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Review Article

Epidemiology and Resistance Pattern in Microbial Pneumonia: A Review

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ABSTRACT

The pneumonia is a significant public health issue because it raises the mortality and morbidity in people of all ages (2.56 million deaths worldwide each year) and has high medical and financial expenses. The two types of pneumonia i.e. community-acquired pneumonia (CAP) and hospital-acquired pneumonia (HAP). The incidences of multi-drug resistance in gram negative bacteria create difficulty in treatment and have negative effect on patients' results. Antimicrobial resistance has also increased with passage of time. The goal of the current study was to describe microbial pneumonia with a focus on the pathogens' etiology, pathogenicity, epidemiology, resistance pathways, diagnosis updates, and vaccine issues in order to address the issue before it has serious consequences. When choosing an antibiotic medication, clinicians face a significant challenge due to the emergence of novel illnesses, the increase in bacteria with multiple medication resistance, and germs that are challenging to cure. It is demonstrated that the effectiveness of first antimicrobial treatment is a critical issue for mortality in pneumonia, it is imperative to manage and effectively guide adequate antibiotic treatment. This requires the knowledge of engagement of the numerous pathogens in etiology of pneumonia. Additionally, until microbiological data are known and prompt de-escalation cannot be conducted; broad-spectrum antibiotic therapy may occasionally be administered. An overview of the epidemiology, resistance trends, microbiological etiology, and microbial diagnostics of pneumonia is given in this review.

INTRODUCTION

In general, pneumonia is the presence of a recent lung infiltrate together with indicators that the infiltrate was caused by an infectious agent including viruses, bacteria, fungi, parasites or leukocytosis [1]. During bacterial

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pneumonia, one or more lung lobes are brought on by bacteria**.** CAP and HAP are two categories of pneumonia that can be categorized according to how the infection is acquired**.** A study explain that CAP is a lung-parenchyma infection which is not contracted from a hospital or other healthcare institution [2]. When pneumonia develops after 48 hours or longer of hospitalization, it is referred to as HAP or Ventilator-associated pneumonia (VAP) if mechanical support is involved [3]. Infections in lower respiratory tract (LRT; including bacterial pneumonia) accounts for about 2-3 million worldwide mortality each year, making them one of the greatest reason of mortality, with South Asia, Sub-Sahara Africa and Southeast Asia having the highest fatality rates [4]. Pathogenic bacteria can spread through the circulation, aspiration, or inhalation to cause bacterial pneumonia [5]. The most prevalent causes of typical pneumonia are *S. aureus*, *K. pneumoniae*, *H. influenzae*, *P. aeruginosa*, *M. catarrhalis*, and *E. coli*, whereas the most frequent causes of atypical pneumonia are L. *pneumophila, C. pneumoniae, and M. pneumonia* [6]. Despite the fact that *A. baumannii*, *E. coli*, *K. pneumoniae*, and *P. aeruginosa* are examples of gram-negative bacteria (GNB) frequently associated with HAP, *S. pneumoniae* still accounts for the majority of CAP cases in all age categories globally [7]. As a result of incorrect use and overuse of antibiotics, Drug resistance is quickly becoming recognized as a severe threat to global health [8]. Multidrug-resistant gram-negative bacteria (MDR-GNB) pneumonia is on the rise nowadays and has a harmful effect on patient health, demonstrating a change in disease patterns with GNB and their fast dissemination, chiefly in hospital environments [9]. The goal of that review is to provide a brief description of bacterial pneumonia with a focus on the epidemiology, pathophysiology, diagnostics, treatment and antibiotic resistance, so that the pertinent bodies may address the problem before it has significant effects**.**

Epidemiology of HAP

After urinary tract infections, HAP is the second-most typical nosocomial disease. HAP is a common issue in general wards, with a frequency of 5-15 cases/1000 hospital admissions (1.6 to 3.67 cases per 1000 admissions, on average) [10]. HAP can occur in up to 20% of patients who are hospitalized in an intensive care unit (ICU), with 60 to 70% of incidents taking place during mechanical ventilation. The occurrence of HAP in the ICU differs by physical region (Table 1) [11, 12]. According to a significant Italian research conducted in 120 intensive care unit (ICUs) with 32,473 patients, nearly 9.2% of all hospitalized patients in Europe experienced nosocomial infections, with pneumonia (more particularly, VAP) accounting for 47.8% of all ICU-acquired illnesses [13].In a prevalence survey conducted in 264 intensive care unit (ICUs) in Mexico, the prevalence of ICU-acquired infections was found to be 22.3%, with ventilator associated pneumonia (VAP) accounting for 42.1% of all infections [14].

Year	Country	Population	Study period	Prevalence Rate	Reference
1991	Spain	VAP	April 1987 to May 1988	78 (24%) per 322 cases	[15]
1991	Spain	VAP	January 1988 to November 1989	58 (21.9%) per 264 cases	[16]
2009	India	VAP	October 2006 to December 2007	22.94 per 1000 ventilator days	[17]
2014	European countries	VAP	6 months	14.6% in patients of age group 45-6417.0% in patients of age group 65-7412.8% in patients of age group ≥ 75	[18]
2007	Japan	VAP	July 2002 & June 2004	53.0% (7.3 cases/ 1000 patient/days)	[19]
2014	Spain	Non-ICU HAP	January 2006 and April 2008	95% (2.45 cases /1000 hospital admission)	[20]
2005	Spain	Non-ICU HAP	November 1997 to January 1999	3.35 cases/1000 hospital admission	[21]
2007	USA	HAP/VAP	2000 to 2003	0.37 cases/1000 hospital admission	[22]
2011	Iran	HAP/VAP	June 2008 and March 2009	6.9% NP, of which 72% were VAP	[23]

Table 1: Occurrence of HAP

Epidemiology of CAP

The actual frequency of CAP is unknown because it is not a reportable disease. Hospitalization is only necessary for 20 to 50% of CAP patients. A yearly prevalence of CAP in young adults in Europe varies from 1.09 to 1.24 in 1000 person and 1.53 to 1.72in 1000 people, and it rises with age (15 cases/1000 persons in individuals of 65 years' age. Men (in comparison to women) and patients around 65 years old were shown to have a higher chance of developing CAP, according to a research by Torres et al [24]. According to estimates, patients with CAP have a death rate that ranges from 1-5% in outpatient settings, from 5.8-14.1% in regular wards, and from 33-50% in intensive care units (mainly in ventilated patient) [25]. The Pneumonia Patient Outcomes Research Team cohort research included CAP patients and the patients' death rates were 8.9% within 90 days of presentation, 29.1% within one year, and 25.3% within five years [26].

Microbial Etiology of Hospital Acquired Pneumonia (HAP)

The environment around hospitals and a patient's own micro biomes is the main sources of HAP infections. Depending on the patient demographic, the ICU conditions, the state, and the type of presentation, various microbes are the cause of HAP in the ICU (early- or late-onset) [27]. Figure 1 shows that six pathogens (Staphylococcus Aureus, Escherichia Coli, Klebsiella species, Acinetobacter species, Pseudomonas Aeruginosa, and Enterobacter species) are thought to be conscientious intended for around 80% of HAP instances [28].

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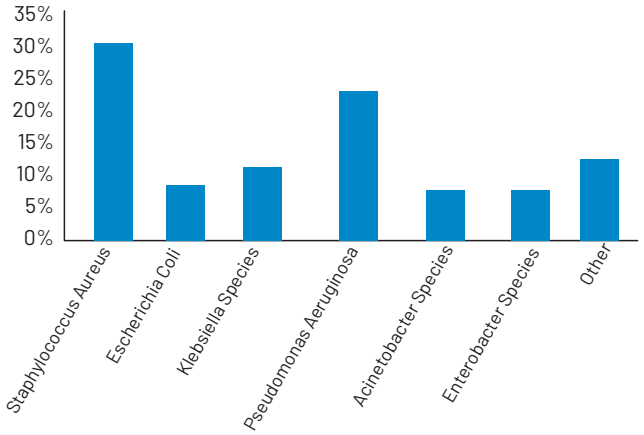

Figure 1: Microbial Etiology of HAP

Microbial Etiology Of Cap: Studies have shown varying percentages of pathogenic bacteria linked to CAP, and these percentages are likely a result of a variety of local epidemiological variables, patient characteristics(e.g. sex, age), and location (outpatients, hospitalized, or ICU).However, it is commonly acknowledged that S. pneumoniae, which may cause CAP in patients [29]. Up to 37% of CAP in patients receiving outpatient treatment is caused by M. pneumoniae, and 10% of cases needed hospitalization. The L. pneumophila pneumonia causes nearly 2-6% of CAP in the immunosuppressed patients, while C. pneumoniae causes 5 to 15% of CAP cases [30, 31]. The main infections responsible for CAP are listed in Table 2

Outdoor patients	Hospitalized (Non- Intensive Care Unit Patients)	Intensive Care Unit Patients
Chlamydia Pneumoniae	Chlamydia pneumoniae	Haemophilus influenzae
Streptococcus Pneumoniae	Streptococcus pneumoniae	Staphylococcus aureus
Haemophilus Influenzae	Legionella pneumophila	Streptococcus pneumoniae
Mycoplasma Pneumoniae	Mycoplasma pneumoniae	Respiratory Viruses
Respiratory Viruses: Influenza A and B	Haemophilus influenzae	Legionella pneumophila
	Respiratory Viruses	Pseudomonas aeruginosa

Table 2: Microbial etiology of CAP

Methods for Determining Pneumonia

Detecting antigens in urine and respiratory specimens, blood cultures, microscopy and culture of respiratory tract specimens and recognition of particular antibodies within blood are still employed often in the regular laboratory examination of patients with pneumonia as shown in Table 3[32].

Diagnosis	Specimen Types
Bacterial Culture	Blood, sputum, pleural fluid, lung aspirates, bronchoscopic specimens
Viral Culture	Nasopharyngeal specimens, oropharyngeal specimens, sputum, lung aspirates, bronchoscopic specimens
Mycobacterial Culture	Blood, sputum, pleural fluid, lung aspirates, bronchoscopic specimens, gastric aspirates
Antibody Detection	Serum
Antigen Detection	Nasopharyngeal specimens, oropharyngeal specimens, urine, pleural fluid
NAD	Nasopharyngeal specimens, oropharyngeal specimens, sputum, lung aspirates, pleural fluid, bronchoscopic specimens, blood

Table 3: Diagnostic Techniques for Determining the Cause of Pneumonia.

Antibiotic Resistance: In the last two decades, antibiotic resistance has grown globally. Nevertheless, measures like the conjugated pneumococcal vaccination, which protects against the serotypes most probable to show resistance, have prevented a rise in the death rates associated with S. pneumoniae that is resistant to antibiotics [33]. Many medicines including cephalosporin, fluoroquinolone, macrolide and penicillin no longer effective against some pneumococcal strains(Table4)[34]. P. aeruginosa in CAP is uncommon and those who have underlying conditions are more susceptible to be impacted by this pathogen are cystic fibrosis, chronic obstructive pulmonary disease, and bronchiectasis. P. aeruginosa is a major contributor to HAP and common reason for VAP [35].The main risk factors for pseudomonas VAP are extended tracheal intubation and previous antibiotic treatment, particularly with some broad-spectrum antibiotics. P. aeruginosa or Acinetobacter infections were significantly more common in VAP patients who had previously received antimicrobial therapy(65%)compared to those who hadn't(19%)[36].

	Infectious Agents	Drugs Resistance	Major Resistance Mechanisms	Risk Factors Of Resistance
CAP resistance	*Streptococcus pneumoniae*	Penicillins	Methylation of the 23S ribosomal objective site, determined via the erm(B) gene	• Age<5 years • Attendance to daycare centers
		Macrolides	Active efflux, determined via the macrolide efflux or mefA genes	• being a resident of a long-term treatment center • Nosocomial acquisition
		Fluoroquino-lones	Alteration in the QRDR of gyrA and/or parC	Older age • Previous use of fluoroquinolones
	Mycoplasma pneumoniae	Macrolides	Mutation in the 23S gene ribosomal RNA	
HAP resistance	*Staphylococcus aureus*	Methicillin (MRSA) Vancomycin (VRSA) Daptomycin	Gene mecA existence of transposon Tn1526	• Hospital environment (ICU) delayed • hospitalization (>5 days)
	Pseudomonas aeruginosa	Penicillins Aminoglyco-sides Fluoroquino-lones	access to bacterial targets is restricted incidence of efflux mechanisms	• For 3 days in the 90 days' prior • Current antibiotic treatment

Table 4: Community-Acquired Pneumonia(CAP)resistance

CONCLUSIONS

A crucial challenge for the most clinically effective treatment of pneumonia is the introduction of novel pathogens and microbiological identification of pathogens causing pneumonia. However, recent studies have proven the need of using novel molecular platforms because

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despite the effort made to collect samples in pneumonia patients, nearly 50% of the cases remain without microbiological diagnosis using conventional approaches. Conventional methods and molecular testing, in our opinion, will enhance the microbiological diagnosis of pneumonia, leading to improved clinical management, including faster start-up of antibiotic treatment, more successful de-escalation, better focused antibiotic selection, and better stewardship for pneumonia patients.

Conflicts of Interest

The authors declare no conflict of interest.

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