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Advanced Pediatric Recurrent Pneumonia in A Sample of Tanta University Hospital Children

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ABSTRACT

Background: Pneumonia is the most frequent reason for morbidity and mortality in children worldwide. As many as ten times as many children die from childhood pneumonia in developing countries, compared to developed countries.
Aim: This study was conducted to investigate severe recurrent pneumonia in children.
Subjects and methods: This prospective & descriptive research were conducted on 200 patients at Tanta University Hospital, Pediatrics Department during the period from the beginning of May 2019 to April 2022. We recruited all patients with advanced recurrent pneumonia (RP).
Results: Mean age of advanced RP children is 15.4 months, while the age at 1st episode of pneumonia was 12.7 months. Between children with advanced RP, the majority were males, being twice compared with females. Cough was the prevalent symptom in 99% of cases then wheezing (63%) and fever (60%). Respiratory abnormalities were the most prevalent (28%) as underlying causes of advanced RP patients, then immune disorders (22%) and congenital heart diseases (16%). The pulmonary hemorrhagic syndrome was the least prevalent cause as it was observed in only 2 cases.
Conclusion: Children with underlying diseases had more serious diseases & poorer clinical results because they were more likely to get recurrent pneumonia & were susceptible to resistant microorganisms. As a result, more emphasis can be placed on clinical severity & therapeutic plan.
Keywords: Advanced pneumonia, Recurrent pneumonia, Underlying reasons, Children, Egypt.

INTRODUCTION

Pneumonia is an infection in children & leading reason for death worldwide. In the first two years of life, at least 1 episode of pneumonia is anticipated in about 6% of young children. The most common cause of illness and mortality in children under the age of five in low- and middle-income nations is pneumonia [(1)]. Pneumonia is an acute lung parenchymal inflammation caused by both infectious & non-infectious reasons. According to World Health Organization, pneumonia impacted around 156 million children [(2)]. 6.49% of children with pneumonia had recurrent pneumonia [(3)].

Recurrent pneumonia is described as having at least two bouts of pneumonia in 1 year or at least three episodes at any period, with no clinical symptoms or chest X-ray abnormalities. Even in industrialized areas, up to nine percent of children with pneumonia will advance to RP. Over eighty percent of the children have underlying illnesses. The morbidity and mortality rate among RP children admitted to Pediatric Intensive Care Unit with severe pneumonia is high [(4)].

Inadequacies in local pulmonary or systemic host defenses, as well as underlying diseases that change lung defense are common causes of recurrent pneumonia. As a consequence, physicians must investigate the possible underlying reasons. There is little known about the underlying diseases that predispose children to recurrent pneumonia. Furthermore, few studies on this topic have been undertaken in developing nations. Potential impact of RP on healthcare system is substantial in terms of recurrent hospitalizations [(5)].

Early discovery and treatment of the underlying cause may reduce hospitalizations, morbidity, and mortality associated with pneumonia. Increased epidemiological studies on recurrent pneumonia, especially in developing countries, will help to improve preventative and treatment strategies [(6)]. The morbidity and mortality rate among RP children known to Pediatric Intensive Care Unit with severe pneumonia is high [(7)]. This study was conducted to investigate severe recurrent pneumonia in children.

Material & techniques

This prospective and descriptive cohort research was conducted on 200 patients at Tanta University Hospital, Pediatrics Department during the period from the beginning of May 2019 to April 2022. Studied cases categorized as advanced recurrent pneumonia, were recruited.

The symptoms of tachypnea, fever, and lobar or broncho-pneumonic infiltration, as well as chest wall in-drawing and breathing trouble, were utilised to make the diagnosis of pneumonia.

According to research conducted by the Pediatric Infectious Diseases Society and the Infectious Diseases Society of America, subjects were deemed to have progressed pneumonia if they met either 1 major or 2 minor criteria for pneumonia [(8)]. With no clinical symptoms or chest X-ray lesions between pneumonia episodes, recurrent pneumonia was defined as two bouts of pneumonia in a year or three episodes of pneumonia in any time [(9)].

STROCSS criteria were used to present this research [(10)]. All advanced RP children who were known

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to the PICU had their medical histories, physical examinations, physical tests, and initial assessments performed to identify the underlying causes. Information was acquired utilising medical record forms for advanced RP-studied cases. Study cases were divided into groups based on whether they had a recurrent lesion in the same lobe or a fresh lesion in a different lobe before completing various exploratory exams to ascertain underlying causes.

Lung biopsy, bronchoscopy, and chest CT scans were utilised to confirm any pulmonary parenchymal or airway abnormalities. Echocardiography, computed tomography, and cardiac catheterization have all been associated with cardiovascular problems. Quantitative immunoglobulins, a lymphocyte counting test using flow cytometry of T-CD3, T-CD4, and T-CD8 cells, or specific illness criteria were used to identify immune diseases. Aspiration syndrome was being identified, and genetic testing was being used to look into genetic illnesses. Children under the age of three were diagnosed with transient recurrent wheeze when there were three episodes, followed by no symptoms, normal physical and mental development, no identifiable underlying cause, and no possibility of API classification. [(11)].

Ethical considerations: The research protocol was formally reviewed and accepted by The Ethical Committee of Pediatrics Department, Faculty of Medicine. Each participant in the study provided written informed consent. The Declaration of Helsinki, the code of ethics of the World Medical Association, was followed when conducting this research on humans.

Statistical analysis

To analyze computer-generated data, IBM SPSS version twenty-two was used. Percentages & numbers were used to express quantitative data.

Before using median in nonparametric analysis or interquartile range in parametric analysis, it was necessary to achieve Kolmogorov-Smirnov exams to confirm that data were normal.

The importance of results was determined using the **(0.05)** significance threshold. The Chi-Square test compares 2 or more groups. To account for any number of cells with a count less than five, the Monte Carlo test can be used. Tables with non-continuous data were subjected to the Fischer Chi-Square adjustment.

RESULTS

Mean age of RP diagnosis was 15.4 months, while mean age at 1st episode of pneumonia was 12.7 months. Between children with advanced RP, most was males, being twice compared with females. Urban were 23% and rurals were 77% (Table 1).

Table (1): Demographic features of advanced RP studied cases

Features	Value
Years old related to diagnosis	
Years old of admission (month)	22.3 ± 21.7
Years old of first episode of pneumonia (month)	12.7 ± 29.2
Years old of RP (month)	15.4 ± 27.8
Sex	
Males/Females	136 (68%) / 64 (32%)
M/F ratio	2.13/1
P-value	<0.001
Kind of dwelling	
Urban	23 (23%)
Rural	154 (77%)

Cough was the most prevalent symptom in 99% of cases then wheezing (63%) and fever (60%). Regarding lung auscultation, crackles were the most observed finding in 86% of cases, then wheezes (60%). Abnormal heart sounds were found in 12% and signs of heart failure were found in 13% of cases (Table 2).

Table (2): Clinical symptoms of patients

Clinical symptoms	N	%
Fever	**120**	**60**
Cough	**198**	**99**
Wheezing	**126**	**63**
Lung auscultation		
Crackles	**172**	**86**
Wheezes	**120**	**60**
No rales	**26**	**13**
Abnormal heart sounds (murmur, gallop)	**24**	**12**
Signs of heart failure	**26**	**13**

Intubation and mechanical ventilation was the most prevalent condition in respiratory support before admission to ICU. However, at respiratory support, twenty-four h after admission to the ICU, regular ventilation was the most prevalent condition.

A decrease of PaO_2 was found in all cases and an increase of $PaCO_2$ was found in 64% of cases. Regarding Oxygenation Index twenty-four h after admission to the ICU, 44% of cases had OI of more than 4 and less than 8. The shock was observed in 35% of cases and multiple organ dysfunction syndromes in 7% of cases. In many cases (24%) Vasoactive-Inotropic Score twenty-four h after admission to ICU was more than ten and less than 25.

Table (3): Advanced conditions on admission to ICU

Advanced situations for ICU admission	N	Percent
Respiratory support before admission to ICU		
Face masks & nasal prongs for oxygen	**48**	**24**
Non-invasive ventilation	**4**	**2**
Intubated & mechanical ventilated	**150**	**75**
Respiratory support twenty-four h afterward ICU admission		
Oxygen by face masks & nasal prongs	**8**	**4**
Non-invasive ventilation	**8**	**4**
Regular ventilation	**160**	**80**
High-frequency oscillatory ventilation	**26**	**13**
kind of respiratory failure		
Reduction of PaO_2	**200**	**100**
Rise of $PaCO_2$	**128**	**64**
Oxygenation Index twenty-four h after admission to ICU		
OI < 4	**60**	**30**
4 ≤ OI < 8	**66**	**33**
8 ≤ OI < 16	**32**	**16**
OI ≥ 16	**32**	**16**
Other conditions		
Shock	**70**	**35**
Multiple organ dysfunction syndromes	**14**	**7**
Vasoactive-Inotropic Score twenty-four h after admission to ICU		
VIS < ten	**2**	**1**
10 ≤ VIS < 25	**48**	**24**
VIS ≥ 25	**20**	**10**

Regarding chest X-rays, lesions in different/multiple lobes were found in most cases (82%) and recurrent lesions in the same lobes were found in only 18% of cases.

Table (4): Chest X-rays findings

Chest X-rays	N	Percent
Recurrent lesions in lobes	**36**	**18**
Lesions in different/multiple lobes	**164**	**82**

Respiratory abnormalities were the most prevalent (28%) as underlying causes of advanced RP patients, then Immune disorders (22%) and congenital heart diseases (16%). The pulmonary hemorrhagic syndrome was the least prevalent cause as it was observed in only 4 cases.

Table (5): Underlying causes of advanced RP patients

Underlying reasons	N	%
Congenital heart diseases	**32**	**16**
Immune disorders	**44**	**22**
Abnormalities in respiration	**56**	**28**
Hemorrhagic respiratory syndrome	**4**	**2**
Obliterative post-infectious bronchiolitis	**10**	**5**
Aspiration syndrome	**22**	**11**
Neuromuscular disorders	**10**	**5**
Recurrent wheezing	**8**	**4**
Unknown	**16**	**8**

DISCUSSION

Deficiencies in local pulmonary and systemic host defences as well as underlying diseases that affect lung defences are the usual causes of recurrent pneumonia. The following categories describe the underlying diseases connected to these infections: (I) congenital malformations of upper & lower respiratory tract and cardiovascular system, (II) recurrent aspirations, (III) faults in airway secretion permission, particularly cystic fibrosis & ciliary abnormalities & (IV) systemic & local immunity disorders [12].

Owayed *et al.* [13] found that 238 of 2952 children (eight percent) hospitalized with pneumonia met the criteria for recurrent pneumonia in a retrospective study. Underlying illness was recognized in 220 (92%), with aspiration syndrome (48%), immune disorders (10%), congenital heart disease (9%), & asthma (9%) being the most common. 8% of the children had pulmonary anomalies. In our study, 75% of advanced RP kids who were admitted to the PICU had intubations and ventilators, 35% had shocks, and 7% had multiple organ failure. The median length of stay for patients with advanced RP was 22.3 months, which is comparable to the results reported by **Ciftci *et al.*** [14] (23.6 months) and **Hoang & Ta,** [1] (22.3 months) (20.8 months). Since there are fewer medical services and parents in low-income areas are less aware of how advanced conditions can affect their children, the majority of cases analysed come from rural areas. We also found that most patients were rural, which goes along with **Hoang and Ta's,** [1] findings.

Along with our results, **Hossain *et al.*** [15] reported that males were more than females with a 1.5/1 ratio. Cough was found in all cases of the Hossain study. In our study, the most prevalent cause was respiratory abnormalities (28%). However, in Hossain study, pulmonary TB was the most prevalent cause (23.3%) may be due to low socioeconomic status and overcrowding of the selected patients in their study.

In our study Immune disorders were found in 22% of cases, which is little more than previous research that proved immune deficiency disorders in 7.7– 17.75% of cases [13, 16].

After a battery of examinations, the majority of cases of advanced RP in our research were linked to underlying reasons. Investigating previous medical history was an important & helpful technique for revealing underlying conditions in several cases of advanced RP. Children with advanced RP with a history of psychomotor impairment may also have inhalation syndrome and neuropathy. A number of respiratory illnesses, inhalation syndromes, and immunological problems can all be indicated by persistent wheezing. History of meal-related coughing or choking was connected to inhalation syndrome, or neuropathy. The underlying cause of an immunological problem may also be indicated by a history of advanced, persistent, or recurrent infection in an organ other than the lung or by a history of long-term corticosteroid treatment. After gathering information about the causal state, a variety of exams can be performed to confirm the diagnosis, including a chest CT scan, bronchoscopy, ECG, ultrasound, and blood tests. Despite this, there were 8% of cases with unknown reasons between advanced RP children.

Aspiration syndrome accounted for 11% of studied cases it is along with previous studies' results as in **Hossain *et al.*** [15] it affected 13.3% of patients. Aspiration syndrome was identified as the reason for recurrent/persistent pneumonia in the majority of research [13, 16]. The most frequent underlying illness related to advanced RP was respiratory abnormalities (28%), followed by immune disorders (22%), congenital heart diseases (16%) & aspiration syndrome (11%). **Bolursaz *et al.*** [16] found that the most common causes of RP (51.75%) were aspiration syndrome, persistent wheeze (20.17%), and congenital heart disease (20.17%).

According to Hossain, immunological deficiency (10%), bronchial asthma, congenital heart disease (16.6%), cystic fibrosis (13%), and pulmonary tuberculosis were the next four most common causes of RP (10%). The majority of the kids in the study were sent to the PICU in a critical state, which can make it difficult to look into the underlying causes. Physicians find it challenging to pursue a causative diagnosis in patients of severe recurrent pneumonia since there are no clinical standards for doing so. As a result, some tests had to be delayed until studied cases were retrieved, and a wide range of exams had to be conducted to cover all potential causes in studied cases where there was no indication of the proper timing or best order of investigations.

The pulmonary parenchyma, thorax, and other tissues of the airway tract were all affected in different ways by the studied subjects' unique respiratory problems [17]. Study subjects with healthy respiratory systems recover from pneumonia more quickly and are less likely to progress to the more severe forms of the illness. A child's risk of developing advanced RP increases if they are born with anomalies in the respiratory system. These malformations necessitated both non-invasive and invasive ventilation, which raised the rate of PICU admission. Patients with severe RP may have a variety of immunological conditions, including as low T-CD4 lymphocyte counts, neutrophil function and quantity abnormalities, and even HIV. Immune problems in children increase the risk of advanced RP. This is caused by the infection of strange organisms and the involvement of numerous infection sites in addition to the lungs [15]. Comprehensive care, such as respiratory ventilation, antibiotics, and heart disease support, are necessary for children with heart

disease. Because of this, PICU hospitalisation rates are higher than those of other children [(1)].

CONCLUSION

Children with underlying diseases had more serious diseases & poorer clinical results because they were more likely to get recurrent pneumonia & were susceptible to resistant microorganisms. As a result, more emphasis can be placed on clinical severity & therapeutic plan.

DECLARATIONS

- **Consent for Publication:** I confirm that all authors accepted the manuscript for submission
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