# Chest Radiographic and Microbial Patterns in Community-Acquired Pneumonia: A Preliminary Study from Lagos, Nigeria.

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#### Abstract

**Background**: Early diagnosis is vital for Community Acquired Pneumonia (CAP), a common respiratory infection. Chest X-ray imaging and microbial tests are common diagnostic tools, yet chest radiographic and microbial aetiologies remain complex. This study evaluated these correlations among patients with CAP in a tertiary care setting in Lagos State, Nigeria.

**Methods:** A retrospective descriptive study was deployed and data from 94 patients diagnosed with CAP, were extracted from the electronic archive of the Respiratory Departments in Lagos State University Teaching Hospital, between October and December, 2024.

**Results:** Majority of the participants were female (69.1%) and the mean age of  $59.54 \pm 18.0$  years. A total of 90.4% of blood culture yielded gram negative bacteria while 9.6% indicated gram positive bacteria. Further, only 71.3% of the 94 patients, presented radiologic abnormalities following Chest X-ray imaging with Cardiomegaly, being the modal pathology, as observed in 7.4% of cases, followed by Congestive heart failure in 6.4% of instances. Other lung-related disorders included bronchopneumonia with left atelectasis in 3.2% of cases, left upper lobe consolidation in 3.2%, and right lower lung consolidation in 4.3% of cases. In 4.3% of patients, pleural effusion and signs of pulmonary metastases were observed.

**Conclusion:**This study highlighted the crucial role of chest X-rays in diagnosing community-acquired pneumonia, revealing a majority of gramnegative bacterial infections. The prevalence of diverse radiographic abnormalities with cardiovascular and respiratory pathologies were more prevalent than other pathologies.

**Keywords:** Radiology, Microbial, Community-Acquired Pneumonia (CAP).

#### Introduction

Pneumonia is a common respiratory infection that affects the distal respiratory tract (alveoli and bronchioles).<sup>1</sup>It isbroadly divided into community-acquired pneumonia (outside the health care settings) or hospital-acquired pneumonia (within the health care settings)<sup>2</sup>.

Pneumonia, is spread through the respiratory droplets of the infected person to the new host with a weakened immune system such as infants, older adults, people with weakened immune systems, chronic illnesses like COPD and heart disease, smokers, and those exposed to pollutants<sup>3</sup>. It isclinically presented as a cough, fever, chest pain, shortness of breath, fatigue, nausea, and vomiting.<sup>4</sup> Despite the availability of potent antimicrobials and effective vaccines, pneumonia remains the third leading reason for hospital admission. accounting for 544,000 hospitalizations from the Emergency Department (ED) annually.<sup>5</sup> and CAP is the leading cause of sepsis and death from infection.<sup>6</sup>

Microbial identification and chest X-ray imaging are indispensable for effective management. Certain bacteria and viruses that cause pneumonia can progress rapidly and become severe if left untreated, underscoring the importance of timely intervention.<sup>7</sup> Precise identification of the microbial cause of pneumonia enables healthcare providers to prescribe targeted antibiotic therapy, which helps stave off antibiotic resistance and ensures optimal treatment.<sup>8</sup>

Collaborative, multi-disciplinary research efforts are imperative to validate the existing associations, explore new diagnostic markers, and develop personalized diagnostic and therapeutic strategies, ultimately improving patient outcomes and reducing the global burden of pneumonia.<sup>9</sup> The timely and effective

of treatment respiratory diseases like pneumonia hinges on early and accurate diagnosis.<sup>10</sup>By offering non-invasive detailed images of the lungs, chest radiography enables visualize consolidations, clinicians to infiltrates, and other pathologies, thus, guiding the diagnostics and assessing the extent of pneumonia pathologies guiding treatment decisions.<sup>11</sup>

Previous studies have attempted to link specific radiographic indicators with the microorganisms that cause pneumonia, in developed countries. <sup>12</sup> While these studies have provided valuable insights into the diagnostic usefulness of chest radiography in pneumonia, the results have been inconclusive and varied with limited studies in developing countries.<sup>4</sup> Therefore, the correlation between radiographic patterns and microbial aetiologies remains a complex and evolving field of research, necessitating ongoing exploration and validation.

This study evaluated the correlation between chest X-ray patterns and microbial findings.

## Materials and Methods Study design

This study deployed a retrospective descriptive study design

### Sample size and setting

A total of 97 patients diagnosed with CAP between October and December, 2024, were extracted from the electronic archive of the electronic archive of the Departments of Respiratory Medicine, Medical Outpatients Departments and Lagos State Emergency Medical Service (LASEMS), Lagos State University Teaching Hospital. However, 3 records were excluded because of incomplete record of either Chest X-ray and microbial findings.

#### **Study Procedure**

Data extraction form was designed on Microsoft Office form to obtain information in the following areas: patient's ID, age, sex, chest X-ray findings, and Microbiological findings were documented for the study

#### **Data Analysis**

The data collected were processed using Microsoft Excel 2016. This study utilized the Statistical Package for Social Science (SPSS) Inc., Chicago, IL, USA, version 27.0 for the analysis.

**Ethical consideration:** Ethical approval was obtained from the Health Research and Ethics Committee of Lagos State University Teaching Hospital with Reference Number; LREC/06/10/2470

#### Results

The study included a total of 94 participants, with 69.1% being female and 30.9% being male. The average age of the participants was 59.54 years with a standard deviation of 18.0 years. The median duration from symptom onset to presentation was 7.0 days, ranging from 5.0 to 21.0 days. The mean length of hospital stay was 10.0 days (range: 9.0-15.0 days), with 2.0 days (range: 2.0-5.0 days). Further, 90.4% of blood culture yielded gram negative bacteria while 9.6% indicated gram positive bacteria.

In 28.7% of patients, Chest X-ray did not show radiologic abnormalities. However, in those with X-ray findings, Cardiomegaly was the most prevalent abnormality, appearing in 7.4% of cases, followed by congestive heart failure in 6.4% of instances. Other lung-related disorders included bronchopneumonia with left atelectasis in 3.2% of cases, left upper lobe consolidation in 3.2%, and right lower lung consolidation in 4.3% of cases. In 4.3% of patients, pleural effusion and signs of pulmonary metastases were observed.

#### Discussion

A global study by Jain et al. demonstrated the wide range of radiological findings and the importance of pathogen identification in guiding management.<sup>13</sup>

By and large, chest radiography is an essential tool for the early and accurate diagnosis of pneumonia, playing a pivotal role in improving patient outcomes and reducing morbidity and mortality associated with this condition. When examining chest radiographs, certain patterns can reveal the likely causative organism of pneumonia even before the culture results are known.<sup>11</sup>

The socio-demographic analysis of the study population provides critical insights into the burden and presentation of chest-related conditions. The predominance of females (69.1%) and the mean age of 59.54 years reflect а demographic with increased vulnerability to both chronic and acute chest conditions. This aligns with global epidemiological data, suggesting a higher incidence of respiratory and cardiovascular diseases among older adults.<sup>14</sup> However, in a study by Barbagelata et al, males are found to have a more severe case fatality and mortality than females.<sup>15</sup> This study also highlighted a median delay of 7 days from symptom onset to hospital presentation, this may be attributed to limited access to healthcare facilities, financial constraints, and the cultural perception of chest-related symptoms as non-urgent as supported in a previous study.<sup>16</sup> Therefore, there is a critical need for public health campaigns to raise awareness of symptom recognition and the importance of early medical intervention along with advanced medical interventions, such as mobile health units and telemedicine services, could improve health care delivery in CAP.<sup>17,18</sup>

Further, 90.4% of blood samples from ninetyfour CAP patients yielded gram-negative pathogens, while only 9.6% yielded grampositive bacteria. The findings support the previous study by Kishimbo et al. <sup>19</sup> On the other hand, Pandey et al.had a contradictory finding, showing the prevalence of grampositive bacteria in blood culture. However, this may be attributed to the age distribution of the population pool, bacterial isolates and emergence of antibiotic resistance at the varying geographical locations of these studies.<sup>20</sup>

The imaging findings in this study offer a comprehensive view of the diagnostic challenges and clinical diversity associated with chest-related conditions. According to a review by Nambu et al., chest radiography is typically sufficient to confirm the diagnosis of CAP, while computed tomography is necessary to identify specific pathogens and differentiate from non-infectious diseases.<sup>21</sup> About 28.7% of participants lacked radiographic the abnormalities, reflecting the occurrence of early-stage pneumonia without clear radiological changes or other respiratory illnesses with similar symptoms and conditions.<sup>22,23</sup>

The prevalence of cardiomegaly (7.4%) in this study is a notable finding. Cardiomegaly can be a consequence of chronic respiratory conditions or an independent risk factor for respiratory infections.<sup>24</sup> In our context, this may reflect cardiovascular underlying comorbidities. Studies have consistently shown a significant overlap between cardiac and pulmonary diseases.<sup>25</sup> The 3.2% incidence of biventricular failure, 6.4% of congestive cardiac failure, and 3.2% of features suggestive of heart failure with cardiomegaly highlight this overlap. The increasing prevalence of cardiovascular diseases, particularly hypertension, in subSaharan Africa, supports this finding according to Atun *et al*.<sup>26</sup> In Nigeria, hypertensive heart disease is a significant public health concern, and its association with respiratory infections warrants further investigation.<sup>27</sup>

The radiological features suggestive of bronchopneumonia (3.2%), bronchopneumonia with left atelectasis (3.2%), and right lower lung zone consolidation (4.3%) are consistent with typical radiological manifestations of CAP. Consolidation, a hallmark of pneumonia, reflects the replacement of air in the lung parenchyma by exudate.<sup>28</sup> The variability in the location and extent of consolidation likely reflects differences in causative pathogens and disease stages. A study by Nakaraniet al has shown diverse radiological patterns in CAP, influenced by patient age, comorbidities, and specific pathogens.<sup>29</sup> In resource-limited settings, the reliance on chest X-rays, due to limited access to advanced imaging like CT scans, may hinder detailed assessment. Pleural effusions, observed in various forms (left-sided massive pleural effusion with mediastinal shift, left-sided pulmonary effusion, cardiomegaly with right pleural effusion, and soft tissue mass in the right lower lung with pleural effusion), each representing 3.2%, are significant findings. Pleural effusions can complicate especially pneumonia. parapneumonic effusions.<sup>30</sup> The soft tissue mass extending to the pleural surface raises concerns for malignancy or non-infectious etiologies. The 4.3% incidence of features suggestive of pulmonary metastases with left-sided pleural effusion emphasizes the need for differential diagnoses. The 3.2% incidence of bilateral senile apical pleural thickening is likely an incidental age-related finding. The 3.2% incidence of hypertensive heart disease with suspected thoracic aorta aneurysm is clinically significant. Thoracic aorta aneurysms can mimic respiratory symptoms.<sup>31</sup>

#### Strength, Limitation and Recommendations

This study is limited by its small sample size, reliance on chest X-rays and inability to correlate the blood culture findings with chest X-ray findings. Future studies will incorporate larger sample sizes, microbiological studies and CT scans along with the correlation with clinical laboratory results.

#### **Conclusion:**

This study highlighted the crucial role of chest X-rays in diagnosing community-acquired pneumonia, revealing a majority of gramnegative bacterial infections. The prevalence of diverse radiographic abnormalities with cardiovascular and respiratory pathologies were more prevalent than other pathologies.

Table 1: S	ocio-demog	raphic chai	acteristics
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Variable	Frequency	Percentage
Sex		
Male	29	30.9
Female	65	69.1
Age (Mean±SD)	59.54±18.0	
Duration from symptoms to presentation (days)	7.00 (5.0-21.0)	
Total length of hospital stays (days)	10.0(9.0-15.0)	
Length of stay before acquired (days)	2.0 (2.0-5.0)	



Figure 1: Bacterial culture status of participants

**Table 2:** Chest X-ray Findings

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		Frequency	Percent
Valid	Bilateral senile apical pleural	3	3.2
	thickening		
	biventricular failure	3	3.2
	bronchopneumonia with left	3	3.2
	atelectasis		
	Cardiomegaly	7	7.4
	Cardiomegaly with right pleural	3	3.2
	effusion		
	Chest CT- Patchy density seen	4	4.3
	in posterior lower segments		
	bilaterally		
	congestive cardiac failure	6	6.4
	features suggestive of	3	3.2
	bronchopneumonia		
	Features suggestive of heart	3	3.2
	failure. Cardiomegaly.		
	Features suggestive of	4	4.3
	pulmonary metastases with left-		
	sided pleural effusion		
	Hypertensive heart disease	3	3.2
	with? thoracic aorta aneurysm		
	Left-sided massive pleural	3	3.2
	effusion with mediastinal shift		
	Left-sided pulmonary effusion	3	3.2
	Left upper lobe consolidation	3	3.2
	No	27	28.7
	No significant radiographic	3	3.2
	abnormality	-	
	Pneumonic changes	3	3.2
	Right lower lung zone	4	4.3
	consolidation		110
	Right upper lung zone opacities	3	3.2
	Soft tissue mass in the Right	3	3.2
	lower lung extending to the	5	0.2
	pleural surface, patchy opacities		
	in the upper right lung and		
	minimal right Pleural Effusion		
-	Total	94	100.0
_	10111	27	100.0

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