

A Study on Association of Acute Illness Observation Scale (AIOS) With Clinical Features in Pneumonia among Children Aged 2 Months to 59 Months.

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1. ABSTRACT

Introduction-*Pneumonia is the infection of lung alveolus and parenchyma. In India, pneumonia accounts for higher burden of childhood illness. In this study we use an illness severity scoring scale- Acute illness observation scale to estimate its association with clinical features, need for oxygen therapy, ICU admission and length of hospital stay in children with pneumonia aged between two to fifty-nine months.*

Materials and Methods-*A cross-sectional study was conducted over a period of 1 year in the pediatric department of Sree Balaji medical college and hospital, Chromepet, Chennai. Children between two months to fifty-nine months of age with pneumonia were scored with Acute illness observation score and further subdivided into three categories namely well-looking (AIOS less than or equal to 10), ill-looking (12 and 14) and severely ill-looking (more than or equal to 16). Clinical features, need for oxygen support, ICU admission and length of stay were compared between the groups.*

Results-*This study included 133 male and 105 female children. The incidence of pneumonia was high in 6-11 months age group. 27.3% had severe pneumonia. 39.1% were well-looking, 32.8% ill-looking and 28.2% were seriously-ill-looking. Duration of fever, cough and fast breathing were significantly higher ($p < 0.001$) in the seriously-ill-looking group. Seriously-ill-looking children had significantly higher prevalence ($p < 0.001$) of general danger signs of IMNCI (49.3%), chest indrawing (80.6%), stridor (28.4%), prolonged capillary refill time (22.4%), abnormal breath sounds (98.5%), oliguria (20.9%), radiological evidence of pneumonia (92.5%) and leukocytosis (98.5%) with a significant trend among the three categories for these variables. Oxygen support requirement (74.6% vs 5.1% vs 1.1%) and need for ICU admission (52.2% vs 3.8% vs 0%) was significantly higher in the seriously-ill-looking group than ill-looking and well-looking groups. Length of stay was significantly higher ($p < 0.001$) in the seriously-ill-looking group than other groups. AIOS score had high positive correlation with need for oxygen support ($r = 0.594$), need for ICU admission ($r = 0.496$) and length of hospital stay ($r = 0.619$).*

Conclusion-*AIOS scoring system can be used to assess the severity of pneumonia and can be used for prognosticating the clinical outcomes of pneumonia.*

Keywords-*Pneumonia, AIOS, IMNCI, under-five, fast-breathing.*

2. INTRODUCTION

Pneumonia is the infection of lung alveolus and parenchyma by a variety of micro-organisms leading to lung parenchymal inflammation [1] which presents clinically as fever, respiratory and systemic symptoms with evidence of radiological findings such as consolidation. In India, pneumonia accounts for high burden of childhood illness. Annually, India reports 3.5 to 3.7 lakh deaths by pneumonia in children [2,3]. Disease burden in India is measured in terms of episodes of pneumonia per one child per one year and it stands at 0.03

to 0.52[4,5].The case-fatality-rate of pneumonia in childhood is varies widely between 2.5% and 12% [6,7].

Therefore, there is a need for prognostication and treatment of pneumonia.Acute illness observation scale is a generic illness severity scale. This scoring system comprises of observations that can be performed within few minutes during initial evaluation. This severity scoring scale is used to assess the entirety rather than focusing on a single illness. [8,9].

The objective of this study was to estimate the association ofAcute Illness Observation Scale (AIOS) with clinical features in children with pneumonia aged between two to fifty-nine months. And the secondary objective was to estimate the association of AIOS score with need for oxygen therapy, ICU admission, and length of hospital stay in children with pneumonia aged between two to fifty-nine months.

3. MATERIALS AND METHODS

This cross-sectional study was conducted in the pediatric department of Sree Balaji medical college and hospital, Chromepet, Chennai fromAugust 2022 to July 2023. We included children aged between 2 months to 59 months who were admitted in the pediatric department with complaints of fever, cough, fast breathing for less than 2 weeks.

Table1: Fast breathing for different age groups

AGE GROUP	RESPIRATORY RATE-FAST BREATHING
2 months to 1 year	≥50/min
1 year to 5 years	≥40/min

Children with more than 2 weeks of illness duration, bronchial asthma, chronic lung disease state, congenital lung malformations, immunocompromised state and underlying cardiac and neurological disorders were excluded from the study. The study was accepted by the institutional scientific committee and clearance obtained from ethical committee. Written informed consent from the primary care taker Was obtained. Sample size was calculated using formula $n = \frac{z^2pq}{d^2}$ (16.9% prevalence of pneumonia inunder5 children in Tamil Nadu).So, $p=16.9\%(0.169)$; $q=83.1\%(0.831)$; $n= \frac{(1.96)^2 * 0.169 * 0.831}{(0.05)^2} = 215.8 = 216$ patients (approx.). Additional 10% for non-response/attrition was included accounting to total sample size of 238 patients. Sampling was done by purposive sampling.

At admission, child's demographic parameters, anthropometric measures, clinical history of duration of fever, cough and fast breathing were recorded. Presence of general danger signs namely inability to drink/feed, convulsion, persistent vomiting, lethargy/unconsciousness were noted. Subsequently patient was scored with AIOS scoring scale based on six variables namely quality of cry, reaction to parent stimulation, state variation, Color, hydration and response to social overtures. Each variable was scored for normal as 1, moderate impairment as 3 and severe impairment as 5. The child was classified into three categories based on AIOS score as less than or equal to 10 as well-looking, 12 and 14 as ill-looking and more than or equal to 16 as severely-ill-looking. On physical examination, temperature, pulse rate, respiratory rate, blood pressure, oxygen saturation using finger pulse oximeter were measured. Presence of chest indrawing, stridor, prolonged CRT(>3sec), and oliguria were noted.

Complete blood count was done to look for leukocytosis, chest x-ray was done to look for the presence of abnormal findings suggestive of pneumonia such as end point consolidation (dense opacity), non- end point infiltrates such as linear and patchy densities with peri-bronchial thickening and areas with atelectasis. Children were treated according to standard treatment protocols with appropriate antibiotics and other supportive measures. Children with hypoxia (oxygen saturation less than 92%), severe tachypnea (respiratory rate >70 breaths/min), chest indrawing, poor feeding or cyanosis were given oxygen support using either nasal prongs (low flow 1 to 2 L/min) or oxygen hood or face mask (4 to 8 L/min).

Children with $PaO_2/FiO_2 < 250$, need for mechanical ventilation, chest X-ray findings of bilateral, multi- lobar pneumonia with heterogenous opacity with subsequent worsening of lesion by above fifty percent in 48 hours after admission, hypotension, need for vasopressors and acute kidney injury (AKI) were admitted under ICU

care. They were followed until discharge. The duration of stay was noted. Final outcome was documented as discharged from hospital care with complete recovery or death. Data management and statistical analysis were done using SPSS software version 27.

4. RESULTS

A total of 238 children were included in this study in which 133 children (55.9%) were male and 105 children (44.1%) were female. The peak incidence of pneumonia was in the age group of 6 to 11 months with 24.8% (59/238). Least frequent age group was the 54 to 59 months group with 4.6% (11/238). Majority of children (45%, 107/238) were in the 50th to 85th percentile weight group.

The mean duration of fever, cough and fast breathing were 3.77 days, 5.45 days and 0.92 days respectively. General danger signs, chest indrawing and stridor were observed in 14.7% (35/238), 26.1% (62/238) and 8% (19/238) respectively. Severe pneumonia, defined by IMNCI as pneumonia with any one of the above three features, was present in 65 children (27.3%).

Table 2: Distribution of AIOS observation items:

AIOS item Observation	Quality of cry	Reaction to parent stimulation	State variation	Color	Hydration	Response to social overtures
Normal	50.4% (120/238)	36.1% (86/238)	42.4% (101/238)	87.4% (208/238)	20.6% (49/238)	56.3% (134/238)
Moderate impairment	46.6% (111/238)	50.0% (119/238)	54.2% (129/238)	12.6% (30/238)	79.0% (118/238)	22.7% (54/238)
Severe impairment	2.9% (7/238)	13.9% (33/238)	3.4% (8/238)	0% (0/238)	0.4% (1/238)	21.0% (50/238)

Patients were scored for the six items of AIOS score. Maximum normal observation was seen for color (87.4%), maximum moderate impairment observation was seen for hydration (79.0%) and maximum severe impairment observation was seen for response to social overtures (21.0%).

Table 3: Distribution of AIOS score with categories:

AIOS score	6	8	10	12	14	16	18	20	22	24	26
%	5.90% (14/238)	16.80% (40/238)	16.40% (39/238)	23.10% (55/238)	9.70% (23/238)	6.30% (15/238)	4.60% (11/238)	8.80% (21/238)	6.30% (15/238)	1.70% (4/238)	0.40% (1/238)
AIOS score categories	Well-looking			Ill-looking		Seriously-ill-looking					
%	39.1% (93/238)			32.8% (78/238)		28.2% (67/238)					

AIOS scores ranged from 6 to 26. Maximum number of children (23.1%) had an AIOS score of 12. Children were classified into three ordinal groups. Maximum number of children were present in the well looking group (39.1%) whereas the ill-looking group had 32.8% and the seriously-ill-looking group had 28.2%.

Table 4: Distribution of AIOS score categories based on IMNCI categories

		AIOS score categories		
		Well-looking	Ill-looking	Seriously-ill-looking
IMNCI classification	Pneumonia	53.2% (92/173)	41.0% (71/173)	5.8% (10/173)
	Severe Pneumonia	1.5% (1/65)	10.8% (7/65)	87.7% (57/65)

Among children classified as pneumonia by IMNCI (n=173), majority were well-looking (53.2%) and ill-looking (41.0%); only 5.8% were seriously-ill-looking. Conversely, 87.7% among those children classified as severe pneumonia by IMNCI were seriously-ill-looking by AIOS score; only 10.8% were ill-looking and 1.5%

were well-looking.

Prolonged capillary refill time was seen in 16 children(6.7%), abnormal breath sounds were present in 187 children (78.6%) and oliguria was seen in 16 children (6.7%). Leukocytosis was observed in 182 children (76.5%) whereas radiological evidence was seen in 117 children (49.2%).

Table5: Kruskal-Wall is test for symptom duration:

Symptom	Mean comparison		Groups compared	Significance
	χ^2	Significance		
Fever	13.940	<0.001	Seriously-ill-looking(vs)Well-looking	<0.001
			Seriously-ill-looking(vs)Ill-looking	0.126
			Well-looking(vs)Ill-looking	0.273
Cough	14.658	<0.001	Seriously-ill-looking(vs)Well-looking	<0.001
			Seriously-ill-looking(vs)Ill-looking	0.040
			Well-looking(vs)Ill-looking	0.594
Fastbreathing	25.813	<0.001	Seriously-ill-looking(vs)Well-looking	<0.001
			Seriously-ill-looking(vs)Ill-looking	<0.001
			Well-looking(vs)Ill-looking	1.000

Duration of clinical symptoms were significantly higher in the seriously-ill looking group compared to the other two groups for fever($p<0.001$), cough ($p<0.001$)and fast breathing($p<0.001$). No significant difference was noted between well-looking and ill-looking groups.

Table 6: Summary of categorical clinical features by Chi-square trend test:

	AIOS categories			P-value for trend
	Well-looking	Ill-looking	Seriously-ill-looking	
Number in group	93	78	67	
General danger signs of IMNCI	0.0%	2.6%	49.3%	<0.001
Chest indrawing	1.1%	9.0%	80.6%	<0.001
Stridor	0.0%	0.0%	28.4%	<0.001
Prolonged capillary refill time	0.0%	1.3%	22.4%	<0.001
Abnormal breath sounds	59.1%	84.6%	98.5%	<0.001
Oliguria	1.1%	1.3%	20.9%	<0.001
Radiological evidence of pneumonia	26.9%	38.5%	92.5%	<0.001
Leukocytosis	58.1%	79.5%	98.5%	<0.001

General danger signs of IMNCI were present in 49.3% (33/67) of seriously-ill-looking children, 2.6% (2/78) of ill-looking children and were completely absent (0/93) in well-looking children. Chest indrawing was present in 80.6% (54/67) of seriously-ill-looking children, 9.0% (7/78) of ill-looking children and 1.1% (1/93) of well-looking children. Stridor was present in 28.4% (19/67) of seriously- ill-looking children and was completely absent in ill-looking children(0/78)and well-looking children (0/93). Prolonged capillary refill time was present in 22.4% (15/67) of seriously-ill-looking children, 1.3% (1/78) of ill-looking children and was completely absent (0/93) in well-looking children. Abnormal breath sounds were present in 98.5% (66/67) of seriously-ill-looking children, 84.6%(66/78) of ill-looking children and 59.1% (55/93) of well-looking children. Oliguria was present in 20.9% (14/67) of seriously-ill-looking children, 1.3% (1/78) of ill-looking children and 1.1% (1/93) of well- looking children. Radiological evidence of pneumonia was present in 92.5% (62/67) of seriously-ill- looking children, 38.5% (30/78) of ill-looking children and 26.9% (25/93) of well-looking children. Leukocytosis was present in 98.5% (66/67) of seriously-ill-looking children, 79.5%

(62/78) of ill- looking children and 58.1% (54/93) of well-looking children.

There was a significant trend among the three ordinal AIOS score categories for general danger signs of IMNCI($\chi^2(1)= 68.497$, $p = <0.001$), chest indrawing($\chi^2(1)= 117.515$, $p= <0.001$), stridor($\chi^2(1)= 38.313$, $p = <0.001$), prolonged capillary refill time ($\chi^2(1) = 28.342$, $p = <0.001$), abnormal breath sounds ($\chi^2(1) = 37.172$, $p = <0.001$), oliguria ($\chi^2(1) = 21.977$, $p = <0.001$), radiological evidence of pneumonia ($\chi^2(1) = 62.827$, $p = <0.001$) and leukocytosis($\chi^2(1) = 35.795$, $p = <0.001$) by using linear- by-linear association in Chi-square trend test.

Table 7: Kruskal-Wallis test for quantitative clinical features:

Clinical features	Mean comparison		Groups compared	Significance
	χ^2	Significance		
SpO ₂	74.695	<0.001	Well-looking(vs)Ill-looking	1.000
			Well-looking(vs)Seriously-ill-looking	<0.001
			Ill-looking(vs)Seriously-ill-looking	<0.001

Between well-looking and seriously-ill-looking pair, there was a significant difference of peripheral oxygen saturation ($p < 0.001$). Between ill-looking and seriously-ill-looking pair, there was a significant difference in peripheral oxygen saturation ($p < 0.001$). Between well-looking and ill-looking pair, there was no significant difference in the peripheral oxygen saturation.

The mean and standard deviation of length of hospital stay was 4.6 ± 2.2 days. In the study population, 23.1% (55/238) required oxygen support and 16.0% (38/238) required ICU admission.

Table 8: Summary of categorical outcomes by Chi-square trend test:

	AIOS categories			P-value for trend
	Well-looking	Ill-looking	Seriously-ill-looking	
Number in group	93	78	67	
Need for oxygen support	1.1%	5.1%	74.6%	<0.001
Need for ICU admission	0.0%	3.8%	52.2%	<0.001

Oxygen support was required in 74.6% (50/67) of seriously-ill-looking children, 5.1% (4/78) of ill- looking children and 1.1% (1/93) of well-looking children. ICU admission was required in 52.2% (35/67) of seriously-ill-looking children, 3.8% (3/78) of ill-looking children and none (0/93) of well- looking children required ICU admission.

There was a significant trend among the three ordinal AIOS score categories for need for oxygen support ($\chi^2(1)=107.902$, $p = <0.001$) and need for ICU admission ($\chi^2(1)=72.387$, $p = <0.001$) by using linear- by-linear association in Chi-square trend test.

Table 9: Kruskal-Wallis test for quantitative outcomes:

Outcome	Mean comparison		Groups compared	Significance
	χ^2	Significance		
Length of hospital stay	123.004	<0.001	Well-looking(vs)Ill-looking	0.003
			Well-looking(vs)Seriously-ill-looking	<0.001
			Ill-looking(vs)Seriously-ill-looking	<0.001

There was significant difference of length of hospital stay noted between the three AIOS categories ($P < 0.001$). Among pair wise comparison, there was significant difference of length of hospital stay noted among seriously-ill-looking & well-looking pair ($P < 0.001$), seriously-ill-looking & ill-looking pair ($P < 0.001$), and well-looking and ill-looking pair ($P = 0.003$).

Correlation analysis was carried out by Kendall's Tau-b test. AIOS score and need for oxygen support had a correlation coefficient τ_b of 0.594, with a p-value of < 0.001 , suggesting a high positive correlation. AIOS

score and need for ICU admission had a correlation coefficient r_b of 0.496, with a p -value of <0.001 , suggesting a high positive correlation. AIOS score and length of hospital stay had a correlation coefficient r_b of 0.619, with a p -value of <0.001 , suggesting a high positive correlation.

There was no mortality in our study population and all 238 children were discharged at the end of treatment.

5. DISCUSSION

This cross-sectional study was undertaken to estimate the association of AIOS score with clinical features of pneumonia, need for oxygen therapy, ICU admission and length of hospital stay among 238 children aged 2 months to 59 months hospitalized for pneumonia from August 2022 to July 2023 in the paediatric department of Sree Balaji Medical College and Hospital located in Chennai, South India after obtaining informed consent of their primary caretaker.

The study sample demonstrated a modest predominance of male children (55.9% male vs 44.1% female). Female children were slightly older (mean age = 23.3 ± 15.7 months in female vs 22.4 ± 16.1 months in male). Older infants had higher incidence of pneumonia (24.8% in 6-11 months group) with marked reduction in incidence above 2 years of age. By IMNCI classification, severe pneumonia was present in 27.3% of the study population with general danger signs in 14.7%, chest indrawing in 26.1% and stridor in 8%.

AIOS score of the study population was between 6 to 26. Maximum number of children (23.1%, 55/238) had an AIOS score of 12 with highest number of children present in the well-looking group (39.1%, 93/238) whereas the seriously-ill-looking group contributed to 28.2% (67/238). Inter-item correlation between the six observational items of AIOS was carried out with Cronbach's alpha and was found to be 0.78, indicating a good internal consistency (minimum desirable level is 0.70). A similar study conducted by Bhavneet Bharti et al. [10] reported a similar Cronbach's alpha of 0.81 with very good reliability of internal consistency between six items of the observational scale.

There was a notable disparity in the duration of symptoms exhibited by the seriously-ill-looking group in comparison to the other groups. Furthermore, no significant difference was observed in the duration of symptoms between the well-looking and ill-looking groups.

The seriously-ill-looking group exhibited a higher prevalence of clinical signs compared to the other two groups. Notably, the well-looking group did not present any instances of inability to drink or feed, persistent vomiting, stridor, lethargy, prolonged capillary refill time, convulsions, or unconsciousness.

Radiological evidence of pneumonia and leukocytosis were almost always present in the group that appeared to be seriously ill. In contrast, in the group that appeared to be well, only approximately one-fourth had radiological evidence of pneumonia and one-third had leukocytosis.

Approximately 75% of the children who appeared seriously ill required oxygen support, while only one child among those who appeared well needed it. Furthermore, around 50% of the seriously ill-looking children necessitated admission to the intensive care unit (ICU), whereas none of the well-looking children required ICU care. There was a statistically significant difference in the length of hospital stay among all three AIOS score categories.

All three outcome variables, namely the need for oxygen support, the need for ICU admission, and the length of hospital stay, had a strong positive correlation with the AIOS score.

These results signify that AIOS scoring system is having a significant association with clinical features of pneumonia and had significant correlation with outcome variables of need for oxygen support, need for ICU admission and length of hospital stay. Similar study by Bhavneet Bharti et al. [10] reported 6.4 days mean length of stay with standard deviation of 2.8 days. Comparing with this our study had a lower length of hospital stay.

This study had limitations of being an observational scoring system, with the reproducibility of the score

affected by less qualified workers. Owing to its relatively smaller sample size and single institutional study, validation with multi-centric studies is further required to recommend its use in routine clinical practice. Multivariate analysis determining the individual contribution of the various clinical parameters and scores in clinical outcomes were not carried out since it was outside the scope of this study. Designing a study for the same would give further insights on this.

6. CONCLUSION

This study was conducted to estimate the association of AIOS with clinical features of pneumonia in children between 2 months to 59 months. It is observed that AIOS scoring system can be used to assess the severity of pneumonia. Further, it can be used for prognosticating pneumonia due to its correlation with need for ICU admissions, need for oxygen supplementation and the length of hospital stay. While IMNCI is a classification system that is used in the peripheral centres by ground level health workers with main focus on classifying patients to determine the appropriate place of treatment, AIOS scoring system is observed by the physician at the point of admission to hospital and can be used to complement IMNCI, in clinically assessing the severity of pneumonia and prognosticating the clinical outcomes.

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