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Document heading **doi: 10.21276/apjhs.2017.4.2.34** **Research Article**

A comparative study of x-ray chest and lung ultrasonography characteristics among community acquired pneumonia in children

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ABSTRACT

Background: Pneumonia is the leading cause of childhood morbidity and mortality worldwide. Each year, approximately 1.6 million children die from pneumonia. According to the estimates of the World Health Organization (WHO), pneumonia accounts for almost one-fifth of overall childhood mortality **Methods:** The study was conducted in Department of Paediatric Medicine, SMS Medical College, Jaipur. **Study Design:** This study is a Hospital based analytical type of observational study, **Sample size:**139 patients. **Inclusion criteria**: Children between 2 months to 18 years admitted with suspicion for pneumonia on the basis of sign and symptoms were enrolled**. Results**: Mean age of study subjects was 3.28 ± 0.62 years with median age was 1.5 years. Out of these, 48 (34.5%) were female and 91 (65.5%) were male. Majority 75(53.95%) of patients were below 5th centile of their weight for age, almost all 138 (99.23%) patients had tachypnoea on clinical examination. According to Chest X-ray findings, 97 (69.78%) patients had consolidation, 12 (8.63%) had peribronchial thickening, 7 (5.03%) had pleural effusion while 2 (1.43%) had consolidation as well as peribronchial thickening and 8 (5.75%) had both pleural effusion and consolidation. On LUS findings on day-1,43 (30.93%) patients had sub pleural lung consolidation, 44 (31.65%)had confluent B-line with consolidation. 2 (1.43%) had confluent B- Lines with pleural line abnormalities. 22 (15.82%) had consolidation with pleural line abnormalities. 21 (15.01%) had pleural effusion with consolidation while 3 (2.15%) had focal or multiple confluent B-line and only 1 (0.72%) had confluent B-line with pleural effusion. 3 (2.15%) patients had no changes in their lung ultrasound. Consolidation was reported in 130 (93.52%) patients. LUS characteristic findings reported that 97 (71.3%) patients had involvement of right lung, 26 (19.1%) patients had involvement of left lung and 13 (9.6%) had involvement of bilateral lung fields. The two characteristic findings common in chest X-ray and LUS are consolidation and pleural effusion. Consolidation was reported in LUS findings of 130 (93.53%) patients and chest X-ray findings of 107 (76.97%) patients. this difference was statistically significant. **Conclusion:** Though **c**hest radiograph (CXR) has been considered the 'gold standard for the diagnosis of pneumonia in children, Lung ultrasound (LUS) is a very easy and versatile application. It is rapid, portable, repeatable, and non-ionizing.

Key words : Bronchopneumonia, Community - acquired pneumonia (CAP),Lung ultrasound (LUS), X-ray chest

Introduction

Community - acquired pneumonia (CAP) can be clinically defined as the presence of signs and symptoms of pneumonia (such as fever of >38.5 C, cough and respiratory distress) in a previously healthy child due to an infection which has been acquired outside the hospital[1]..

Pneumonia is the leading cause of childhood morbidity and mortality worldwide. Each year, approximately 1.6 million children die from pneumonia[2].According to the estimates of the World Health Organization (WHO), pneumonia accounts for almost one-fifth of overall childhood mortality[3,4].Early diagnosis and management are critical to short- and long-term health outcomes. Despite the commonality of pneumonia in children, disagreement remains about diagnosis in both clinical and research settings[5,6].Many factors contribute to these differences, including: health

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systems resourcing, the number of possible causative micro-organisms, host and environmental factors, timing of presentation to a health service, expertise of the health service providers at various levels of the health care system, availability of diagnostic facilities and the absence of a true diagnostic gold standard[7,8].

The World Health Organization (WHO) clinical definition developed for the community setting in developing countries is based on the presence of cough and tachypnoea [9]. This definition was developed particularly with the intention of identifying children who had bacterial pneumonia and required antibiotics [10] however, while highly sensitive, this definition lacks specificity. The major reason for this is the problem of viral infections affecting airways but not lung parenchyma in children with these infections,[11] although many of these children may have co-infection particularly with *Streptococcuspneumoniae* .[12] In addition, in settings where there is a high prevalence of conditions with similar symptoms and signs like malaria and tuberculosis (TB), [13, 14], differentiating pneumonia from malaria 1 and TB (with human immunodeficiency virus) at the time of presentation may be difficult [15]. Pneumonia may also be masked in cases of severe diarrhoea and hypokalaemia [16].

Chest radiograph (CXR) has long been considered the 'gold standard for the diagnosis of pneumonia in children'. Historically, this has been largely driven by the need to identify bacterial pneumonia and hence inform the use and choice of antibiotic therapy[5].

The use of ultrasound for the evaluation of the lung is relatively recent. Lung ultrasound (LUS) is a very easy and versatile application of echography. It is rapid, portable, repeatable, and non-ionizing. The aim of this study was to define the ultrasonography appearance of pneumonia in children, and to evaluate the correlation between clinical and ultrasound findings during the course of the disease.

Materials and methods

The study was conducted in Department of Paediatric Medicine, SMS Medical College, Jaipur. This study is a Hospital based analytical type of observational study. Children between 2 months to 18 years admitted due to clinical suspicion of pneumonia on the basis of sign and symptoms were enrolled. Cases of pneumonia fulfilling the inclusion and exclusion criteria were choosers for the study. Sonography machine used HITACHI PRIESVS with probe frequency 5-18 MHz. In all patients' first lung ultrasonography examination was performed on the day of the admission, defined as day 1, then between days 3 and 6, 7 and 10, and 11 and 14. All patients were undergo a clinically - driven postero - anterior OCR on the day of the admission.

Written consent were taken from parents or attendants of all enrolled children. A predesigned and pretested structural Performa was used to collect information. Basic demographic data e.g. age, sex, caste, religion, parents name and education status, age at diagnosis, treatment was collected from all patients.

Inclusion Criteria

1. Clinical signs and symptoms suggesting pneumonia (cough, tachypnoea, crackle and or decreased breath sound, fever with or without chills, chest pain).
2. Children aged ≤ 18 years.

Exclusion Criteria

1. Unwilling parents/guardians
2. Patients with congenital heart disease and /or metabolic disorders.
3. Pre-established cases of pyrexia and cough other than pneumonia.
4. Seriously ill patients with multi organ failure.

Collecting and interpretation of data

1. Data were collected with reference to
a. Clinical examination
b. Chest X-ray and lung ultra-sonographic findings
2. After evaluation data were tabulated in appropriate manner.

Data Evaluation: Statistical analysis was done by using chi square tests.

Results

In our study a total of 139 children between 2 months to 18 years admitted with a clinical suspicion for pneumonia on the basis of sign and symptoms were enrolled. Following salient observations were made on the basis of detailed evaluation.

Table 1: Baseline characteristics of study subjects

Baseline characteristics	No (Percentage)
Patients, No. (%)	139 (100%)
Age, mean ± 95%CI,Y	3.28 ± 0.62
Median, years	1.5
Sex, No. (%)	
Female	48 (34.5%)
Male	91 (65.5%)
Weight, mean ± 95%CI, kg	12.76 ± 1.62
Median, kg	9.2
Geographical distribution, No. (%)	
Rural	72 (51.79%)
Urban	57 (41.00%)
Slum	10 (7.19%)
Religion, No. (%)	
Hindu	109 (78.41%)
Muslim	30 (21.58%)
Immunization status, No. (%)	
Complete immunization	61 (43.88%)
Partial immunization	67 (48.20%)
Unimmunized	11 (7.91%)
Previous history of hospitalization due to respiratory distress, No. (%)	
Yes	22 (15.82%)
No	117(84.17%)

Our study included 139 patients ranging from 2 months to 18 years of age. Mean age of study subjects was 3.28 ± 0.62 years with median age was 1.5 years. Out of these, 48 (34.5%) were female and 91 (65.5%) were male. The mean weight of the patients was 12.76 ± 1.62 kg and median weight was 9.2 kg. 72 (51.79%) were from rural background, 57 (41%) were from urban background and 10 (7.19%) belonged to slum areas. Out of 139 patients 109 (78.41%) were Hindu and 30 (28.51%) were Muslims. In study group, 61 (43.88%) were fully immunized, 67 (48.2%) were partially immunized and 11 (7.91%) were not immunized and. 22 (15.82%) had previous history of hospitalization due to some respiratory illness. Majority 75(53.95%) of patients were below 5th centile of their weight for age, 38 (27.33 %) patients were between 5^{th} and 25^{th} centile, 20 (14.38%) patients were between 25^{th} and 50^{th} centile, 5 (3.59%) patients were between 50^{th} and 75^{th} centile, 1 (0.72%) patient were between 75^{th} and 90th centile. There were no Patients above 90th centile. In these children cough was presenting complaint in 132 (95%), Fever in 125 (89.9%) and Chest pain in 22 (15.82%) patients.

Table 2: Distribution of patients according to their clinical signs

Respiratory findings	No. of patients (%) n=139
Tachypnoea	138 (99.23%)
Nasal flaring	133 (95.68%)
Use of accessory muscle (chest in drawing)	133 (95.68%)
Oxygen saturation <90%	12 (8.63%)
pallor	78 (56.11%)

Almost all 138 (99.23%) patients had tachypnoea on clinical examination. Nasal flaring and use of accessory muscles i.e. respiratory distress was present in 133 (95.68%) patients. 12 (8.63%) patients had an oxygen saturation of <90%. Pallor was present in 78 (56.11%) patients.

Table 3: Distribution of Patients according to auscultatory findings of lungs

Auscultation finding	No, of patients (%) N=139
Crepts	82 (58.09%)
Wheeze	18 (12.94%)
Decreased breath sounds	10 (7.19%)
Crepts + Decreased breath sounds	7 (5.03%)
Crepts + Wheeze	22 (15.82%)

Out of 139 patients, 82 (58.99%) had Crepts on auscultation. 18 (12.94%) had Wheeze, 10 (7.19%) as decreased breath sounds, 7(5.03%) had Crepts as well as decreased breath sounds and 22 (15.82%) had both crepts is and wheeze on auscultation.

Table 4: Distribution of patients according to their Total Leukocyte Count

Age group	Increased TLC according to age, No. (%)	Total number of patients (%) N=139
2 months — less than 5 years	59 (60.82%)	97
5 years — less than 10 years	24 (77.41%)	31
10 ears — 18 years	9 (81.81%)	11

(Chi-square p=0.1)
In the age group of 2 months to 5 years, 59 (60.8%) out of 97 patients had leucocytosis. In the age group of years to 10 years, 24 (77.41%) out of 31 patients had leucocytosis. In the age group of 10 years to 18 years, 9 (81.81%) out of 11 patients had leucocytosis. However, the difference between all the three groups is insignificant (p=0.1).

Table 5: Distribution of study subject according to Chest X-ray findings

Chest X-ray findings	No. of patients (%)N=139
Consolidation	97 (69.78%)
Peribronchial thickening	12 (8.63%)
Pleural effusion	7 (5.03%)
Consolidation and peribronchial thickening	2 (1.43%)
Pleural effusion and consolidation	8 (5.75%)
Normal	13 (935%)

According to Chest X-ray findings, out of 139 patients, 97 (69.78%) patients had consolidation, 12 (8.63%) had peribronchial thickening, 7 (5.03%) had pleural effusion while 2 (1.43%) had consolidation as well as peribronchial thickening and 8 (5.75%) had both pleural effusion and consolidation.
Out of 139 patients, 13 (9.35%) patients had normal chest X-ray.

Table 6: Distribution of patients according to their LUS findings on day-1

LUS characteristics	No. of patients (%)
Sub pleural lung consolidation	43 (30.93%)
Confluent B-lines + consolidation	44 (31.65%)
Confluent B-line + pleural line abnormalities	2 (1.43%)
Consolidation + pleural line abnormalities	22 (15.82%)
Pleural effusion + consolidation	21 (15.10%)
Focal or multiple confluent B-lines	3 (2.15%)
Confluent B-lines + Pleural effusion	1 (0.72%)
Normal	3 (2.15%)

Out of 139 patients, 43 (30.93%) patients had sub pleural lung consolidation, 44 (31.65%)had confluent B-line with consolidation. 2 (1.43%) had confluent B- Lines with pleural line abnormalities. 22 (15.82%) had consolidation with pleural line abnormalities. 21 (15.01%) had pleural effusion with consolidation while 3 (2.15%) had focal or multiple confluent B-line and only 1 (0.72%) had confluent B-line with pleural effusion. 3 (2.15%) patients had no changes in their lung ultrasound.

Table 7: Follow up of lung consolidation findings as reported by LUS

Maximum thickness of consolidation (mm)	No. of patients (%)				
	Day 1	Day 3 - 6	Day 7 - 10	Day 11-14	Total
Group A(<15)	57 (34.75%)	70 (42.68%)	30 (18.29%)	7 (4.26%)	164 (100%)
Group B(15-29)	66 (71.73%)	15 (16.3%)	6 (6.52%)	5 (5.43%)	92 (100%)
Group C(≥30)	7 (50%)	5 (35.71%)	2 (14.28%)	0 (0.0%)	14 (100%)
Total	130 (93.52%)	90 (64.75%)	38 (27.34%)	12(8.63%)	

Consolidation was reported in 130 (93.52%) patients out of 139 on LUS on day 1 of Presentation. On follow- up studies between day 3 to day 6 of presentation, 90 (64.75%) had consolidation, which was reduced to 38 (27.34%) on day 7 to day 10 & 12 (8.63%) on day 11 to 14. These patients were divided into three groups according to the maximum thickness of consolidation. In group A (patients having consolidation of < 15 mm), on day 1, LUS reported 57 (34.75) patients, which were increased to 70 (42.68%) patients on follow-up LUS done on day 3 — day 6 and then decreased to 30 (18.29%) patients on follow-up LUS done on day 7 — day 10 and to 7 (4.26%) patients on follow-up LUS done on day 11— day 14.

In group B (patients having consolidation of 15 — 29 mm), there were 66 (71.73%) patients on LUS done on day 1, 15 (16.3%) patients on follow-up LUS done from day 3 — day 6, 6 (6.52%) patients on follow-up LUS done on day 7 — day 10, and 5 (5.43%) patients on follow-up LUS done on day 11 to day 14.

In group C (patients having a consolidation of ≥30 mm), number of Patients steadily declined on subsequent follow-up LUS. On day 1 LUS, 7 (50%) patients were reported to be in this group, on LUS done on day 3 — day 6, 5 (35.71%) patients, 2 (41.28%) patients on day 7 --day 10 and no Patients were reported in this group on LUS done on day 11 to day 14.

According to LUS characteristics on day 1, a total of 22 patients had pleural effusion, Out of them, 13 (59.1%) had a maximum thickness of <15 mm, 8 (36.4%) patients had a thickness of 15 - 29 mm and 1 (4.5%) patient had a thickness of > 30 mm.

Table 8: Follow-up of patients according to pleural effusion as reported by LUS

Maximum thickness of effusion (mm.)	No. of patients (%)			
	Day 1	Day 3-6	Day 7-10	Day 11-14
< 15	13(59.1%)	16(84.2%)	10(90.9%)	2(66.7%)
15-29	8(36.4%)	2(10.5%)	0(0.0%)	1(33.3%)
≥ 30	1(4.5%)	1(5.3%)	1(9.1%)	0(0.0%)
Total	22(15.8%)	19(13.7%)	11(7.9%)	3(2.2%)

19 (13.7%) patients had pleural effusion on follow-up LUS done from day 3-day 6.11 (7.9%) patients had pleural effusion on follow-up LUS done from day 7-day 10.3 (2.2%) patients had pleural effusion reported by follow-up LUS on day 11- day 14.

Table 9: Follow-up characteristics of LUS in patients

LUS characteristics	No. of patients (%)			
	Day 1	Day 3-6	Day 7-10	Day 11-14
Confluent B-lines	50 (67.57%)	40(68.96%)	20(62.50%)	8 (57.14%)
Pleural line abnormalities (L-lines)	24 (32.43%)	18(31.03%)	12 (37.50%)	6 (42.86%)
Total	74 (53.24%)	58(41.73%)	32(23.02%)	14 (10.07%)

LUS on day reported confluent B-lines and pleural line abnormalities in 74 (53.24%) patients out of 139. On subsequent follow-up LUS done on 3-6 day 7-10 and day 11 – 14, 58 (41.73 %), 32 (23.02%) and 14 (10.07%) patients were reported having confluent B-line and pleural line abnormalities respectively.

LUS characteristic findings reported that 97 (71.3%) patients had involvement of right lung, 26 (19.1%) patients had involvement of left lung and 13 (9.6%) Patients had involvement of bilateral lung fields. On comparison between right and left lung involvement in LUS, the difference is statistically significant (p<0 001).

Comparison between lung ultrasound and cuest x-ray for the suggestive findings of pneumonia

Table 10: Comparison of Chest X-ray and LUS characteristic findings for the diagnostic findings of pneumonia

	USG Positive	USG negative	Total
Chest X-ray positive	126 (90.64%)	0	126 (90.64%)
Chest X-ray negative	10 (7.19%)	3 92.16 %)	13 (9.35%)
Total	136 (97.84%)	3 (2.16%)	139 (100%)

Chi-square (p=-0.01)

Among 139 patients having pneumonia, chest X-ray was suggestive of pneumonia in 126 (90.64%) patients while LUS was suggestive of pneumonia 136 97.84%) patients. This difference was statistically significant (p=0.01).

Table 11: comparison between LUS and Chest X-Ray findings suggestive of Pneumonia

Characteristics	LUS	Chest X-Ray	p-value
Consolidation	130 (93.53%0	107 (76.97%)	0.0001
Plural effusion	22 (15.83%)	15 (5.03%)	0.2

The two characteristic findings common in chest X-ray and LUS are consolidation and pleural effusion. Consolidation was reported in LUS findings of 130 (93.53%) patients and chest X-ray findings of 107 (76.97%) patients. this difference was statistically significant (p<0.001).

LUS reported pleural effusion in 22 (15.83%) patients while chest X-ray reported pleural effusion in 15 (5.03%) patients. This difference was statistically not significant (p=0.2).

Discussion

Chest radiography has been widely used for the diagnosis of pneumonia because of its convenience and ease of access. However, substantial variability in the interpretation of chest radiographs as well risk of the development of cancer after radiation exposure in early life. Some studies have focused on the use of LUS in the diagnosis and follow up of community-acquired pneumonia in adults.

In this study a total of 139 children were enrolled with a mean age of 3.28±0.62 yrs and a median age of 1.5 yrs. The study subjects involved were 48 (34.5%) females and 91 (65.5%) males. Mean weight of the study subjects was 12.76±1.62 kg and median weight was 9.2 kg. Children belong to rural background 72 (51.79%), urban 57 (41.0%) and slum background l0 (7.19%). We observed that 109 (78.41%) children were Hindu and 30 (21.58%) Muslim. Sixty one (43.9%) were fully immunized, 67 (48.2%) were partially immunized and 11 (7.91%) were immunized.

In our study we found that 75 (53.95%) patients weight were below 5^{th} centile of their weight for age. 38 (27.33%) Patients were between 5^{th} and 25^{th} Centile, 20 (14.38%) Patients were between 25^{th} and 50^{th} centile between 50^{th} and 75^{th} centile were 5(3.59%) and 1(0.72%) patient were between 75^{th} and 90^{th} centile weight for age. There were no patients above 90^{th} centile. We found that 54% of CAP were malnourished.

Rudan et al. (2008) analysed the 28 community based longitudinal studies done in developing countries that were published between 1969 and 1999 and concluded that malnutrition (weight for age <-2 SD) and LBW (≤2.5 kg) is a definitive risk factor for pneumonia(17).*Salih et al*. (2012) studied role of chest radiography in diagnosis of pneumonia in 150 subjects aged 1-59 months and found malnutrition in 41.4% cases of pneumonia(18). Findings of these studies were quite similar with our observations.

In our study, presenting complaints were cough in 132 (95%), fever in 125 (89.9%) and chest pain in 22 (15.82%) children. *Juven et al*. (2000) studied aetiology of community-acquired pneumonia in 254 hospitalized children and observed that 76.0% had cough, 96.0 % had fever and 10.0% had chest pain(19). Observation of our study is consistent with that of *Shah et al*. (2013) who studied 209 patients from 0 – 21 years having clinical suspicion of community -acquired pneumonia and found that among the study subjects cough was in 81.8% and 73% patients had a history of fever[20].In our study on clinical examination out of 139 study subjects tachypnoea in 138 (99.23%), respiratory distress in 133 (95.68%).Observed oxygen saturation of < 90% in 12 (8.63%), and pallor in 78 (56.11%) patients. Similarly *Juven et al*. (2000) found tachypnoeic was present in 51.0%[19].

Elina Lahti et al. (2008) observed that 36.0% had tachypnoea , they observed oxygen saturation of < 90% in 4.0%(19) while *Shah et al.* (2013) studied 209 patients from 0-21 years having clinical suspicion of community acquired pneumonia 26.0% had tachypnoea.[20]Difference in our observations might be because of the fact we selected subject only on clinical ground.

In our study group signs on auscultation i.e. Crepts, wheeze, decreased breath sounds, crepts as well as decreased breath sounds and both crepts and wheeze in 82 (58.99%), 18 (12.94), 10 (7'19%), 7 (5.03%), and 22 (15.82%) respectively. Similarly *Juven et al*. (2000) observed crackles in 24.0.0%, wheeze in 20.0 %, and decreased breath sound was present in 15.0%.[19]*LimaLahti et al*. (2008) observed crackles in 19.0%, decreased breath sound in 27.0 %.[21].

According to the leukocyte count, we divided the patients in three groups as 2 months to 5 years, 5 to 10 years and 10 to 18 years. We observed thatleucocytosis in group of 2 months to 5 years, 5 to 10 years and 10 to 18 years 59 (60.8%) out of 97, in 24 (77.41%) out of 31 and in 9 (81.81%) out of 11 patients respectively.. However, the difference between all the three groups is insignificant (p=0. 1).

Chest X-ray findings observed in our study were consolidation in97 (69.78%) patients, peribronchial thickening in 12 (8.63%), pleural effusion 7 (5.03%), while consolidation as well as peribronchial thickening in 2 (1.43%) and had both pleural effusion and consolidation in 8 (5.75%). Out of 139 patients CXR was normal in 13 (9.35%) patients. Similarly *Caiulo et al*. (2012) describe the CXR and ultra-sonographic appearance of CAP at presentation and during the follow-up. A final diagnosis of pneumonia was confirmed in 89/102 patients. In CXR they found consolidation in 73/89(82.02%), peribronchial thickening in 8/89(8.98%), had pleural effusion in 3/89(3.37%) and normal x-ray in 8/89(8.98%). [22]

In our study out of 139 patients on LUS shows sub pleural lung consolidation in 43 (30.93%), confluent B-lines with consolidation in 44 (31.65%), confluent B-lines with pleural line abnormalities in 2 (1.43%), consolidation with pleural line abnormalities in 22 (15.82%), pleural effusion with consolidation in 21 (15.10%), focal or multiple confluent B-lines in 3 (2.15%) and confluent B-lines with pleural effusion in 1 (0.72%). No changes on their lung ultrasound in 3 (2.15%).

Caiulo et al. (2012) found only consolidation in 13/89(14.60%), consolidation With B-lines in 55/89(61.79), only B-line in 3/89(3.37%) and normal LUS in 12%). Pleural line abnormalities and pleural effusion were always associated with areas of confluent B-line and/ or lung consolidations. [22] These finding were consistent with our study.

In our study LUS observed consolidation in day one, on follow-up or during stay between day 3-6, 7-10, and 11-14 of illness in 130 (either absolute consolidation and/ or with other findings) (93.52%), 90 (64.75%), 38 (2734%) and 12(8.63%) patients respectively.

Observations are further analysed and divided into three groups according to the maximum thickness of consolidation in Group A, Group B and Group C as < 15 mm, 15 - 29 mm, and ≥30 mm respectively.

Group A included patients having consolidation of <15 mm. In this group, LUS reported consolidation on day 1, day 3 - day 6, day 7 - day 10, and day 11-day 14 in 57 (34.75%) , 70 (42.68%) (This increase in number is due to group B patient falls in this category after 3-4 day treatment), 30 (18.29 %) and 7 (4.26%) patients respectively.

Group B included patients having consolidation of 15-29 mm. In this group, LUS reported consolidation on day 1, day 3 - day 6, day 7 day 10, and day 11-day 14 in 66 (71.73%), 15(16 3%), 6 (6.52%) and 5 (5.43%) patient respectively.

Group C include patients having a consolidation of ≥30 mm. Number of patients in this group steadily declined on subsequent follow-up LUS. In this group, LUS reported consolidation on day 1 day 3-day 6, day 7, day 10, and day 11- day 14 in 7(50.0 %), 5(35.71%), 2(14.2%) and 0 patients respectively.

Meng-ChiehHo et al. (2014) studied usefulness of LUS in the diagnosis of CAP in Children. LUS follow up was also performed on 23 patients Day 1, Days 3 to 5, and Days 7 to 14. The results showed the decreasing size of the pneumonia patch from 10.9± 8.7 cm^2 to 5.5 ±4.8 cm^2 and finally to 2± 1.9 cm^2. This study also shows gradual decline in size of consolidation as in our results [23].

According to their LUS characteristics out of 130 patients consolidation thickness < 15 mm in 57 (43.84%) between 15 - 29 mm in 66 (50.76%), while ≥30 mm only in 7 (5.38%) as reported on day one. The size of consolidation ranges from 5-48 ram with the average 16.72 mm. *Caiulo et al*. (2012) studied LUS Characteristics of Community-Acquired Pneumonia in Hospitalized Children found lung consolidation of mean size 18 mm (range 6-48mm). Our study findings also were similar. [22] In our study in seven patient initially there is increase in size of consolidation then gradual decrease in size of consolidation due change in antibiotics. In our study according to LUS characteristic on day 1, a total of 22 patients had pleural effusion. Out of them, maximum thickness was < 15 mm in 13(59.1%), between 15-29 mm in 8 (36.4%) and ≥30 mm in 1(4.5 %).One thirty nine patients underwent LUS and pleural effusion observed on day 1, between day 3-6, 7-10 and 11-14 in 22 (15.8%), 19 (13.7%), 11(7.9%) patients respectively. *Reissig et al*. (2012) the aim of this prospective, multicentre study was to define the accuracy of lung ultrasound (LUS) in the diagnosis of acquired pneumonia (CAP).Three hundred sixty-two patients community with suspected CAP were enrolled in 14 European centres. During follow-up decreased pleural effusion from 50ml to 0 ml[24]

We also observed decline in size and number of patient during follow up.

In our study LUS 011 day 1 reported confluent B-lines and pleural line abnormalities in 74 (53.24%) patients out of 139. on subsequent follow-up done on day 3 — 6, day 7 - 10 and day 11-14, 58 (41.73%), 32 (23.(02%) and 14 (10.07%) patients were reported having confluent B-lines and pleural line abnormalities respectively.

Cauilo et al. (2012). Studied the CXR and ultra-sonographic appearance of CAP at presentation and during the follow-up and observed B-line in 59 patient which disappear in follow up and also there were disappearance of pleural line abnormalities in follow up.[22]Our study shows observation as above study.

In our study LUS characteristic findings on right side in lung 97 (713%), left lung side in 26 (19.10%) and bilateral lung fields in 13(9.6%). On comparison between right and left lung involvement in LUS, the difference is statistically significant (p<0.001).

MengchiehoHo et al. (2014) retrospective study usefulness of lung ultrasound in the diagnosis of CAP in children, observed that characteristic location on right side in 59.5%, left side in 30.2% and on both side in 10.1%. [23] Our findings are similar to above study.

In our study among 139 patients having pneumonia, chest X-ray was suggestive of pneumonia in 126 (90.64%) patients while LUS was suggestive of pneumonia in 136(97.84%) patients with sensitivity 97.84% and specificity 100%. This difference was statistically significant (p=0.01).

Caitilo et al. (2012) studied the CXR and ultra-sonographic appearance of CAP at presentation and during the follow-up. 89 patients of CAP chest X- ray detected pneumonia in 81/89(91.01%) while LUS detected pneumonia in 88/89(98.87%)[22].

MengchieHo et al. (2014) retrospective study usefulness of lung ultrasound in the diagnosis of CAP in children, observed that chest X-ray detected pneumonia in 152(93.3%) and LUS detect detected pneumonia in 159(97.5%). [23]

Reissing et al. (2012) reported first prospective study in adults for the diagnosis of community acquired pneumonia using LUS and revealed a sensitivity of 93.4%, specificity of 97.7% [24].

These studies show sensitivity and specificity similar to our observations.

In our study the two characteristic findings common in chest X-ray and LUS consolidation and pleural effusion. Consolidation was reported in LUS findings of 130 (93.53%) patients and chest X-ray findings of 107 (76.97%) patients. This difference was statistically significant (p<0.001). LUS reported pleural effusion in 22 (15.83%) patients while chest X-ray reported pleural effusion in 15 (5.03%) patients. This difference was statistically not significant (p=0.2).*Mengchieho et al*. (2014) studied the usefulness of lung ultrasound in the diagnosis of CAP in children, and found pleural effusion in 28.5% in LUS. [23]

Conclusion

Our study showed a high detection rate for LUS in identifying pneumonia in children. It also proved to be a promising tool for the follow up of patients with pneumonia. Patients can receive more frequent follow up using LUS during treatment and more information can be made available to paediatricians for decision-making. We suggest that LUS can be complementary tool to chest radiography in the diagnosis of pneumonia in children and follow up of these patients by LUS can prevent or reduce the exposure to ionizing radiations.

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Ethical approval

This study was an observational study. The investigations required were a part of routine management of illness. No change was made in usual management of subjects under study, informed consent was taken from the patients who were enrolled for study. In case of refusal of consent, subjects continue to receive the standard treatment as per protocol.

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