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Original Research Article

Prospective Cohort Assessment of the Factors Associated with Risk of Hospitalization in Children with Community-Acquired Pneumonia (CAP)

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Abstract

Objective: To evaluate factors associated with risk of hospitalization in children with community-acquired pneumonia (CAP).

Material & Methods: This was a prospective cohort study conducted over a period of two years in Department of Pediatrics, SKMCH, Muzaffarpur, Bihar, India. A total of 300 children with pneumonia were included in the study.

Results: Hospitalization was needed in 167 (55.6%) children with pneumonia including 6 patients who were initially given ambulatory treatment and were later admitted in view of deteriorating respiratory distress. Amongst children with pneumonia, reportable chest X-rays were available in 160 cases (total X-rays 176).

Conclusion: Present study found SpO2 <90% at room air, serum procalcitonin level >0.5 ng/mL and lower weight for height z-score to be predictors for risk of hospitalization in under-five children presenting with community acquired pneumonia. These factors can be utilized to assess a child with CAP regarding the need of hospitalization.

Keywords: Hypoxia, Outcome, Procalcitonin, Underweight.

Introduction

Globally, pneumonia is the leading cause of death among under-five children with more than

90% of these occurring in resource-limited settings [1]. Implementation of feasible and effective interventions has reduced under-five pneumonia death substantially from 13.6 per 1000 live births in 2000 to 6.6 per 1000 live births in 2015 [2, 3], yet, pneumonia ranked top in mortality. Childhood death due to pneumonia occurs disproportionately in low-and middle-income countries (LMICs) with the greatest number observed in South Asia and sub-Saharan African countries [3, 4]. Compared to deaths due to other childhood diseases, pneumonia related deaths are declining at a slower rate [5]. Rudan et al. reported the incidence of clinical pneumonia in under-five children was approximately 0.29 episodes per child-year in LMICs of the world [6]. This means,

every year 151.8 million incidences with 13.1 million (8.7%) episodes progressing from pneumonia to severe pneumonia that require hospitalization [6, 7].

Children living in remote regions where poverty and hunger are severe are most susceptible to pneumonia [8]. In general, the poorer access of less privileged families to healthcare services means that they delay seeking adequate care, resulting in the deterioration of their condition and an increased risk of hospitalization [9, 10].

Although a reduction in all-cause of child mortality occurred worldwide between 2000 and 2011, including a reduction in pneumonia-related deaths, in 2011, CAP was estimated to account for more than one million child deaths, 80 % of which occurred in children under 2 years of age [11].

WHO revised case definition for CAP in under-five children has two categories – 'pneumonia', which is treated at home with oral amoxicillin and 'severe pneumonia, which requires hospitalization and parental antibiotics. Despite the improvement in case management of childhood pneumonia, mortality and morbidity still remains high, especially in resource-constrained settings. The early identification of important risk factors for hospitalization among these patients could help to prioritize the management and potentially increase their likelihood of surviving. This prospective study was conducted to evaluate the factors associated with risk of hospitalization in children with CAP.

Material & Methods

This was a prospective cohort study conducted over a period of two years in Department of Pediatrics, SKMCH, Muzaffarpur, Bihar, India.

Methodology

A total of 300 children with pneumonia were included in the study. Previously healthy children, 2 to 59 months of age, with acute respiratory infection (ARI) of less than 2 weeks duration were assessed for inclusion in the study. Children suffering from chronic respiratory diseases (asthma, cystic fibrosis, Broncho pulmonary dysplasia (BPD), and airway anomalies), congenital heart disease, gastro esophageal reflux disease (GERD)/recurrent aspirations, suspected/ known immunodeficiency, patient living outside the city where the study site was based, history of radiologically confirmed pneumonia in last 2 months, and very sick child requiring immediate ICU care, were excluded.

A separate acute respiratory tract infection treatment unit (ATU) was established to manage all ARI patients. The ATU team comprised of a pediatrician and a trained nurse. All children between 2 months to 59 months of age with history of ARI were directed to attend ATU during working hours of the hospital. The revised WHO case definition for ARI was used across all the study sites to ensure uniformity in management of ARI patients. The revised classification includes two categories of pneumonia; 'pneumonia' with fast breathing and/or chest in drawing, and 'severe pneumonia,' pneumonia with any general danger sign [12]. Children were enrolled in the study after obtaining written, informed consent from parents or legal guardians. A detailed history was taken, and physical examination, including respiratory rate, presence of chest in drawing, pulse, temperature, oxygen saturation by pulse oximetry and anthropometry was done by the research nurse under the supervision of research officer. Each child's respiratory rate was counted for a full minute when the child was calm and quiet. If the child presented with fever and fast breathing, appropriate paracetamol dose was given and respiratory rate was reassessed after 30 minutes. Children presenting with wheeze and fast breathing were administered salbutamol nebulization (0.15 mg/kg single dose) and respiratory rate was

reassessed after 10-15 minutes. Weight was measured to the nearest 0.1 kg using calibrated electronic scales, and height was measured to the nearest 0.1 cm using a standardized stadiometer. If a child was less than 2 years of age, recumbent length was measured by using an infantometer. Clinical history and examination findings of enrolled children were recorded on a predesigned case record form.

Every fifth child with ARI underwent a chest X-ray. The chest radiographs were interpreted by site investigator at the time of enrolment, thereafter, either original films or digital copies were sent to the coordinating centre at AIIMS, New Delhi. All chest X-rays were read by two independent pediatricians, who were blinded for the clinical diagnosis of the patient. In case of disagreement about the presence or absence of pathology, chest X-rays were read by a third pediatrician without knowledge of the previous evaluations and final findings matching for two of them were considered for purpose of analysis. Patients with suspected pneumonia underwent serum quantitative procalcitonin (PCT) estimation. All children were followed till 7 days (±1 day) after enrolment. Parents were given reminder telephone call one day prior to the anticipated follow-up. All admitted patients were examined daily until discharge.

Management of children with pneumonia was done according to the WHO recommendations [12]. Any child with severe pneumonia was hospitalized; the treating physicians' assessment was the deciding factor in other cases.

Statistical analysis

Children with CAP (as per WHO criteria) needing hospitalization were compared to those who did not, by univariate analysis, followed by multivariate analysis using a logistic regression model; the dependent criteria was whether hospitalization occurred or not, independent covariates were the ones which emerged statistically significant in univariate analysis. The z-scores for weight for age, height for age and weight for height were calculated using the WHO Anthro software.

Results:

Hospitalization was needed in 167 (55.6%) children with pneumonia including 6 patients who were initially given ambulatory treatment and were later admitted in view of deteriorating respiratory distress. 121 (40.3%) children with pneumonia received ambulatory treatment. The baseline demo-graphic and clinical characteristics of the study population are shown in **Table I**. Amongst children with pneumonia, reportable chest X-rays were available in 160 cases (total X-rays 176).

Factors associated with hospitalization in children with pneumonia were younger age, lower weight- and height-forage z-scores, higher PCT levels, lower SpO2, and higher percentage of significant pathology in chest-X-rays as compared to those receiving ambulatory treatment (**Table II**).

On multivariate analysis, factors associated with hospitalization were SpO2 <90% in room air [OR (95%CI) 7.33(1.2-31.3); P=0.01], PCT level > 0.5 ng/mL [OR (95%CI) 7.2 (1.2-54.5); P=0.05] and low weight for height z-score [OR (95%CI) 0.9 (0.5-0.7); P = 0.01].

Table 1: Demographic and Clinical Details of Children with Community-acquired Pneumonia (N=300)

Characteristics	Values
Age, mo[a]	15 (8.36)
Boys	215 (71.6)
Weight for age z-score[a]	-1.28 (-2.4, -0.16)

Height for age z-score[a]	-1.3 (-2.2, 0.14)
Weight for height z-score[a]	-0.65 (-1.37, 0.4)
Respiratory rate /min, mean (SD)	46 (11)
Chest in drawing present	205 (48.5)
SpO_2 %, mean (SD)	95.4 (5.6)
Procalcitonin level, ng/mL(n= 12)[a]	0.1 (0.05 , 0.57)
Significant pathology in CXR (n=563)	160 (53.3)

Table 2: Factors Associated with Hospitalization in Community-acquired Pneumonia (N=300)

Characteristics	Hospitalized children (n=200)	Ambulatory treatment (n=180)
Age, mo[a]	12 (7.67)	18 (9.65)
Boys, n (%)[b]	211 (70.3)	190 (63.3)
Weight for age z-score[a]	-1.52 (-2.46, -0.22)	-0.76 (-2.11, 0.19)
Height for age z-score[a]	-1.27 (-2.62, -0.15)	-0.7 (-2.32, 0.5)
Weight for height z-score[a]	-1.08 (-2.51, 0.02)	-0.29 (-1.41, 0.61)
Significant pathology in CXR, n (%)[c]	189 (63.0)	55 (30.5)
Procalcitonin level, ng/mL[d]	0.14 (0.05, 0.54)	0.05 (0.05,0.07)
SpO_2 %, mean (SD)	93 (5.9)	95.9 (3.1)

Discussion:

The role of sex as a risk factor for CAP remains unclear, and no consensus has been reached in the literature

[13-15]. Males are more likely to develop lower respiratory tract infections. The greater resistance found in females can be explained by their enhanced Th1 immune response [14].

One systematic review suggested that like the severely malnourished children, children with moderate degrees of malnutrition may also be at increased the risk of death due to pneumonia [16-17]. Studies that evaluated the impact of moderate malnutrition are comparatively few as moderate degree of malnutrition in health facilities in developing countries is not recorded as an admission diagnosis. Notably, we found severe stunting to be associated with severe pneumonia. Stunting is established to have long-term sequels on lung development and growth and to be associated with prolonged acute course of pneumonia treatment and delay in recovery [18].

The WHO recommendations: however, do not include several parameters which have been proven to predict severity of pneumonia in under-five children more accurately [19-20]. Studies from different parts of the world have observed that hypoxic children are more likely to die than adequately oxygenated children [21-22].

It was apparent that the case–mortality rate in untreated children with pneumonia is high, sometimes reaching as high as 20%, and deaths can occur as early as 3 days after illness onset [23]. We also found that duration of illness at home for 3 days or more was significantly associated with the likelihood of disease progression to severe pneumonia. The same observation was reported from Kenya [24].

Serum PCT level > 0.5 ng/mL had a higher odd of hospitalization in our cohort of children with CAP. Multiple studies in both adults and children have shown that serum PCT is a surrogate tool to differentiate between viral and bacterial

pneumonia, and the latter has higher probability of hospitalization [25-27].

Conclusion:

Present study found SpO2 <90% at room air, serum procalcitonin level >0.5 ng/mL and lower weight for height z-score to be predictors for risk of hospitalization in under-five children presenting with community acquired pneumonia. These factors can be utilized to assess a child with CAP regarding the need of hospitalization.

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