Clinical profile of acute lower respiratory tract infections in children aged 2–60 months: An observational study

Nandimalla Vinaykumar, Pawar Jalinder Maruti

Department of Pediatrics, Krishna Institute of Medical Sciences, Karad, Maharashtra, India

ABSTRACT

Background: Assessment of risk factors and clinical profile for acute lower respiratory tract infections (ALRIs) with severe and very severe pneumonia in children <5 years of age is obligatory. Objective: To study the clinical profile, risk factors, and clinical outcomes associated with ALRIs in children aged 2–60 months. Methodology: In total, 130 children of either gender, diagnosed with ALRIs, admitted in a tertiary care hospital were enrolled. Demographic data and clinical history was collected. Clinical profile data such as respiratory and heart rate, oxygen supplementation, ventilator use, and lab investigation such as erythrocyte sedimentation rate, hemoglobin, total leucocyte count, differential leucocytes count, and blood culture were analyzed and noted. Results: The study findings demonstrated male gender predominance for ALRIs with 1.3:1 male to female ratio. Around 16% of them had pneumonia, 61% had severe pneumonia, and 23% had very severe pneumonia. The birth weight of child, maternal and paternal literacy, socioeconomic status, overcrowding at home, immunization status of children, type of kitchen and fuel used for cooking, malnutrition, anemia, and need for oxygen supplementation were found to be associated with the occurrence of ALRIs (P < 0.05). Most of the presented symptoms were cough (100%), breathlessness (96.92%), and fever (92.31%). Bronchiolitis (63%), bronchopneumonia (27%), and lobar pneumonia (25%) were the major clinical outcomes. Conclusion: The study identified various sociodemographic, environmental, and nutritional risk factors for ALRIs along with the clinical profile, which can be managed by effective peripheral health personnel’s training and persuasive community health education.

Keywords: Birth weight, bronchopneumonia, cough, infant, risk factors

Introduction

Severe and very severe pneumonia are its most virulent forms and are characterized by the presence of central cyanosis, chest in-drawing, convulsions, and lethargy.[5]

On an average, about five episodes of ALRIs occur per year in children below 5 years and most of the recurrences are self-limiting and mild. Yet, they cause about 20–40% hospital admissions and 30–50% of visits to health facilities.[6]

ALRIs are a group of infections with different risk factors and are affected by sociodemographic, environmental, and sociocultural factors in terms of morbidity and mortality.[7,8]

Most of the population-based studies have focused on studying the clinical profile, risk factors, and outcomes of ALRIs in adults.[9] Hence, there is a dearth of literature in pediatric groups,
especially in the first 5 years of life.[8] Thus, this study was aimed to perform an observational study on the clinical profile, risk factors, and outcomes of ALRIs in children aged 2–60 months.

Materials and Methods

With the institutional ethics committee’s approval and written informed consent from their parents, this single-centered, hospital-based, prospective, observational study was conducted in the Department of Pediatrics at a private medical college in Karad for 2 years (2017–2019). To show a medium difference as statistically significant, we needed to choose a medium effect size (Cohen’s-w). With a medium effect size (w = 0.8), 80% power at 95% confidence level, we required a sample size of ~12 for Chi-square test of independence with df 2 (2-1 x 3-1). Based on the availability of the patient pool, the final sample size was made up to 130.

In total, 130 children of either gender, aged between 2 and 60 months, diagnosed with ALRIs (viz., pneumonia [P], severe pneumonia [SP], and very severe pneumonia [VSP]) as per WHO criteria[14] were included in the study. Children with underlying pulmonary tuberculosis or heart diseases were excluded from the study.

A case of ALRI was defined according to the acute respiratory infection control program as, “presence of cough with fast breathing of more than 60 breaths/min at < 2 months of age, more than 50/min at 2–12 months of age, and more than 40/min at 12–60 months (5 year) of age, the duration of illness being less than 30 days.” The presence of lower chest wall in-drawing was taken as SP. The presence of central cyanosis, lethargy, refusal of feeds, or convulsions was taken as VSP.[11]

Data including detailed history of relevant symptoms, history of similar complaints, immunization, breastfeeding and weaning, family history of upper respiratory tract infection (URTI) in the preceding 2 weeks, smoking, and cooking fuel details were recorded. The dietary intake of the child prior to current illness was calculated by 24-h dietary recall method. Grading of housing conditions, socioeconomic status was done according to Modified Kuppuswamy classification.[2] Malnutrition was graded as per Indian Academy of pediatrics in the year 1972.[13]

Clinical examination

During a detailed clinical examination, the respiratory, heart rates, and anthropometry measures were measured by standard techniques. Signs of pallor and vitamin deficiencies were also recorded.

Routine blood investigations such as erythrocyte sedimentation rate, hemoglobin, and total leucocyte count were performed. Chest X-ray was performed to examine the type and site of associated complications. Blood was collected from vein for culturing and isolation of the microorganisms. Based on the organisms isolated from the culture and their sensitivity reports, an etiological diagnosis was established. Daily clinical monitoring and data recording were done until discharge or death.

Statistical analysis was performed using R software (Version. 3.6.0). The qualitative variables were analyzed using Chi-square test of independence. Ordinal logistic regression was used to predict an ordinal-dependent variable given one or more independent variables at 95% confidence interval.

Results

The present prospective study was carried out in 130 children diagnosed with ALRIs, i.e., P (16%), SP (61%), and VSP (23%). Majority of them were 13–60 months old (60%) with a male predominance and male to female ratio of 1.3:1, stipulating that male children are more prone to ALRI as compared to female children.

No significant (P > 0.05) association was observed between age, gender, smoking history in the family, and family history of URTI in the previous 2 weeks with the occurrence of ALRIs. However, birth weight of child, maternal and paternal literacy status, socioeconomic status of parents, overcrowding at home, and immunization status of children were found to be associated with the occurrence of ALRIs (P < 0.05) [Table 1].

The type of kitchen and fuel used for cooking were significantly associated (P < 0.05). However, the type of floor and cross ventilation had no association with the occurrence of ALRIs (P > 0.05) as majority of the houses had pucca (solid) flooring and adequate cross ventilation [Table 2].

A significant (P < 0.05) association was found between malnutrition, anemia status of the child, and the occurrence of ALRIs with SP mostly occurring in children with grade I and II malnutrition. Also, a significant (P < 0.05) association was found between the occurrence of ALRIs and the need for oxygen supplementation as most of the children needed oxygen supplementation (80.6%). Ventilatory support was not required by majority of the children (81%) suffering from ALRIs. Most of the children were diagnosed with bronchiolitis (63%), bronchopneumonia (27%), and lobar pneumonia (25%). As most of the children showed an improved outcome (83%), no significant association was observed between occurrence of ALRIs and the type of outcome [Table 3]. Leucocytosis was observed in a small percentage (48%) of children, and no significant association with ALRI severity was noted. The blood culture status was mentioned in Table 3.

The birth weight contributed significantly as a risk factor in predicting the status of pneumonia (P < 0.05) as when moving from a birth weight of ≤2.5 kg to a birth weight >2.5 kg; the odds of occurrence of pneumonia increased by 0.30 times. However, the weaning status did not contribute significantly (P > 0.05) in the prediction of the pneumonia status [Table 4].
The risk factors such as type of fuel, ventilation, and flooring did not contribute significantly ($P > 0.05$) in predicting the status of pneumonia [Table 5]. However, upon moving from adequate to inadequate ventilation, the odds of occurrence of pneumonia increased by 1.38 times.

The present prospective study was carried out to study the clinical profile, risk factors, and outcomes associated with ALRIs.
in children aged 2–60 months. Most children with SP were reported in the age group of 2–12 months and with VSP being reported in 13–60-month-old children, and similar observations were made by Champatiray et al.[8] This major occurrence of SP in the age group of less than 1 year could be attributed to the fact that infants aged less than a year have low immunity, poor nutritional status, narrower and smaller airways, frequent exposure to infections, and more susceptibility to general and viral infections.[7,14]

The male to female ratio in this study was in accordance with previous studies in which it is ranged between 1.4:1 and 1.5:1.[15,16] This could be due to the preferential treatment usually being given to the male child in families. Furthermore, as per a study by Libert et al.[17] the lower incidence of ALRIs in girls could be due to their inherent immunity due to the presence of extra “X” chromosome in their genotype.[17]

Majority of the children suffering from SP and VSP in our study had a low birth weight (<2.5 kg). Birth weight as a risk factor significantly contributed in predicting the status of pneumonia, as

| Nutritional and clinical factors | Clinical diagnosis (n=130) | Total | P |
|---------------------------------|---------------------------|-------|---|
| Weaning (months)                | P (21) a (%) | SP (79) a (%) | VSP (30) a (%) |
| <4                              | 5 (12.5) | 21 (52.5) | 14 (35) | 40 | 0.676 |
| 4-6                             | 4 (14.29) | 19 (67.86) | 3 (17.86) | 28 | 0.010 |
| >6                              | 12 (19.35) | 39 (62.9) | 11 (17.74) | 62 | 0.003 |
| Malnutrition (grade)            |                          |       |   |
| Not known                       | 15 (20.83) | 39 (54.17) | 18 (25) | 72 | 0.010 |
| I                               | 4 (22.22) | 14 (77.78) | 0 (0) | 18 | 0.173 |
| II                              | 2 (12.5) | 13 (81.25) | 1 (6.25) | 16 | 0.706 |
| III                             | 0 (0) | 12 (54.55) | 10 (45.45) | 22 | 0.003 |
| IV                              | 0 (0) | 1 (50) | 1 (50) | 2 | 0.003 |
| Anemia                          |                          |       |   |
| Present                         | 2 (3.64) | 37 (67.27) | 16 (29.09) | 55 | 0.003 |
| Absent                          | 19 (25.33) | 42 (56) | 14 (18.67) | 75 | 0.706 |
| Leucocytosis                    |                          |       |   |
| Yes                             | 10 (15.38) | 38 (58.46) | 17 (26.15) | 65 | 0.000 |
| No                              | 11 (16.92) | 41 (63.08) | 13 (20) | 65 | 0.003 |
| Blood culture                   |                          |       |   |
| No growth                       | 21 (16.8) | 78 (62.4) | 26 (20.8) | 125 | 0.071 |
| Staphylococcus aureus           | 0 (0) | 1 (25) | 3 (75) | 4 | 0.173 |
| Streptococcus pneumoniae        | 0 (0) | 0 (0) | 1 (100) | 1 | 0.073 |
| Oxygen supplementation          |                          |       |   |
| Present                         | 5 (4.46) | 77 (68.75) | 30 (26.79) | 112 | 0.000 |
| Absent                          | 16 (88.89) | 2 (11.11) | 0 (0) | 18 | 0.003 |
| Ventilatory support             |                          |       |   |
| Present                         | 0 (0) | 3 (30) | 7 (70) | 10 | 0.003 |
| Absent                          | 21 (17.5) | 76 (63.33) | 23 (19.17) | 120 | 0.000 |
| Clinical outcome                |                          |       |   |
| ALTB                            | 0 (0) | 4 (80) | 1 (20) | 5 | 0.071 |
| BRCHPN                          | 5 (18.52) | 16 (59.26) | 6 (22.22) | 27 | 0.073 |
| BRNCHIO                         | 11 (17.46) | 41 (65.08) | 11 (17.46) | 63 | 0.073 |
| LOBPNE                          | 2 (8) | 11 (44) | 12 (48) | 25 | 0.073 |
| WLRI                            | 3 (30) | 7 (70) | 0 (0) | 10 | 0.073 |
| Outcome                         |                          |       |   |
| EXP                             | 0 (0) | 0 (0) | 2 (100) | 2 (7%) | 0.003 |
| IMP                             | 21 (16.41) | 79 (61.72) | 28 (21.88) | 128 (83%) | 0.003 |

Table 4: Logistic regression coefficient data for the prediction of pneumonia based on birth weight and weaning

| Estimate | Std. Error | P |
|----------|------------|---|
| Intercept | 2.606 | 0.5586 | 3.09e-06 |
| Birth weight (>2.5 kg) | -1.1942 | 0.5956 | 0.044 |
| WNG (>6 months) | -0.2614 | 0.4952 | 0.597 |

WNG: Weaning

ALTB: Acute Laryngotracheobronchitis; BRCHPN: Bronchopneumonia; BRNCHIO: Bronchiolitis; C: Chi-square test of independence; EXP: Expired; IMP: Improved; LOBPNE: Lobar pneumonia; P: Pneumonia; SP: Severe pneumonia; VSP: Very severe pneumonia; WLRI: Wheeze-associated lower respiratory infection
the odds of occurrence of pneumonia increased when the birth weight increased from ≤2.5 to >2.5 kg. This is in accordance with a previous study which reported that 84% of SP cases had a low birth weight.[15] A previous study has also shown that low birth weight increases the vulnerability to infectious diseases and has implications for immunocompetence.[18]

The parents of most children suffering from severe pneumonia had completed primary or middle-school education in our study. Similar findings were observed by Gornale et al.[19] as most of the parents of SP children in their study were educated till primary or middle-school level.[19]

Majority of the children with severe pneumonia in the present study belonged to upper lower (IV) and lower middle (III) class. This is in accordance with the study conducted by Champatiray et al. in which most cases of SP belonged to those classes.[19]

In our study, most of the SP-affected children were immunized for age. In contrast, a study conducted by Debnath et al.[13] found that only 23.8% children were immunized as per NIS and 51.2% children had incomplete immunization.[13]

In developing countries like India, biomass fuels are used widely in households with attached kitchens, which affect the nonspecific and specific local defense mechanisms of the respiratory tract. Due to proximity of young children to their mother during cooking and longer indoor stays especially with attached kitchens, they are at greater risk.[20] Most of the children with SP (68.83%) and VSP (25.97%) in our study lived in houses where biomass fuels other than gas such as kerosene and firewood were used for cooking and had attached kitchens. This is in accordance with the study conducted by Sikolia et al.[21]

Early weaning (before 4 months of age) can weaken the immunity of the child and in study conducted by Savitha et al.[22] showed that weaning was significantly associated with occurrence of ALRIs.[22] However, in the present study, no significant association was observed between ALRI severity and weaning age.

In our study, majority of the SP-affected children had grade I and II malnutrition. This is in contrast with the study conducted by Debnath et al.[13] in which grade IV malnutrition was observed in 44.7%, grade III in 28.9%, and normal malnutrition in 9.5% of the cases.[13] Malnutrition has been significantly associated with the occurrence of ALRIs, especially among children below 5 years of age. It predisposes a child to infection by defective cell-mediated immune response.[9]

Anemia was a significant risk factor for SP and VSP in the present study. This is in accordance with a study done by Ramakrishnan et al., who reported it as a significant contributing factor for ALRIs.[23]

In comparison to previous studies,[8] the present study showed a less positive blood culture. This discrepancy could be due to a smaller number of VSP cases in the present study. Furthermore, the most common organism in both these studies was S. aureus, which was associated with malnutrition.

Regarding the laboratory findings, leucocytosis was observed in small percentage and reason could be that majority of the cases were on oral antibiotics before getting admitted to the hospital. This is in accordance with a previous study.[8] Respiratory support required by children in the present study substantiate with results obtained by Kannam,[24] as SP and higher cases required oxygen supplementation in their study. However, mechanical ventilation was required in VSP cases.[24]

The final diagnoses in our study indicated that most of the children had bronchiolitis, bronchopneumonia, and lobar pneumonia. This is in line with the study conducted by Kannam in which 40% cases were diagnosed with bronchopneumonia, 25% with lobar pneumonia, and 19% with bronchiolitis.[24]

Mortality observed in the study was in accordance with a previous study where the mortality rate among VSP cases was 1.2%.[24] However, these studies are in contrast with a study conducted by Tiewsoh et al.[25] in which the mortality rate due to VSP was 10.5%.[23] This difference in the mortality rate could be attributed to the fact that this comparative study by Tiewsoh et al. was conducted in an urban research institute where the probability of a greater number of positive cases is high.[25]

The study has limitations being a hospital-based, single-center study, and might not be presenting the true incidence of ALRIs and their different etiologies for the entire population. Also, due to diagnosis based on the case management protocol of WHO and PCR non-availability at our center, viral pathogens were not routinely identified. For the true rate of incidence, multicentric studies in future are recommended.

**Conclusion**

The results elucidate that early referrals based on risk factors are of paramount importance as it will not only halt the progression of ALRI severity but lower the mortality rate as well. Parental literacy is important for acquiring health knowledge, as adequately literate parents have better health awareness as compared to their illiterate counterparts. Most of these recommendations
can be which can be educated in the early detection at primary care physicians.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

**References**

1. Hien TP, Phuc N, Sinh TT, Thuy TB. Clinical and pathogenic characteristics of lower respiratory tract infection treated at the Vietnam National Children’s Hospital. Can J Infect Dis Med Microbiol 2020;2020:7931950. doi: 10.1155/2020/7931950.
2. Agrawal RC. Pneumonia. In: Parthasarathy A, editor. IAP Textbook of Pediatrics. 5th ed. Jaypee Brothers Medical Publishers (P) Ltd.; 2013. p. 470-4.
3. Rudan I, Boschi-Pinto C, Biloglav Z, Mulholland K, Campbell H. Epidemiology and etiology of childhood pneumonia. Bull World Health Organ 2008;86:408-16.
4. Black RE, Cousens S, Johnson HL, Lawn JE, Rudan I, Bassani DG, et al. Global, regional, and national causes of child mortality in 2008: A systematic analysis. Lancet 2010;375:1969-87.
5. Francis BV. Abhilash TG. Study of acute respiratory tract infection in children. Internat J Sci Res 2016;5:1791‑2.
6. Boschi-Pinto C, Young M, Black RE. The Child Health Epidemiology Reference Group reviews of the effectiveness of interventions to reduce maternal, neonatal and child mortality. Int J Epidemiol 2010;39:3-6.
7. Divyaran DC, Patil GR, Ramesh K. Profile on risk factors of pneumonia among Under-five age group at a Tertiary care hospital. Int J Curr Microbiol App Sci 2014;3:750-4.
8. Champatiray J, Satapathy J, Kashyap B, Mondal D. Clinico-aetiological study of severe and very severe pneumonia in two months to five years children in a Tertiary Health Care Centre in Odisha, India. J Clin Diagn Res 2017;11:SC06-10.
9. Lim WS, Macfarlane JT, Boswell TC, Harrison TG, Rose D, Leinonen M, et al. Study of community acquired pneumonia aetiology (SCAPA) in adults admitted to hospital: Implications for management guidelines. Thorax 2001;56:296-301.
10. World Health Organization. Technical bases for the WHO recommendations on the management of pneumonia in children at first level health facilities. WHO/ARI/91.20 Geneva. 1991.
11. World Health Organization. A programme for controlling acute respiratory infections in children: Memorandum from a WHO meeting. Bull World Health Organ 1984;62:47-58.
12. Shaikh Z, Pathak R. Revised Kuppuswamy and BG Prasad socio-economic scales for 2016. Int J Community Med Public Health 2017;4:997-9.
13. Shah PM. Report of nutrition sub-committee of Indian Academy of Pediatrics. Indian Pediatr 1972;9:360.
14. Madhi SA, Levine OS, Hajjeh R, Mansoor OD, Cherian T. Vaccines to prevent pneumonia and improve child survival. Bull World Health Organ 2008;86:365-72.
15. Deb Nath D, Wanje P, Kakrani V, Singru S. Clinical and epidemiological study of acute respiratory infection cases in children below twelve years of age in a tertiary care teaching hospital in Pune, India. Med J DY Patil Univ 2012;5:125-8.
16. Banstola A, Banstola A. The epidemiology of hospitalization for pneumonia in children under five in the rural western region of Nepal: A descriptive study. PLoS One 2013;8:e71311.
17. Libert C, Dejager L, Pinheiro I. The X chromosome in immune functions: When a chromosome makes the difference. Nat Rev Immunol 2010;10:594-604.
18. Raqib R, Alam DS, Sarker P, Ahmad SM, Ara G, Yunus M, et al. Low birth weight is associated with altered immune function in rural Bangladeshi children: A birth cohort study. Am J Clin Nutr 2007;85:845-52.
19. Gornale VK, Minarey N, Chhina AS, Katwe N, Harsha PJ, Iyer C. Demographic profile of children with acute lower respiratory tract infections of age between 2 months to 5 years. Pediaitr Rev: Int J Pediatr Res 2015;2:15-20.
20. 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 Pediatr 2001;38:1361-9.
21. Sikolia DN, Mwololo K, Cherop H, Hussein A, Juma M, Kurui J, et al. The prevalence of acute respiratory infections (ARI) and the associated risk factors; A study of children under five years of age in Kibera Lindi village, Nairobi, Kenya. J Natl Inst Public Health 2002;51:67-72.
22. Savitha MR, Nandeeshwara SB, Pradeep Kumar MJ, ul-Haque F, Raju CK. Modifiable risk factors for acute lower respiratory tract infections. Indian J Pediatr 2007;74:477-82.
23. Ramakrishnan K, Harish PS. Hemoglobin level as a risk factor for lower respiratory tract infections. Indian J Pediatr 2006;73:881-3.
24. Kannam D. A clinical study of profile of acute lower respiratory tract infections in children. Sch J App Med Sci 2018;6:2811-5.
25. Tiwsoh K, Lodha R, Pandey RM, Broor S, Kalavani M, Kabra SK. Factors determining the outcome of children hospitalized with severe pneumonia. BMC Pediatr 2009;9:15.