Section: Microbiology

Case Series

ROLE OF LABORATORY-BASED SURVEILLANCE IN INFECTION CONTROL OF STREPTOCOCCUS PNEUMONIAE: A CASE SERIES

Saranya CK[1], Regha IR[2], Roopak Suresh[3]

[1]Assistant Professor, Department of Microbiology, Sree Narayana Institute of Medical Sciences, Kochi, India.
[2]Professor &HOD, Department of Microbiology, Sree Narayana Institute of Medical Sciences, Kochi, India.
[3]Assistant Professor, Department of Surgery, Sree Narayana Institute of Medical Sciences, Kochi, India.

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Corresponding Author:
Dr. Saranya CK,
Assistant Professor, Department of Microbiology, Sree Narayana Institute of Medical Sciences, Kochi, India.
Email: drsaranyack@gmail.com

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ABSTRACT

Background: *Streptococcus pneumoniae* is a leading cause of lower respiratory tract infection in older adults with chronic lung disease but is seldom regarded as a healthcare-associated pathogen. This study aimed to describe the role of laboratory-based surveillance in the early detection of a cluster of *S. pneumoniae* isolates and in guiding timely infection control interventions in a tertiary care hospital.

Materials and Methods: This retrospective case series included six adult inpatients of the pulmonary ward whose sputum samples yielded *S. pneumoniae* on routine culture within a one-week period. Demographic, clinical and microbiological data were analysed descriptively. Infection control interventions followed cluster recognition, and ward surveillance was continued.

Results: Patients were aged 52 to 82 years, and five were male. Chronic obstructive pulmonary disease (COPD) and previously treated pulmonary tuberculosis were the predominant comorbidities; others included type 2 diabetes mellitus, hypertension, chronic liver disease and hypothyroidism. Cough was the predominant symptom, with wheeze, dyspnoea or fever in most patients. Two patients developed acute respiratory failure. Three patients had an acute exacerbation of COPD and three had a lower respiratory tract infection. *S. pneumoniae* was the only pathogen isolated. Reinforced hand hygiene, respiratory etiquette, contact and droplet precautions, enhanced environmental cleaning and patient cohorting were instituted, after which no further isolates were detected.

Conclusion: Laboratory-based ward surveillance enabled early recognition of a cluster of *S. pneumoniae* infections and prompted coordinated infection control measures, after which further cases ceased. Clustering of pathogens traditionally considered community-acquired warrants prompt investigation in high-risk wards.

Keywords: *Streptococcus pneumoniae*; Cross Infection; Infection Control; Population Surveillance; Pulmonary Disease, Chronic Obstructive.

INTRODUCTION

Streptococcus pneumoniae is a Gram-positive, alpha-hemolytic bacterium and a major cause of respiratory infections globally, including community-acquired pneumonia, invasive pneumococcal disease, and bacteremia, particularly in older adults and individuals with chronic comorbidities such as chronic obstructive pulmonary disease and diabetes mellitus.[1-3] In adults, S. pneumoniae remains one of the most frequent bacterial pathogens leading to hospitalization for pneumonia, with increased severity and mortality in elderly or immunocompromised populations.[1,3] Adult pneumococcal disease burden continues to be substantial despite advances in vaccination and antimicrobial therapy, and non-vaccine serotypes

have emerged as important contributors to disease in the post-pneumococcal conjugate vaccine era.[4-6]

Hospital-acquired infections are recognized as significant adverse events in healthcare settings, associated with increased morbidity, mortality, and healthcare costs.[7,8] Surveillance of healthcare-associated infections is a core component of effective infection prevention and control programs, as it enables early detection of unusual pathogen clusters and prompt intervention to prevent spread.[7,8] Pneumonia that develops ≥48 hours after hospital admission, defined as hospital-acquired pneumonia, represents one of the most common healthcare-associated infections and is associated with high mortality rates compared with other nosocomial infections.[9,10] While classical hospital-acquired pneumonia etiologies include gram-negative bacilli and Staphylococcus aureus, S. pneumoniae has also been identified in a subset of hospital-acquired pneumonia episodes, underscoring the importance of continuous microbiological surveillance in respiratory wards.[9-11]

Laboratory-based surveillance integrates clinical, microbiological, and epidemiological data to monitor pathogen trends, detect clusters, and support infection prevention and control measures.[7,14] Active microbiology surveillance has been shown to reduce healthcare-associated infection rates when combined with effective infection prevention practices such as hand hygiene reinforcement, standard and contact precautions, and environmental cleaning.[7,14] Automated surveillance systems leveraging electronic health records and advanced analytics are increasingly recognized as valuable tools for improving detection timeliness and accuracy.[7,15] In high-risk units such as pulmonary wards managing patients with chronic lung disease and frequent antibiotic exposure, laboratory surveillance enables early recognition of patterns that may signal increased transmission within the healthcare environment.[14]

Globally, pneumococcal disease surveillance systems track trends in invasive disease and inform vaccine policy and clinical management.[2,16] Surveillance data demonstrate persistent circulation of multiple pneumococcal serotypes in adult populations, with temporal changes influenced by vaccination strategies, serotype replacement, and local epidemiology.[4,6,17] Continuous monitoring of serotype distribution and antimicrobial resistance profiles remains essential for optimizing empirical treatment guidelines and vaccine recommendations, particularly in high-risk adult cohorts.[6,17,18]

Patients with underlying respiratory conditions such as chronic obstructive pulmonary disease are at increased risk for both community- and healthcare-associated pneumococcal infections due to impaired pulmonary defense mechanisms and repeated healthcare exposure.[1,3,19] Clinical manifestations range from cough, fever, and dyspnea to severe complications including bacteremia and acute respiratory failure.[1,3] Although non-invasive pneumococcal disease is not universally captured by national surveillance systems, laboratory identification of S. pneumoniae from respiratory specimens provides critical epidemiological insight and supports timely infection prevention responses when clustering is detected.[2]

An abrupt increase in S. pneumoniae isolates from sputum specimens within a confined time period and ward setting suggests a potential cluster event rather than coincidental community acquisition. Such observations necessitate an integrated response involving clinicians, microbiologists, and infection prevention teams to mitigate onward transmission.[9,14] Recent infection prevention guidelines emphasize systematic surveillance, trend analysis, and rapid multidisciplinary communication as essential components of effective healthcare-associated infection prevention programs.[7,14]

In summary, Streptococcus pneumoniae remains a clinically significant respiratory pathogen with evolving epidemiology shaped by host susceptibility, vaccination practices, and healthcare exposure. Robust laboratory-based surveillance within tertiary care hospitals is essential for early detection of clustering events, implementation of targeted infection prevention measures, and improvement of patient outcomes in high-risk clinical environments such as pulmonary wards.

Objectives

To describe the role of laboratory-based surveillance in the early detection of clustered Streptococcus pneumoniae infections and its impact on guiding timely infection control interventions in a tertiary care hospital.

Case Series Description

This retrospective case series comprises six adult patients admitted to the pulmonary ward of a tertiary care hospital over a one-week period, in whom Streptococcus pneumoniae was isolated from sputum samples during routine microbiological processing. All isolates were identified within a narrow temporal window and originated from the same inpatient ward, prompting further evaluation for a potential clustering event.

The patients ranged in age from 52 to 82 years, with a predominance of elderly males (five males, one female). Most patients had significant underlying respiratory comorbidities, including chronic obstructive pulmonary disease and a history of treated pulmonary tuberculosis. Additional comorbid conditions included type 2 diabetes mellitus, systemic hypertension, dyslipidemia, chronic liver disease with portal hypertension, and hypothyroidism. Several patients had a history of recurrent respiratory infections or prior pneumonia, indicating heightened baseline vulnerability to lower respiratory tract infections.

Clinical presentation was broadly consistent across cases and dominated by respiratory symptoms. All patients presented with cough, with associated wheeze, dyspnea, or fever in the majority. Two patients developed acute respiratory failure, one

classified as type 1 and the other as type 2, necessitating closer respiratory monitoring. On physical examination, bilateral rhonchi and/or crepitations were common findings, reflecting lower airway involvement. No extrapulmonary focus of infection was identified in any patient.

Sputum specimens were collected as part of standard diagnostic evaluation for suspected lower respiratory tract infection or acute exacerbation of chronic lung disease. Microbiological culture of all six samples yielded Streptococcus pneumoniae, identified by alpha-haemolytic colonies on blood agar, optochin susceptibility and demonstration of the capsule on India ink preparation (Figures 1–3). No concurrent bacterial respiratory pathogens were isolated from these specimens. The repeated recovery of the same organism from multiple patients within a short time interval and a single ward setting was considered epidemiologically significant.

All cases were managed according to institutional protocols for lower respiratory tract infection or acute exacerbation of chronic obstructive pulmonary disease, with antimicrobial therapy guided by microbiological results and clinical judgment. Following recognition of the cluster, the microbiology laboratory promptly communicated the findings to the infection control team and treating clinicians. Standard and contact precautions were reinforced for healthcare workers and patients in the pulmonary ward, with emphasis on respiratory hygiene, hand hygiene compliance, and appropriate use of personal protective equipment. Enhanced environmental cleaning measures were also implemented.

Following these interventions, no additional cases of Streptococcus pneumoniae isolation from sputum were detected in the pulmonary ward during subsequent surveillance, suggesting effective containment of further transmission.

Table 1: Clinical Characteristics of Patients with Streptococcus pneumoniae Isolation

Age (years)	Sex	Presenting Symptoms	Relevant Comorbidities	Examination Findings	Final Diagnosis
82	M	Cough, wheeze, chest tightness	COPD, old pulmonary tuberculosis	Bilateral crepitations	Acute exacerbation of COPD with type 2 respiratory failure
65	M	Epistaxis, hematemesis	COPD, chronic liver disease, old pulmonary tuberculosis	Rhonchi, fine crepitations	Acute exacerbation of COPD
67	M	Cough, wheezing	Type 2 diabetes mellitus, hypertension, dyslipidemia	Bilateral rhonchi	Lower respiratory tract infection
52	F	Fever, cough, dyspnea	Hypothyroidism	Bilateral rhonchi	Lower respiratory tract infection
65	M	Cough, shortness of breath	Prior pneumonia	Scattered crepitations	Lower respiratory tract infection
75	M	Cough, fever, dyspnea	COPD, old pulmonary tuberculosis	Bilateral rhonchi	Acute exacerbation of COPD with type 1 respiratory failure

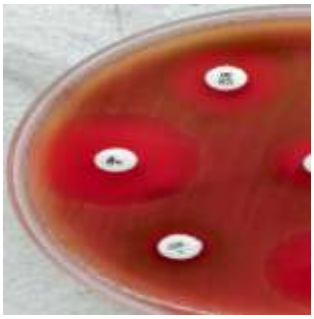


Figure 1: Optochin susceptibility test showing a zone of inhibition around the optochin disc, consistent with *Streptococcus pneumoniae*.



Figure 2: Alpha-haemolytic colonies of *Streptococcus pneumoniae* on blood agar, with greenish discolouration of the surrounding medium.



Figure 3: India ink preparation showing capsulated *Streptococcus pneumoniae*, with a clear halo around the organisms.

Infection Control Intervention

Following detection of multiple *Streptococcus pneumoniae* isolates from sputum samples originating from the pulmonary ward within a short time frame, the microbiology laboratory promptly notified the hospital infection control team and treating clinicians. The temporal and spatial clustering triggered a coordinated infection prevention response.

Standard infection prevention measures were reinforced across the ward, including strict hand hygiene compliance, respiratory etiquette, and appropriate use of personal protective equipment. Contact precautions were implemented for affected patients, with droplet precautions advised during close patient contact and aerosol-generating procedures. Environmental cleaning and disinfection of high-touch surfaces and shared respiratory equipment were intensified, and patient cohorting was applied where feasible to minimize cross-transmission.

Targeted communication was provided to healthcare workers to reinforce adherence to existing infection control protocols and maintain heightened vigilance for respiratory symptoms among inpatients. Continued laboratory surveillance after implementation of these measures did not identify any further *S. pneumoniae* isolates from the pulmonary ward, indicating effective containment.

DISCUSSION

This case series documents a temporal clustering of Streptococcus pneumoniae isolates from sputum specimens obtained from patients admitted to a pulmonary ward within a one-week period, emphasizing the value of laboratory-based surveillance in identifying unusual pathogen patterns that may not be apparent through routine clinical assessment alone.[20] Although S. pneumoniae is classically associated with community-acquired pneumonia, it continues to play a clinically relevant role in inpatient settings, particularly among elderly patients with chronic lung disease and previous pulmonary pathology.[21] Colonization of the respiratory tract, combined with impaired mucociliary clearance and frequent healthcare exposure, increases susceptibility to both infection and severe disease in this population.[21,22]

Healthcare-associated infections remain a major global patient safety concern, contributing to increased morbidity, mortality, and healthcare costs. Hospital-acquired pneumonia is among the most frequent and severe forms of healthcare-associated infection.[23] While gram-negative bacilli and Staphylococcus aureus are traditionally emphasized as predominant pathogens, S. pneumoniae has been identified in hospital-acquired and healthcare-associated pneumonia, particularly in early-onset cases and high-risk wards.[24] Repeated isolation of the same organism within a confined temporal and spatial setting warrants heightened epidemiological scrutiny, even when the pathogen is not classically considered nosocomial.[20,24]

The clustering observed in this pulmonary ward likely reflects a convergence of patient vulnerability, shared care environments, and increased opportunities for transmission.

Pulmonary wards represent intrinsically high-risk settings due to the concentration of patients with chronic respiratory disease, frequent aerosol-generating procedures, and shared respiratory equipment.[25] Although molecular typing was not performed, international infection prevention guidance supports early intervention based on epidemiological signals rather than waiting for definitive proof of transmission, particularly when patient safety may be compromised.[23,26]

Laboratory-based surveillance serves as a cornerstone of effective infection prevention and control programs. By integrating microbiological results with ward-level and temporal data, surveillance systems can identify emerging clusters and prompt timely interventions.[20,26] Reinforcement of standard precautions, including hand hygiene, respiratory etiquette, and appropriate use of personal protective equipment, remains fundamental to interrupting transmission of respiratory pathogens in healthcare settings.[25,27] Surveillance-driven feedback to clinical teams has been associated with improved compliance with infection prevention practices and reductions in healthcare-associated infection rates.[26,27]

Advances in digital health and automated surveillance platforms have further strengthened the capacity to detect healthcare-associated infection clusters. Systems that integrate laboratory data with electronic health records and ward location data can enhance early recognition of abnormal infection patterns and support rapid infection control responses.[28] Such approaches are particularly valuable in tertiary care hospitals, where patient complexity and high throughput increase the risk of unrecognized transmission events. In parallel, antimicrobial stewardship programs complement infection control efforts by optimizing antibiotic use and reducing selective pressure that may facilitate persistence and spread of pathogenic organisms.[27]

This case series has limitations. The absence of molecular typing limits the ability to confirm clonal relatedness among isolates, and differentiation between healthcare-associated acquisition and early detection of community-acquired infection remains challenging. Nonetheless, the temporal and ward-specific clustering identified through laboratory surveillance, coupled with the absence of additional cases following intervention, supports the effectiveness of the infection control response.[20,26]

In conclusion, this series reinforces the importance of laboratory-driven ward surveillance as an essential component of infection prevention frameworks. Even pathogens traditionally regarded as community-acquired, such as S. pneumoniae, may signal

potential transmission risks when clustering is detected. Early recognition, rapid communication, and coordinated infection control interventions are critical to safeguarding patient safety in high-risk inpatient settings.

CONCLUSION

This case series demonstrates the value of laboratory-based ward surveillance in identifying temporally clustered respiratory infections within a high-risk inpatient setting. The detection of multiple Streptococcus pneumoniae isolates from a single pulmonary ward over a short period prompted timely infection control interventions that were associated with cessation of further cases. These findings reinforce that even pathogens traditionally regarded as community-acquired may warrant heightened attention when clustering occurs in vulnerable hospital populations.

Integrated surveillance systems that combine microbiological data with ward-level clinical context enable early recognition of potential transmission events and support rapid, targeted infection prevention responses. Strengthening such surveillance frameworks, alongside

consistent adherence to standard infection control practices, is essential to mitigating healthcare-associated infection risks and safeguarding patient safety in tertiary care hospitals.

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