Original Research Article

Under 5 pneumonia a forgotten pandemic: an insight into risk factors predicting outcome of severe pneumonia in children aged 2 months to 5 years of age

Naresh D. Gaikwad, Nusrat R. Inamdar*, Anupama V. Mauskar

Department of Pediatrics, Hinduhriday Balasaheb Thackeray Medical College and Dr. R. N. Cooper Municipal General Hospital, Mumbai, Maharashtra, India

*Correspondence:
Dr. Nusrat R. Inamdar,
E-mail: nusratinamdar@gmail.com

ABSTRACT

Background: Pneumonia is the leading cause of morbidity and mortality in the pediatric population. In developing countries like India, multiple sociodemographic and environmental factors influence the outcome of severe pneumonia so this study explores these risk factors with aim of finding ways to improve the outcome.
Methods: It is a prospective observational study conducted over a period of 12 months on 2 months to 5 years, children with severe pneumonia admitted in ward and PICU of tertiary medical care institute. A total of 100 patients were enrolled in the given study after meeting the inclusion criteria. Predesigned proforma was used to record sociodemographic details, patient history, detailed examination findings and laboratory reports. Outcome in terms of mortality and morbidity was noted. Data analyzed using appropriate statistical tests, p values <0.05 accepted as statistically significant.
Results: The severe pneumonia was more common in the age group of 2 months to 1 year of age (59%) and in males (60%). Malnutrition and leukocytosis was statistically significant. 53 subjects were exclusively breastfed. Type of family, mother & father's education status, mother's employment status, tobacco exposure and contact with tuberculosis were not found statistically significant in the given study. 21 participants required PICU and 10 patients required mechanical ventilation. 92 patients were discharged, while 2 patients expired.
Conclusions: Pneumonia is an important preventable and treatable cause of under 5 mortalities. In developing countries like India an awareness and proper management of risk factors like malnutrition, low birth weight, immunization status can improve the outcome.

Keywords: Pneumonia, Respiratory distress, Severe acute malnutrition, Under 5 mortalities

INTRODUCTION

Pneumonia is the leading cause of mortality in the pediatric population worldwide, including India, with India accounting for 20% of this mortality and a significant proportion of morbidity in pediatric population. The United Nations Children's Fund (UNICEF) observed that pneumonia claimed lives of more than 8,00,000 children worldwide in the year 2018 under the age of 5 meaning one child dying of pneumonia every 39 seconds.

Pneumonia cost more pediatric lives in the world than due to diarrhea and malaria combined in 2018.[1]

Pneumonia is an infection of the lungs that is characterized by inflammation of air sacs in one or both of the lungs.[2] It is a multi-factorial disease with air-borne transmission, mainly from person-to-person as most pathogens do not survive outside the body for long. The symptoms of pneumonia range from cough, cold, fever, loss of appetite, nausea, and vomiting. The pediatric population show some

specific symptoms like fast breathing, wheezing, refusal to feed, lethargy and so on.

At present, India has the largest population of children worldwide, making pneumonia a vital player, not only in the health of these children but also in the health of the nation. And even though pneumonia remains a completely preventable and treatable disease, the association of pneumonia with other factors like malnutrition, indoor air pollution, low birth weight, incomplete immunization, and difficult access to healthcare services makes it really difficult for developing nations like India to combat this entity. Pneumonia is one of the major reasons for which children are brought to hospitals and health facilities. The reason for high case fatality may also be due to the fact that children are either not brought to the attention of healthcare or they are brought late. Such are the devastating outcomes associated with pneumonia that some people have even called it the "forgotten pandemic" and yet little attention is paid to it.

The predictors of severe pneumonia are well identified; hence this study was conducted with the objective of studying the association between individual risk factors and their association with severe pneumonia so that a targeted-level approach on those individual risk factors could be applied to reduce the incidence of severe pneumonia and improve its outcome.

METHODS

The study assessed the various risk factors and their association with the outcome of severe pneumonia in children aged 2 months to 5 years of age. It was a prospective observational study, conducted over a duration of 12 months from March 2021 to February 2022. Institutional ethics committee (IEC) permission was taken prior to commencement of the study.

Children aged 2 months to 5 years of age, diagnosed with severe pneumonia and admitted in pediatric ward and pediatric intensive care unit (PICU) of a Hinduhridaysamrat Balasaheb Thackeray Medical College and Dr. R.N. Cooper Hospital, a tertiary care medical institute, whose parents consented for taking part in the study were included. Patient who had hospital acquired pneumonia- i.e. patient acquired pneumonia after 48 hours of admission in a healthcare setting, patient having structural lung/ airway deformity and patient having congenital immunodeficiency were excluded from the study. The sampling technique was consecutive sampling i.e. all consecutive admissions meeting in the inclusion criteria during the study were enrolled.

Along with the history, detailed clinical examination of children were recorded in a pre-designed proforma. The socio demographic details were noted. Exclusive breastfeeding (EBF) was considered when, as per recommendations, the infant only receives breast milk without any additional food or drink, not even water.[3]

Family consisting of married couple and their dependent children was noted as nuclear family and joint or extended family was a family where number of married couple and their children in the same household.[4] Presence of overcrowding was said to be present when two persons, above 9 years of age, of opposite sexes, not husband and wife, were made to sleep in the same room.[4] Any newborn born before 37 completed weeks of gestation is called as preterm and after that called full term.[5] Nutritional status was assessed by World Health Organization (WHO) guidelines and patients were classified as severe malnutrition and moderate malnutrition.[6] Patients were diagnosed with severe pneumonia as per - integrated management of newborn and childhood illness (IMNCI) guidelines.[7]

Severe pneumonia is characterized by following danger signs and symptoms: respiratory rate (RR) more than 50 breaths per minute (2 months to 1 years of age); more than 40 breaths per minute (1 to 5 years of age); and nasal flaring, fever, cyanosis, inability to drink or feed, grunting, chest indrawing, stridor in a calm child, wheezing, lethargic, abnormally sleepy, difficult to wake child, convulsions, underlying severe malnutrition. Children were investigated with blood and radiological investigations after the assessment as needed. The risk factors and relevant laboratory reports were noted.

For interpretation of laboratory reports following cut offs were used. Anaemia is defined as hemoglobin concentration 2 standard deviations below the mean, based on age specific norms.[8] The range for normal serum electrolytes were considered as follows - sodium 136-146 meq/l, potassium - 3.4 to 5 meq/l, chloride - 100 to 107 meq/l; any deviations from these were considered as abnormal.[9] C-reactive protein (CRP) was considered significant at values more than 6 gm/dl.[9] Total leucocyte counts (TLC) of 4000 to 11,000/mm^3 were considered as within normal limits.[9] Outcome in terms of mortality and morbidity was noted. The recorded data was then analyzed.

Statistical analysis

Results were analyzed using statistical software IBM statistical package for the social sciences (SPSS) version 23.0 and Microsoft office. Continuous data has been expressed as median (interquartile range). The categorical data is summarized as frequencies and percentages. The normality of the continuous data is tested by Shapiro-Wick test. The continuous variables have been analyzed by Mann-Whitney U test. Categorical data is analyzed using Fisher's exact test. P values <0.05 are accepted as statistically significant.

RESULTS

The study included 100 children in the age group of 2 months to 5 years admitted with severe pneumonia. The median (interquartile range) for age of the participants is

0.8 (0.3-1.5) years. The youngest participant is 2 months old and the oldest is 5 years old. Maximum patients are between 2-12 months of age. Males are more (60%) compared to females. In history 19 were born pre term, 34 had LBW, 2 were unimmunized, 12 had NICU stay, 42 had previous hospitalization and 5 patients had measles in past (Table 1).

Table 1: Age/sex wise distribution, birth history, early infancy nutrition, immunization status, previous hospitalization details of participants.

Characteristics	Number/ percentage*
Age group	
2 months to less than 1 year	59
1 year to less than 2 years	19
2 years to less than 3 years	10
3 years to less than 4 years	5
4 years to 5 years	7
Birth history	
Gestation	
Preterm	19
Full term	81
Birth weight**	
Low birth weight	34
Normal	66
Steroid given to mother in ANC period	
Yes	7
No (applicable to preterm births)	12
NICU stay	
Yes	12
No	88
Total	100
Sex	
Male	60
Female	40
Immunization status	
Unimmunized	2
Age-inappropriate immunization	51
Appropriately immunized for age	47
Past history of measles	
Yes	5
No	95
Previous hospitalization	
Yes	42
No	58
Exclusively breastfed till 6 months of age	
Yes	53
No	47
Total	100

*Number and percentages are the same as total number of subjects enrolled in the study were 100; **The median (IQR) for the birth weight is 2.6 (2.3-2.8) kg

63 patients were from joint family. Majority of mothers were illiterate or had only primary education (76%). 28

mothers were working. Overcrowding was present in 44 families and tobacco smoking history Father was present in 27 patients (Table 2).

Table 2: Family and environmental history of the participants.

Characteristics	Number/percentage
Type of family	
Nuclear	37
Extended/joint	63
Mother's education	
Illiterate	38
Primary	38
Secondary	21
Graduation	3
Father's education	
Illiterate	5
Primary	29
Secondary	52
Graduation	14
Total	100
Mother employment status	
Working	28
Not working	72
Environmental history	
Type of house	
Kaccha	2
Pukka	98
Overcrowding	
Yes	44
No	56
Tobacco smoking in father	
Yes	27
No	73
Total	100

On general examination 97 patients had bradycardia and 93 had tachypnea. 9 patients had SAM while 47 had MAM. 22 patients had rickets. Only 18 patients had cyanosis.

On respiratory system examination nasal flaring was present in 82 patients, 53 had chest indrawing and wheeze was present in 29 cases (Table 3).

On investigation 29 patients had anemia, 21 had lekocytosis while 19 had leukopenia. CRP was reactive in 48 patients. Majority of patients (65%) had normal electrolytes while 17 patients had hyponatremia (Table 4).

92 patients were discharged while 5 patients expired. 2 of the patients who expired required mechanical ventilation. Amongst the patients who expired, longest stay of ward was 6 days and for PICU was 6 days while shortest being 1 day in ward and 1 day in PICU (Table 5).

Table 3: Clinical features of the participants.

General examination findings	Number/ percentage
Heart rate	
Normal	2
Tachycardia	1
Bradycardia	97
Respiratory rate	
Normal	7
Increased	93
SpO$_2$	
Normal	46
Hypoxia	54
Anthropometry	
Appropriate for age	43
Failure to thrive	1
Moderate acute malnutrition	47
Severe acute malnutrition	9
Anaemia	
Present	29
Absent	71
Rickets	
Yes	22
No	78
Total	100
Respiratory system examination findings	
Running nose	
Yes	54
No	46
Nasal flaring	
Yes	82
No	18
Chest indrawing	
Yes	53
No	47
Accessory lung sounds	
Wheeze	29
Conducted sounds	20
Bronchospasm	11
Crepitation	10
Wheeze crepitation	13
Wheeze bronchospasm	1
Crepitation conducted sound	1
None	15
Cyanosis	
Present	18
Absent	82
Total	**100**

Section II: Association of the risk factors with the outcome

The outcome was known in 97 participants, hence only these are included in the bivariateanalysis.

Highest number of cases were from 2 months to 1 year of age group. Male preponderance was found in the given study.

Table 4: Investigation findings in the participants.

Investigation findings	Number/ percentage
Hemoglobin	
Normal	71
Below normal	29
White blood corpuscles count (WBC)	
Normal	60
Decreased	19
Increased	21
Platelets	
Normal	75
Thrombocytopenia	25
Total	100
C-reactive protein	
Negative	52
Reactive	48
Serum electrolytes	
Normal	65
Hyperkalemia	5
Hypokalemia	3
Hypernatremia	3
Hyponatremia	17
Hyponatremia and hyperkalemia	3
Hyponatremia and hypokalemia	4
Total	**100**

Table 5: Outcome of the participants and association of deaths with duration of stay and mechanical ventilation.

Outcome	Number/ percentage
Discharge/survival	92
Death	5
Discharge against medical advice	2
Transfer (for VATS)	1
Total	100
Duration of stay ward/ PICU (in patients who expired)	Mechanical ventilation
5 days/4 days	No
1 day/1 day	Yes-1 day
<1 day/No	No
6 days/6 days	Yes-6 days
1 day/No	No

Birth weight, prematurity, NICU stay, antenatal steroids, immunization (appropriate/inappropriate for age), past history of measles and previous hospitalizations werenot found to be statistically significant.

Type of family, mothers and father's education status, mother's occupation status, mother's employment of status, type of home, overcrowding and tobacco smoking in father were not foundto be statistically significant.

Malnutrition was statistically found to be significant with occurrence of severe pneumonia. All5 deaths recorded in this study were from this group. No deaths were recorded in children withnutrition appropriate for age.

Runny nose, chest indrawing, nasal flaring and accessory lung sounds were not statistically significant.

While no association was found with anaemia, thrombocytopenia, C reactive protein and deranged serum electrolytes, deranged total white blood cell counts were significantly associated with increased risk for severe pneumonia.

There is a significant higher duration of hospital stay in the surviving participants as compared to the ones who did not survive. Duration of mechanical ventilation differed significantly in these two groups. Those who survived initial management showed better outcomes.

Table 6: Outcome of the participants based on age and sex of the participants.

Characteristics	Outcome		P value@
Age group	**Survival**	**Death**	0.208
2 months to less than 1 year	55 (96.5)	2 (3.5)	
1 year to less than 2 years	16 (88.9)	2 (11.1)	
2 years to less than 3 years	10 (100)	0 (0)	
3 years to less than 4 years	4 (80)	1 (20)	
4 years to 5 years	7 (100)	0 (0)	
Sex			1.000
Male	37 (94.9)	2 (5.1)	
Female	55 (94.8)	3 (5.2)	
Total	92 (94.8)	5 (5.2)	

@Fisher's exact test used, *significance level is 0.05

Table 7: Outcome of the participants based on birth history, early infant nutrition, immunization and past medical history, parental sociodemographic factors.

Variables	Outcome		P value@
	Survival	**Death**	
Gestation			1.000
Preterm	16 (94.1)	1 (5.9)	1.000
Full term	76 (95)	4 (5)	
Birth weight*			1.000
Low birth weight	31 (96.9)	1 (3.1)	1.000
Normal	61 (93.8)	4 (6.2)	
Steroid given to mother in ANC period			1.000
Yes	7 (100)	0 (0)	1.000
No	85 (94.4)	5 (5.6)	
NICU stay			0.427
Yes	9 (90)	1 (10)	0.427
No	83 (95.4)	4 (4.6)	
Exclusive breast feeding till 6 months of age			0.656
Yes	51 (96.2)	2 (3.8)	0.656
No	41 (93.2)	3 (6.8)	
Immunization status			0.117
Unimmunized	2 (100)	0 (0)	0.117
Partial immunization done	46 (90.2)	5 (9.8)	
Completely immunized	44 (100)	0 (0)	
Previous hospitalization			1.000
Yes	39 (95.1)	2 (4.9)	1.000
No	53 (94.6)	3 (5.4)	
Past history of measles			1.000
Yes	5 (100)	0 (0)	1.000

Continued.

Variables	Outcome		P value@
	Survival	**Death**	
No	87 (94.6)	5 (5.4)	
Total	92 (94.8)	5 (5.2)	-
Type of family			
Nuclear	34 (97.1)	1 (2.9)	0.651
Extended/joint	58 (93.5)	4 (6.5)	
Mother's education			
Illiterate	36 (94.7)	2 (5.3)	0.596
Primary	34 (91.9)	3 (8.1)	
Secondary	19 (100)	0 (0)	
Graduation	3 (100)	0 (0)	
Father's education			
Illiterate	4 (80)	1 (20)	0.475
Primary	28 (96.6)	1 (3.4)	
Secondary	48 (94.1)	3 (5.9)	
Graduation	12 (100)	0 (0)	
Mother employment status			
Working	24 (92.3)	2 (7.7)	0.608
Not working	68 (95.8)	3 (4.2)	
Type of house			
Kaccha	2 (100)	0 (0)	1.000
Pukka	90 (94.7)	5 (5.3)	
Overcrowding			
Yes	39 (92.9)	3 (7.1)	0.649
No	53 (96.4)	2 (3.6)	
Tobacco smoking in father			
Yes	22 (88)	3 (12)	0.106
No	70 (97.2)	2 (2.8)	

@Fisher's exact test used, *significance level is 0.05

Table 8: Outcome of the participants based on clinical examination findings of the participants.

Variables	Outcome		P value@
	Survival	**Death**	
Heart rate			0.148
Normal	90 (95.7)	4 (4.3)	
Tachycardia	1 (100)	0 (0)	0.148
Bradycardia	1 (50)	1 (50)	
Respiratory rate			0.278
Normal	5 (83.3)	1 (16.7)	
Increased	87 (95.6)	4 (4.4)	0.278
SpO$_2$			1.000
Normal	43 (95.6)	2 (4.4)	
Hypoxia	49 (94.2)	3 (5.8)	1.000
Anthropometry			0.048
Appropriate for age	41 (100)	0 (0)	
Failure to thrive	1 (100)	0 (0)	
Moderate acute malnutrition	43 (93.5)	3 (6.5)	0.048*
Severe acute malnutrition	7 (77.8)	2 (22.2)	
Rickets			0.295
Yes	19 (90.5)	2 (9.5)	
No	73 (96.1)	3 (3.9)	0.295
Anaemia			1.000
Present	27 (96.4)	1 (3.6)	
Absent	65 (94.2)	4 (5.8)	1.000

Continued.

Variables	Outcome		P value@
	Survival	Death	
Cyanosis			1.000
Present	17 (94.4)	1 (5.6)	1.000
Absent	75 (94.9)	4 (5.1)	
Total	92 (94.8)	5 (5.2)	-
Running nose			
Yes	48 (94.1)	3 (5.9)	1.000
No	44 (95.7)	2 (4.3)	
Nasal flaring			
Yes	75 (94.9)	4 (5.1)	1.000
No	17 (94.4)	1 (5.6)	
Chest indrawing			
Yes	50 (94.3)	3 (5.7)	1.000
No	42 (95.5)	2 (4.5)	
Accessory lung sounds			
Wheeze	25 (92.6)	2 (7.4)	0.334
Conducted sounds	19 (100)	0 (0)	
Bronchospasm	9 (81.8)	2 (18.2)	
Crepitation	10 (100)	0 (0)	
Wheeze crepitation	12 (92.3)	1 (7.7)	
Wheeze bronchospasm	1 (100)	0 (0)	
Crepitation conducted sound	1 (100)	0 (0)	
None	15 (100)	0 (0)	
Total	92 (94.8)	5 (5.2)	-

@Fisher's exact test used, *significance level is 0.05

Table 9: Outcome of the participants based on investigation findings of the participants.

Variables	Outcome		P value@
	Survival	Death	
Hemoglobin			0.624
Normal	66 (95.7)	3 (4.3)	0.624
Below normal	26 (92.9)	2 (7.1)	
White blood corpuscles count (WBC)			0.030
Normal	58 (98.3)	1 (1.7)	
Decreased	15 (83.3)	3 (16.7)	0.030*
Increased	19 (95)	1 (5)	
Platelets			0.589
Normal	71 (95.9)	3 (4.1)	0.589
Thrombocytopenia	21 (91.3)	2 (8.7)	
C-reactive protein			0.666
Negative	49 (96.1)	2 (3.9)	0.666
Reactive	43 (93.5)	3 (6.5)	
Serum electrolytes			0.193
Normal	60 (95.2)	3 (4.8)	
Hyperkalemia	5 (100)	0 (0)	
Hypokalemia	3 (100)	0 (0)	
Hypernatremia	2 (66.7)	1 (33.3)	0.193
Hyponatremia	16 (100)	0 (0)	
Hyponatremia and hyperkalemia	3 (100)	0 (0)	
Hyponatremia and hypokalemia	3 (75)	1 (25)	
Total	92 (94.8)	5 (5.2)	-

@Fisher's exact test used, *significance level is 0.05

Table 10: Difference in the duration of stay in the hospital, intensive care and duration of mechanical ventilation in the different outcomes among the participants.

Measure	Outcome		P value@
	Survival	Death	
Total duration of stay (in days)	6 (4-11.5)	1 (1-5)	0.016*
Duration of stay in pediatric ICU (in days)	0 (0-0)	1 (0-4)	0.063
Duration of mechanical ventilation (in days)	0 (0-0)	0 (0-1)	0.029*

@Mann-Whitney U test used, *significant at 0.05 level

DISCUSSION

Age distribution of patients

The youngest participant is 2 months of age and the oldest is 5 years of age.59 participants were between two months to 1 years of age. Similar findings have been reportedin some of the other studies. In the study by Kasundriya et al severe pneumonia was more commonly associated in the age group of 2 to 12 months as compared to 13 to 60 months.[10] In the study by Williams et al median age of the affection was 28 months.[11] In the study by Broor et al majority of the cases were infants (62.5% cases).[11] In the study of Shah et al it was shown that infants less than six months of age were more prone to develop severe pneumonia and the risk of infection decreases with age.[13] In the study by Mehta et al, 43% of cases belonged to 2-12 months of age while 47% were between 1-5 years of age.[14] In the study by Shan et al, 53% cases belonged to age group of 1-12 months again focusing on higher incidence in infants.[15] In the study by Onyango et al, the median age was 14 months.[16] In the study by Hemagiri et al, 29% were infants and 53% of the cases belonged to below 2 years of age.[17]

Gender distribution of patients

In this study 60% participants were males while 40% were females. Similar findings have been reported in other studies. In the study by Kasundriya et al 60% were boys and 40% were girls.[10] In the study by Williamset al 55% were boys and 45% were girls.[11] In the study by Broor et al males were more commonly affected (73%).[12] In the study by Shah et al higher incidence was observed in males.[13] In the study by Mehta et al, 59% of cases were males.[14] In the study by Shan et al 62% were males and 38% were females.[15] In the study by Onyango et al females were 50.5% as comparedto males who were 49.5% of study group.[16] Hemagiri et al found higher incidence in male 67.9% whereas 32.1% in females.[17]

Exclusive breastfeeding till 6 months of age

A total 53% of cases in this study were exclusively breastfeed while 47% were not till 6 months of age. Kasundriya et al found that 73% of cases of severe pneumonia were exclusively breastfedwhereas 27% were not.[10] In a study conducted by Broor et al lack of breastfeeding for the first four months of life was an independent risk factor for developing severe lower respiratory tract infections.[12] Shah et al found that discontinuation of breastfeeding before 6 months of age was asignificant risk factor for developing severe lower respiratory tract infections in infants less than 6 months of age whereas weaning appropriately was found as protective factor for the same.[13] In a study conducted by Hemagiri et al 79% of cases were exclusively breastfed for 6 months while rest were not.[17] In a study by Onyango et al 56% were exclusively breastfed while 44% were not.[16]

Independent birth variables

A total 34% of cases in this study were low birth weight with the median for weight being 2.6 kg. 81% were full term and 19% being preterm births. Kasundriya et al found that 79% cases were preterm births and 21% full term births.[10] 21% cases were low birth weights, 79% appropriate birth weights. In a study conducted by Shah et al low birth weight and prematurity were not observed as significant risk factors for the development of severe pneumonia.[13] Hemagiri et al found that children with a history of low birth weight were at more risk of severe pneumonia.[17]

Immunization status

In this study 47 children were appropriately immunised for age whereas 51 were partially immunised. 2 children were unimmunized. Mortality was recorded highest in partially immunised group, in this study. In a study conducted by Kasundriya et al, partial immunisation status was found to be associated with severe pneumonia in 51% of cases.[10] Broor et al observed that children who were immunised for age were less likely to suffer from lower respiratory tract infections as compared to partially immunised children.[12] Shah et al found that vaccine preventable diseases were more likely to cause severe lower respiratory tract infections attributing that vaccinationhelps in prevention against severe pneumonia.[13] Mehta et al found lack of vaccination was significantly associated with development of severe pneumonia.[14] In a study by Hemagiri et al, partial immunisation was found to be statistically significant with development of severe pneumonia.[17]

Environmental and socio-demographic factors

Factors like type of family (nuclear/extended), mothers' education status, father's education status, mothers' employment status, type of house, tobacco smoking in father, contact with tuberculosis case were not found to be

statistically significant in the given study. Findings of this study were not in complete parity with other similar studies. Kasundriya et al found significant association with overcrowding, joint family and development of severe pneumonia.[10] Other factors like smoking at home, mothers' education status and type of home were not statistically significant. In a study by Broor et al smoking by the mother, father or grandparents did not emerge as a significant risk factor.[12]

In a study by Shah et al smoke exposure, type of housing and floor were not significantly associated with increased risk of severe pneumonia.[13] In a study by Mehta et al type of house and fuel for cooking (smoke exposure) were found to be statistically significant with associated severe pneumonia.[14] In a study by Onyango et al mother and father's education as well as occupation were not found to be statistically significant.[16] Hemagiri et al showed that mother and father's education, overcrowding was significant whereas type of housing, type of floor, socio economic class were not significant.[17]

Past variables

A total 39% of children had history of previous hospitalisation and 5% of all cases had previous historyof measles. Both of them were not found to be statistically significant in this study. In study conducted by Shah et al it was found that history of acute respiratory infections increased the risk of severe illness in later episodes.[13] Mehta et al found that pervious history of similar illness was significantly associated with severity of pneumonia.[14]

Anthropometry

In the given study, moderate acute malnutrition was found to be statistically significantly associated with occurrence of severe pneumonia. In a study by Shah et al malnutrition was found to be statistically significant with severe pneumonia.[13] Broor at al demonstrated that malnutrition was significant risk factor in children less than 5 years of age.[12] In a study by Mehta et al, malnutrition was found to be highly significant risk factor associated with severe pneumonia.[14] Hemagiri et al also found malnutrition to be highly significantly associated risk factor with severe pneumonia.[17]

Rickets

The study did not find any statistical significance with association of rickets and severe pneumonia. This was in contrast to corresponding studies. In study by Banejah et al rickets was found to be statistically significantly associated with reduced successful treatment outcomes.[18] Rickets was more significantly associated with poor treatment outcomes in age groups 2-12 months. Ngari et al found that rickets was associated with increased risk of death and hospital admissions with severe pneumonia.[19] Haider et al observed that rickets is often present in children with severe pneumonia.[20] It was recommended to treat rickets early to reform the skeletal system as well as to avoid increased risk of infections.

Markers of inflammation

In the given study, C reactive protein was not found to be statistically significant while total white blood cell count was found to be statistically significant with development of severe pneumonia. These findings were not in complete parity with other similar studies. Berg et al found relatively high specificity for CRP and WBC counts in suspected pneumonia but with low sensitivity.[21]

Williams et al also found that elevated CRP in 24 hours of admission was associated with hospital length of stay and fever duration.[11] Peripheral WBC count had no association. Jianjun et al, Dewi et al and Yadav et al found increased association of CRP with severe pneumonia.[22-24] Rashad et al showed that CRP and increased WBC counts were higher in patients group as compared to control with statistically significant difference.[25]

Anaemia

Anaemia was not found to be statistically significant in the given study. In a study by Rani et al very high frequency of anaemia was found in children being admitted with severe pneumonia.[26]

While on the other hand, Saswan et al found no significant association of anaemia is cases as well as controls but found that anaemic hospitalised children had history of recurrent respiratory infections.[27]

Clinical parameters

In the given study clinical findings like running nose, nasal flaring, chest indrawing and accessory lung sounds and clinical parameters like heart rate, respiratory rate and SpO_2 (oxygenation) were not found to be statistically significant with severity of severe pneumonia.

Limitations

Our study is conducted at government hospital so all patients are belonged to low socioeconomic status which can affect sociodemographic factors. Our study has not evaluated the treatment details e.g. time of initiation and choice antibiotic which could affect the outcome.

CONCLUSION

In this study it is found that among the risk factors studied age less than 12 months and male gender are more affected. Moderate acute malnutrition had significant association with severe pneumonia and cases of SAM and MAM had higher mortality. Elevation in white blood cell counts was found to be associated with severe pneumonia therefore timely administration of antibiotics and supportive care for children with raised TLC could be helpful in

improving the outcome as it was a bad prognostic factor in our study.

Recommendations

Severe pneumonia affects infants more than elder kids as many factors play role i.e. immaturity of immune system, feeding practices, vaccination and nutrition of child. Focussing on child's nutrition status and immunization in early infancy are therefore very important aspect of prevention. Even though exclusive breastfeeding and rickets did not show statistical significance in the given study, it could be said, from the review of extensive literature that exclusive breastfeeding for 6 months of life and gradual transition to complementary feeding and early diagnosis and treatment of rickets has been proven to be effective against development of severe pneumonia.

REFERENCES

1. United Nations International Children's Emergency Fund. Childhood pneumonia: Everything you need to know; Pneumonia kills more children than any other infectious disease. 2022. Available at: https://www.unicef.org/stories/childhood-pneumonia-explained. Accessed on 12 January 2024.
2. World Health Organization. Pneumonia in children. 2022. Available at: https://www.who.int/news-room/fact-sheets/detail/pneumonia#:~:text=Pneumonia%20is%20a%20form%20of,painful%20and%20limits%20oxygen%20intake. Accessed on 12 January 2024.
3. Eichewald EC, Hansen AR. Exclusive breastfeeding, Cloherty and Stark's Manual of Neonatal Care, 8th Edition, Volume 1. Wolters Kluwer, India, Gurugram. 2017;285.
4. Kasturba P. Types of Families. In Park's textbook of Preventive and Social Medicine. 26th Edition. M/s Banarsidas Bhanot Publishers: Jabalpur, India. 2021;758;94.
5. Eichewald EC, Hansen AR. Exclusive breastfeeding, Cloherty and Stark's Manual of Neonatal Care, 8th Edition, Volume 1. Wolters Kluwer, India, Gurugram. 2017;79.
6. World Health Organization. Severe acute malnutrition. WHO, UNICEF, and SCN Food and Nutrition Bulletin (Supplement - SCN Nutrition Policy Paper No. 21). 2006;27:3.
7. Ministry of Health & Family Welfare, Govt. of India. Facility Based Integrated Management of Neonatal And Childhood Illness (F-Imnci) Imnci Chart Booklet World Health Organization. Available at: https://nhm.gov.in/images/pdf/programmes/child-health/guidelines/imnci_chart_booklet.pdf. Accessed on 12 January 2024.
8. Hughes H, Kahl L. The Harriet Lane Handbook: A Manual for Pediatric House officers. 22nd Edition. Elsevier Publishers, Gurgaon, India. 2020;328-67.
9. Hughes H, Kahl L. The Harriet Lane Handbook: A Manual for Pediatric House officers. 22nd Edition. Elsevier Publishers, Gurgaon, India. 2020;641-52.
10. Kasundriya SK, Dhaneria M, Mathur A, Pathak A. Incidence and Risk Factors for Severe Pneumonia in Children Hospitalized with Pneumonia in Ujjain, India. Int J Environ Res Public Health. 2020;17(13):1-16.
11. Williams DJ, Hall M, Auger KA, Tieder JS, Jerardi KE, Queen MA, et al. Association of White Blood Cell Count and C-Reactive Protein with Outcomes in Children Hospitalized for Community-acquired Pneumonia. Pediatr Infect Dis J. 2015;34(7):792-3.
12. Broor S, Pandey RM, Ghosh M, Maitreyi RS, Lodha R, Singhal T, et al. Risk Factors for Severe Acute Lower Respiratory Tract Infection in Under-Five Children. Indian Paediatrics. 2022;38(12):1361-9.
13. Shah N, Ramankutty V, Premila PG, Sathy N. Risk factors for severe pneumonia in children in south Kerala: a hospital-based case-control study. J Trop Pediatr. 1994;40(4):201-6.
14. Shah VB, Mehta K. Study of risk factors for severe pneumonia among children between 2 months to 5 years of age. Int J Contemp Pediatrics. 2019;6(4):1627-31.
15. Shan W, Shi T, Chen K, Xue J, Wang Y, Yu J, et al. Risk Factors for Severe Community-aquired Pneumonia Among Children Hospitalized With CAP Younger Than 5 Years of Age. Pediatr Infect Dis J. 2019;38(3):224-9.
16. Onyango D, Kikuvi G, Amukoye E, Omolo J. Risk factors of severe pneumonia among children aged 2-59 months in western Kenya: a case control study. Pan Afr Med J. 2012;13:45.
17. Khan H. Risk factors for severe pneumonia in under five children – A hospital based study. Int J Res Health Sci. 2014;2(1):47-57.
18. Banajeh SM. Nutritional rickets and vitamin D deficiency - Association with the outcomes of childhood very severe pneumonia: A prospective cohort study. Pediatric Pulmonol. 2009;44(12):1207-15.
19. Ngari MM, Thitiri J, Mwalekwa L, Timbwa M, Iversen PO, Fegan GW, et al. The impact of rickets on growth and morbidity during recovery among children with complicated severe acute malnutrition

in Kenya: A cohort study. Matern Child Nutr. 2018;14(2):e12569.

20. Haider N, Nagi AG, Khan KM. Frequency of nutritional rickets in children admitted with severe pneumonia. J Pak Med Assoc. 2010;60(9):729-32.

21. Berg AS, Inchley CS, Fjaerli HO, Leegaard TM, Lindbaek M, Nakstad B. Clinical features and inflammatory markers in pediatric pneumonia: a prospective study. Eur J Pediatr. 2017;176(5):629-38.

22. Wu J, Jin YU, Li H, Xie Z, Li J, Ao Y, Duan Z. Evaluation and significance of C-reactive protein in the clinical diagnosis of severe pneumonia. Exp Ther Med. 2015;10(1):175-80.

23. Dewi NPS, Purniti P, Naning R. Serum C-reactive protein levels in severe and very severe pneumonia in children. Indonesian J Pediatrics Perinatal Med. 2012;52(3):161.

24. Yadav KK, Awasthi S, Takia L, Agarwal J, Agarwal GG. Procalcitonin and C-reactive protein in WHO defined severe and very severe community acquired pneumonia: A hospital based cross-sectional study. Clinical Epidemiology and Global Health. 2015;3(1):S3-9.

25. Rashad MM, Ismail YM, Sobeih AA, Aziz OSA. Procalcitonin, C-reactive Protein and White Blood Cells Count in Children with Community Acquired Pneumonia. Benha Med J. 2021;38(1):125-36.

26. Rani N, Zubair N, Atta HI. Frequency of anaemia in children suffering from pneumonia at a tertiary care hospital. J Med Physiol Biophysics. 2018;41:53-7.

27. Mourad S, Rajab M, Alameddine A, Fares M, Ziade F, Merhi BA. Hemoglobin level as a risk factor for lower respiratory tract infections in Lebanese children. N Am J Med Sci. 2010;2(10):461-6.

Cite this article as: Gaikwad ND, Inamdar NR, Mauskar AV. Under 5 pneumonia a forgotten pandemic: an insight into risk factors predicting outcome of severe pneumonia in children aged 2 months to 5 years of age. Int J Contemp Pediatr 2024;11:368-78.