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Evaluation of Role of Lung Ultrasound in Childhood Pneumonia: An Institutional Based Study

S R Chauhan[1], *Ghanshyam G. Patel[2]

[1]Assistant Professor, Department of Radiology, Index Medical College Hospital & Research Centre, Indore, Madhya Pradesh, India.
[2]Assistant Professor, Department of Paediatrics, Index Medical College Hospital & Research Centre, Indore, Madhya Pradesh, India.

Abstract

Background: Pneumonia is more prevalent in early childhood than in any other age group. Numerous studies conducted over the past decade have focused on the challenges associated with the diagnosis and management of pediatric pneumonia. Hence; the present study was conducted to evaluate the role of lung ultrasound in childhood pneumonia. **Materials & Methods:** A total of 100 children with clinical symptoms of that of pneumonia were enrolled. Complete demographic and clinical details of all the patients were obtained. According to ARI control program, pneumonia was classified into pneumonia, severe pneumonia and very severe pneumonia respectively. Lung ultrasound was done, and characterization of the features was done to find correlation with severity of pneumonia. Each hemithorax was divided into three parts: anterior, lateral, and posterior. The anterior part extended from the parasternal to the anterior axillary line; the lateral part was defined as the area between the anterior and the posterior axillary line; and the area from the posterior axillary line to the paravertebral line was defined as the posterior part. Each part can be subdivided into upper and lower halves. The probe was placed perpendicular, oblique, and parallel to the rib in the anterior, lateral, and posterior thorax and every intercostal space was examined in detail. All the results were recorded and evaluated using SPSS software. **Results:** A total of 100 children were evaluated. The mean age of the children was 12.9 years. Majority proportion of children were boys. Cough, fever, tachypnea, chest indrawing, lethargy and tachycardia were seen in 100 percent, 100 percent, 97 percent, 77 percent, 39 percent and 43 percent of the children respectively. Based on ARI criteria, 12 percent, 65 percent and 23 percent of the cases were of pneumonia, severe pneumonia and very severe pneumonia respectively. Out of 12 cases of pneumonia, an abnormal ultrasound was seen in 8.33 percent of the cases. Among 65 cases of severe pneumonia and 23 cases of very severe pneumonia, 26.15 percent, and 39.13 percent of the cases showed abnormal ultrasound. **Conclusion:** Lung ultrasound had very limited utility among childhood pneumonia cases.

Key Words: Childhood, Pneumonia, Ultrasound.

INTRODUCTION

Pneumonia is more prevalent in early childhood than in any other age group. Numerous studies conducted over the past decade have focused on the challenges associated with the diagnosis and management of pediatric pneumonia, particularly in developing nations where acute respiratory infections have become the leading cause of mortality among young children. Determining the specific etiology of pneumonia in this demographic poses significant challenges due to the absence of rapid, commercially available, and accurate laboratory tests for most pathogens.[1,2] Consequently, empirical treatment is often the standard approach in many instances. Historically, children have been omitted from treatment guidelines due to the differences in the frequency and nature of underlying conditions and causative pathogens when compared to adults. In 1994, the Anti-infective Guidelines for Community-acquired Infections were released to assist primary care providers in Ontario. While a section addressing pediatric pneumonia was included, it failed to adequately represent the diverse severity and etiologies across different age groups.[3,4]

Address for correspondence*
Dr. Ghanshyam G. Patel,
Assistant Professor,
Department of Paediatrics,
Index Medical College Hospital & Research Centre,
Indore, Madhya Pradesh, India.
Email: drggpatel176@gmail.com

As previously described chest X-ray and blood cultures were not helpful in discriminating etiological categories of pneumonia. Duration of hospitalization was correlated with clinical severity essentially because WHO criteria define children with stage III pneumonia as requiring oxygen supplementation. Pain was the only clinical sign significantly associated with bacterial pneumonia. Acute-phase surrogate markers such as CRP and PCT, were significantly higher in bacterial infection regardless of the presence or absence of co-infecting viruses, corroborating several previous analyses even if these findings are controversial in recent literature.[5-7] Hence; the present study was conducted to evaluate the role of lung ultrasound in childhood pneumonia.

METHODS

A total of 100 children with clinical symptoms of that of pneumonia were enrolled. Complete demographic and clinical details of all the patients were obtained. According to ARI control program[7], pneumonia was classified into pneumonia, severe pneumonia and very severe pneumonia respectively. Lung ultrasound was done, and characterization of the features was done to find correlation with severity of pneumonia. Each hemithorax was divided into three parts: anterior, lateral, and posterior. The anterior part extended from the parasternal to the anterior axillary line; the lateral part was defined as the area between the anterior and the posterior axillary line; and the area

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RESULTS

A total of 100 children were evaluated. The mean age of the children was 12.9 years. Majority proportion of children were boys. Cough, fever, tachypnea, chest indrawing, lethargy and tachycardia were seen in 100 percent, 100 percent, 97 percent, 77 percent, 39 percent and 43 percent of the children respectively. Based on ARI criteria, 12 percent, 65 percent and 23 percent of the cases were of pneumonia, severe pneumonia and very severe pneumonia respectively. Out of 12 cases of pneumonia, an abnormal ultrasound was seen in 8.33 percent of the cases. Among 65 cases of severe pneumonia and 23 cases of very severe pneumonia, 26.15 percent, and 39.13 percent of the cases showed abnormal ultrasound.

Table 1: Clinical profile

Clinical profile	Number	Percentage
Cough	100	100
Fever	100	100
Tachypnea	97	97
Chest indrawing	77	77
Lethargy	39	39
Tachycardia	43	43

Table 2: Correlation of lung ultrasound with final diagnosis

Diagnosis	Ultrasound on admission		Total N (%)
	Normal N (%)	Abnormal N (%)	
Pneumonia	11 (91.67 %)	1 (8.33 %)	12 (100 %)
Severe pneumonia	48 (73.85 %)	17 (26.15 %)	65 (100 %)
Very severe pneumonia	14 (60.87 %)	9 (39.13 %)	23 (100 %)
Total	63 (63 %)	27 (27 %)	100 (100 %)

DISCUSSION

Community acquired pneumonia (CAP) is common in childhood. The clinical manifestations of pneumonia in neonates are often nonspecific, presenting as poor feeding, hypotonia, decreased muscle tone, lethargy, episodes of apnea, variations in body temperature (either elevated or reduced), and hypotension. In older pediatric populations, respiratory infections may be indicated by tachypnea, which can occasionally escalate to hypoxia, leading to apnea and the necessity for ventilatory assistance. The World Health Organization has established specific clinical criteria for diagnosing pneumonia, which include the presence of a cough accompanied by tachypnea. Tachypnea is operationally defined as a respiratory rate exceeding 40 breaths per minute in children aged one to five years, over 50 breaths per minute in those aged two to twelve months, and more than 60 breaths per minute in infants under two months. Adhering to the World Health Organization's guidelines yields a sensitivity range of approximately 70% to 74% and a specificity range of 40% to 70% in accurately diagnosing pneumonia as confirmed by chest radiography.[8-10] Hence; the present study was conducted to evaluate the role of lung ultrasound in childhood pneumonia.

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Shah VP et al. evaluated the effectiveness of point-of-care ultrasonography in diagnosing pneumonia among children and young adults, conducted by a team of clinicians. The study included patients ranging from birth to 21 years who were undergoing chest radiography due to suspected community-acquired pneumonia. A subgroup analysis focused on patients exhibiting lung consolidation greater than 1 cm, where sonographic air bronchograms were identified through ultrasonography. Specificity and positive likelihood ratios (LR) were calculated for cases with a lung consolidation of 1 cm or less, where air bronchograms were not detectable via chest radiography. The study comprised 200 patients, with 56.0% being male and a pneumonia prevalence of 18.0% as determined by chest radiography. The overall sensitivity of ultrasonography was found to be 86%, with a specificity of 89%, a positive LR of 7.8, and a negative LR of 0.2 for pneumonia diagnosis based on the visualization of lung consolidation and air bronchograms. In the subgroup analysis of 187 patients with lung consolidation exceeding 1 cm, ultrasonography demonstrated a sensitivity of 86%, a specificity of 97%, a positive LR of 28.2, and a negative LR of 0.1 for pneumonia diagnosis. This indicates that clinicians can effectively utilize point-of-care ultrasonography to diagnose pneumonia in pediatric and young adult populations, achieving high specificity.[11]

Kurian J et al. conducted a comparative study of chest ultrasound and chest computed tomography (CT) in pediatric patients diagnosed with complicated pneumonia and parapneumonic effusion. Among the 19 subjects, 18 exhibited effusions detectable by both imaging modalities. The assessment of effusion loculation, as well as the presence of parenchymal consolidation, necrosis, or abscess, yielded comparable results across both techniques. Notably, chest ultrasound demonstrated superior capability in visualizing fibrin strands within the effusions. Of the 14 patients who underwent video-assisted thoracoscopy, five were confirmed to have parenchymal abscess or necrosis through surgical intervention. Preoperatively, chest ultrasound identified parenchymal abscess or necrosis in four patients, while chest CT identified it in three. Both imaging methods were equally effective in detecting loculated effusion and lung necrosis, or abscess associated with complicated pneumonia. Importantly, chest CT did not reveal any additional clinically relevant information beyond what was observable with chest ultrasound.

The authors recommended that the imaging evaluation for complicated pediatric pneumonia should primarily involve chest radiography and chest ultrasound, with chest CT reserved for instances where ultrasound results are technically inadequate or inconsistent with clinical assessments.[12]

CONCLUSION

Lung ultrasound had very limited utility among childhood pneumonia cases.

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