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Panacea Journal of Medical Sciences

Journal homepage: http://www.pjms.in/

Original Research Article

Clinico-etiological profile and outcome of pneumonia in under five children with special reference to severe acute malnutrition

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ARTICLE INFO

Article history:
Received 18-01-2023
Accepted 12-06-2023
Available online 13-08-2024

Keywords:
Malnutrition
Pneumonia
Mortality
Morbidity

ABSTRACT

Introduction: Pneumonia is the leading cause of morbidity and mortality in children in developing countries. Pneumonia is the most common cause of death in under-five children, responsible for 18% deaths in this age-group and more than 50% percent of death associated with malnutrition. According to UNICEF in 2018 over 800000 children death due to pneumonia and around 2200 per day and in south east Asia 2500 case per 100000 childeren. In India pneumonia killed more than127000 under five children in 2018 and >50% death associated with severe acute malnutrition (SAM).
Aim & Objective: To know the incidence, prevalence, clinical presentation etc. of pneumonia in SAM and various factors affecting its outcome.
Materials and Methods: After getting clearance from the institutional clearance committee this hospital based observational study was done in the Nutritional Rehabilitation Centre of SVP PG Institute of Pediatrics & SCB Medical College, Cuttack from October 2019 to September 2021.
Observation: The overall prevalence of pneumonia in SAM children in our study was 46.2%. Children aged 6-12 months (40% of total study population) were more vulnerable group for pneumonia with SAM. The most organisms isolated from blood cultures are Staphylococcus aureus followed by klebsiella, streptococcus, GDS, acinetobactor, pseudomonas, CONS, *E.coli*. 114 patients (93.4%) were cured and discharged with variable number of admission days and 8 patients (mortality 6.6%) died due to various complications with pneumonia.
Conclusion: Protein Energy Malnutrition and Pneumonia associated with protein energy malnutrition is very much prevalent in this region of our country and its severe form can contribute to significant mortality and morbidity for the under-five children in general and 6-12 month of age in particular. The hospital stay prolonged in pneumonia with SAM children as compared to SAM children with other morbidity.

1. Introduction

SAM affects nearly 20 million preschool age children, mostly from African region and South East Asia region. Malnutrition is a significant factor in approximately one third of the nearly 8 million deaths in children who are under 5 years of age worldwide.[1] In Asia prevalence of stunting is 87 million and wasting is 36 million. So more than two thirds of all wasted children and more than half of all stunted children under five lived in Asia.[2]

In the developing world, prevalence of malnutrition among under fives is 41% with an estimated 230 million (39%) children being chronically malnourished.[3,4] It is responsible for 60% of the 10 million deaths annually

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https://doi.org/10.18231/j.pjms.2024.097

among children under five.[5] In India, more than 33% deaths under five years of age are associated with malnutrition.[6] SAM affects about 20 million children globally and contributes to an estimated one million deaths every year.[7]

Malnutrition in children is widely prevalent in India. It is estimated that 57 million children are underweight (moderate and severe). More than 50% of deaths in 0-4 years are associated with malnutrition. The median case fatality rate is approx 23.5% in severe malnutrition, reaching 50% in edematous malnutrition.[8] In India, prevalence of severe malnutrition is 6.4% in children below five years with 100 focus districts having high prevalence of malnutrition being situated in 6 states: Bihar, Jharkhand, Madhya Pradesh, Rajasthan, Odisha and Uttar Pradesh.

The 2017 Global hunger index report ranked India 97th out of 118 countries with a serious hunger situation. Subsequently, India's position has even deteriorated to rank 103rd among 119 countries in 2018 which is worrisome scenario. Amongst South Asian nations, it ranks third behind only Afghanistan and Pakistan.[9]

United Nations International Children's Emergency Fund(UNICEF) estimated malnutrition(45%) to be the most common cause of under five mortality, with India and Nigeria accounting for more than one-third of deaths.[10]

NFHS 3 shows that the proportion of children who are stunted or underweight increases rapidly with the child's age from birth to age 20-23 months peaking at 20 months. Even during the first six months of life, when most infants are breastfed, 20-30% of children are underweight. It is notable that by age 18-23 months when many children are being weaned from breast milk, 30% children are severely stunted and one fifth are severely underweight.

According to NFHS 4[11]: 35.7% children under age of five years are under weight., 38.4% children under five are stunted. 21% children under five years of age are wasted. Over 6% of these children are severely wasted. In addition nearly 70% children have anaemia. Of these 26% have mild anaemia, 40% moderate anaemia and 3% severe anaemia. 22% newborns have low birth weight.

At national level NFHS-4 data revealed the national under five mortality rates is 50 per 1000 live births, with 34 in urban and 56 in rural area. Odisha's U5MR is estimated to be 49 per 1000 live births with 25 in urban area. Assessing national prevalence of under nutrition among under five, NFHS-4 data shows underweight is 35.7 %. Wasting is 21%, and stunting 38.4% in India.[11] The same indicator for Odisha is 34.4%, 20.4%, and 34.1% respectively.[11]

In Odisha the prevalence of under nutrition is high. According to state tribal health report card 54.4% of children below three years are underweight(weight for age), 57.2% stunted(height for age) and 27.6% are wasted(weight for height). Data from UNICEF global database on child malnutrition in 2011 showed that 40.7 % of under-fives in Odisha were moderately and severely wasted.[12,13]

Pneumonia is the leading cause of morbidity and mortality in children in developing countries. Pneumonia is the most common cause of death in under-five children, responsible for 18% deaths in this age-group and more than 50%percent of death associated with malnutrition. According to UNICEF in 2018 over 800000 children death due to pneumonia and around 2200 per day and in south east Asia 2500 case per 100000 childeren. In India pneumonia killed more than 127000 under five children in 2018 and >50% death associated with SAM.[14]

There exists a vicious cycle between pneumonia and malnutrition. Early exposure to infection has been associated with malnutrition in children in low-resource settings. Malnutrition in association with frequent pneumonia episode slow cognitive and physical development of the child the relationship between pneumonia and malnutrition is bidirectional.[15,16] Malnutrition predispose to impaired immunity defense predisposing children to pneumonia infection and pneumonia causes acute energy loss during illness plus increasing demand of body leading to malnutrition. Taking this fact into consideration, our study was conducted on children between 60days to 59month who were admitted for pneumonia having features of severe acute malnutrition with special emphasis on aetiology and their outcome.

2. Aim

To know the incidence, prevalence, clinical presentation etc. of pneumonia in SAM and various factors affecting its outcome.

3. Objectives

To find out the incidence of pneumonia among severe acute malnourished children admitted to NRC in our medical college and hospital And Spectrum of aetio-pathological agents, clinical presentation and the outcome of pneumonia in severe acute malnutrition. As prospective observational study of patients with acute severe malnutrition admitted to the department of Pediatric in S.C.B medical college & Hospital and SVPPGIP Cuttack during the period of October 2018 to September 2020.

4. Materials and Methods

After getting clearance from the institutional ethical committee this hospital based observational study was conducted at SCB Medical College and SVPPGIP which is one of the referral hospitals in Odisha. It serves as a zonal referral, research and teaching hospital, located in the Central part of Odisha. Being a tertiary care hospital, it caters all the districts of the state of Odisha. The Pediatric department is subdivided into seven subunits namely, General Pediatric ward, Pediatric semi-intensive unit, Pediatric ICU, Newborn ICU, Newborn ward, SNCU

for premature infants, and nutritional rehabilitation centre (NRC) for SAM patients, with the total bed capacity of 500. The malnutrition patients are admitted within the general ward and in NRC.

During the study period (October 2019 to September 2021) children aged 2 months to 5yr presented with pneumonia, admitted in pediatric ward at SCB Medical College and SVPPGIP, were screened for their nutritional status and those found to have severe acute malnutrition were included in this study.

4.1. Inclusion criteria

Children from 2 months to 5yr of age with pneumonia with severe acute malnutrition satisfying following criteria were included.

1. Weight-for-height less than -3 SD(WHO/NCHS median height) and/or.
2. Visible severe wasting and/or.
3. Arm circumference (MUAC) < 11 5 cm and/or.
4. Bilateral pedal edema.

4.2. Exclusion criteria

1. Children <2 month and >5 yrs.
2. Critically sick children who needs admission in ICU or HDU.
3. Children with congenital malformation.
4. Children with secondary malnutrition due to cardiac, respiratory, neurological, hepatic, mental retardation, cerebral palsy, metabolic or genetic disorders.

4.3. Sampling technique

The sampling technique used was a sampling without replacement, which by definition, refers to inclusion of all the sample elements only once.

4.4. Sampling procedure

All children aged 2 month to 5 yr presented with pneumonia admitted, were screened in order to determine their nutritional status. Those patients having severe acute malnutrition were screened. For children who met the inclusion criteria and none of the exclusion criteria, their parents/caretaker were given a written informed consent and enrolled in the study. Convenient serial sampling method was used to enroll in admitted children.

4.4.1. Data analysis

Using IBM SPSS 26 and Microsoft Data were entered into a computer Excel 2007, cleaned and analyzed using SPSS software version 26.0, IBM Co. The 95% confidence interval was determined and factors/predictors with p-value of less than 0.05 were considered significant all data were double entered into an Access database and checked for errors. Data was collected from the study population.

4.5. Observation

A total of 264 SAM patients enrolled in the study between 60 days to 59 month of age during this period of 2years(October 2018 to September 2020). From the 264 patients 122 cases are presented with pneumonia, which constitute the study population.

Out of total 264 study population admitted within 2 year of study period, 122 SAM patients having clinical features of Pneumonia, which is 46.2% of total study population.

In this study children aged 2-6 month were 11.5% of total pneumonia study population, children aged more than 6-12month 40.2% and children aged more than 12-24 month constituted 24.6% of total study population and children aged more than 24-60 month constituted 24.6%. The median age of presentation was 12 month. P value >0.05 which is statistically nonsignificant for the study.

Male child constituted 49.2% and female child constituted 50.8 with female to male ratio is 1.03:1. P value >0.05 which is statistically insignificant but Relative Risk >1 implies a positive correlation.

Most were from upper lower class 57.4%followed by lower class 25.4%, which is followed by lower middle class 12.3%.children from both upper middle and upper class are very low which is 3.3% and 1.6% respectively. P value >0.05 which is statistically insignificant.

Most of the patients were from rural areas i.e, 84.4% and only a small proportion of the study population were from urban 15.6%. P value >0.05 which is statistically non-significant whereas Relative Risk >1 implies good correlation.

Relative risk for diarrhea>1 implies a positive correlation but results were statistically non significant probable because of smaller people size. Out of 122 patient of pneumonia 68(55.7%) patient had associated with diarrhea and 54(44.3%) had no diarrhea.

Relative risk for fever >1 which implies a good correlation and it is statistically significant p value<0.05. Fever present in (72.1%) 88 patient suffering from pneumonia and 34(27.9%) patient had no fever.

Value statistically non- significant for vomiting but relative risk >1implies good correlation.

Relative risk for cough >1 which implies good correlation and it is statistically significant with p value<0.05

All the patient who had pneumonia 119(97.5%) had tachypnoea and 3(2.5%) had normal respiratory rate. p value>0.05 and relative risk>1.

Out of 122 patient 118(96.7%) had presented with respiratory distress and 4(3.3%) had none. p value>0.05, relative risk >1.

Table 1: Prevalence of pneumonia in the sam children

Total no of SAM Population included	No of SAM Patients without pneumonia	SAM Patients with pneumonia
264	142(53.8%)	122(46.2%)

Table 2: Age variation of study population

General p arameter		Pneumonia						p-value
		Present		Absent		Total		
		Frequency	%	Frequency	%	Frequency	%	
Age	>12-24 M	30	24.6	42	29.6	72	27.3	**>0.05**
	>24-59 M	29	23.8	31	21.8	60	22.7	
	>6-12 M	49	40.2	46	32.4	95	36.0	
	2-6 M	14	11.5	23	16.2	37	14.0	
	Total	122	100.0	142	100.0	264	100.0	
Sex	Female	62	50.8	61	43.0	123	46.6	>0.05
	Male	60	49.2	81	57.0	141	53.4	
	Total	122	100.0	142	100.0	264	100.0	
Socio economic status	low middle	15	12.3	25	17.6	40	15.2	>0.05
	Lower	31	25.4	37	26.1	68	25.8	
	up lower	70	57.4	76	53.5	146	55.3	
	up middle	4	3.3	4	2.8	8	3.0	
	Upper	2	1.6	-	-	2	.8	
	Total	122	100.0	142	100.0	264	100.0	
Place of living	Rural	103	84.4	117	82.4	220	83.3	>0.05
	Urban	19	15.6	25	17.6	44	16.7	
	Total	122	100.0	142	100.0	264	100.0	
Immunization status	Complete	14	11.5	26	18.3	40	15.2	>0.05
	Incomplete	42	34.4	42	29.6	84	31.8	
	Unimmunized	66	54.1	74	52.1	140	53.0	
	Total	122	100.0	142	100.0	264	100.0	
EBF upto (in months)	UPTO 2	45	36.9	53	37.3	98	37.2	>0.05
	2 TO 6	60	49.2	68	48	128	48.5	
	More than 6	17	13.9	21	14.7	38	14.3	
	Total	122	100	142	100	264	100	
Age of weaning	UPTO 2	45	36.9	52	36.6	97	36.7	>0.05
	2 TO 6	60	49.2	69	48.6	129	48.9	
	More than 6	17	13.9	21	14.8	38	14.4	
	Total	122	100.0	142	100.0	264	100.0	
Method of weaning	Both	16	13.1	19	13.4	35	13.3	>0.05
	Bottle	74	60.7	79	55.6	153	58.0	
	k & s	22	18.0	30	21.1	52	19.7	
	No	10	8.2	14	9.9	24	9.1	
	Total	122	100.0	142	100.0	264	100.0	
Use of sanitary latrine	No	82	67.2	100	70.4	182	68.9	>0.05
	yes	40	32.8	42	29.6	82	31.1	
	Total	122	100.0	142	100.0	264	100.0	
Safe drinking water	absent	77	63.1	84	59.2	161	61.0	>0.05
	present	45	36.9	58	40.8	103	39.0	
	Total	122	100.0	142	100.0	264	100.0	

Table 3: Pneumonia presentation of study population

General Parameter		P neumonia Present		Absent		Total		p-value/relative risk (RR)
		Frequency	%	0.001 Frequency	%	Frequency	%	
Diarrhea	Absent	54	44.3	67	47.2	121	45.8	p>0.05 RR>1
	Present	68	55.7	75	52.8	143	54.2	
	Total	122	100.0	142	100.0	264	100.0	
Dehydration	107	87.7	116	81.7	223	84.5		p>0.05 RR>1
	15	12.3	26	18.3	41	15.5		
	122	100.0	100.0	100.0	264	100.0		
Fever	Absent	34	27.9	68	47.9	102	38.6	RR>1
	Present	88	72.1	74	52.1	162	61.4	
	Total	122	100	142	100	264	100	
Vomiting	Absent	73	59.8	82	57.7	155	58.7	>0.05 RR>1
	Present	49	40.2	60	42.3	109	41.3	
	Total	122	100.0	142	100.0	264	100.0	
Cough and cold		1	.8	140	98.6	141	53.4	<0.05 RR>1
	Present	121	99.2	2	1.4	123	46.6	
	Total	122	100.	142	100.0	264	100.0	
Respiration rate	Normal	3	2.5	140	98.6	143	54.2	<0.05 RR>1
	Tachypnic	119	97.5	2	1.4	121	45.8	
	Total	122	100.0	142	100.0	264	100.0	
Retraction	Absent	4	3.3	140	98.6	144	54.5	<0.05 RR>1
	Present	118	96.7	2	1.4	120	45.5	
	Total	122	100.0	142	100.0	264	100.0	
Lethargy	Absent	72	59.0	69	48.6	141	53.4	>0.05 RR>1
	Present	50	41.0	73	51.4	123	46.6	
	Total	122	100.0	142	100.0	264	100.0	
Edema	Absent	90	73.8	107	75.4	197	74.6	>0.05 RR>1
	Present	32	26.2	35	24.6	67	25.4	
	Total	122	100.0	142	100.0	264	100.0	
Convulsion	No	116	95.1	138	97.2	254	96.2	>0.05 RR>1
	Yes	6	4.9	4	2.8	10	3.8	
	Total	122	100.0	142	100.0	264	100.0	
Pallor	No	53	43.4	70	49.3	123	46.6	>0.05 RR>1
	Yes	69	56.6	72	50.7	141	53.4	
	Total	122	100.0	142	100.0	264	100.0	
Visible severe wasting	Absent	74	60.7	95	66.9	169	64.0	>0.05 RR>1
	Present	48	39.3	47	33.1	95	36.0	
	Total	122	100.0	142	100.0	264	100.0	
Shock	Absent	119	97.5	135	95.1	254	96.2	>0.05 RR>1
	Present	3	2.5	7	4.9	10	3.8	
	Total	122	100.0	142	100.0	264	100.0	

Out of 122 pneumonia patient admitted 50 patient (41%) presented with lethargy. Relative risk more than > 1implies good correlation but the results were statistically insignificant.

Out of 122 patient suffering from pneumonia 32(26.2%) patient had edema. Relative risk more than >1 implies a good correlation but the study were statistically non-significant with p value >0.05.

Out of 122 study population about 5% had convulsion. Relative risk more than >1 which implies good correlation but the study were statistically non-significant.

Out of 122 study population 69(56.6%) patient had anemia and 53(43.4%) had no anemia. p value >0.05 which is statistically nonsignifacant but the relative risk >1 implies good correlation with pneumonia.

Out of 122 study population 48 patient had visible severe wasting which is a risk factor associated with pneumonia. Relative risk>1 implies good correlation but the study were statistically non-significant.

Value >0 05 statistically insignificant but relative risk>1 implies a good correlation for shock.

Table 4: Investigation finding of study group

Investigation		Pneumonia Present		Pneumonia Absent		Total		p-value /Relative risk
		Frequency	%	Frequency	%	Frequency	%	
R B S	Low	22	18.0	19	13.4	41	15.5	p>0.05 RR>1
	Normal	100	82.0	123	86.6	223	84.5	
	Total	122	100.0	142	100.0	264	100.0	
MP ICT	negative	120	98.4	135	95.1	255	96.6	P>0.05 RR<1
	positive	2	1.6	7	4.9	9	3.4	
	Total	122	100.0	142	100.0	264	100.0	
X-Ray chest	Abnormal	120	98.4	-	-	120	45.5	p>0.05 RR>1
	normal	2	1.6	142	100.0	144	54.5	
	Total	122	100.0	142	100.0	264	100.0	
Mantoux Test	NR	116	95.1	142	100.0	258	97.7	p>0.05 RR>1
	Positive	6	4.9	-	-	6	2.3	
	Total	122	100.0	142	100.0	264	100.0	
Serum Na	Hyponatremia	1	0.8	5	3.5	6	2.3	p>0.05 RR>1
	normal	121	99.2	137	96.5	258	97.7	
	Total	122	100.0	142	100.0	264	100.0	
Serum K	Hypokalemia	3	2.5	6	4.2	9	3.4	p>0.05 RR>1
	Normal	119	97.5	136	95.8	255	96.6	
	Total	122	100.0	142	100.0	264	100.0	
Blood Culture Sensitivity	Negative	82	67.2	114	80.3	196	74.2	p>0.05 RR>1
	Positive	40	32.8	28	19.7	68	25.8	
	Total	122	100.0	142	100.0	264	100.0	

For RBS p value >0.05 statistically insignificant but relative risk>1 implies a good correlation.

For malaria p value more than >0.05 which is statistically insignificant and relative risk <1 implies not good correlation.

Out of 122 patient 120 patient had x ray finding in chest which is 98.4% and 2 patient (1.6%) had normal x ray finding. relative risk > implies good correlation and study were statistically significant.

Value >0 05 statistically nonsignificant but relative risk more than> 1 implies a good correlation.

Out of 122 patient 6 (4.9%) patient had mantoux positive reaction and 115(95.1%) had nonreactive mantoux. p value >0.05 statistically nonsignificant but relative risk more than> 1 implies a good correlation.

Value less than >0 05 the study were non- significant for Serum Na & K.

Out of 264 blood culture sent 68 blood culture came positive and from 68 blood culture 40 blood culture had pneumonia case. p value less than <0.05 the study were significant and relative risk >1 implies a good correlation.

The above table shows, 122 case of pneumonia from study population. In 40 (33%) cases we could able to identify pathogens and no pathogens could be isolated in 82 (7%) cases. Staph aureus found to be the commonest pathogen (40%) followed by both klebsiella and streptococcus (20 %) respectively.

Value <0 05 the study were statistically significant with relative risk>1 implies a good correlation.

Those who are suffering from pneumonia had longer hospital stay than no pneumonia patient which is out of 122 patient 120 patient (98.4%) more than 10 days of hospital stay and only 1.6%(2) had less than 10 days of hospitalization.

chi square 0.09and p value >0.05 which is statistically nonsignificant but the relative risk more than >1 implies a good correlation. The above table shows, out of 122 cases of pneumonia from study population 114 (93.4%) patients cured and discharged with variable number of admission days and 8 (6.6%) patients died due to various complications with septicemia contributing more than two third number of cases.

5. Discussion

In this study, total 264 SAM children were included in study population. 122(46.2%) SAM children are suffering from pneumonia. A similar study carried out by CHRISTI M J et al in 2009, included 509 malnourished children out of which 214 patients (42%) were found to have pneumonia.[17]

A total of 150 malnourished children between 2m-5y were studied out of which total 69 (46%) children have Pneumonia studied by G ARPITHA et al in 2014.[18] In Bangaladesh case studied by Naheed et al found that out of 4155 children 1842(42%) were found to have pneumonia).[19] A study made in ethiopia in 2018 found that 54% of pneumonia case in study population of SAM child by Deresh B et al.[20]

Table 5: Etiological agents identified in pneumonia cases in study population

Organism	P neumonia					
	Present		Absent		Total	
	Frequency	%	Frequency	%	Frequency	%
Acinetobacter	2	1.6	4	2.8	6	2.3
CONS	1	0.8	-	-	1	.4
E coli	1	0.8	-	-	1	.4
GDS	3	2.5	1	.7	4	1.5
klebsiella	8	6.6	2	1.4	10	3.8
negative	82	67.2	115	81.0	197	74.6
pseudomonas	1	.8	1	.7	2	.8
staph	16	13.1	16	11.3	32	12.1
streptococcus	8	6.6	3	2.1	11	4.2
Total	122	100.0	142	100.0	264	100.0

Table 6: Length of hospital stay of study population

Length of hospital stay	P nuemonia						p-value	Relative risk
	Present		Absent		Total			
	Frequency	%	Frequency	%	Frequency	%		
<10 days	2	1.6	16	11.3	18	6.8		
>=10 days	120	98.4	126	88.7	246	93.2	<0.05	>1
Total	122	100.0	142	100.0	264	100.0		

Table 7: Outcome of pneumonia cases

Outcome	P nuemonia						p-value	Relative risk
	Present		Absent		Total			
	Frequency	%	Frequency	%	Frequency	%		
C & D	114	93.4	134	94.4	248	93.9		
Death	8	6.6	8	5.6	16	6.1	>0.05	>1
Total	122	100.0	142	100.0	264	100.0		

On analysing the age wise distribution of cases, shows most of the cases (40.2%) are under 6-12 month of age, 24.6% children are in between 12-24 month similarly 24.6% children in between 24-59 month and 11.5% between 2-6 month. median age presentation was 12 month. In a study made in sudan out of 40 children suffering from pneumonia majority of them 23 (57.50%) were less than one year while 17 (42.50%) were found 1-4 years of age in the year 2018 by Siham M.O. Gritly et al.[21] Out of 150 children, 21 children under 1y and 17 children between 1y to 2y and 15 children between 2y to 3y, were found to have Pneumonia compared to 7 children in 3y to 4yand 9 children in 4y to 5y. The prevalence of very severe Pneumonia was found to be highest in children<1year studied made by G ARPITHA et al in 2014.[18]

In a study by Omprakash Shukla et al out of 60 patient pneumonia presentation 0f which22(36.7%)of the patients presented during infancy, 27(45%) presented between 1 year to 3 years of age (toddler age group) and 11(18.3%) presented between 3 years to 5years (preschool age group) in 2017.[22]

Higher frequency of cases in infants may be due to exposure of the infant to infection when a completely a breast fed baby weaned, poor hygiene of feeding bottle and to some extent because of the organism prevalent. The gradual fall in incidence in the later age group is possible due to environment factors and protective immunity to common pathogens due to repeated exposure.

There were inequality between the sexes with a slight female predominance. Females were more than males (50.8% /s49.2%) with aratio of 1.03:1. Study made by Omprakash Shukla et al out of 60 patient showed that 45% of cases were male and 55% cases were females attaining Female to male ratio of 1:0.8. Study conducted by Arpitha G at Department of Pediatrics, Telangana, India showed a male preponderance with a sex ratio of 1.05:1. According to a study conducted by Elsayh KI, Sayed DM at the Department of Pediatrics, Assiut University, Egypt in 2013, the female to male ratio was1.1:1 which was comparable to our study.[23] In a study made in Sudan out of 40 children suffering from pneumonia majority of them 23 (57.50%) children were males, while 17 (42.50%) were female with ratio 1.35:1.

The study shows that both malnutrition and pneumonia are more common in female children probability due to social and nutritional neglect of the girl child.

Although the cases were distributed into all socioeconomic classes, lower class accounted for greater than 75% of the cases. It is known that pneumonia have higher incidence in lower socioeconomic class which is shown by study in NFHS-4(2015-2016). Low socioeconomic status is a known risk factor for pneumonia. Low income family, low level of education of mothers, unhygienic environment, lack of knowledge by mother about the causes of diarrhoea and foods that prevent malnutrition are inter-related and the net effect of their interaction is higher incidence of diarrhoea in lower socioeconomic status. In similar study made by Shukla at al revealed that lower socioeconomic status about 88% associated with pneumonia in their study. The significant socio-demographic risk factors were parental illiteracy, low socioeconomic status, overcrowding and partial immunization.[24] In study in sudan 72% pneumonia family belongs to lower class. Soni et al[25] and Ashraf at al[26] in their studies reported that majority of malnourished children belong to lower socioeconomic status (iv and v)72.8% and 90% respectively

In this study majority of the cases (84.4%) were from rural areas. Ashraf at al[26] in their study revealed that pneumonia and diarrhea in malnutrition was more prevalent($p<0.01$)in children living in non industrial area than industrial area(82.8% v\s 17.1%). In similar study made by Shukla et al[22] revealed that out of all pneumonia case 82% case were from rural areas. All these suggested that poor nutritional status of rural children compared to their urban counterparts is due to the cumulative effect of a series of less favorable condition including lower socioeconomic conditions, improper maternal prenatal and birthing care, poor quality of complementary feeding and poor immunization status.

Most of the children in our study were either unimmunized (54.4%) or partially immunized (34.1%). Study made by Shukla et al found that total 73% of incomplete and unimmunized children in their study population. The Haemophilus influenzae type b (Hib) and pneumococcal conjugate vaccines (PCV) are effective in preventing the two most common bacterial causes of childhood pneumonia. The use of vaccines against measles and pertussis in national immunization programmes substantially reduces pneumonia illness and death in children. In 2018, 71 million children did not receive the recommended three doses of PCV, putting them at higher risk of pneumonia.(UNICEF NOV 2019). We have observed that only 49.2% patients had exclusive breast-feeding up-to 6 month of age. Nearly 36.9% children were exclusively breast fed only up-to two months of age. Suboptimal breastfeeding practices among infants and young children <24 months of age are associated with elevated risk of pneumonia morbidity and mortality. Pneumonia mortality was higher among not breastfed compared to exclusively breastfed infants 0-5 months of age (RR: 14.97; 95% CI: 0.67-332.74) and among not breastfed compared to breastfed infants and young children 6-23 months of age (RR: 1.92; 95% CI: 0.79-4.68[27].Severe pneumonia was observed in higher proportion in children who were not exclusively breast fed with p value <0.05. In under five children with SAM in a study made by kamathammadhusudan.[28]

49.2% cases complementary feeding started before 6 month of age and in 36.9% cases it was started in before 2month of age. Rasania and Sachdev[29] in their study reported that weaning was started at optimum age (4-6month) in 42.9% children, started early (<4month) in 24.5% and in rest it was delayed beyond 6 months of age. Hossain et al[30] showed in their study severe malnutrition. It was significantly higher ($p<0.05$) in children where weaning was delayed. Delayed weaning is also detrimental to health. Apart from age of weaning, type of supplementary food and method of feeding are also important.

In our study common mode of feeding top milk was bottle (60%) followed by katori spoon (18%) and both katori spoon and bottle (13.1%). Rasania and Sachdev[29] also observed in their study that 65.8% of mothers were using bottle for feeding top milk and overall malnutrition prevalence was higher ($p<0.001$) in bottle fed children (83%)which is similar to our study.

In our study found that those who not use sanitary latrine 67.2% and those who not drinking safe water 66.3% have higher risk of pneumonia. Proper hand washing according to Partnership for Transforming Health Systems – PATHS (2005) is among the universal hygienic precautions that should be adopted by women to prevent occurrence of diseases. Proper hand washing entails use of clean water and soap to ensure total elimination of germs underneath the nails that may have access to the child's food. Hands should be washed carefully after defecation, before handling food and before eating. All the aforementioned hygienic precautions are likely to reduce the risk of infection and improve the health status of the child bearing mothers and their children (PATHS, 2005). Frequency of pneumonia episodes and malnutrition in a community or country is a sensitive index of socioeconomic status and sanitary condition, availability of safe drinking, hygienic awareness and educational status. Unavailability of food, poor purchasing power, inappropriate distribution and inadequate utilization coupled with lack of health education contributes largely to higher incidence of pneumonia (Shobha Rao et al.,2000).[31]

In our study patient with pneumonia Cough and cold was the predominant symptom found in 99% of patients, followed by fast breathing (97.5%), respiratory distress (96.7%) fever (72.1%). Less common is inability to feed or lethargy (41.%). A similar study made by Shukla O et al in which Cough and cold was the predominant symptom

found in 98% of patients, followed by fast breathing (95%), fever (90%). Less common symptoms were cold (73.3%) and inability to feed or lethargy (51.7%). The above-mentioned study conducted by Arpitha G, Rehman MA et al 2014 specifically undertook the study of pneumonia in malnourished children and their findings were similar to ours having Tachapnea (95%), Chest indrawing (90%), Fever(72%), Cough (66%), Refusal of feeds (15%) . In our study, we observed many infection presented with pneumonia in SAM children. Out of all infection diarrhea (55.7%) is the most commonest followed by sepsis in 8% case and malaria in1.6% case.

Bernal et al,.(2008) reported that most common associated illness at admission in malnourished children with diarrhoea was respiratory tract infection[32].Analysis by Schmidt et al. demonstrates that diarrhea frequently precedes pneumonia in undernourished children. Using a time-to-event analysis in a cohort of children from Ghana at high-risk of diarrhea and malnutrition, they found that each additional day of diarrhea in the preceding 2 weeks augmented the risk of developing pneumonia by a factor of 1.08, demonstrating a linear relationship between the number of days of diarrhea in the preceding 28 days and the subsequent risk of pneumonia.[33] Walker and Black suggest that increased loss of zinc in stools or electrolyte imbalances following diarrhea may be potential mechanisms of increased risk of pneumonia[34].Studies by Stephensen have shown that children with diarrhea have increased renal losses of vitamin A and suggest another mechanism by which diarrhea might predispose to pneumonia.[35]

56.6% patient have anemia associated with pneumonia. Nutritional and socio-economic factors were responsible for anemia in present study. Out of the 122 patients enrolled in our study, 32 (26.2%) patients presented with bilateral pedal edema and the rest 90 fulfilled weight/height<-3SD criteria.

Complications associated with acute diarrheal cases showed in dehydration present in 12.3% cases, sepsis present in 8% cases. hypoglycemia in 18% cases and hyponatremia, hypokalemia, convulsion, shock comprises 1%, 2.5%, 4.9%, and 2.5% cases respectively.

In a study made in dhaka 40% case have dehydration features suffering from pneumonia in SAM child.[36]

Blood culture yield out of 122 blood culture sent 40(33%) came positive. Higher percentage of negative blood culture may be because of prior use of antibiotics decreasing the yield of pathogens. Among the pathogens, Staph aureus was the most common organism isolated comprising 40% of total positive case followed by *klebsiella* and streptococcus both 20% respectively followed by group D streptococcus, acinetobactor, CONS, *E.coli*, pseudomonas complicating 7.5%, 5%, 2.5%, 2.5% and 2.5% respectively. Similar study made by Shukla O et al found *Klebsiella* and streptococcus are the prominent organisms comprises 15% each followed by Pseudomonas and Enterococcus (10%), MRSA (8.3%), CONS (8.3%), E. coli (5%) and Staphylococcus Aureus (1.1%) In all four studies originating from Nigeria (Diallo et al, Johnson et al, Fagbule 1993) S. aureuswas a relatively common isolate, accounting for 14–30% of the cases[37] followed by *klebsiella* and streptococcus pneumonia. The most commonly isolated organisms in severely malnourished children with pneumonia were, in descendingorder: *Klebsiellaspecies* (26%) S.aureus (25%), *S.pneumoniae* (18%), *E.coli* (8%), H.influenzaea (8%) and Salmonella species (5%). Otherorganisms, including Acinetobacter species, Pseudomonasspecies, Moraxellaspecies and Enterobactor species were rare. Studied made by CHRISTI M J et al in 2009.[17] In a similar study made by Madhusudan et al in 2017[28] and found that most common organism isolated in SAM child with pneumonia are staph aureus and *klebsiella* (30%) both followed by CONS (6.6%), acinetobactor (6.6%), citrobactor (5%), pseudomonas and streptococcus (1.6%) respectevily. Staphylococcus aureus and Streptococcus pneumonia were predominant organism on blood culture and oropharyngeal swab culture respectively in case of pneumonia a studied made by Chaudhary G.S et al in 2018.[38]

98% case of pneumonia have longer hospital stay more than 10 days. In a similar study made by Arpitha G The duration of hospital stay for malnourished children with pneumonia the result showed that 45% percent children have less then 7 day hospital stay and 55% had more than 7 days of hospitalization.

In our study the overall mortality rate of all the pneumonia cases in SAM population is 6.6%.In 2008 naheed et al study that the death percentage of in pneumonia in SAM children is12%.[19] The overall decrease of death may due to advance health facility now a days comparing to those days. In a similar study made by Farah ahmad et al in 2016 shows that the death percentage of pneumonia in malnourished children is 7.25%.[39] A study made in ethiopia in 2018 found that 5.8% mortality in study population of SAM child by Deresh B et al.[20]

Sixteen relevant studies were identified, which universally showed that children with pneumonia and moderate or severe malnutrition are at higher risk of death. For severe malnutrition, reported relative risks ranged from 2.9 to 121.2; odds ratios ranged from 2.5 to 15.1. For moderate malnutrition, relative risks ranged from 1.2 to 3.5.[17]

6. Conclusion

Protein Energy Malnutrition and Pneumonia associated with protein energy malnutrition is very much prevalent in this region of our country and its severe form can contribute to significant mortality and morbidity for the

under-five children in general and 6-12 month of age in particular. Pneumonia with SAM is more prevalent in age less than one years, rural area, lower socio-economic status of family, lack or incomplete immunization, lack of exclusive breast feeding for 6 months, bottle feeding, delayed introduction of complimentary feeding, low birth weight, absence of sanitary latrine and access to safe drinking water supply. The most common presenting symptom in the present study was cough and cold, hurried breathing, respiratory distress, fever and lethargy Hence, we can conclude that children with severe acute malnutrition have more chances of developing very severe pneumonia. Whereas most common co morbidity associated with pneumonia malnutrition was acute gastroenteritis, followed by septicemia. Staphylococcus aureus and *klebsiella* are the most common organisms isoltaed in the study. We concluded that organism causing pneumonia in severe acute malnutrition children differ from those in well nourished children. The hospital stay prolonged in pneumonia with SAM children as compared to SAM children with other morbidity. The mortality rate still high in pneumonia cases associated with SAM. To prevent malnutrition and pneumonia in SAM children research and improved policy are needed to explore the significance and impact of viral agents and M.tuberoculosis on acute respiratory disease in malnourished children and ultimately to improve the prevention, early detection management and outcome of pneumonia in SAM children in resource poor settings.

7. Limitation

This hospital based observational study could not focus on the true prevalence of SAM in the community. Only the malnourished children admitted in the hospital were included in the study. So it does not give the exact magnitude of pneumonia in malnourished children in the community. So a larger sample size in this scenario would have been a better representative of the true prevalence of the condition. Only children with severe and very severe pneumonia are included in the study as only these children are admitted in hospital.

8. Authors Contribution

All authors were involved in research design, data analysis, and manuscript preparation and editing.

9. Conflict of Interest

The authors report no conflicts of interest in this work.

10. Source of Funding

None.

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Cite this article: Das DK, Patra AK, Singh M, Murmu MC. Clinico-etiological profile and outcome of pneumonia in under five children with special reference to severe acute malnutrition. *Panacea J Med Sci* 2024;14(2):534-544.