]. In the case of *Gram-Positive Cocci*, vancomycin was found as the most sensitive drug which obeyed the observation from Daka [22].

In pus sample analysis, *E. coli* was found the dominant bacterial isolate followed by methicillin-resistant *Staphylococcus aureus* and *Pseudomonas* (MRSA) spp. in both IPD samples while in the case of OPD isolates, *Pseudomonas* spp. was dominated. However, contradictory observation was reported from Tertiary Care Government Hospital in Tamilnadu, India where *Staphylococcus aureus* was dominated by spp. [23]. In the case of *E. coli* spp., imipenem has higher sensitivity in both IPD and OPD isolates which obeys the pattern observed by Tameez-ud-Din in 2020 [24]. In the case of *Pseudomonas* spp. were found to have good sensitivity for ceftazidime which is similar to previous sensitivity studies carried out across the world [24-25]. Gram-Positive *Cocci*, was only recorded from IPD samples with maximum sensitivity against vancomycin and it was reported as a useful antimicrobial drug against Gram-Positive Cocci [26-27].

Conclusion

This microbial profile and antimicrobial sensitivity study concluded that there is a huge difference in the antimicrobial drug pattern for a single isolate which might be due to the variation in geographical ecosystem and economic status of families. The increasing trend of resistance has serious consequences for humans, hence, to detect changes in sensitivity patterns, regular surveillance of IPD, OPD (if possible) and ICU should be conducted by infection control doctors and nurses working in close collaboration at regular intervals.

Authors' Contributions: The authors contributed to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript.

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