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DESTRUCTIVE BACTERIAL INFLAMMATIONS: MICROBIOLOGICAL SPECTRUM AND DYNAMICS OF ANTIBIOTIC SUSCEPTIBILITY

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Abstract: Destructive bacterial inflammations represent a group of severe infections characterized by tissue necrosis, systemic inflammatory response, and often life-threatening complications. The present study investigates the etiological structure, evolving microbial spectrum, and the dynamics of antibiotic susceptibility in patients diagnosed with destructive infectious diseases. Microbiological analysis of clinical specimens from 400 patients revealed a dominance of multidrug-resistant (MDR) pathogens, including MRSA, ESBL-producing Klebsiella pneumoniae, Pseudomonas aeruginosa, and Acinetobacter baumannii. Antibiotic susceptibility testing showed a progressive decline in carbapenem effectiveness, with colistin and glycopeptides retaining relatively high activity. The study emphasizes the importance of continuous microbiological monitoring and personalized empirical therapy protocols based on local resistance patterns.

Keywords: Destructive inflammation, multidrug-resistant bacteria, antimicrobial resistance, microbiological surveillance, empirical antibiotic therapy, MRSA, ESBL, carbapenem-resistant pathogens.

Introduction

Destructive bacterial inflammations are a category of infections that involve rapid tissue destruction, necrosis, and the formation of abscesses, accompanied by severe systemic responses, including sepsis and multi-organ dysfunction. These infections commonly manifest as necrotizing pneumonia, empyema, osteomyelitis, necrotizing fasciitis, and abdominal sepsis. Their clinical course is often aggressive, requiring immediate diagnosis and urgent surgical and antimicrobial interventions [1–3].

The global burden of such infections has increased, in part due to the growing incidence of antibiotic-resistant pathogens. In nosocomial environments, Gram-negative bacilli such as Klebsiella pneumoniae, Pseudomonas aeruginosa, and Acinetobacter baumannii, as well as Gram-positive organisms like methicillin-resistant Staphylococcus aureus (MRSA), have become leading causes of destructive infections. Their resistance mechanisms include the production of extended-spectrum beta-lactamases (ESBL), carbapenemases, efflux pumps, and biofilm formation [4–6].

The inadequate selection of empirical antibiotics, delayed diagnosis, and insufficient infection control measures exacerbate the severity of these infections. The World Health Organization (WHO) and European Centre for Disease Prevention and Control (ECDC) have highlighted antimicrobial resistance as one of the top threats to global public health [7,8]. Effective management of destructive infections depends on a precise understanding of the

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microbial landscape and dynamic resistance profiles. This study aims to analyze the current microbiological patterns and antibiotic susceptibility trends associated with destructive bacterial inflammations, based on a large clinical dataset collected over three years in specialized tertiary medical centers.

Materials and Methods

This prospective observational study was conducted between 2022 and 2024 and included 400 patients admitted to tertiary care centers with clinically and radiologically confirmed destructive infections. The patient cohort comprised a wide age range (3 to 79 years), including both community-acquired and hospital-acquired infection cases.

Sample Collection and Microbiological Identification:

Samples included pus, pleural effusion, bronchoalveolar lavage, bone tissue, and blood cultures. Specimens were processed in BSL-2 certified laboratories. Bacterial species were identified using MALDI-TOF mass spectrometry and traditional biochemical methods.

Antibiotic Susceptibility Testing (AST):

AST was conducted using both disk diffusion (Kirby-Bauer) and broth microdilution methods in accordance with CLSI and EUCAST standards. The following antibiotics were tested:

- **Beta-lactams:** Penicillins, cephalosporins, carbapenems
- **Glycopeptides:** Vancomycin, teicoplanin
- **Aminoglycosides:** Gentamicin, amikacin
- **Polymyxins:** Colistin
- **Oxazolidinones:** Linezolid
- **Tetracycline derivatives:** Tigecycline
- **Fluoroquinolones:** Ciprofloxacin, levofloxacin

Data Analysis:

Descriptive and inferential statistics were applied. Trends in antibiotic susceptibility were analyzed using χ^2 tests for proportions across the three-year period.

Results

Microbiological Etiology

A total of 400 isolates were analyzed. The leading causative agents of destructive infections were:

Bacterial Species	**Frequency (%)**
Staphylococcus aureus (incl. MRSA)	28%
Klebsiella pneumoniae (ESBL+, CRE)	21%

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Pseudomonas aeruginosa	18%
Escherichia coli (ESBL+)	14%
Acinetobacter baumannii	10%
Anaerobes (Bacteroides spp.)	6%
Others (e.g., Enterococci, Proteus)	3%

MRSA was predominantly isolated from osteomyelitis and soft-tissue infections. K. pneumoniae and A. baumannii were most common in necrotizing pneumonia and empyema cases. P. aeruginosa and E. coli showed polymicrobial associations in intra-abdominal abscesses and diabetic foot infections.

Antibiotic Susceptibility Dynamics:

Resistance patterns were alarming in many of the identified strains:

Pathogen	**Meropenem (%)**	**Vancomycin (%)**	**Ceftazidime (%)**	**Colistin (%)**
MRSA	–	90	22	–
K. pneumoniae (ESBL+)	34	–	30	84
P. aeruginosa	48	–	41	76
A. baumannii	18	–	15	72
E. coli (ESBL+)	42	–	25	78

Meropenem resistance increased from 39% in 2022 to 62% in 2024 among K. pneumoniae and P. aeruginosa. Colistin retained the highest effectiveness across all MDR pathogens. Vancomycin susceptibility remained above 90% for MRSA.

Discussion

Our findings reflect global trends of increasing resistance among key bacterial pathogens involved in destructive infections. The growing prevalence of carbapenem-resistant K. pneumoniae and A. baumannii is especially concerning, as these organisms are associated with high morbidity, mortality, and limited therapeutic options [6,9].

The emergence of pan-drug-resistant isolates, especially among ICU patients, underscores the need for rapid diagnostic tools, antibiotic stewardship, and surveillance

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networks. Empirical therapy should be based on local antibiograms, and de-escalation should follow culture results.
Infection control protocols, including hand hygiene, environmental cleaning, and isolation of infected patients, are equally critical to limit nosocomial transmission. Furthermore, innovative approaches such as phage therapy and novel antimicrobials are being explored to combat MDR pathogens.

Conclusion

Destructive bacterial inflammations are increasingly caused by multidrug-resistant organisms, particularly in healthcare settings. Our study highlights the evolving microbial etiology and alarming resistance patterns, especially against carbapenems and cephalosporins. The implementation of rigorous microbiological surveillance and tailored empirical antibiotic regimens is vital to improving patient outcomes and mitigating the AMR crisis.

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