Original Article

Prevalence of persistent pneumonia among severe pneumonia and nutritional status as its associated risk factor: A prospective observational study among under-five children

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Abstract

Background: Malnourishment is a risk factor for persistent pneumonia among under-five children with severe pneumonia. This study aims to determine the prevalence of persistent pneumonia and the association between nutritional status and pneumonia severity in children under 5 years of age. **Methodology:** A prospective observational hospital-based study was conducted in the Department of Paediatrics, King George's Medical University (KGMU) from May 2019 to April 2020 among children aged 1 month to 5 years admitted with a diagnosis of severe pneumonia. An anthropometric assessment along with general and systemic examination was conducted. Weight for age, height for age and weight for height were calculated to assess the nutritional status. Children with severe pneumonia were followed for 4–6 weeks to assess the prevalence of persistent pneumonia. **Results:** The prevalence of persistent pneumonia was 6.8%, while 32 (31.1%) and 64 (62.1%) patients had recurrent and severe pneumonia, respectively. No statistically significant distribution was observed in age, sex, residential area, parent's education or occupation of the child. The statistically significant distribution was seen on assessing nutritional status based on weight for age, height for age and weight for height (*P* value- 0.001, 0.001, 0.0001). Those with weight for age ≤ 3SD were anaemics and up to 1 year of age had 5.21, 3.52 and 2.83 times more odds of having persistent pneumonia, respectively. **Conclusion:** The prevalence of persistent pneumonia among children less than 5 years of age was 6.8%. Malnutrition can be considered a major determinant of persistent pneumonia among children under 5 years of age.

Keywords: Malnutrition, persistent pneumonia, pneumonia, risk factors

Introduction

One of the leading causes of mortality and morbidity among children worldwide is consistently pneumonia/lower respiratory tract infection (LRTI) over the last few decades.[1] Persistent pneumonia infers chronic, non-resolving pneumonia where the persistence of symptoms and radiographic abnormalities last for at least 6 weeks.[2] The time taken for radiographic resolution mostly depends on the causative agent; this may extend from 2 weeks to as long as 12 months with infection from parainfluenza virus or respiratory syncytial virus (RSV) and adenovirus infection, respectively. Henceforth, landing on a particular cut-off period to define persistent pneumonia seems difficult.[3]

According to the World Health Organization (WHO), an incidence of 0.37 episodes per child per year has been estimated

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for clinical pneumonia, of which India tallies for 36% of the total burden of the Southeast Asia region.[4,5] Of all these episodes, almost 10% to 20% are considered severe.[6] Recently, it was estimated that among the mortality associated with acute lower respiratory infections in India, 369,000 deaths (28% of all deaths) were due to pneumonia, establishing it to be a critically fatal disease in this age-group.[7,8]

Approximately one-half of mortalities in children are due to malnutrition which constitutes wasting, stunting and a few specific nutritional deficiencies.[9] Not only it affects mortality but also has been shown to have a vicious cycle with infectious diseases, such as pneumonia. It affects the frequency and severity status of pneumonia implying that deficient immunity due to malnutrition is not well studied.[10,11] Additionally, other than an important determinant of infectious diseases, the status of nutrition in children determines present and future health status and outcome after admission to the hospital.

To protect children against pneumonia, there is need to improve the preventive measures, identify the disease in the early phase and diagnose the malnourished cases with pneumonia, even though clinically pneumonia might not be typical in such children, and the stratification of risk to understand and pick out those who are at higher risk for mortality depends greatly on their nutritional status.[12] In India, there is a paucity of documentation on the distribution and determinants as well as causative factors of persistent pneumonia which acts as a paramount hurdle in valuable drafting and execution of preventive strategies.[7,8] Malnutrition and pneumonia are part of a vicious cycle which needs to be addressed robustly. Moreover, this will also help the primary care physicians in understanding the disease and advise adequate treatment as well as referral. So, this study aims to determine the prevalence of persistent pneumonia among children under 5 years of age hospitalized with community-acquired severe pneumonia and the association between nutritional status and pneumonia severity.

Methodology

Study design and participants

A prospective observational hospital-based study was conducted at a tertiary care centre of northern India from May 2019 to April 2020 among children aged 1 month to 5 years admitted with a diagnosis of severe pneumonia. Children with upper respiratory tract infection, probable or confirmed case of swine flu or acute febrile respiratory illness (fever >38°C) with the spectrum of disease from influenza-like illness to pneumonia, suspected foreign body aspiration or diphtheria were excluded. The children enrolled in the study were followed till discharge to assess the final diagnosis which was severe, recurrent and persistent pneumonia.

Sample size

With a prevalence (p) of recurrent pneumonia among under-five children attending a paediatric chest clinic with symptoms of severe pneumonia = 3.4%,[13] confidence interval taken as = 95%, α error = 0.05% and precision = 3.8%, the minimum sample size calculated was 88 patients.[14] With 15% loss to follow-up, the final sample size was 101 patients. Overall, the data were obtained from 103 patients with severe pneumonia.

Operational definitions

Pneumonia and severe pneumonia: WHO defines pneumonia among children aged 2–59 months with cough or difficult breathing and fast breathing and/or chest indrawing. Severe pneumonia is pneumonia with any danger sign (fast breathing/chest indrawing).[15]

Recurrent pneumonia is defined as at least two episodes of pneumonia in 1 year or three episodes in any time frame, with the inter-critical radiographic clearing of densities.[16]

Persistent pneumonia is defined as the persistence of clinical symptoms and radiographic abnormalities in a child with LRTI for more than a month despite a course of antibiotic therapy for 10 days.[16]

Anaemia: WHO defines anaemia in children as haemoglobin levels less than 11 gm/dl.[17]

Malnutrition

Malnutrition refers to deficiencies, excesses or imbalances in a person's intake of energy and/or nutrients. The indicators of malnutrition used in this study are as per WHO criteria which are given in Table 1.[18]

Data collection

The following study enrolled children of age 1 month to 5 years suffering from pneumonia and admitted to the department for treatment and followed up for 4–6 weeks. Data have been collected on a pre-designed and pre-tested questionnaire followed by a collection of basic demographics, and clinical and laboratory information. A detailed history of the present illness, history, immunization and pre-hospital treatment history was taken. An anthropometric assessment along with general and systemic examination was conducted. Chest X-ray findings, oxygen saturation and other relevant examinations such as 2D echo, high-resolution computed tomography (HRCT) thorax and immunological workup were conducted as advised by the

Table 1: Indicators of malnutrition as per WHO criteria[18]

Indicator	Definition
Stunting	Height for age <-2 SD of the WHO Child Growth Standards median.
Wasting	Weight for height <-2 SD of the WHO Child Growth Standards median.
Overweight	Weight for height >+2 SD of the WHO Child Growth Standards median.
Underweight	Weight for age <-2 SD of the WHO Child Growth Standards median.

clinician. Blood samples were collected if needed. Weight for age, height for age and weight for height were calculated to assess the nutritional status. Children admitted with a diagnosis of community-acquired pneumonia were followed for 4–6 weeks to know the prevalence of persistent pneumonia.

Statistical analysis

Data collected were entered in Microsoft Excel 2010 software and were analysed using the Statistical Package for the Social Sciences (SPSS) version 24.0. Quantitative data were presented as mean and standard deviation. To test the differences, Chi-square tests and Fisher's exact test were used for categorical variables. Binomial multivariate logistic regression analysis was performed to ascertain the effect of height for age, status of anaemia, sex and weight for age on the likelihood of predicting persistent pneumonia.

Ethical considerations

The study was approved by the Institutional Research Ethical Review Committee [ECR/262/Inst/UP/2013/RR-16].

Results

Of 103 patients, 32 (31.1%), seven (6.8%) and 64 (62.1%) had recurrent, persistent and severe pneumonia, respectively, as shown in Figure 1. Hence, the prevalence of persistent pneumonia was 6.8%.

The majority of the study participants with recurrent (53.2%), persistent (57.1%) and severe pneumonia (81.2%) were of the age-group of up to 1 year. Male preponderance was seen in all the three types, that is, 81.2%, 42.9% and 76.6% in recurrent, persistent and severe pneumonia, respectively. Most of the children with recurrent (68.8%), persistent (71.4%) and severe (59.4%) pneumonia were from rural, the residential regions, respectively. The distribution of the mother's and father's education and occupation was statistically insignificant (*P* value- 0.893, 0.240, 0.422, 1.00) across the three types of pneumonia, respectively [Table 2].

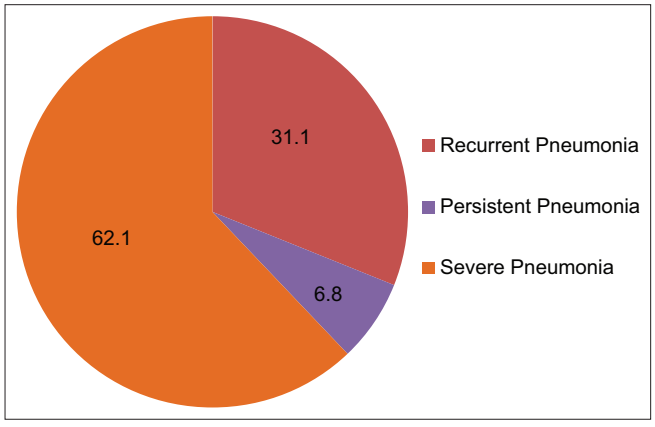

Figure 1: Distribution of study participants based on severity of pneumonia

Of the seven patients with persistent pneumonia, five (71.4%) had weight for age ≥-2 SD, followed by one (14.3%) had between -2 SD and -3 SD and one (14.3%) had ≤ -3 SD. There was a significant association between persistent pneumonia and weight for age (*P* = 0.001). Similarly, significant association was observed between the three types of pneumonia and height for age. As per the weight for height criteria, three (42.9%) patients with weight for height between -2SD to -3SD and ≤ -3SD, respectively, had persistent pneumonia. There was a highly significant association between weight for height and presence of persistent pneumonia as well as the other types (*P* value- 0.0001). The status of anaemia was not associated with the type of pneumonia among the children, and this was statistically nonsignificant (*P* value-0.457). Among the seven children with persistent pneumonia, six were anaemic, while among those with severe and recurrent pneumonia, 45 and 20 patients were anaemic, respectively [Table 3].

Binomial logistic regression was performed to ascertain the effect of height for age, status of anaemia, sex and weight for age on the likelihood of predicting persistent pneumonia. Linearity assumption was tested using model fit and pseudo-R square statistics. The Hosmer and Lemeshow test indicated that the model was a good fit for the observed data, $\chi 2 = 3.050$, $P = .931$. The model explained 65.9% (Nagelkerke R2) of the variance in the severity of pneumonia. Of all the predictor variables, three were statistically significant: that is, weight for age, the status of anaemia and age. Those with weight for age ≤ -3SD had 5.21 times more odds of having persistent pneumonia as compared to those with -2SD to - 3SD and ≥ -2SD. Those who were anaemic had 3.52 times more odds of having persistent pneumonia as compared to those with normal haemoglobin levels. Those aged up to 1 year and >1 yr–3yr had 2.83 and 1.76 more odds, respectively, of chances of suffering from persistent pneumonia in comparison with children >4 years [Table 4].

Discussion

Pneumonia is a major cause of mortality among under-five children and can be easily prevented if identified early, and appropriate action is taken timely. Malnourishment is a crucial parameter responsible for pneumonia becoming persistent or chronic and hence should never be overlooked during management of this disease. However, very few studies have explored the association of persistent pneumonia with malnutrition. The following study describes this association prospectively.

The prevalence of persistent pneumonia, in our study, was found to be 6.8%. Not many studies have focused on the prevalence of persistent pneumonia but the data that exist show a varied prevalence of 9.2%–20%, which was slightly higher than our study.[19,20] Malnourishment has been associated with persistent pneumonia because with altered nutritional status in children, there is lowered defence of the body system, which makes them sustain the infections for a long period of time.[21]

Table 2: Association of sociodemographic parameters with the type of pneumonia

Sociodemographic parameters	Type of pneumonia			*P**
	Recurrent pneumonia (*n*=32)	Persistent pneumonia (*n*=7)	Severe pneumonia (*n*=64)	
Age intervals				
Up to 1 year	17 (53.2%)	4 (57.1%)	52 (81.2%)	0.059
>1-3 years	8 (25.0%)	2 (28.6%)	6 (9.4%)	
>3-4 years	5 (15.6%)	0 (0%)	5 (7.8%)	
>4-5 years	2 (6.2%)	1 (14.3%)	1 (1.6%)	
Gender				
Male	26 (81.2%)	3 (42.9%)	49 (76.6%)	0.097
Female	6 (18.8%)	4 (57.1%)	15 (23.4%)	
Residential area				
Rural	22 (68.8%)	5 (71.4%)	38 (59.4%)	0.598
Urban	10 (31.2%)	2 (28.6%)	26 (40.6%)	
No. of siblings				
≤2 siblings	23 (71.9%)	6 (85.7%)	52 (81.2%)	0.512
>2 siblings	9 (28.1%)	1 (14.3%)	12 (18.8%)	
Father's education				
Illiterate	5 (15.6%)	0 (0%)	8 (12.5%)	0.893
Primary school certificate	15 (46.9%)	3 (42.9%	30 (46.9%)	
Middle school certificate	5 (15.6%)	2 (28.6%)	11 (17.2%)	
High school certificate	2 (6.2%)	1 (14.3%)	3 (4.7%)	
Intermediate or post-high school diploma	2 (6.2%)	0 (0%)	8 (12.5%)	
Graduate or postgraduate	3 (9.4%)	1 (14.3%)	4 (6.2%)	
Mother's education				
Illiterate	13 (40.6%)	5 (71.4%)	28 (43.8%)	0.240
Primary school certificate	11 (34.4%)	0 (0%)	26 (40.6%)	
Middle school certificate	4 (12.5%)	1 (14.3%)	6 (9.4%)	
High school certificate	0 (.0%)	0 (0%)	2 (3.1%)	
Intermediate or post-high school diploma	2 (6.2%)	0 (0%)	2 (3.1%)	
Graduate or postgraduate	2 (6.2%)	1 (14.3%)	0 (.0%)	
Father's occupation				
Unemployed + daily wages	16 (50.0%)	1 (14.3%)	39 (60.9%)	0.422
Employed	16 (50.0%)	6 (85.7%)	25 (39.1%)	
Mother's occupation				
Housewives + daily wages	30 (93.8%)	6 (85.7%)	61 (95.3%)	1.000
Employed	2 (6.2%)	1 (14.3%)	3 (4.7%)	

*P<0.05 is significant

Table 3: Association of anthropometry parameters and anaemia with the type of pneumonia

Nutritional status	Type of pneumonia			Total	*P**
	Recurrent pneumonia (*n*=32)	Persistent pneumonia (*n*=7)	Severe pneumonia (*n*=64)		
Weight for age					
≥ -2SD	25 (78.1%)	5 (71.4%)	23 (35.9%)	53 (51.5%)	0.001
-2SD to -3SD	6 (18.8%)	1 (14.3%)	41 (64.1%)	48 (46.6%)	
≤ -3SD	1 (3.1%)	1 (14.3%)	0 (0)	2 (1.9%)	
Height for age					
≥-2SD	19 (59.4%)	4 (57.1%)	17 (26.6%)	40 (38.8%)	0.001
-2SD to -3SD	12 (37.5%)	2 (28.6%)	47 (73.4%)	61 (59.2%)	
≤ -3SD	1 (3.1%)	1 (14.3%)	0 (0)	2 (1.9%)	
Weight for height					
≥ -2SD	1 (3.1%)	1 (14.3%)	0 (0)	2 (1.9%)	0.0001
-2SD to -3SD	13 (40.6%)	3 (42.9%)	14 (21.9%)	30 (29.2%)	
≤-3SD	18 (56.3%)	3 (42.9%)	50 (78.1%)	71 (68.9%)	
Status of anaemia					
Anaemia	20 (62.5%)	6 (85.7%)	45 (70.3%)	71 (68.9%)	0.457
No anaemia	12 (37.5%)	1 (14.3%)	19 (29.7%)	32 (31.1%)	

*P<0.05 is significant

Table 4: Multivariate regression analysis of the predictors of persistent pneumonia

Parameters	Adjusted odds ratio	95% confidence interval		*P*
		Lower	Upper	
Age				
Up to 1 year	2.83	1.28	24.91	0.03
>1 to 3 years	1.76	1.34	34.2	0.008
>3 to 4 years	1.02	0.889	11.56	0.09
>4 to 5 years		Reference		
Status of anaemia				
Anaemic	3.52	2.96	5.07	0.0001
Non-anaemic		Reference		
Sex				
Male	1.37	0.743	21.09	0.273
Female		Reference		
Weight for age				
≤ -3SD	5.21	1.08	22.87	0.022
-2SD to - 3SD	4.32	0.889	18.95	0.334
≥ -2SD		References		

In this study, most of the under-five children of age up to 1 year had persistent pneumonia (4/7 infants). Similar age prevalence was seen in other studies where children under 5 years of age with persistent pneumonia were mostly under 24 months of age.[22,23] Children under 1 year of age have relatively narrower respiratory tracts due to which they easily succumb to longer duration of morbidity due to pneumonia.[23] There was male preponderance in all three studied types of pneumonia, which was 81.2% in recurrent, 42.9% in persistent and 76.6% in severe pneumonia children, although this distribution was not statistically significant. Male dominance was observed in other studies where community-acquired pneumonia was studied.[22-25] This can be attributed to the fact that male child has better health-seeking behaviour as compared to female child in India.[26]

The following study showed a statistically significant association of recurrent, persistent and severe pneumonia with the status of malnutrition ($P = 0.001$). Weight for height among these children was less than -3SD with 78.1%, 42.9% and 56.3% for severe, persistent and recurrent pneumonia, respectively. Similar significant distribution of malnourishment in children with pneumonia was observed by other researchers also.[21-25] A study by Artawan *et al.*[20] also revealed that there was a statistically significant relationship between the severity of pneumonia and status of nutrition ($P = 0.02$), with 2.176 higher risk of suffering from severe pneumonia among the malnourished children. Similar findings were seen in other studies as well with one study showing 3.44 higher odds of severe pneumonia, signifying malnutrition as a major concern and determinant of severe pneumonia.[22,27,28] A systematic review concluded that the severity and mortality of childhood pneumonia increase immensely with an increase in undernutrition. The adjusted odds ratio (AOR) of mortality from pneumonia was 2.0 and 4.6 in children who were moderately and severely underweight, respectively.[29]

Anaemia has also been observed to be associated with persistent pneumonia. Multivariate regression also showed 3.52 odds of occurrence of persistent pneumonia in the anaemics when compared to the non-anaemics. Similarly, Sushila In conducted a study in Indonesia among under-five children and showed that malnourished children were 3.27 times more likely to be affected by severe pneumonia compared to children with proper nutritional status.[25] The treatment for both severe and persistent pneumonia differs as per the clinician's perspective as well as seeing the local resistance patterns. It includes mainly hospital admission, antibiotic treatment, intensive care unit (ICU) admission (if needed) and supportive care. Persistent pneumonia requires more investigations to rule out the various causes.[30]

The following study unravels the dynamics of persistent pneumonia and factors responsible for it which has not been much explored and is the strength of this study. However, the small sample size and data from a single centre limit the generalizability of the results.

Conclusion and Recommendations

The prevalence of persistent pneumonia among children less than 5 years of age was 6.8%. Malnutrition can be considered a major determinant of persistent pneumonia among children under 5 years of age. However, other factors need to be explored at the same time to draw relevant conclusions. More evidence needs to be generated to understand the association of malnutrition with persistent pneumonia with a deep insight into other related factors also which can act as confounders.

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Conflicts of interest

There are no conflicts of interest.

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