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Original Research Article

Risk factors associated with mortality in children with severe pneumonia

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ABSTRACT

Background: Pneumonia remains a global health problem; however, there are limited data available on the specific risk factors for pneumonia and pneumonia-related mortality in children. Aims and objectives were to analyze the risk factors and various demographic factors which are associated with mortality in children with severe pneumonia.
Methods: This observational cross-sectional study was conducted in a tertiary care PICU in central India on pediatric patients aged 2 months to 5 years admitted with severe pneumonia. Final outcome was measured in terms of discharge and death. Statistical analysis was done using the SPSS program for windows, version 25.
Results: The mortality rate in an upper-lower class of children was 51.9% and the association between mortality and SES was significant with a p<0.001. Also, lack of exclusive breastfeeding, delay in seeking medical care especially in >72 hours, delay in transport from the referral center, severe acute malnutrition among the children, and leucocytosis 61.5% were found to be significant predictors of mortality. The oxygen requirement association with mortality was significant (p=0.001), similar to the need for mechanical ventilation within 6 hours.
Conclusions: Factors like delay in seeking medical care for >72 hours, contact with COVID patients, lack of exclusive breastfeeding, and delay in transport are the risk factors that are significantly associated with pneumonia-related mortality.

Keywords: Severe pneumonia, Pneumonia-related mortality, Risk factors

INTRODUCTION

Pneumonia is the most common cause of under-5 (U-5) mortality and contributed to 15% of U-5 mortality in 2017. Pneumonia killed 740180 children under the age of 5 in 2019, accounting for 14% of all deaths of children under five years old.[1,2] India contributes about 23 percent of the global pneumonia burden and 36 percent of the WHO regional burden in patients under 5 years of age.[3]

Trends in paediatric mortality and morbidity are reliable indices of the state of health in underdeveloped nations. Infancy, lack of immunisation, malnutrition, chronic underlying disorders, HIV infection, young maternal age, low maternal education, low socioeconomic position, and smoke exposure/indoor air pollution are all risk factors for pneumonia incidence and severity.[4] The most important risk variables identified in the 2015 global burden of disease (GBD) were malnutrition, household air pollution, ambient particulate matter, or inadequate breastfeeding.[5]

Several developing countries have reported risk factors for the development of pneumonia and patient fatalities; however, India has inadequate data for the same.[7,8] Despite the fact that pneumonia-related mortality can be avoided with modest actions and effective treatment, identifying children with pneumonia who are at high risk of death remains difficult. Therefore, our study aimed to identify risk factors in order to aid in the prevention of death from this devastating disease "pneumonia".

METHODS

An observational cross-sectional study was carried out on 240 patients over the course of 18 months at the Gandhi medical college's paediatric intensive care unit (PICU), department of paediatrics, in Bhopal, India, from March 2021 to September 2022. Patients in the age group of 2 months to 5 years admitted to the PICU with severe pneumonia were included in the study. Patients with known cases of congenital heart disease, asthma, COPD and tuberculosis were excluded.

A complete history was obtained pertaining to demographic profile, presenting complaints, diet, contact with COVID patients, and home environment.

A thorough evaluation included vital signs (heart rate, respiratory rate, temperature, blood pressure, oxygen saturation) and an assessment of fast breathing. Axillary temperature was recorded with a digital thermometer, and fever was considered when the reading was above 100 degrees Fahrenheit. Baseline oxygen saturation was measured using a pulse oximeter. Chest indrawing, signs of hypoxia (head nodding, grunting, and cyanosis) were noted. Other than these vital signs; anthropometry, including weight, length/height, and mid-upper arm circumference (MUAC), was measured.

The risk factors evaluated were clinical and socio-demographic parameters (absence of exclusive breastfeeding, smoking member in family, history of COVID contact within 14 days of onset of symptoms, socio-economic status, use of biomass fuel), delay in seeking medical care, delay in transport (>24 hours after referral), and nutritional status (SAM, MAM, NO malnutrition). SES (socio-economic status) was determined using a modified Kuppuswamy scale. Laboratory investigations, apart from chest X-rays, included an absolute leukocyte count. Extreme leucocytosis was defined as an absolute leukocyte count above or equal to 11,000/mm.

All the information was filled out in a pre-designed study proforma. All patients were given treatment as per the protocol. The final outcome was measured in terms of discharge and death.

Statistical analysis plan

The data was analysed using the SPSS program for Windows, version 25. The associations of categorical variables were presented as absolute numbers and percentages. P<0.001 considered statistically significant.

RESULTS

Study was conducted among 240 subjects, out of which (57.5%) belonged to age group of 2 to 6 months. Males (62.9%) outnumbered females (37.1%) in our study, and 169 patients (70.4%) belonged to upper lower class.

In present study, 140 patients' mothers (48.3%) illiterate. The 53.3% of children had not received exclusive breastfeeding. In 116 patients (48.3%) with severe pneumonia, family member(s) were found to be smokers, 25.8% of patients had history of contact with COVID patients, and 39.6% were using biomass fuel. Delay in transport was important risk factor in 87 patients (36.3%).

The mortality rate due to pneumonia in patients aged 2 months to 5 years was 21.7% (Figure 1).

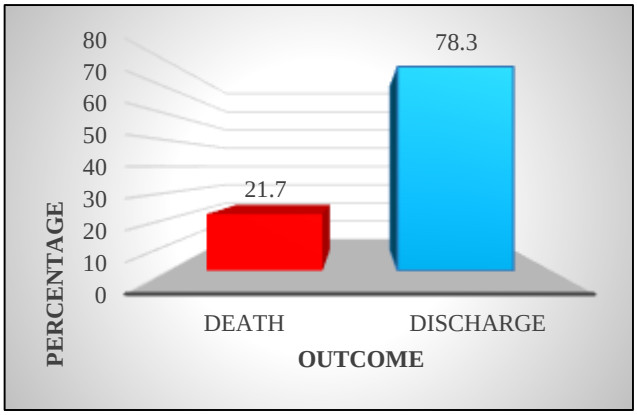

Figure 1: Outcome of children admitted with severe pneumonia, (n=240).

On comparing the outcome among the children with severe pneumonia with sociodemographic parameters, it was revealed that age and gender of the children with severe pneumonia were not associated with mortality, however, SES of the children was a significant predictor of mortality, (51.9%) of the children who died belong to the upper lower class, whereas a quarter (25%) of the children who died belong to the lower middle class. The mortality rate in the lower class of children was 17.3%, whereas the mortality rate in the upper middle class was 5.8%. The association between mortality and SES was significant, with a p<0.001, as shown in Table 2.

On comparing the risk factors with the outcome, it was revealed that maternal education has no role in determining mortality in the present study (p=0.396); however, delay in seeking medical care, especially in >72 hours, have higher risk of mortality (Table 2). In addition to this, malnutrition among the children was a significant predictor of mortality. Children with SAM had the highest mortality (40.4%) Also, leucocytosis 61.5% (p<0.001) was found to be significantly associated with mortality in children with severe pneumonia (Table 3).

On the contrary, other factors in terms of clinical features, such as presence of fever (p=0.320), cough (p=0.438) and refusal to feed (p=0.594) did not have any significant association with mortality.

The association of oxygen requirement with mortality was found to be significant (p=0.001) similarly to the need for mechanical ventilation within 6 hours (Table 4).

Table 1: Association of sociodemographic parameters with outcome, (n=240)

Sociodemographic parameters		Outcome, n (%)		Total	P value
		Death	Discharge		
Age (Months), (n=240)	2-6	31 (59.6)	107 (56.9)	138 (57.5)	0.910
	6-12	9 (17.3)	40 (21.3)	49 (20.4)	
	12-24	6 (11.5)	18 (9.6)	24 (10)	
	24-60	6 (11.5)	23 (12.2)	29 (12.1)	
Gender, (n=240)	Female	24 (46.2)	65 (34.6)	89 (37.1)	0.126
	Male	28 (53.8)	123 (65.4)	151 (62.9)	
SES, (n=240)	Upper	0 (0)	0 (0)	0 (0)	<0.001
	Upper middle	3 (5.8)	13 (6.9)	16 (6.7)	
	Lower middle	13 (25)	27 (14.4)	40 (16.7)	
	Upper lower	27 (51.9)	142 (75.5)	169 (70.4)	
	Lower	9 (17.3)	6 (3.2)	15 (6.3)	

Table 2: Association of various risk factors with outcome, (n=240).

Risk factors		Outcome, n (%)		Total	P value
		Death	Discharge		
Education	Illiterate	33 (63.5)	107 (56.9)	140 (48.3)	0.396
	Primary school	11 (21.2)	53 (28.2)	64 (26.7)	
	Middle school	5 (9.6)	12 (6.4)	17 (7.1)	
	High school	3 (5.8)	8 (4.3)	11 (4.6)	
	Post high school	0 (0)	8 (4.3)	8 (3.3)	
Exclusive breast feeding	No	40(76.9)	88(46.8)	128(53.3)	<0.001
	Yes	12(23.1)	100(53.2)	112(46.7)	
Smoking in family	No	20 (38.5)	104 (55.3)	124 (51.7)	0.031
	Yes	32 (61.5)	84 (44.7)	116 (48.3)	
H/o contact with COVID patient	No	21 (40.4)	157 (83.5)	178 (74.2)	<0.001
	Yes	31 (59.6)	31 (16.5)	62 (25.8)	
Delay in seeking medical care	<72 hours	26 (50)	159 (84.6)	185 (77.1)	<0.001
	72 hours-7 days	10 (19.2)	20 (10.6)	30 (12.5)	
	>7 days	16 (30.8)	9 (4.8)	25 (10.4)	
Delay in transport	No	21 (40.4)	132 (70.2)	153 (63.7)	<0.001
	Yes	31 (59.6)	56 (29.8)	87 (36.3)	

Table 3: Association of vitals on admission with outcome, (n=240).

Vitals on admission		Outcome, n (%)		Total	P value
		Death	Discharge		
Hypoxia	80-91%	47 (90.4)	137 (72.9)	184 (76.7)	<0.001
	<80%	5 (9.6)	5 (2.7)	10 (4.2)	
	No	0 (0)	46 (24.5)	46 (19.2)	
Blood pressure	< 90th centile	50 (96.1)	150 (79.8)	235 (97.9)	<0.001
	>90th centile	2 (3.8)	38(20.2)	5 (2.1)	
Temperature (^{0}F)	>100	20 (38.5)	109 (58)	129 (53.8)	0.312
	<100	32 (61.5)	79 (42)	111 (46.3)	

Table 4: Association of laboratory parameters with outcome.

Laboratory parameters		Outcome, n (%)		Total	P value
		Death	Discharge		
Leucocytosis	No	20 (38.5)	141 (75)	161 (67.1)	<0.001
	Yes	32 (61.5)	47 (25)	79 (32.9)	
Serum calcium (mg/dL)	<8	32 (61.5)	102 (54.5)	134 (56.1)	0.537
	8-11	20 (38.5)	83 (44.4)	103 (43.1)	
	>11	0 (0)	2 (1.1)	2 (0.8)	

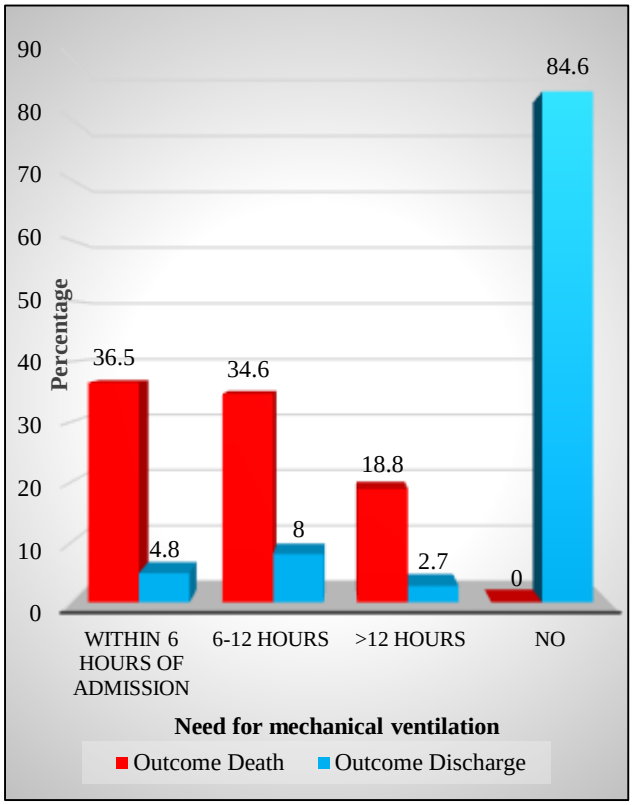

Figure 2: Association of need for mechanical ventilation with outcome, (n=240).

DISCUSSION

In our study, mortality rate for children aged 2 months to 5 years with severe pneumonia was 21.7% (Figure 1).

The maximum number of children were between the ages of 2 and 6 months (Table 1). Moreover, in a recent Indian study11, the most common age group in children with severe pneumonia was found to be 2 to 12 months. However, the global prevalence of pneumonia is highest in the age group of 1-4 years.[12] Shah et al demonstrated that the case fatality rate was 6.3% (9 cases), with 55.5% (5 cases) of the fatal cases occurring within 24 hours.[11] Bokade et al found an overall case fatality rate of 8.62% compared to 3.9% for an all-cause mortality in this age group.[12]

In our study, severe pneumonia was found to be more common in males (62.9%) as compared to females (37.1%) (Table 1). However, it was revealed that the age and gender of the children with severe pneumonia were not associated with mortality. Shah et al reported that nearly 60% of pneumonia cases were male, with a male-to-female ratio of 1.45.[11] In another study by Nasrin et al the severe pneumonia group included a preponderance of male children (63%).[13]

A further finding from our study revealed that SES was a significant predictor of mortality in severe pneumonia. The maximum number of the children who died belonged to the upper lower class (51.9%), whereas a quarter (25%) of the children who died belonged to the lower middle class (Table 1) Nirmolia et al reported that the maximum number of mortalities was noticed in the upper lower class (42.3%).[14] In our study, maternal education was found to have no role in determining mortality. Similarly, Sutriana et al found that there was no relationship between the educational status of the mothers and the incidence of pneumonia in children.[15]

In our study, lack of exclusive breast feeding was seen in 76.9% of total deaths due to severe pneumonia (Table 2). Recent research in the United States and the United Kingdom showed children who were breastfed exclusively became ill much less frequently than children who were not breastfed.[16] Research from the group of Lamberti et al showed children who were not breastfed optimally or exclusively had a higher risk for morbidity and mortality secondary to pneumonia at all age levels.[17]

In the present study, we did not find any association between children who has smoker(s) in family and increased mortality. Greenberg et al showed that children under 5 years of age who are exposed to second hand smoke are at a higher risk of pneumonia than children who are not exposed to cigarette smoke (p=0.016).[18] Our study also reported that delay in seeking medical care for more than 7 days (30.8%) and between 72 hours to 7 days (19.2%); (p<0.001) and delay in transport (59.6%); (p<0.001) are the significant predictors of mortality in present study. Similarly, Kirolos et al reported that the mean delay before seeking care for the pneumonia group was 3.6 days (median 3.0, interquartile range IQR=2-4, range=0-20).[19] For the group without pneumonia, the mean delay was 3 days (median=2.0, IQR=1-4, range=0-21).

Malnutrition was found to be a predictor of mortality in our study. SAM children had maximum mortality (40.4%) whereas 13.5% of the MAM children had mortality. These findings are consistent with the findings by Caulfield et al which indicated that malnutrition in childhood contributes significantly to the GBD, specifically that 52.3% of child deaths due to pneumonia are directly related to malnutrition.[20] In keeping with our study results, a study revealed that children less than 5 years old are most vulnerable to major diseases, and the majority of them are treated in the PICU. Worldwide statistics in all age groups indicate pneumonia remains the main cause of PICU utilisation and is also associated with a mortality rate of 29.9%.[21]

In present study, hypoxia, as a major indicator of disease severity, was observed in almost 76.7% of children with severe pneumonia. In our study, the presence of hypoxia (<92% oxygen saturation) (p<0.001) was significantly associated with mortality (Table 3). 100% of children who died and 75.6% of children who got discharged required oxygen on admission (p=0.001). Several studies

have investigated factors associated with hypoxemia, particularly clinical predictors.[22]

Kasundriya et al study evaluated host biomarkers like the TLC count, which was useful only in the presence of moderate leucocytosis.[23] However, in our study, leucocytosis (61.5%; p<0.001) was found to be significantly associated with mortality in children with severe pneumonia (Table 3).

Mechanical ventilation is a widely used form of respiratory support in pediatric intensive care units (PICU). In our study, mortality was highest among those who required mechanical ventilation Within 6 hours of admission (36.5%) (Figure 2). Zhang et al demonstrated in another trial that extended use of mechanical ventilation results in complications and mortality.[24]

CONCLUSION

Our study of pediatric patients with severe pneumonia provides data on pneumonia-related mortality in children aged 2 months to 5 years, and this further demonstrates that lower socio-economic class, delayed seeking of medical care, delay in transport, severe acute malnutrition, hypoxia and low blood pressure on admission, leucocytosis, and the need for mechanical ventilation were associated with a substantial increase in pneumonia-related mortality. However, some factors like age, gender, maternal education, smoker(s) in the family were found to have no association with mortality in children due to severe pneumonia. We believe that the results of this study will not only contribute to our knowledge of pneumonia-related mortality, but also provide valuable information to clinicians in primary care settings.

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