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Original Research Article

Role of Clinical Features (Including That of Current WHO Criteria), and Oxygen Saturation (SpO_2) in the Diagnosis of Childhood (2-59 Months) Pneumonia in Northern Bihar

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Abstract

Aim: To study the role of clinical features (including that of current WHO criteria), and oxygen saturation (SpO_2) in the diagnosis of childhood pneumonia.

Material & Methods: This prospective, cohort study was conducted in Darbhanga Medical College & Hospital, Laheriasarai, Darbhanga, Bihar, India, from October 2020 to May 2021. Children aged 2-59 months with ARI (any cough and/or breathing difficulty for <2 weeks) were enrolled.

Results: A total of 1100 children with ARI were enrolled in the study. According to WHO criteria, 139 (12.6%) and 988 (89.8%) of the enrolled children had pneumonia and no pneumonia (URI), respectively. Around 68% (22/32) children had pneumonia (kappa=0.4, *P*<0.001).

Conclusion: Current WHO criteria based on rapid respiratory rate and/or chest in drawing has modest sensitivity and specificity, considering CXR abnormalities as gold standard for diagnosis of pneumonia. Addition of SpO_2 of <92% to chest in drawing alone or WHO criteria increases the probability of pneumonia diagnosis and is important in the management of a child with pneumonia.

Keywords: Acute respiratory infection, Sensitivity, Specificity.

Introduction

Community-acquired pneumonia (CAP) is a common clinical problem in childhood. [1] Bacterial pneumonia cannot be differentiated from viral pneumonia based on clinical or chest radiographic findings. [2] The use of biomarkers in clinical practice has increased substantially specially because proponents claim that biomarkers may improve the early diagnosis of infections and be available as a point-of-care tool. [3] This may allow earlier and better identification and treatment of patients with severe life-threatening infections.

The WHO and UNICEF developed integrated management of childhood

illness (IMCI) for healthcare workers at primary care facility [5] and integrated community case management (iCCM) protocol for community-level health workers (CLHWs). [6] Both IMCI and iCCM protocols enable health workers to identify children with pneumonia using clinical signs such as respiratory rate and lower chest-in drawing. [5-6] Globally, an estimated 138 million under-5 children had clinical pneumonia in 2015, and of these, 16% (22 million episodes) had chest-in drawing pneumonia. [4]

Several studies have shown the effectiveness of oral amoxicillin in treating chest-in drawing pneumonia in children 2–59 months of age. [7-10] Based on this evidence, the WHO modified the pneumonia guidelines [9] and subsequently IMCI chart booklet to recommend a 5-day course of oral amoxicillin in 2–59-month- old children with chest-in drawing pneumonia without referring them to a hospital. [11]

The WHO algorithm for pneumonia was revised in 2014, combining severe and very severe pneumonia as one category, with pneumonia being defined as fast breathing and/or lower chest in drawing (LCI). [12] However, this revised algorithm retained the signs and symptoms used in the older version for classifying severity of pneumonia in children. As per a recent systematic review, absence of cough was a significant negative predictor, while SpO_2 of ≤95 % or increased work of breathing (nasal flaring, grunting or lower chest in drawing) was significant diagnostic predictors of pneumonia. [13] Thus, this study aims to study the role of clinical features (including that of current WHO criteria), and oxygen saturation (SpO_2) in the diagnosis of childhood pneumonia.

Material & Methods:

This prospective, cohort study was conducted in Darbhanga Medical College & Hospital, Laheriasarai, Darbhanga, Bihar, India, from October 2020 to May 2021. Children aged 2-59 months with ARI (any cough and/or breathing difficulty for <2 weeks) were enrolled. Those with chronic respiratory diseases (asthma, cystic fibrosis, broncho-pulmonary dysplasia, airway anomalies), congenital heart disease, gastro-oesophageal reflux/ recurrent aspirations, immunosuppression, radiologically confirmed pneumonia in last 2 months, residing outside the study city, and who were critically ill (impending respiratory failure, cyanosis at room air, shock), were excluded. The study was initiated after clearance by the respective Ethics Committees of all five study sites. Children were enrolled after obtaining written, informed consent from parents or legal guardian.

Methodology

Details regarding clinical features, nutritional and immunization status, treatment history, demographic information, and examination findings were recorded. A staff nurse was trained to assess breathing difficulty by counting respiratory rate and identifying chest in drawing under supervision of a trained research officer. Ausculta-tory findings were also recorded. Fever was defined as an axillary temperature of ≥37.5 ºC. Tachypnea was defined and clinical diagnosis of pneumonia was made as per the WHO criteria [11]. SpO_2 was recorded using Nellcorportable pulse oximeter (measurement range 60% to 100%). As previous studies had reported an SpO_2 of <92% to indicate pneumonia with good sensitivity and specificity, we used the same cut-off in the present study [12-13]. Antipyretic was given for fever and respiratory rate was reassessed after 30 minutes. In case of wheezing, salbutamol nebulization (0.15 mg/kg/dose) was administered, and respiratory rate reassessed after 10-15 minutes.

A chest *X*-ray (CXR) was obtained in all children clinically assessed to have acute lower respiratory tract infection (ALRI/pneumonia) as per the WHO criteria. CXR was also obtained in every fifth child assessed as no pneumonia (URI) [14]. Radiographic findings were recorded in a standardized form based on previously published WHO standards and definition for epidemiological studies [15]. The digital CXR films or hard copies of CXRs were sent to the coordinating center. All CXRs were read by two independent pediatricians, who were blinded for the clinical diagnosis of patients. In case of disagreement, CXRs were read by a third pediatrician without knowledge of the previous evaluations, and findings matching with previous two were considered final. Radiographic pneumonia was diagnosed if there was agreement on presence of any abnormality (pulmonary infiltrate or pleural effusion) in two independent assessments. The site investigator managed the patient as per his interpretation based on WHO guidelines.

Statistical analysis:

For analysis, the data were entered into Microsoft excel sheet and analyzed using Stata v.14 (Stata Corp LLC) statistical software. Categorical data were analyzed by Chi-square test. For studying the association between WHO pneumonia classification and CXR findings, risk ratio (RR) with 95% confidence interval (95% CI) was calculated. Sensitivity, specificity, likelihood ratio (LR), and post-test probability were calculated. A *P* value <0.05 was taken as significant.

Results:

A total of 1100 children with ARI were enrolled in the study. According to WHO criteria, 139 (12.6%) and 988 (89.8%) of the enrolled children had pneumonia and no pneumonia (URI), respectively. Baseline demographic and clinical characteristics of the enrolled children are given in **Table 1**.

The presence of any abnormality on CXR was considered as the gold standard for diagnosis of pneumonia. Abnormalities in CXR were identified based on points published by WHO: consolidation (alveolar shadows), infiltrates (small infiltrates involving multiple segments), interstitial shadows, and pleural effusion [15]. Around 68% (22/32) children had pneumonia based on these criteria. The crude agreement between the two readers of CXR was 80.5% (kappa=0.4, *P*<0.001). As shown in **Table 2**, a chest *X*-ray showing any abnormal finding, consolidation, and alveolar infiltrates was found to be significantly associated with a pneumonia diagnosis made as per WHO criteria.

Table 1: Baseline Demographic and Clinical Characteristics of Enrolled Children (*N*=1100)

Characteristics	Value	%
Age (mo)	24 (12.3)	-
Boys [a]	665	60.45
Weight for age z-score	-0.89 (-3.71,0.62)	-
Height/Length for age z-score	-0.64 (-6.83,0.87)	-
Weight for height z-score	-0.72 (-2.62,0.77)	-
Mid upper arm circumference z-score	-2.33 (-4.12, -0.9)	-
Pneumonia	988	89.8
Cough[a]	1025	93.18
Fever[a]	598	54.36
Audible wheeze[a]	98	8.909

Fast breathing post-nebulization[a]	139	12.64
Chest indrawing [a]	3	0.273
Clinical URI [a]	985	89.55
Clinical LRTI [a]	1001	91

Table 2: Association between WHO Pneumonia Classification and Chest *X*-Ray Findings (*N*=1100)

Chest X-ray findings	Pneumonia	No pneumonia	Relative risk (95% CI)
Any abnormal finding (*n*=601)[a]	413 (68.7)	188 (31.3)	2.81 (2.12-1.2)
Consolidation (*n*=120)[a]	76 (63.3)	44 (36.7)	4.30 (1.69-5.82)
Alveolar infiltrates (*n*=442)[a]	318 (71.9)	124 (28.1)	2.43 (1.64-2.90)
Peribronchial thickening (*n*=86)	53 (61.6)	33 (38.4)	2.36 (0.93-1.09)
Interstitial thickening (*n*=32)	22 (68.7)	10 (31.2)	2.84 (0.78-2.63)
Atelectasis (*n*=3)	2 (66.6)	1 (33.4)	2.39 (0.23-15.82)

All values expressed as n (%). [a-]P<0.001. WHO: World Health Organization.

Discussion:

The World Health Organization (WHO) Integrated Management of Childhood Illness (IMCI) guidelines provide the basis for treatment recommendations for children with pneumonia in most low-resource settings [5]. The

IMCI guidelines were written for doctors, nurses, and other nonphysician clinicians working at first-level outpatient facilities in low-resource settings such as clinics, health centers, or outpatient departments of hospitals [6]. In contrast, the WHO integrated community case management guidelines were envisioned to target lay, informally trained healthcare providers, often called community health workers, who staff community-level village clinics or conduct household-level care [7].

Reliably identifying respiratory signs, whether severe or not, can be difficult, as accurate identification requires additional healthcare worker training and supervision that is not routinely available in most low-resource settings. Respiratory signs can be subtle, infrequent, and variably present, even during single patient encounters, particularly if the child is agitated with an unstable respiratory pattern. Agitated breathing is common during busy, anxiety-provoking clinical environments and can distort respiratory patterns and may lead healthcare providers to miss nonsevere or severe respiratory signs. In one study, pediatricians failed to successfully count the respirations in 16% of agitated children, compared to only 6%–8% of children who were either awake, feeding, or sleeping ($P < .01$) [16]. Investigators studying pediatric respiratory patterns at a Tanzanian outpatient clinic found an agitated state to be independently associated with a greater variation of respiratory rates over a 60-minute period of observation, concluding that respiratory examinations in busy, noisy clinics may be unreliable and can misclassify pneumonia cases [17].

In an effort to improve the clinical diagnosis of pneumonia and adding point of care test like PCT levels, we evaluated the sensitivity and specificity of some of the pertinent clinical features, and PCT levels alone or in combination. The sensitivity and specificity of the existing

WHO criteria was 56.5% and 66.2%, respectively. Adding PCT level > 0.5 ng/mL increased the specificity at the cost of sensitivity. If both existing criteria and PCT were taken as and/or criteria, the sensitivity and specificity did not change much (57.7%% and 65.9%, respectively). However, when used as part of an algorithm in adults in combination with clinical judgment in patients with LRTIs, procalcitonin has been shown to reduce unnecessary antibiotic use by about 25 to 50% without increasing morbidity or mortality [18-20]. Dudognon et al. cautioned to promote a rational implementation of PCT especially in children with community acquired pneumonia [21].

Fever, which is commonly seen in pneumonia [22-23], had a sensitivity of 85.7% and specificity of 26.6% for diagnosing pneumonia in the present study. The British Thoracic Society (BTS) Guideline mentions that, in children below 3 years, high fever along with chest indrawing and tachypnea (>50/min) is suggestive of pneumonia [23,24]. On the contrary, a systematic review showed that temperature >37.5°C was not strongly diagnostic of pneumonia [13]. Chest signs on auscultation (e.g., crackles, rales, or rhonchi) were neither sensitive nor specific for pneumonia [13].

Conclusion:

Current WHO criteria based on rapid respiratory rate and/or chest indrawing has modest sensitivity and specificity, considering CXR abnormalities as gold standard for diagnosis of pneumonia. Addition of SpO_2 of <92% to chest indrawing alone or WHO criteria increases the probability of pneumonia diagnosis and is important in the management of a child with pneumonia.

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