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ORIGINAL

Microbial Trends and Antibiotic Susceptibility in ICU-Admitted Patients: A Hospital-Based Study Examining Prevalence Across Multiple Critical Therapies

Tendencias microbianas y susceptibilidad a los antibióticos en pacientes ingresados en la UCI: un estudio hospitalario que examina la prevalencia en múltiples terapias críticas

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ABSTRACT

Healthcare practitioners can adjust treatment plans, choose efficient antimicrobial agents, enhance patient outcomes, reduce antibiotic-resistant strains and ultimately improve patient outcomes by keeping an observation on microbial trends and antibiotic susceptibility in Intensive Care Unit (ICU) admitted patients. In the research, antibiotic susceptibility and microbial trends in ICU patients were investigated in hospital. The research is to examine antibiotic susceptibility and microbiological trends in ICU patients. It aims to understand how often such infections develop, and what happens next among a group of 312 high-risk patients in medical care. It also reveals the type of appropriate treatment plans that tells the levels of antibiotic resistance and identifies the most frequent microbial patterns. Research findings are expected to improve practical methodologies for operations of a clinical setting, to inform the lawmakers, and ensure that antibiotics remain useful in hard for more time. However, the research provides some insights into antibiotic susceptibility and microbiological profile in ICU. It can also be used as a framework for clinical processes that are to take place, decisions that are to be made in legislation, and reasons that can prompt further research to ensure long term effectiveness of antibiotics in the ICU is achieved.

Keywords: Intensive Care Unit (ICU); Antibiotic; Microbial Trends; Infections; Bacteria.

RESUMEN

Los profesionales sanitarios pueden ajustar los planes de tratamiento, elegir agentes antimicrobianos eficaces, mejorar la evolución de los pacientes, reducir las cepas resistentes a los antibióticos y, en última instancia, mejorar la evolución de los pacientes mediante el seguimiento de las tendencias microbianas y la susceptibilidad a los antibióticos en los pacientes ingresados en la Unidad de Cuidados Intensivos (UCI). En la investigación, se investigó la susceptibilidad a los antibióticos y las tendencias microbiológicas en pacientes de la UCI. El objetivo de la investigación es comprender la frecuencia con la que se desarrollan estas infecciones y qué sucede a continuación en un grupo de 312 pacientes de alto riesgo que reciben atención médica. También revela el tipo de planes de tratamiento adecuados que determinan los niveles de resistencia a los antibióticos e identifican los patrones microbianos más frecuentes. Se espera que los resultados de la investigación mejoren las metodologías prácticas para las operaciones en el entorno clínico, informen a los legisladores y garanticen que los antibióticos sigan siendo útiles en el hospital durante más tiempo. Sin embargo, la investigación proporciona información sobre la susceptibilidad a los antibióticos y el perfil microbiológico en la UCI. También puede utilizarse como marco para los procesos clínicos, las decisiones legislativas y las razones que pueden impulsar la investigación para garantizar la eficacia a largo plazo de los antibióticos en la UCI.

Palabras clave: Unidad de Cuidados Intensivos (UCI); Antibiótico; Tendencias microbianas; Infecciones; Bacterias.

INTRODUCTION

The complications arising from bacterial infections are extensive and have tremendous effects on the trends of Intensive Care Unit (ICU) especially those caused by Gram-negative bacteria. There is evidence that shows that ICU acquired infection increases morbidity, mortality and the cost of health care.[1] This is especially the case with gram-negative bacterial infections because the nature of these bacteria makes it difficult to treat. Thus, Gram-negative bacteria have a high potential to amplify quickly for genes with encoding of mechanisms of resistance to antibacterial stress. Because of such versatility, attempts at administering treatment to infections occasioned by such organisms become nearly impossible and this is perhaps the reasons as have developed the multidrug-resistant (MDR) strains.[2] Because of the existence of MDR Gram-negative bacteria, the evidence is that there is a very little of pharmacopeial weapons, in terms of drugs needed to overcome these organisms. In particular, there are not many new management strategies specifically for MDR infections, mostly in contrast to substantial progress towards antibiotics for Gram-positive infections. There are considerable barriers due to which healthcare systems are challenged, particularly on the part of ICU diagnosis, and the quality of patient care and infection control when there are no effective treatment options. Due to lack of new treatments, infection control is even more complicated and the risk of cross infection as well as the emergence of antibiotic resistance in ICU is further enhanced.[3] To compound things, the magnitude of the problem is further exaggerated by the fact that health complications are worse when antibiotic medication is started much later and, as is evident, antibiotic medication is directly proportional to morbidity.[4] Therefore, using multi/ broad-spectrum antimicrobial drugs in ICU has become inevitable given that many patients present with infectious illnesses whose etiological agents are not easy to define. While the approach is often necessary when treating serious infections caused especially by Gram, negative species this has underscored the need to have efficient diagnostic tools and effective reporting systems for Antimicrobial Resistance (AR) at the local, regional and national levels.[5] Early warning diagnostic tools are essential since it is known that enhancing patient outcomes requires timely beginning of suitable antimicrobial medication. Identifying infectious agents and customizing treatment approaches require a proactive approach due to the increasing severity of infections and the increased likelihood of widespread resistance to antibiotics. Sturdy monitoring systems for antibiotic resistance that function at various geographic scales are essential for the tactical use of antimicrobial drugs because the help to maintain their effectiveness and reduce the establishment of resistance.

It is important to admit, however, that the problem of antimicrobial resistance is much worse on the global scale if the drugs are used or abused in any way. Hence, there is need for a coordinated approach of the following: Empirical therapy alone is inadequate; new antimicrobial agents must be developed; efforts to promote rational use of antimicrobials must be enhanced; sustained surveillance of resistance profiles is required; and development of multiple strategies in tackling resistance. These challenges should be addressed to ensure that the effectiveness of the antimicrobial drugs is maintained and to ensure proper management of contagious diseases within hospital facilities is achieved. To assess microbial trends and antibiotic resistance patterns in ICU patients to improve infection control and antibiotic therapy.

Research[6] brought attention to the significant issue that Acinetobacter baumannii (AB) that was MDR presents in ICUs, especially the strains that were carbapenem-resistant (CR). Nevertheless, there was a lack of monitoring data in several nations with limited resources. It evaluated the mortality and infection risk variables together with the frequency of patients hospitalized in the critical care unit. Research demonstrated significant levels of resistance to ceftriaxone, imipenem, and cefotaxime (98,04 %).[7] Meropenem and fluoroquinolones were relatively effective against inaccessible isolates of Acinetobacter spp. Research conducted from May 1, 2015, to October 30, 2016, on adult patients in the critical care unit, pulmonary medicine, and medicine departments of their tertiary care hospital.[8] The patients were regularly given blood cultures, expectorated sputum, and bronchoalveolar lavage fluid. Pneumococcus pneumoniae and Legionella pneumophila were detected via urine antigen screening.[9] Research identified the microorganisms, patterns of antibiotic susceptibility, and warning signs for death connected to COVID-19 patients in hospitals. Work examined the molecular typing of K. pneumoniae isolated that produced extended-spectrum beta-lactamases and were obtained from Beheshti Hospital in Kashan, Iran.[10] Investigation conducted at the provincial level in two hospitals. To ascertain the appropriate quantity of antibiotic prescriptions, a clinical panel including the best doctors and ward supervisors examined the data.[11] At the prescription level, mixed-effect logistic regressions were used to look at the factors associated with the most effective usage of antibiotics. Research examined the Screening and contact precautions for carriers appeared to provide a slight added benefit when combined with rigorous adherence to hand hygiene, especially for MDR gram-negative bacteria.[12] Research findings that were not consistently positively hinder the increased use of chlorhexidine baths for skin cleaning. Investigation performed out in an academic medical center in the northeast of India Pediatric ICU.[13] Hospitalized broods by means of a culture-positive S. aureus infection were included in the investigation. Children that were clinically suspected of having a Staphylococcus aurous infection but did not have a positive culture were not allowed to attend the hearings. Research showed feasible to apply the methodology inside the Department of Anesthesia and Intense Care's varied intense structures, as it was repeatable and does not require human resources.[14]

It could serve as a starting point for an internal comparison and more sophisticated antimicrobial stewardship (AS) techniques. Research characterized the percentage of ventilator-associated pneumonia (VAP)-related MDR bacteria that occurred in 536 individuals with low-risk indicators for illnesses associated to multidrug-resistant microorganisms (MDROs) as their first hospital-acquired illness.[15] Research utilized the data from the European Centers for Disease Control'.[16] The European Surveillance System to examine a group of adults transferred to the ICU due to an invasive procedure-related ICU-acquired illness. Techniques for regression analysis matchmaking, and time-to-event were used to examine the relationship between infections brought on by particular antibiotic-resistant bacteria that were significant for public health and an overabundance of litigation. Article discovered antimicrobial resistance (AMR) prevalence.[17] AMR and patient outcomes in the ICU did not correlate. To fully comprehend AMR's effects in resource-variable environments, more research was required. Research evaluated the University Hospital of Modena's experience with COVID-19 in relation to antibiotic usage and antimicrobial resistance.[18] The antimicrobial consumption (AC), bloodstream infection incidence rate, and C. difficile infection (CDI) incidence rate from January 2015 to October 2021 were examined using a time series analysis. Research tracked the prevalence of hospital-acquired infections (HAIs) that were drug-resistant during the course of the three COVID-19 waves.[19] At 1000-bed Molinette Hospital, a teaching hospital with surgical, medical, and ICUs, the data were compared to the pre-pandemic era. The most prevalent MDR infections, according to the research, were A. baumannii, and K. pneumoniaecarbapenemase-producing K. pneumoniae (KPC-Kp). Analysis examined how the COVID-19 pandemic impacted the use of antibiotic prescriptions and the emergence of antibiotic resistance, with an emphasis on the possible roles played by co-infections and super infections in the outcomes.[20] Research investigated the resistance traits, clinical outcomes. In addition to the clinical information of 209 ICU patients, the research comprised 393 of S. maltophilia specimens were identified in various clinical collections.[21] Research described the proportion of MDROs connected to pneumonia associated with ventilators, which occurred in 536 people with minimal indicators of risk for MDRO-related illness and was the first hospital-acquired disease.[22] During 2003 and 2016, there was a sharp decrease in the percentage of MDROs participating in VAP; nevertheless, the percentage rose when VAP happened after day ten. In research, the antibiotic susceptibility patterns of hospitalized patients in ICUs were assessed and contrasted with those of non-ICU patients in figure 1.

Figure 1. ICU-Admitted Patient.

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METHOD

Research involved a thorough collection and analysis of a large set of demographic and health-related data from the laboratory records of 312 patients in the ICU, including 235 male and 77 female. Based on the gender distribution of sample participants, the majority of the population is male (75,3 %), with women making up the remaining 24,7 %. This gender-specific breakdown offers a fundamental comprehension of the research cohort's demographic composition, providing information that might be vital for further analysis and interpretation. A more comprehensive approach was attempted to gain a detailed image of the patients in the regional ICU including various types of diseases and demographics. It was to provide valuable information regarding the incidence, characteristic, and prognosis of the patients in question based on this rich data source. The research also helped in constructing a current and comprehensive image of the medical scenario in the ICU is a chosen period of the research apart from contributing to the existing database of knowledge.

Inclusion Criteria

The research focuses on sick patients who are not surgical patients and postoperative and medical ICU patients. Patients in need of advanced life support measures as well as those with organ failure or malfunction are included. A diversified representation of patients with severe medical diseases needing specialized interventions and intensive care, concerns particular to a given gender are considered.

Exclusion Criteria

Patients with unrelated illnesses ought to be removed and age limitations might be imposed to target particular age groups. Additionally, patients with short stays or quick transfers out of the ICU have to be disqualified. These requirements improve the dataset's accuracy, match it to the goals of the research and make meaningful analysis easier.

Antimicrobial Susceptibility Testing

A suspension was created from the bacterial isolate by combining the pure colony with sterile normal saline and incubating it for 15 minutes at 37°C. After that, a sterilized cotton tip stick was used to do grass culture on Muller-Hinton agar.[23] The Kirby-Bauer disk diffusion technique was employed for the antimicrobial susceptibility tests (AST). The antibiotic disks utilized in AST, which included ampicillin, cefuroxime, cefoxitin, cefotaxime, cefepime, ciprofloxacin, levofloxacin, ampicillin-sulbactam, imipenem, tetracycline and clindamycin were measured for the zone of inhibition using a ruler.[24] Performance requirements for antimicrobial susceptibility testing, the AST result was evaluated as susceptible, intermediate and resistant.[25] Concurrently, the isolates were screened for resistance mechanisms such as methicillin-resistant Staphylococcus aureus (MRSA), amp C beta-lactamase, metallo beta-lactamase, inducible methylase production and extended-spectrum beta-lactamase (ESBL). A mixture of two percent fructose, 0,5 µg/ml of methylene blue dye and Mueller-Hinton agar was utilized for antifungal susceptibility testing, in compliance with the guidelines on the subject as stated in the M-44 A2 material.

RESULTS

The constantly evolving background for this extended period was Hospital, a core healthcare organization in which the struggle against microbial diseases and the multifaceted process of patients' treatment meet. An essential process that went into identification of multifaceted dynamics of microbial trends and antibiotic susceptibility among a cross-section of patients within the hospital was the systematic sampling of clinical specimens as part of the execution of the research. Body fluids and tissues were collected strictly from the research patients ranging from saliva, sputum, blood, urine, stool, vomit, and endotracheal secretions. These samples such as endotracheal aspirates, blood, urine, sputum, and wound exudates were important since provided an array of view to the research on the microbiological profile of the patients within the hospital. Every sample was properly identified with full patient information and all the relevant clinical and research details to ensure the accuracy of the data and sample tracking. To the hospital's microbiological laboratory that was a major location in which the scientific investigation started to pick up, this center represented an important point of convergence of scientific research, and through this laboratory, all the samples collected were processed systematically. Among others, these procedures ensured that materials were processed and analyzed with ultimate accuracy by making use of state-of-the-art laboratory technologies. As much as there is no way can underestimate how important correct labelling and keeping records are to give valid data and help understand better every individual's microbial profile. From table 1 below it can be observed that Klebsiella species was more prevalent than other microbes present in the sample, accounting for 104 (33,3 %). Pseudomonas aeruginosa is identified 31 times (9,93 %), followed by Escherichia coli 22 times (7,06 %). Enterococcus species account for 68(21,8 %), followed by Acinetobacter baumannii 64 times (20,51 %). Streptococcus species are identified 23 times (7,4 %). This data provides insights into microbial composition and their potential applications in healthcare and environmental studies.

Table 1. Percentage of microorganisms isolated from the ICU.

Micro Organism	No	Percentage
Klebsiella species	104	33,3
Pseudomonas aeruginosa	31	9,93
Escherichia coli	22	7,06
Enterococcus species	68	21,8
Acinetobacterbaumannii	64	20,51
Streptococcus species	23	7,40

Figure 2 and table 2 show high prevalence of antibiotic resistance in Enterobacteriaceae, with 170 cases of ampicillin, 142 cases of cefotaxime, 118 cases of ciprofloxacin, 59 cases of levofloxacin, 124 tetracyclines and 162 ampicillin/sulbactam instances. This calls for prudent antibiotic use and continuing research aimed at developing effective antimicrobial strategies to tackle this rising public health issue.

Table 2. Development of resistance to antibiotics in enterobacteriaceae species.

Antibiotic Resistance	Enterobacteriaceae
Ampicillin	170
Cefotaxime	142
Ciprofloxacin	118
Levofloxacin	59
Tetracycline	124
Ampicillin/sulbactam	162

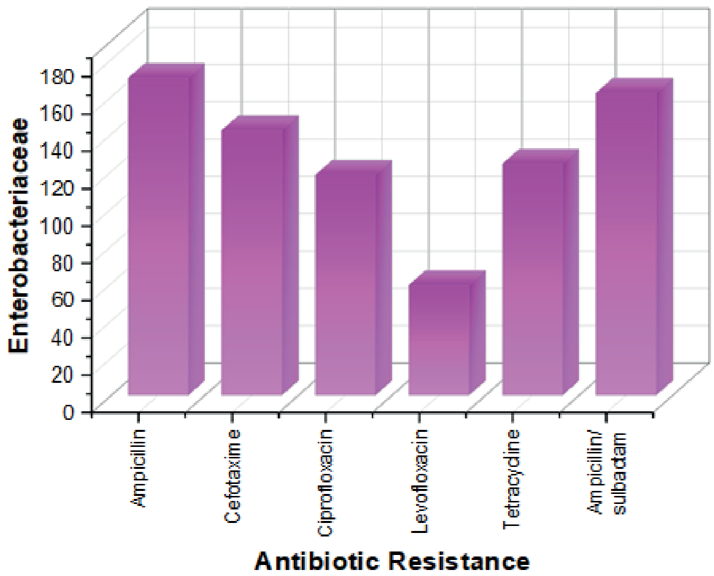

Figure 2. Antibiotic resistance in Enterobacteriaceae.

As presented in table 3 and figure 3, many important antibiotics like ciprofloxacin, levofloxacin, imipenem, ceftazidime and piperacillin have faced strong resistance from Pseudomonas aeruginosa. These findings are extremely significant for medical professionals as they provide key information that can help figure out the most appropriate way to treat patients and establish strategies to prevent antibiotic resistance in a clinical context. Managing infections can be challenging while dealing with Pseudomonas aeruginosa due to its natural or innate resistance mechanisms as well as ability of acquiring resistances through horizontal gene transfer. To tailor efficient and specific antimicrobial therapies, it is vital to have a complete understanding of the unique profiles of resistance displayed by this organism. With this information, medical professionals can improve patient outcomes as well as contribute to the worldwide effort to lessen the rising threat of antibiotic resistance by implementing infection control measures, optimizing medication regimens and using alternative therapies.

Table 3. The development of antibiotic resistance in Pseudomonas aeruginosa species.

Antibiotic Resistance	Pseudomonas aeruginosa
Ceftazidime	26
Piperacillin	18
Ciprofloxacin	13
Levofloxacin	10
Imipenem	11

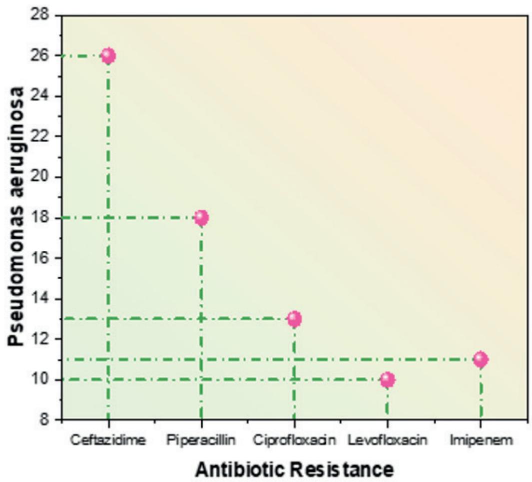

Figure 3. Antibiotic resistance in Pseudomonas aeruginosa.

Table 4 and figure 4 demonstrate the antibiotic resistance profiles of Enterococcus species, with Cefoxitin, Cefotaxime and Cefepime as the most common. Levofloxacin and Tetracycline resistance were observed. For the purpose of directing treatment choices and putting plans into place to manage antibiotic resistance in clinical settings, healthcare providers must take these results seriously. Understanding these specific resistance profiles is essential for effective and targeted antimicrobial therapy, as it is significant in healthcare-associated infections.

Table 4. The development of resistance to antibiotics in Staphylococcus species.

Antibiotic Resistance	Enterococcus species
Cefoxitin	23
Cefotaxime	23
Cefepime	23
Levofloxacin	17
Tetracycline	17

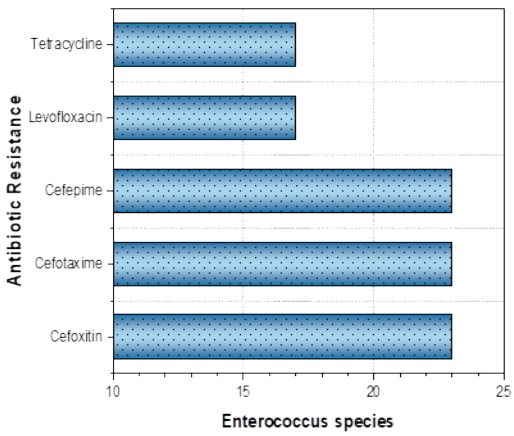

Figure 4. Antibiotic resistance in Staphylococcus.

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The bacteria known to cause several illnesses, Staphylococcus aureus, have patterns of antibiotic resistance that are shown in table 5 and figure 5. The statistics indicate the number of cases where Staphylococcus aureus has demonstrated antibiotic resistance. In particular, resistance to ampicillin (24 instances), cefotaxime (20 cases), levofloxacin (4 cases), cefoxitin (6 cases) and cotrimoxazole (12 cases) have been reported. Because Staphylococcus aureus strains are becoming resistant to antibiotics, healthcare providers need this knowledge to develop successful treatment plans. It contributes to the overall efforts to manage antibiotic resistance in clinical settings by helping to guide the selection of appropriate medications to treat illnesses brought through these microorganisms.

Table 5. The development of resistance to antibiotics in Enterococcus species.

Staphylococcus aureus	Antibiotic resistance
24	Ampicillin
20	Cefotaxime
4	Levofloxacin
6	Cefoxitin
12	Cotrimoxazole

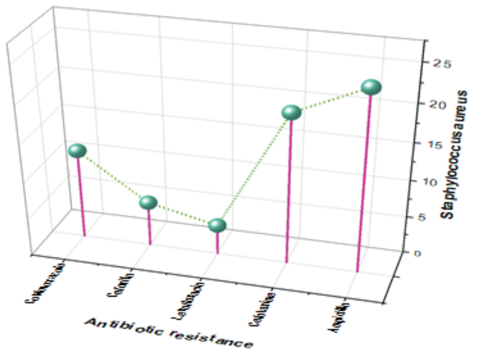

Figure 5. Antibiotic resistance in Enterococcus species

DISCUSSION

The research explores the complex relationship between antibiotic susceptibility and microbial changes in the high-stakes setting of the ICU. The research highlights the vital necessity for ongoing monitoring of these dynamic interactions, acknowledging the fundamental relevance of customizing treatment programs, exercising caution when using antibiotics, and improving patient outcomes while reducing the rise of antibiotic-resistant bacteria. The research, which was carried out in a hospital, uses a large dataset that includes the personal and medical histories of 312 ICU patients. This thorough investigation highlights the predominance of Pseudomonas species and uncovers the leading microbial compositions in this difficult environment. In-depth profiles of antibiotic resistance are also provided by the research, which highlights the urgent need to address resistance concerns in important organisms such Pseudomonas aeruginosa, Enterococcus species, Staphylococcus aureus, and Enterobacteriaceae. Recognizing the difficulties in maintaining a careful equilibrium between the need for prompt replies and the accuracy of data gathering, the research emphasizes the concrete advantages of identifying these changing patterns. These benefits include the capacity to apply customized therapies, proactively track resistance patterns, and stimulate research into the creation of new medications. The results of the research highlight the complexity of the ICU setting and the critical importance of stringent infection control protocols focused antibiotic regimens, and ongoing observation. This multidisciplinary approach is intended to protect patient outcomes in the dynamic, constantly changing field of intensive care unit medicine.

CONCLUSION

An in-depth understanding of the intricate interactions between infectious disorders and antibiotic resistance is provided by the extensive research on microbiological trends and drug susceptibility among ICU-admitted patients carried out at a hospital. The research findings highlight the need of individualized treatment plans and strong infection control protocols in critical care environments, which makes a substantial contribution to the larger healthcare context. The research demonstrates the significant obstacles that Gram-negative bacterial infections in intensive care units present, including the rise of antibiotic-resistant strains with restricted treatment alternatives. It emphasizes how important prompt and focused antibiotic therapy is to reducing the morbidity and death brought on by these illnesses. The increasing prevalence of antibiotic resistance highlights the need for ongoing surveillance and monitoring to guide clinical decision-making, particularly with regard to Gram-negative bacteria such as Acinetobacterbaumannii. The research specifically examines the resistance patterns of important pathogens as Pseudomonas aeruginosa, Enterococcus species, Klebsiella species, and Staphylococcus aureus. The research findings about the significant incidence of antibiotic resistance in these organisms emphasize how urgent it is to implement responsible antibiotic prescribing practices and look into alternative treatment approaches. When it comes to developing successful treatment plans, healthcare professionals can gain useful insights from the comprehensive analysis of resistance patterns for every infection.

Limitations and Future Research

The research looks at how antibiotic resistance affects critically sick ICU patients by concentrating on customized treatment plans, continuous monitoring, and new treatment approaches. It draws attention to the strict antibiotic susceptibility testing procedures that are employed, as well as the necessity of specific therapies and intense care. The results can direct medical professionals, have an impact on policy choices, and stimulate more research to maintain antibiotic effectiveness and control infectious diseases in critical care settings.

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