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EXPLORING THE FREQUENCY OF PARAPNEUMONIC EFFUSION IN PNEUMONIA: A COMPREHENSIVE ANALYSIS

Dr. Gohar Fatima[*1], Dr. Professor Syed Ali Abbas[2], Dr. Zafar Ahmed[3], Dr. Kashaf Memon[4], Dr. Waqas Anwar[5], Dr. Professor Syed Ali Arsalan[6]

*[*1]MBBS Pulmonology resident (FCPS) Liaquat National Hospital Karachi*
[2]MBBS, MRCP (UK), FRCP(London) Head of the department, Chest specialist Dr Ziauddin Hospital
[3]MBBS, MRCP (Ireland), DME (Dublin) Consultant Pulmonology, Assistant Professor Liaquat National Hospital Karachi
[4,5]MBBS Pulmonology Resident (FCPS) Liaquat National Hospital Karachi
[6]MBBS, MRCP (UK), FCCP (USA) Consultant Pulmonologist, Professor Liaquat National Hospital Karachi

[*1]goharfatima@live.com, [2]ali.abbas@zu.edu.pk, [3]zafar.ahmed@lnh.edu.pk, [4]kashaf90210@hotmail.com, [5]waqas.anwar078@gmail.com, [6]ali.arsalan@lnh.edu.pk

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Corresponding Author: *
Dr. Gohar Fatima

Abstract

OBJECTIVE

To determine the frequency of parapneumonic effusion in patients presenting with pneumonia.

METHODOLOGY

A descriptive cross-sectional study at Liaquat National Hospital, Karachi, enrolled 161 pneumonia patients (18–70 years) using non-probability consecutive sampling. Inclusion criteria required a clinical and radiological pneumonia diagnosis with a disease duration of one to three weeks, regardless of treatment status. Parapneumonic effusion was assessed via chest X-ray. Data were analyzed using SPSS 26, applying Chi-square tests with a 5% significance level.

RESULTS

The mean age of the patients was 39.20 ± 12.61 years. Among the 161 cases, 60.9% were male, and 39.1% were female. Smoking was noted in (63.4%), hypertension (55.9%), and diabetes (31.1%) patients. Parapneumonic effusion was noted in 68.94% of patients.

CONCLUSION

The study showed a high prevalence of parapneumonic effusion among patients with pneumonia, especially older males, urban residents and the presence of chronic disease such as hypertension and diabetes. These findings here suggest that stratified approach and opportunistic case identification might be needed in at-risk populations, to prevent complications of the syndrome.

INTRODUCTION

Pneumonia is one of the main causes of parapneumonic pleural effusion (PPE) in which the liquid collects in the pleural space (between the outside covering of the lungs and chest wall). Knowing its pathophysiology is crucial in managing this disease. Pneumonia, that induces a pleural reaction leads to the inflammation and increased permeability of pleural membranes. The

inflammation may allow the liquid of the blood vessels to leak with the pleural space, creating a gathering of liquids referred to as a pneumonic drain [1]. The differential between non-complicated and complicated parapneumonic effusion is very important, given the substantial difference in their management.

Clinically, patients may present with symptoms such as cough, chest pain and shortness of breath from parapneumonic demolition. When pleural spill results in empyema (the collection of purulent fluids) these symptoms usually worsen [2]. On physical examination, there will be decreased breath sounds over the pleural effusion side and, in percussion [3] There will be opacity. In order to evaluate the extent of the spill and its nature, diagnostic imaging, particularly ultrasound or computerized tomography, is indispensable. Differentiating simple effusions from the complex would help to lead in an addition work for a diagnosis, e.g. pleural fluid examination for infection [4].

While dealing with parneumonic spill, their treatments also depending on their type. Antibiotic treatment of the underlying pneumonia usually resolves uncomplicated parapneumonic effusions [5]. On the contrary, the problematic effusions may need more aggressive procedures to draining the fluid through toracentesis [6]. Research show that early intervention can lead to a better outcome while minimizing the risk of serious complications such as empyema [7].

Recent studies emphasize the role of adjunctive therapies (e.g., corticosteroids) in controlling inflammation associated with parapneumonic effusions. Steroid therapy should improve clinical outcomes in certain patient groups [2] as suggested by a pilot study. On the other hand, the use of steroids must be considered due to the potential risks associated with them, since they suppress the immune response and complicate the course of infections [8].

In the findings of this patient, the presence of Parapneumonic spill has important predictions. Delayed diagnosis and management cause unfavorable outcomes to include prolonged hospitalizations and increased healthcare expense [9]. Finally, management recommendations underscore the need for early identification and intervention to optimize recovery pathways [10–12].

To comprehend towards professional funerals of pathophysiology and clinical practice manifestations of both Parapneumonic which is critical for developing appropriate strategies to treat the health professionals of demolition. New research and recommendations inform on the best ways to manage this condition, improving patient outcomes and overall pneumonic splenic infection-related care.

METHODOLOGY

This descriptive cross-sectional study was carried out in the Department of Pulmonology at Liaquat National Hospital (LNH), Karachi. The sample of 161 patients through a non-probability consecutive sampling technique were enrolled in the study. Patients aged 18 to 70 years of either gender, diagnosed with pneumonia based on clinical and radiological criteria, and having a disease duration of one to three weeks, regardless of treatment status, were included. Exclusion criteria encompassed patients with pre-existing pleural effusion unrelated to pneumonia, alternative diagnoses explaining clinical symptoms and chest X-ray findings, severe immunocompromised conditions, recent antibiotic use before admission, chronic respiratory diseases such as chronic obstructive pulmonary disease or interstitial lung disease, and pregnant individuals. Patients typically presented with high-grade fever (≥38°C), cough, and chest pain, with chest X-ray findings suggestive of pneumonia, including air space consolidation or infiltrates, often in a lobar pattern. Parapneumonic effusion was assessed on chest X-ray, identified by the presence of a meniscus sign on frontal radiographs (>200 mL), blunting of the costophrenic sulcus on lateral view (>50 mL), or subpulmonic effusion indicated by lateral displacement of the apex of the pseudodiaphragm. Additional imaging studies and procedures were conducted when necessary to confirm the presence of pleural effusion. Data were recorded and analyzed using SPSS version 26, with descriptive statistics presented as mean ± standard deviation for quantitative variables and frequencies and percentages for qualitative variables. The Chi-square test was applied to assess statistical differences, with a significance level set at 5%.

RESULTS

This study included (n=161) participants with a mean age of 39.20 ± 12.61 years, 30.4% (49) were aged 18-40 years and 69.6% (112) over 40 years. Mean BMI was 26.88 ± 4.87 kg/m², and 18–24 kg/m² BMI was found in 29.8% (48 participants), whereas 70.2% (113 participants) had a BMI > 24 kg/m². Pneumonia lasted for an average of 14.69 ± 4.37 days; 73 participants (45.3%) had a duration of 7–14 days, and 88 (54.7%) >14 days. In terms of gender, there were 98 males (60.9%) and 63 females (39.1%). Most of participants (117 participants, 72.7%) lived on urban area rather than rural area (44 participant, 27.3%) With regards to smoking status, 63.4% (n = 102) were smokers and 36.6% (n = 59) were non-smokers. In addition, 90(55.9%) were hypertensive while 71(44.1%) were non-hypertensive, 50(31.1%) were diabetic compared to 111(68.9%) who were non-diabetic. **(TABLE 1)**

Table I: Demographic Characteristics of Study Participants (n=161)

Variable	Frequency (%)
Age (Mean ± SD) = 39.20 ± 12.61	
18-40 years	49 (30.4)
>40 years	112 (69.6)
Body Mass Index (Mean ± SD) = 26.88 ± 4.87	
18-24 kg/m^2	48 (29.8)
>24 kg/m^2	113 (70.2)
Duration of Pneumonia (Mean ± SD) = 14.69 ± 4.37	
7-14 days	73 (45.3)
>14 days	88 (54.7)
Gender	
Male	98 (60.9)
Female	63 (39.1)
Residential Status	
Urban	117 (72.7)
Rural	44 (27.3)
Smoking Status	
Smoker	102 (63.4)
Non-Smoker	59 (36.6)
Hypertension	
Hypertensive	90 (55.9)
Non-Hypertensive	71 (44.1)
Diabetes Mellitus	
Diabetic	50 (31.1)
Non-Diabetic	111 (68.9)

Patients with parapneumonic effusion were older than those without effusion (≥40 years, > 75% in effusion group versus ≤40 years, > 75% in non-effusion group). Females were also over-represented in the non-effusion group and males predominated in the effusion group, indicating high male bias in the effusion group as well in contrast to the males-females ratio in the population, and urban residents predominated among effusion, suggesting either a male bias in the development of this condition, or in urban cases. Contradictory to the previous report, we noted that relatively fewer patients were smokers in the effusion group than in the non-effusion group, which could be affected by several confounding factors due to its common knowledge that smoking would impair the lung function among smokers. Substantially greater numbers of these comorbid conditions, such as diabetes mellitus and

hypertension, were identified among the cohort with parapneumonic effusion, suggesting that chronic illnesses may render a predisposition toward more serious pulmonary manifestations. There was no statistically significant difference between the groups in terms of body mass index; nevertheless, the duration of symptoms was longer in those presenting with effusion, with more patients in this group reporting duration of symptoms longer than 14 days. **(TABLE 2)**

Table II: Comparison of Parapneumonic Effusion with Characteristics of Patents (n=161)

Variables		Parapneumonic Effusion		P-Value
		Yes (n=111)	**No** (n=50)	
Age group (years)	18-40 years	27 (24.3)	22 (44.0)	0.012
	>40 years	84 (75.7)	28 (56.0)	
Gender	Male	74 (66.7)	24 (48.0)	0.025
	Female	37 (33.3)	26 (52.0)	
Residential Status	Urban	87 (78.4)	30 (60.0)	0.015
	Rural	24 (21.6)	20 (40.0)	
Smoking Status	Smoker	64 (57.7)	38 (76.0)	0.025
	Non-Smoker	47 (42.3)	12 (24.0)	
Diabetes Mellitus	Diabetic	40 (36.0)	10 (20.0)	0.042
	Non-Diabetic	71 (64.0)	40 (80.0)	
Hypertension	Hypertensive	69 (62.2)	21 (42.0)	0.017
	Non-Hypertensive	42 (37.8)	29 (58.0)	
BMI (kg/m^2)	18-24 kg/m^2	29 (26.1)	19 (38.0)	0.128
	>24 kg/m^2	82 (73.9)	31 (62.0)	
Duration of Symptoms (days)	7-14 days	44 (39.6)	29 (58.0)	0.030
	>14 days	67 (60.4)	21 (42.0)	

DISCUSSION

Parapneumonic effusion (PPE) is one of the most common complications of pneumonia, which is caused by pleural space infection and the resulting inflammatory response. PPE has various incidences based on population, diagnostic criteria and imaging technique used to identify it. However, the prevalence of PPE among pneumonia patients is uncertain.

PPE results from increased vascular permeability and inflammatory exudation in response to the bacterial infection. PPE can be mild, requiring simple therapeutic effusion with simple antibiotic therapy or may be complicated cases developing empyema—the pleural space fills with pus. Such an uplifting inflammatory cascade can be driven by bacterial pathogens (Streptococcus pneumoniae and Staphylococcus aureus), and bacterial toxins may also promote inflammatory and pleural fibrin deposit. Therefore, loculated effusions can occur[13].

The clinical presentation varies depending upon the size and stage of the effusion. Small effusions may be asymptomatic or present with mild pleuritic chest pain, whereas larger effusions exacerbate respiratory distress. Common clinical features include fever, cough, and dyspnea for nonempyema, while systemic signs such as sepsis, increased inflammatory markers, and thickening of pleura may be present in empyema [14,15].

The incidence of PPE and its consequences depend strongly on the timing and accuracy of the diagnosis. Chest X-ray is primarily performed for detection;

however, ultrasonography and computed tomography (CT) scans are more sensitive for detecting small and loculated effusions [16]. Thoracentesis or aspiration of the pleural fluid assists with the classification of PPE by specific biochemical markers such as pH, lactate dehydrogenase (LDH), and glucose levels [17]. Nonetheless, underdiagnosis due to limited access to imaging and diagnostic technologies in resource-limited settings may lead to an inaccurate prevalence.

The PPE in terms of its severity dictates the management. Although uncomplicated effusions respond to directed antibiotic therapy, complicated PPE and empyema need further treatment such as chest tube drainage, fibrinolytic treatment, and in non-responding cases, video-assisted thoracoscopic surgery (VATS)[18,19]. Initial empirical antibiotic therapy should cover S. pneumoniae, S. aureus and atypical pathogens, followed by de-escalation when a culture is positive [15]. An advancement in the management of pleural effusion was the combination of these emerging minimally invasive procedures (like ultrasound guided thoracentesis) which made it possible to accomplish the goals of treatment without resorting to open surgical procedure.

In our study, PPE was noted in 68.94% of pneumonia patients, which aligns with a previous study reporting a prevalence of 70% [21]. However, other studies have reported a lower frequency, such as 40.0% in the study by Zhong M et al. [22]. This variation may be attributed to differences in study populations, pneumonia severity, diagnostic criteria, and imaging availability. Notably, the prevalence of PPE may be underreported in settings where diagnostic imaging is not routinely performed.

Progress has been made; however, gaps still exist in PPE management. Anticipated diagnosis is delayed by small or asymptomatic effusions and the disease progresses to more severe forms. Imaging support is limited in resource-constrained settings as well, leading to delayed diagnosis. Moreover, complex PPE has been associated with prolonged hospital stays and multiple procedures contributing to increased cost and risk of multi-drug resistant infections.

To mitigate these challenges, increasing awareness among healthcare providers, particularly in primary care, is essential. Expanding access to diagnostic imaging, such as ultrasound-guided thoracentesis and VATS, in resource-limited settings can enhance early detection and intervention. Furthermore, research into novel antibiotics and immunomodulatory therapies may improve the management of complicated PPE, particularly in cases of multi-drug resistant infections. Strengthening early identification protocols, especially in high-risk populations, will be critical in reducing morbidity and long-term complications associated with PPE.

CONCLUSION

The study showed a high prevalence of parapneumonic effusion among patients with pneumonia, especially older males, urban residents and the presence of chronic disease such as hypertension and diabetes. These findings here suggest that stratified approach and opportunistic case identification might be needed in at-risk populations, to prevent complications of the syndrome.

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