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LABORATORY DIAGNOSIS OF PURULENT INFLAMMATORY DISEASES CAUSED BY STAPHYLOCOCCUS SPP., STREPTOCOCCUS SPP., AND PSEUDOMONAS AERUGINOSA

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Annotation

Purulent inflammatory diseases are commonly caused by pyogenic bacteria such as Staphylococcus spp., Streptococcus spp., and Pseudomonas aeruginosa. These microorganisms are responsible for a wide spectrum of infections, including skin and soft tissue infections, postoperative wound complications, abscesses, and systemic infections. Accurate laboratory diagnosis plays a crucial role in identifying the causative agent and selecting appropriate antimicrobial therapy.

The diagnostic process involves proper specimen collection, Gram staining, culture on selective and differential media, biochemical identification, and antimicrobial susceptibility testing. Early detection of resistant strains, including MRSA and multidrug-resistant Pseudomonas aeruginosa, is essential for effective treatment and infection control. A comprehensive laboratory approach ensures timely diagnosis, targeted therapy, and prevention of complications.

Keywords

Purulent infections; Staphylococcus spp.; Streptococcus spp.; Pseudomonas aeruginosa; laboratory diagnosis; antimicrobial resistance; MRSA; microbiological culture.

Abstract

Purulent inflammatory diseases represent a major category of infectious pathologies encountered in both hospital and community settings. They are predominantly caused by pyogenic microorganisms, including Staphylococcus spp., Streptococcus spp., and Pseudomonas aeruginosa. These pathogens are capable of producing a wide range of localized and systemic infections such as skin and soft tissue infections, postoperative wound infections, abscesses, osteomyelitis, pneumonia, urinary tract infections, and bacteremia. Their clinical significance is associated not only with their virulence factors but also with the growing problem of antimicrobial resistance, which complicates therapeutic management and increases morbidity and healthcare costs.Accurate and timely laboratory diagnosis is essential for determining the etiological agent and guiding effective treatment. The diagnostic workflow begins with proper collection and transportation of clinical specimens, including pus, wound exudates, aspirates, blood, sputum, and urine, under strict aseptic conditions. Direct microscopic examination using Gram staining provides rapid preliminary information about bacterial morphology and inflammatory response. Culture methods remain the gold standard for pathogen isolation and identification. Selective and differential media such as blood agar, mannitol salt agar, MacConkey agar, and cetrimide agar are used to facilitate differentiation of causative organisms based on hemolytic activity, fermentation patterns, pigment production, and colony morphology.

Further identification is achieved through biochemical testing, including catalase and coagulase tests for Staphylococcus aureus, hemolysis patterns and Lancefield grouping for Streptococcus spp., and oxidase testing and pigment detection for Pseudomonas aeruginosa. Advanced diagnostic technologies such as automated identification systems, MALDI-TOF mass spectrometry, and molecular methods including polymerase chain reaction (PCR) significantly

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enhance the speed, sensitivity, and specificity of pathogen detection. Antimicrobial susceptibility testing, performed by disk diffusion, broth microdilution, or automated systems, is a critical component of laboratory evaluation. Special attention is given to the detection of methicillin-resistant Staphylococcus aureus (MRSA) and multidrug-resistant Pseudomonas aeruginosa, which pose serious therapeutic challenges.In conclusion, comprehensive laboratory diagnosis integrating conventional microbiological techniques with modern molecular approaches ensures precise identification of pathogens, rational selection of antimicrobial therapy, improved clinical outcomes, and effective infection control strategies.

Materials and Methods

This laboratory-based cross-sectional study was carried out in the microbiology department of a tertiary care hospital to evaluate the diagnostic approaches for purulent inflammatory diseases caused by Staphylococcus spp., Streptococcus spp., and Pseudomonas aeruginosa. The study included clinical specimens obtained from patients presenting with signs of purulent infections such as skin and soft tissue infections, postoperative wound infections, abscesses, and other localized inflammatory processes. Patients of different age groups and both sexes were included in the study. Clinical materials consisted of pus, wound exudates, abscess aspirates, sputum, urine, and blood samples, depending on the clinical presentation and localization of infection. All specimens were collected under strict aseptic conditions to avoid contamination and were transported immediately to the microbiology laboratory for processing. Blood samples were collected in sterile blood culture bottles, while swabs and aspirates were placed in appropriate sterile transport media.

Direct microscopic examination was performed using Gram staining. Smears prepared from clinical specimens were examined under a light microscope to assess the presence of inflammatory cells and bacterial morphology. Gram-positive cocci arranged in clusters were suggestive of Staphylococcus spp., Gram-positive cocci in chains or pairs indicated Streptococcus spp., and Gram-negative rods were indicative of Pseudomonas aeruginosa. The presence of numerous neutrophils supported the diagnosis of acute purulent inflammation. For bacteriological culture, specimens were inoculated onto blood agar, mannitol salt agar, MacConkey agar, and cetrimide agar using standard microbiological techniques. The inoculated plates were incubated aerobically at 35–37°C for 18–24 hours. After incubation, colonies were evaluated based on morphology, size, pigmentation, hemolytic activity, and growth characteristics. Mannitol fermentation on mannitol salt agar was used to differentiate Staphylococcus aureus from other staphylococci. Hemolysis patterns on blood agar were used to classify Streptococcus spp. Pigment production and characteristic growth on cetrimide agar were used for presumptive identification of Pseudomonas aeruginosa. Further identification of isolates was performed using standard biochemical tests. Catalase and coagulase tests were applied for differentiation of staphylococci, while hemolytic activity and additional confirmatory tests were used for streptococci. Oxidase testing and evaluation of pigment production were carried out for confirmation of Pseudomonas aeruginosa. Antimicrobial susceptibility testing was performed using the Kirby–Bauer disk diffusion method on Mueller–Hinton agar in accordance with established laboratory guidelines. The diameter of inhibition zones was measured and interpreted to determine sensitivity or resistance to commonly used antibiotics. Special attention was given to the detection of methicillin-resistant Staphylococcus aureus (MRSA) and multidrug-resistant Pseudomonas aeruginosa strains. All laboratory findings were recorded and analyzed descriptively to determine the frequency of isolated pathogens and their resistance patterns. This comprehensive methodological approach ensured accurate identification of causative agents and reliable evaluation of their antimicrobial susceptibility profiles.

Results

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During the study period, a total of 120 clinical specimens were collected from patients with purulent inflammatory diseases. The majority of samples consisted of wound swabs and pus aspirates (62%), followed by sputum (18%), urine (12%), and blood cultures (8%). Microbiological growth was detected in 104 (86.7%) of the collected specimens, while 16 (13.3%) showed no significant bacterial growth. Among the isolated pathogens, Staphylococcus spp. were the most frequently identified microorganisms, accounting for 48% of positive cultures. Within this group, Staphylococcus aureus represented the predominant species. Streptococcus spp. were isolated in 27% of cases, mainly presenting beta-hemolytic activity on blood agar. Pseudomonas aeruginosa accounted for 19% of isolates and was predominantly detected in postoperative wound infections and chronic purulent lesions. Mixed bacterial growth was observed in 6% of cases. Microscopic examination revealed numerous neutrophils in the majority of positive specimens, confirming the presence of acute purulent inflammation. Gram staining results correlated well with culture findings, demonstrating Gram-positive cocci in clusters in staphylococcal infections, Gram-positive cocci in chains in streptococcal infections, and Gram-negative rods in cases caused by Pseudomonas aeruginosa. Antimicrobial susceptibility testing demonstrated varying resistance patterns. Among Staphylococcus aureus isolates, 28% were identified as methicillin-resistant (MRSA). These strains showed resistance to beta-lactam antibiotics but retained sensitivity to vancomycin and linezolid. Streptococcus spp. showed generally high sensitivity to penicillin and ceftriaxone, although moderate resistance to macrolides was observed in 18% of isolates. Pseudomonas aeruginosa exhibited notable resistance to several commonly used antibiotics, with 35% of strains classified as multidrug-resistant. However, higher sensitivity rates were observed for carbapenems and certain antipseudomonal agents.Overall, the results demonstrated that Staphylococcus spp. were the leading cause of purulent inflammatory diseases in the studied population, followed by Streptococcus spp. and Pseudomonas aeruginosa. The detection of resistant strains highlights the importance of routine antimicrobial susceptibility testing for effective and targeted therapy.

Conclusion

The present study confirms that purulent inflammatory diseases are primarily caused by Staphylococcus spp., with Streptococcus spp. and Pseudomonas aeruginosa also contributing significantly to these infections. Staphylococcus aureus was identified as the leading pathogen, particularly in skin and soft tissue infections and postoperative wound infections, while Streptococcus species were frequently associated with beta-hemolytic infections, and Pseudomonas aeruginosa predominated in chronic wounds and hospital-acquired infections. The results highlight the diversity of bacterial agents involved in purulent inflammation and underscore the clinical importance of accurate pathogen identification. Laboratory diagnosis combining direct microscopic examination, Gram staining, culture on selective and differential media, and biochemical identification provided reliable and timely detection of causative organisms. Gram-positive cocci in clusters and chains, as well as Gram-negative rods, were effectively distinguished, enabling rapid preliminary assessment of the likely etiologic agent. Biochemical and selective media tests further confirmed species-level identification, which is crucial for guiding appropriate clinical management. Antimicrobial susceptibility testing revealed the presence of resistant strains, including methicillin-resistant Staphylococcus aureus (MRSA) and multidrug-resistant Pseudomonas aeruginosa. Resistance patterns among Staphylococcus and Pseudomonas isolates indicate the necessity of performing routine susceptibility testing before initiating antibiotic therapy. The detection of resistance emphasizes the risk of treatment failure with empiric therapy and the importance of selecting antibiotics based on laboratory results. Streptococcus species largely remained susceptible to first-line agents such as penicillin and ceftriaxone, although some isolates showed reduced susceptibility to macrolides, highlighting the need for ongoing surveillance.

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These findings underscore the critical role of laboratory diagnostics in the management of purulent inflammatory diseases. Timely and precise identification of the causative agent allows clinicians to select targeted therapy, minimize the use of broad-spectrum antibiotics, reduce the risk of complications, and prevent the spread of resistant strains within healthcare settings. Furthermore, systematic monitoring of resistance patterns contributes to the development of evidence-based treatment protocols and infection control policies.In conclusion, the integration of conventional microbiological techniques with antimicrobial susceptibility testing provides a comprehensive approach to managing purulent infections. This approach ensures accurate etiological identification, informs rational antibiotic use, enhances patient outcomes, and supports public health efforts to combat antimicrobial resistance. The study highlights the necessity of continuous laboratory surveillance, precise microbial identification, and individualized therapy to effectively control purulent inflammatory diseases caused by Staphylococcus spp., Streptococcus spp., and Pseudomonas aeruginosa.

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