

Study of Lower Respiratory Tract Infections in Children in a Tertiary Care Hospital

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ABSTRACT

Objective: This study was designed to evaluate the efficacy of ultrasound and chest X-ray among children with low respiratory tract infection.

Place and Duration: POF Hospital Wah Cantt from September 2020 to June 2021

Study type: Case control study

Methodology: Children diagnosed with symptoms of respiratory distress, persistent cough, prolonged fever, abnormal auscultatory findings, and acute wheezes were included. Chest X-ray of frontal view was performed in antero-posterior lie-down or posteroanterior upright view depending on the age of the patients. To avoid unnecessary radiations lateral radiographs were not performed. A chest X-ray was performed to report inflammatory infiltrate, pneumothorax, Interstitial infiltrates, and lung hyper expansion. Meanwhile, a sonography examination was performed to diagnose Small subpleural consolidations < 10 mm in diameter, Interstitial syndrome –B7 lines

Results: All the patients reported cough however, the persistent cough was reported in 11% of cases. Regarding chest, x-ray current work found consolidation in 68% along with 20% interstitial infiltrates in pneumonia cases. Patients with bronchiolitis had interstitial infiltrates in 50% of cases and lung hyper-expansion in 20% of cases.

Conclusion: Our results concluded that chest ultrasound has better sensitivity and specificity for the diagnosis of pneumonia and bronchiolitis than a chest X-ray. Ultrasound can easily detect the small consolidations and numerous B lines than chest X-ray. Hence, chest ultrasound can be used as an alternative method for diagnosing lower respiratory tract infection.

Keywords: Lower respiratory tract infection, pneumonia, bronchitis, ultrasound, Chest X-ray

INTRODUCTION

Lower respiratory tract infections are one of the leading causes of mortality and morbidity worldwide. Children under 5 years of age are more vulnerable to these infections.¹ In Egypt, health care professionals marked lower tract infection as the second leading cause of death.² These infections include bronchitis, bronchiolitis, and pneumonia which cause pediatric emergency hospitalization.³ In diagnosing a wide range of respiratory infections and imaging play a massive role in detecting and in the evaluation process.⁴ However, pediatric radiology is a complex issue. A wide range of imaging modalities is used for the timely diagnosis of different diseases found in a pediatric chest.^{5,6} These modalities also enable the early treatment and saving of the lives of pediatrics. Traditionally plain chest X-rays were widely used and still play a great role in the diagnosis of respiratory diseases.⁷ However, this procedure has several limitations for pediatrics, especially in terms of interpretation, increased medical cost, time consumption, and unnecessary radiation exposure.^{8,8} To avoid these limitations, especially radiation exposure alternative technology has to be investigated.¹⁰ Chest ultrasonography is an appealing alternative technology that can be repeated without difficulty.¹¹ Furthermore, new ultrasound devices are small, easy to handle, and less costly making ultrasound testing possible. Along with these advantages, ultrasound is cheaper than other imaging modalities in less developing countries.¹² Recent publications observed that ultrasound provided promising results in the assessment of lung parenchyma and can be easily replaced by chest radiographs.³ In the pediatric group, lower respiratory tract infections are the most common and required effective diagnostic tools. For this purpose, this study was designed to evaluate the efficacy of ultrasound and chest X-ray among children with low respiratory tract infection.

METHODOLOGY

In this case-control study, 100 children with lower respiratory tract infections were recruited aged 6 months to 6 years in POF Hospital Wah Cantt. A total of 100 healthy controls was also included during the period September 2020 to June 2021. Children diagnosed with symptoms of respiratory distress, persistent cough, prolonged

fever, abnormal auscultatory findings, and acute wheezes were included. However, cases of chronic lung diseases, congenital heart disease, and hemodynamic instability were excluded. Severe cases of the neuromuscular disease were not entertained in this work.

Guidelines provided by the American Academy of Pediatrics were used to define the clinical symptoms of bronchiolitis in children under 2 years.¹³ Patients having fever > 38.5°C with chest indrawing and a high respiratory rate were categorized under the category of pneumonia.¹⁴ Meanwhile, acute bronchitis was diagnosed when cough was associated with degrees of moist rales in both lungs or wheezing without evidence of pneumonia.¹⁵ Research was conducted after obtaining ethical approval from the research department of institute. Patient guardians were well informed about the research objectives, and procedures. Written consents were obtained from guardians and volunteer participation was encouraged. All the principles of Helsinki declarations were followed throughout the study timeframe.

Radiological Assessment: Chest X-ray of frontal view was performed in antero-posterior lie-down or posteroanterior upright view depending on the age of the patients. To avoid unnecessary radiations lateral radiographs were not performed.¹⁶ A chest X-ray was performed to report inflammatory infiltrate, pneumothorax, Interstitial infiltrates, and lung hyper expansion. Meanwhile, a sonography examination was performed to diagnose Small subpleural consolidations < 10 mm in diameter, Interstitial syndrome –B7 lines, and Alveolar-interstitial syndrome –B3 lines. Consolidation >10 mm diameter was also analyzed by performing a chest ultrasound.^{17,18} For this purpose chest was divided into three areas including the front, back, and sides to scan.

Statistical Analysis: Data were analyzed by using student software version 23.0. Student t-test and Mann Whitney test were used for continuous variables whereas qualitative variables were analyzed by using Fisher exact test or Chi-square formula. P-value was set as < 0.05 for statistical significance.

RESULTS

In this study total of 100 patients suffering from lower respiratory tract infection were recruited. In the case group 41% cases of

pneumonia, 36% of bronchiolitis, and 23% were observed. The mean age of children was observed as 34.2 ± 11.5 months. In current work, male cases were more frequent than females. The major symptoms were nasal discharge in 97% of cases, respiratory distress (65%), Bronchial breathing (15%), fever (92%), crackles and prolonged expiration in 52% of cases, and decreased air entry in 74% was observed. All the patients reported cough however, the persistent cough was reported in 11% of cases. Regarding chest,

x-ray current work found consolidation in 68% along with 20% interstitial infiltrates in pneumonia cases. Patients with bronchiolitis had interstitial infiltrates in 50% of cases and lung hyper-expansion in 20% of cases. In 82.5% of cases of bronchitis, normal X-ray findings were observed. Chest ultrasound revealed numerous B3 lines and increase B7 lines. Table 5 represents the diagnostic performance of both techniques. Lung ultrasound had more advantages over chest X-ray.

Table 1:

Variables	Control group (n=100)	Case group (n=100)	Fisher or Chi square test	p-value
Age in months	36.1 ± 13.4	34.2 ± 11.5	1.07	0.28
Sex			0.51	0.47
Females	47 (47%)	42 (42%)		
Males	53 (53%)	58 (58%)		
Fever	37.1 ± 0.22	38.12 ± 0.67	14.5	<0.001
C-reactive protein	2 (1 - 3)	12 (4.5 - 18)	11.1	<0.001
Heart rate	107.4 ± 12.5	123.6 ± 18.3	7.3	<0.001
Lymphocytes count	3.12 ± 1.47	4.87 ± 1.25	4.34	<0.001
Respiratory rate	27.89 ± 4.66	43.65 ± 13.8	10.8	<0.001
Neutrophils count	4.83 ± 1.23	6.35 ± 2.51	5.43	<0.001
Total leukocytes	7.45 ± 2.02	11.71 ± 2.40	13.5	<0.001

Table 2:

Variables	Bronchitis (n = 23)	Pneumonia (n = 41)	Bronchiolitis (n = 36)
Chest ultrasonography			
Negative lung ultrasound	18 (78%)	1 (2.5%)	3 (8%)
Consolidations > 10 mm	0 (0%)	28 (68%)	1 (3%)
Pleural effusion	0 (0%)	4 (10%)	1 (3%)
Sub-pleural consolidations	2 (8.5%)	3 (7.5%)	8 (22%)
Numerous B7 lines	3 (13%)	1 (2.5%)	9 (25%)
Numerous B3 lines	0 (0%)	4 (10%)	14 (39%)
Chest X-ray findings			
Negative chest radiography	19 (82.5%)	3 (7.5%)	8 (22%)
Consolidation, non-interstitial infiltrates	0 (0%)	28 (68%)	3 (8.5%)
Pleural effusion	0 (0%)	2 (5%)	0 (0%)
Increased interstitial markings	2 (8.5%)	8 (19.5%)	18 (50%)
Lung hyper-expansion	2 (8.5%)	0 (0%)	7 (19.5%)

Table 3:

Variables	Chest X-ray		Chest ultrasonography	
	Pneumonia	Bronchiolitis	Pneumonia	Bronchiolitis
Sensitivity	92.7%	77.8%	97.6%	91.7%
Specificity	95.6%	89.7%	95.9%	95.9%
Positive predictive value	84.4%	66.7%	88.9%	86.8%
Negative predictive value	98.1%	93.8%	99.1%	97.5%

DISCUSSION

Diagnosis of lower respiratory tract infections is based on clinical symptoms however some cases required radiological assessment. Lung ultrasound has advantages in terms of low cost, less radiation exposure, and lessened emergency stay.¹⁹ In this study, the case group reported 42% cases of consolidation, along with 31% cases of numerous B lines on lung ultrasound. However, 22% of cases of negative ultrasound were also reported in the case group. Previous studies related to lung ultrasound in the determination of lower respiratory tract infection show heterogeneity which causes hurdles in making longitudinal comparisons. A study by Buonsenso et al²⁰ explored 91% cases of consolidation in lower respiratory tract infected patients along with the 28% cases of pleural effusion and 72% of vertical deep artifacts. However, their study failed to differentiate between B3 and B7 lines. The pediatric study of Ellington et al²¹ revealed normal ultrasound findings in 36.5% of children having lower respiratory tract infection moreover they also found 16.5% cases had large while 33% cases of small consolidation were also reported. They did not comment on B3 line frequency. In developing countries, ultrasonography is one of the effective techniques to examine the patients due to low cost than the other imaging tools. Ultrasound can be easily learned by health care professionals and can be operated by a single operator.²² Due to these advantages, ultrasound is an attractive option for

clinical application in developing countries.²³ Comparing the chest X-ray and sonography results of this study researcher examined the frequent frequency of consolidation in both techniques. However, the sensitivity of consolidation was better in ultrasonography than in x-ray. To examine pediatric pneumonia ultrasound is widely used. Positive findings of pneumonia involved pleural effusion, lung consolidation, pleural line abnormalities, and confluent B lines.

In the past huge amounts of literature produced which highlights the role of ultrasound in pediatric pneumonia. In 98% of pediatric pneumonia, at least one area of consolidation was detected with positive X-rays.¹⁰ Ultrasound identified 91% of consolidations on X-ray. A study by Yadav et al²⁴ revealed 98.02% sensitivity, 64.71% specificity, 84.62 negative predictive value, and 94.29 positive predictive value for diagnosing community-acquired pneumonia. In a study by Ellington et al.,²¹ a total of 79% of pneumonia showed normal ultrasound findings. Contrastingly, the study by Biagi et al²⁵ observed positive findings in 98% of cases of parenchymal consolidation consistent with pneumonia in a chest x-ray. In the current research chest, X-rays had 96% sensitivity and 87.1% specificity in diagnosing bronchiolitis in children affected by concurrent bacterial pneumonia. In these cases, the negative predictive value was observed at 98.2% while the positive predictive value was observed at 75%. However, ultrasonography

had 83.9% specificity, 100% sensitivity, and 100% negative predictive value. Interestingly positive predictive value of ultrasonography was less than chest X-ray (71.4% vs 75%) in current research.

Comparing the results with international literature we found that Berce et al²⁶, diagnosed 76.7% of cases of pneumonia on chest X-ray while multiple consolidation and bilateral consolidations were detected on ultrasound (40.8% vs 20.8%). Similar results were found in a study by Bloise et al²⁷ in which bilateral and multiple consolidations were detected on chest X-ray. However, this study confirms that ultrasonography is better able to diagnose community-acquired pneumonia in 97% of cases with 97% sensitivity and 96% specificity. One of the systematic reviews also observed the better outcomes of ultrasonography in diagnosing pneumonia.²⁸ During the Covid, pandemic ultrasonography was used to diagnose pneumonia cases worldwide.^{29,30} In the current study bronchiolitis and interstitial infiltrate were the major findings of chest X-ray while B lines were the major findings of ultrasonography.

CONCLUSION

Our results concluded that chest ultrasound has better sensitivity and specificity for the diagnosis of pneumonia and bronchiolitis than a chest X-ray. Ultrasound can easily detect the small consolidations and numerous B lines than chest X-ray. Hence, chest ultrasound can be used as an alternative method for diagnosing lower respiratory tract infection.

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