Original Article

Association of different Co-morbidities as Predictors of Severe Pneumonia in under five Children

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ABSTRACT:

Background: *Pneumonia has been one of the leading causes of morbidity and mortality among children under five years of age for several decades. Pediatric patients with pneumonia often present with additional comorbidities that may delay recovery and increase overall morbidity. Therefore, we aimed to identify and analyze the risk factors and predictors associated with childhood pneumonia.*

Objectives: *To find out the association of different co-morbidities as predictors of outcome of pneumonia patients in under five children.*

Methods: *A total of admitted 292 patients with severe or very severe pneumonia with radiological findings were followed up and categorized into two groups, group A (n-178) with risk factors and the comorbidities and the other group B (n-122) without risk factors or co-morbidities. Both groups were compared prospectively to see the outcome. Probable predictors were found as prematurity, low-birth weight, absence of exclusive breast feeding, lack of immunization, episodes of respiratory disease in life time and comorbidities like congenital heart disease (VSD, ASD, PDA or other), Severe Acute Malnutrition (SAM), Down syndrome, Cerebral Palsy (CP), Nephrotic syndrome, Cystic Fibrosis, Duchene-Muscular Dystrophy (DMD), cleft lip or cleft palate. Out come or dependent variables were considered as duration of hospital stay (≥ 7days), use of 2nd line antibiotic, oxygen requirement\ (> 2 L), development of heart failure, use of digitalis and death if any. Study participants were provided standard treatment for pneumonia and both groups were compared prospectively to see the outcome.*

Results: *Overall comorbidities had more in group-A, compared to group-B (66.9% vs. 10.5%) and on the contrary, absent of comorbidities had more in group-B, compared to group-A (89.5% vs. 33.1%). Severe Acute Malnutrition (SAM), heart failure, cleft palate, Down syndrome, VSD, prematurity, low birth weight, ASD and PDA in terms of comorbidity had significantly more in group-A compared to group-B children. Out of them VSD, Heart Failure, SAM, Down syndrome, prematurity and low birth weight were found to be significantly associated with group-A patients compared to group-B patients with Odd Ratios being 8.49, 7.09, 4.42, 3.65, 3.20 and 2.92 respectively by simple regression analysis.*

Conclusion: *Early identification and management of co-morbidities in childhood pneumonia can help to prevent serious complications and reduce morbidity, thereby may lessen the hospital burden in low-income countries such as Bangladesh.*

Key Words:
Childhood Pneumonia, Co-morbidity, Predictor

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Introduction

Community-acquired pneumonia (CAP) is a major public health issue and a principal cause of morbidity and mortality in children under 5 years of age.1 Compared to deaths due to other childhood diseases, pneumonia related deaths are declining at a slower rate.2 Rudan et al. reported every year 151.8 million incidences with 13.1 million (8.7%) episodes progressing from pneumonia to severe pneumonia that require hospitalization5.3,4 Pneumonia incidence is high among children in South Asia and it is the leading cause of hospitalization among children under five years of age in Bangladesh and is still the major killer (19%), accounting for approximately 24,268 under-five deaths per-year.5 But the risks of death are high when children with pneumonia also have other co-morbid condition.6

According to World Health Organization (WHO), United Nations Children's Fund (UNICEF), the risk factors for severe childhood pneumonia in low and middle income countries include bacterial etiology, young age, low birth weight, malnutrition, lack of breast feeding, household crowding, exposure to indoor air pollution and low-level schooling of mothers.7

Approximately 50 conditions have been described in the literature that, if present, may increase the risk of developing severity of pneumonia.7 The WHO classifies the risk factors for pneumonia in children living in developing countries as definite, likely or possible.7A recent systematic review with meta-analysis evaluated the quality of evidence and the strength of the association between 19 risk factors and severe acute lower respiratory tract infection in children under five.2,7 Most patients admitted to pediatric ward of this hospital are mainly of pneumonia. It is found that many of them have multiple risk factors and comorbidities that often predict the outcome in terms of morbidity and mortality. So, our study analyzed the association of different co-morbidities as predictors of outcome of pneumonia patients in under five children.

Materials and methods:

This prospective, analytical study was carried out in the in-patient department of Pediatrics, Shaheed Suhrawardy Medical College Hospital over a period of 2 (two) years from January 2022 to December 2023 and the study population were the patients aged 2 month to 59 months admitted with very severe or severe pneumonia according to WHO classification with radiological findings who were willing to participate.

According to WHO guideline (revised,2005) the pediatric patients with cough and/or difficulty in breathing, plus danger signs (central cyanosis, difficulty breast-feeding/drinking, vomiting everything, multiple or prolonged convulsions, lethargy/unconsciousness or head nodding) are considered as "very severe pneumonia," and only the patients with fast breathing and lower chest wall indrawing are considered as "severe pneumonia."3,4 A total 292 children aged 2-51 months were enrolled after taking the informed consent. X-rays were interpreted by the radiologists and radiological pneumonia was defined as the presence of end-point consolidation or other (non-end point) infiltrates in lungs according to WHO radiological classification of pneumonia.1,4 After admission, detail history and clinical examination were done and a written pretested questionnaire with check list was applied for data collection. Demographic and clinical data were collected in a pretested, semi-structured questionnaire including the probable predictors like prematurity, low-birth weight, absence of exclusive breast feeding, lack of immunization, episodes of respiratory disease in life time and comorbidities like congenital Heart Disease (VSD, ASD, PDA or other), Severe Acute Malnutrition (SAM), Down syndrome, Cerebral Palsy (CP), Nephrotic syndrome, Cystic Fibrosis, Duchene -Muscular Dystrophy (DMD), cleft lip or cleft palate and any other condition (if any). Out come or dependent variables are considered as duration of hospital stay (≥ 7days), use of 2nd line antibiotic, oxygen requirement\ (> 2 L), development of heart failure, use of digitalis and death if any. Among total admitted 292 patients with severe or very severe pneumonia with radiological findings are followed up and categorized into two groups, group A (n-178) with risk factors and the comorbidities and the other group B (n-114) without above-mentioned risk factors or co-morbidities. Both groups were compared prospectively to see the outcome. Study participants were provided standard treatment for pneumonia. In addition, detection and management of hypoxemia, hypoglycemia, fluid management and nutritional support were given and followed up until discharge. Patients who did not respond after 72 hours of giving antibiotics are assessed clinically and by doing hematological tests and thereafter second line of antibiotics were given. The oxygen saturation of <90% was the threshold to define hypoxia based on

WHO guideline.4 Heart failure was diagnosed with tachypnea, tachycardia, enlarged-tender liver with or without edema or ascites. Pneumonia patients with heart failure were treated with oxygen, diuretic and digoxin (if needed). Severe Acute Malnutrition patients were treated according to WHO guideline. Once the patients were considered to have clinical improvement for pneumonia (normal respiratory rate, absence of chest indrawing) and stabilized then they were discharged.

Statistical Analysis/ Data analysis:

Quantitative variables were presented as mean±SD and comparison between two study groups were performed by means of Independent Sample t test. Qualitative variables were presented as percentages and compared by the Chi square/Fisher's exact test. Simple regression analysis was performed to find out the predictors of the variables on pneumonia patients with co-morbidities (group-A). Differences with p values < 0.05 were considered statistically significant. All analysis was performed using SPSS V 16.0 for Windows.

Results

The study consisted of 292 children aged 2-51 months in which 202 (69.2%) were male and 90 (30.8%) were female. Out of 292 children, 178 were assigned as pneumonia with co-morbidities (group-A) in which 122(68.5%) were male and 56 (36.5%) were female and remaining 114 as pneumonia without co-morbidities (group-B) in which 80 (70.2%) were male and 34 (29.8%) were female. (Table 1)

The mean age of study children was 11.4±9.6 months. The mean age of group-A patients was 10.9±7.3 months and mean age of group-B patients was 12.1±11.4 months with statistically no significant difference by independent sample t-test (p=0.24). The table.1 indicates that majority of the children were in the 2-11 months age group in both study groups (67.4% vs. 72.8%) respectively. Children in the 12-23 months age group were observed significantly higher in group-A, compared to group-B (26.4% vs. 12.3%, p=0.003) with statistically significant difference. On the contrary, children in the 24-23 months age group were observed significantly higher in group-B, compared to group-A (14.9% vs. 6.2%, p=0.01) with statistically significant differences. Most of the children lived in urban area in both study groups (70.8% vs. 69.3%, p=0.78) with statistically insignificant difference.

Household income in the BDT <10000 was observed higher in group -B, compared to group-A (64.9% vs. 46.6%, p=0.002) with statistically significant difference. On the other hand, household income in the BDT 10000-15000 was observed higher in group-A, compared to group-B (18.5% vs. 1.8%, p=0.001) with statistically significant difference.

Exclusive breast feeding was found almost identical in both study groups with statistically insignificant difference.

Recurrent attack of pneumonia and vaccination by EPI were found almost similar in both study groups with statistically insignificant differences.

Table 1. Demographic & baseline characteristics of the study patients (n=292)

Characteristics	Pneumonia (with comorbidities) Group A(n=178)		Pneumonia (without co-morbidities Group-B (n=114)		p value
	No.	%	No.	%	
Child's sex					
Male	122	68.5	80	70.2	0.76^{ns}
Female	56	31.5	34	29.8	
Child's age					
2-11 months	120	67.4	83	72.8	0.32^{ns}
12-23 months	47	26.4	14	12.3	**0.003^{s}**
24-51 months	11	6.2	17	14.9	**0.01^{s}**
Child's residence					
Urban	126	70.8	79	69.3	0.78^{ns}
Rural	52	29.2	35	30.7	
Household income in BDT					
<10000	83	46.6	74	64.9	**0.002^{s}**
10000-15000	33	18.5	2	1.8	**0.001^{s}**
>15000	62	34.8	38	33.3	0.79^{ns}
Exclusive breast feeding	75	42.1	56	49.1	0.24^{ns}
Recurrent attack of pneumonia					
Once	123	69.1	84	73.7	0.40^{ns}
Twice	55	30.9	30	26.3	
Vaccination by EPI					
Appropriately	116	65.2	79	69.3	0.46^{ns}
Not appropriately	62	34.8	35	30.7	

p value reached from Chi Square test and its value <0.05 and >0.05 treated as significant(s) and non-significant(ns) respectively.

Table 2. Comorbidities among the study patients (n=292)

Comorbidities	Pneumonia, Group-A (n=178)		Pneumonia, Group-B (n=114)		P value
	No.	%	No.	%	
Rickets	2	1.1	0	0.0	0.25ns
Hurlers Syndrome	2	1.1	1	0.9	0.83ns
DMD	6	3.4	1	0.9	0.17ns
Achondroplasia	2	1.1	0	0.0	0.25ns
SAM	19	10.7	3	2.6	0.01s
Heart failure	20	11.2	2	1.8	0.003s
Cleft palate	12	6.7	0	0.0	0.005s
Down syndrome	16	9.0	3	2.6	0.03s
VSD	42	23.6	4	3.5	<0.001s
Prematurity	14	7.9	2	1.8	0.02s
Low birth weight	13	7.3	2	1.8	0.03s
ASD	17	9.6	0	0.0	0.001s
PDA	10	5.6	1	0.9	0.03s
Nephrotic syndrome	2	1.1	0	0.0	0.25ns

p value reached from Chi Square/Fisher's exact test and its value <0.05 and >0.05 treated as significant and non-significant respectively.

The table.2 depicts that Severe Acute Malnutrition (SAM), heart failure, cleft palate, Down syndrome, VSD, prematurity, low birth weight, ASD and PDA in terms of comorbidity had significantly more in group-A compared to group-B children.

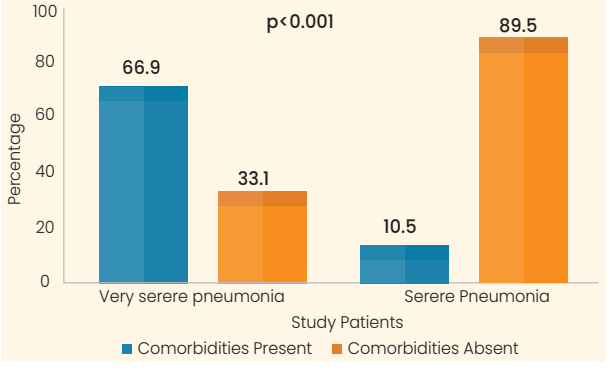

FIG. 1. Existing of overall comorbidities among the study patients (n=292)

The figure shows that overall comorbidities had more in group-A, compared to group-B (66.9% vs. 10.5%) and on the contrary, absent of comorbidities had more in group-B, compared to group-A (89.5% vs. 33.1%).

Table 3. Interventions among the study patients due to co-morbidities (n=292)

Interventions	Group-A (n=178)		Group-B (n=114)		P value
	No.	%	No.	%	
Digoxin					
Given	28	15.7	14	12.3	0.41ns
Not given	150	84.3	100	87.7	
Duration of treatment/ Hospital stay					
>7 days	95	53.4	46	40.4	**0.03s**
≤7 days	83	46.6	68	59.6	
Oxygen					
Used	72	40.4	31	27.2	**0.02s**
Not used	106	59.6	83	72.8	
Use 2nd line antibiotics					
Used	67	37.6	28	24.6	**0.02s**
Not used	111	62.4	86	75.4	

p value reached from Chi Square test and its value <0.05 and >0.05 treated as significant and non-significant respectively.

The table.3 describes that prolonged hospitalization, oxygen and use of 2nd line antibiotics were needed more in group A patients compared to group-B patients with statistically significant differences. It was also observed that digoxin was applied almost identically in both study groups.

Table 4. Mortality among the study patients (n=292)

Mortality	Group-A (n=178)		Group-B (n=114)		P value
	No.	%	No.	%	
Yes	2	1.1	0	0.0	0.25^{ns}
No	176	98.9	114	100.0	

p value reached from Fisher's exact test and its value <0.05 and >0.05 treated as significant and non-significant respectively.

The table shows that 2 (1.1%) children of group-A died as a complication of VSD with heart failure with cardiogenic shock and also from SAM but none in group-B with statistically no significant difference.

Table 5. Comorbidities associated with group -A patients compared to group-B among the study patients (n=292)

Comorbidities	OR	95% CI	p value
VSD	8.49	2.954 – 24.413	<0.001s
Heart failure	7.09	1.624 – 30.940	0.009s
SAM	4.42	1.278 – 15.302	0.01s
Down syndrome	3.65	1.040 – 12.839	0.04s
Prematurity	3.20	1.033 – 14.640	0.04s
Low birth weight	2.92	1.020 – 19.931	0.04s

All significant comorbidities mentioned in table 2 were entered into the simple regression analysis. Out of them VSD, Heart Failure, SAM, Down Syndrome, Prematurity and Low birth weight were found to be significantly associated to predict group-A patients compared to group-B patients with Odd Ratios being 8.49, 7.09, 4.42, 3.65, 3.20 and 2.92 respectively by simple regression analysis.

Discussion

This study highlights the significant role of co-morbidities in determining the severity of pneumonia among children under five. The findings revealed that children who had a higher prevalence of comorbid conditions such as ventricular septal defect (VSD), heart failure, severe acute malnutrition (SAM), Down syndrome, prematurity, and low birth weight experienced a slow recovery when compared to those with pneumonia having no associated comorbidities. Among these, VSD showed the highest odds ratio (OR: 8.49), indicating a strong predictive value, followed by heart failure (OR: 7.09) and SAM (OR: 4.42).

Congenital heart diseases, including VSD, are well-documented risk factors for lower respiratory tract infections in children due to impaired pulmonary circulation and reduced immune competence. Studies have shown that children with congenital heart defects are more prone to develop pneumonia and often require prolonged hospitalization and other supportive management. 8,9 Similarly, children with heart failure exhibit decreased oxygenation and pulmonary congestion, which may aggravate respiratory infections and increase the likelihood of severe presentations. 10

Severe Acute Malnutrition (SAM) compromises both innate and adaptive immunity, making children more susceptible to infections and increasing the severity of common illnesses like pneumonia. 11.12 Our findings are consistent with previous studies that have demonstrated that SAM is strongly associated with increased mortality and morbidity from pneumonia in under-five children.13

Prematurity and low birth weight are also known risk factors for severe pneumonia due to underdeveloped lungs and immature immune responses.14,15 Premature infants are at increased risk for respiratory distress syndrome and bronchopulmonary dysplasia, which predispose them to recurrent and severe infections.16 Furthermore, children with genetic disorders such as Down syndrome often present with immunodeficiencies and structural airway anomalies, contributing to recurrent and severe respiratory infections that is compatible with other studies.17

Socio-economic status showed to influence disease outcomes, with lower household income being more prevalent among severe pneumonia cases. This is similar with global findings that poverty contributes to delayed health-seeking behavior, undernutrition, and limited access to quality healthcare.18 In contrast, exclusive breastfeeding and vaccination status did not show statistically significant differences between the groups, although they are known to offer protective effects against pneumonia in general populations.19,20

The need for more aggressive treatment modalities—such as oxygen therapy, second-line antibiotics, and longer hospital stays—was significantly higher among children with pneumonia cases with co-morbidities. This underscores the additional healthcare burden associated with managing high-risk pediatric patients and reflects the complexity of treatment in the presence of comorbid conditions.21

Conclusion: Finally, this study showed the importance of early identification and management of comorbidities in children who present with pneumonia. Targeted interventions focusing on high-risk groups—such as those with congenital heart disease, malnutrition, or preterm birth—can help in reducing disease severity, complications, and hospital load in low-resource settings.

References

1. Chisti MJ, Salam MA, Ashraf H, Faruque AS, Bardhan PK, Hossain MI, Shahid AS, Shahunja KM, Das SK, Imran G, Ahmed T. Clinical risk factors of death from pneumonia in children with severe acute malnutrition in an urban critical care ward of Bangladesh. PLoS One. 2013 Sep 9;8(9.):e73728. doi: 10.1371/journal.pone.0073728. PMID: 24040043; PMCID: PMC3767805.
2. Geoghegan T. Global Childhood Report 2019: Changing lives in our lifetime. Save The Children, 2019 ISBN: 1-888393-36-X.
3. Rudan I, Boschi-Pinto C, Biloglav Z, Mulholland K, Campbell H. Epidemiology and etiology of childhood pneumonia. Bulletin of the World Health Organization. 2008;86(5):408–16. Epub 2008/06/12. doi: 10.2471/-blt.07.048769 ; PubMed Central PMCID: PMC2647437. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
4. Nair H, Simões EA, Rudan I, Gessner BD, Azziz-Baumgartner E, Zhang JSF, et al. Global and regional burden of hospital admissions for severe acute lower respiratory infections in young children in 2010: a systematic analysis. Lancet (London, England). 2013;381(9875):1380–90. Epub 2013/02/02. doi: 10.1016/S0140-6736(12)61901-1 ; PubMed Central PMCID: PMC3986472. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
5. Naheed A, Breiman RF, Islam MS, Saha SK, Tabassum Naved R. Disparities by sex in care-seeking behaviors and treatment outcomes for pneumonia among children admitted to hospitals in Bangladesh. PloS one. 2019;14(3):e0213238. Epub 2019/03/08. doi: 10.1371/journal.pone.0213238 ; PubMed Central PMCID: PMC6405050. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
6. Rahman AE, Hossain AT, Siddique AB, Jabeen S, Christi MJ, Dockrell DH, Nair H, Jamil K, Campbell H, Arifeen SE. Child mortality in Bangladesh – why, when, where and how? A national survey-based analysis. J Glbo Health 2021;11:04052. www.jogh.org • doi: 10.7189/-jogh.11.04052
7. Aston SJ. Pneumonia in the developing world: Characteristic features and approach to management. Respirology (Carlton, Vic). 2017;22(7):1276–87. Epub 2017/07/07. doi: 10.1111/resp.13112 . [PubMed] [CrossRef] [Google Scholar]
8. Lodha R, Kabra SK. Pneumonia in children with congenital heart disease. Indian J Pediatr. 2000;67(11):805–10.
9. Mahle WT, Sutherland JL, Frias PA. Respiratory infections and congenital heart disease. Cardiol Young. 2011;21(1):32–8.
10. Sachdev A, Das RR. Management of pneumonia in children. Indian J Pediatr. 2016;83(11):1124–34.
11. Chisti MJ, Salam MA, Ashraf H, et al. Clinical risk factors of death from pneumonia in children. Trop Med Int Health. 2013;18(12):1311–7.
12. Black RE, Allen LH, Bhutta ZA, et al. Maternal and child undernutrition. Lancet. 2008;371(9608):243–60.
13. Caulfield LE, de Onis M, Blössner M, Black RE. Undernutrition as an underlying cause of child deaths. Bull World Health Organ. 2004;82(2):79–83.
14. Liu L, Oza S, Hogan D, et al. Global, regional, and national causes of child mortality. Lancet. 2015;385(9966):430–40.
15. Mussi-Pinhata MM, Clark DA. Infectious disease risk in preterm infants. Curr Opin Infect Dis. 2017;30(3):260–6.
16. Ralser E, Mueller W, Haberland C, et al. Respiratory syncytial virus and preterm infants. Pediatric Pulmonol. 2012;47(8):761–6.
17. Ram G, Chinen J. Infections and immunodeficiency in Down syndrome. Clin Exp Immunol. 2011;164(1):9–16.
18. Rudan I, Boschi-Pinto C, Biloglav Z, et al. Epidemiology and etiology of childhood pneumonia. Bull World Health Organ. 2008;86(5):408–16.
19. Bhandari N, Bahl R, Mazumdar S, et al. Effect of exclusive breastfeeding on incidence of pneumonia. Lancet. 2003;361(9359):451–5.
20. O'Brien KL, Wolfson LJ, Watt JP, et al. Burden of disease caused by Streptococcus pneumoniae. Lancet. 2009;374(9693):893–902.
21. Zar HJ, Madhi SA. Childhood pneumonia—progress and challenges. S Afr Med J. 2006;96(9 Pt 2):890–900.