The Egyptian Journal of Hospital Medicine (October 2018) Vol. 73 (5), Page 6753-6762

Diagnostic Performance of Point of Care Ultrasonography in Identifying Etiology of Respiratory Distress in Neonates

Hany Abdul-Hady El-Khaleegy, *Elsayed Mohamed Abd El-Hamid Hassan, Hoda Abd El Hareth Ibrahim Shehata*

Department of Pediatrics, and Department of Radiology, New Damietta Faculty of Medicine, Al-Azhar University, Damietta, Egypt

Corresponding author: **Hany Abdul-Hady El-Khaleegy,** Email: hodaabdelhareth@gmail.com

Abstract

Background: Numerous studies have shown the role of lung ultrasound in identifying etiology of respiratory distress in neonates. **Aim of the Work:** was to detect the efficacy of ultrasonography versus x-ray in identifying the etiology of respiratory distress in neonates. **Patients and Methods:** A cross sectional study that includes 50 neonates with respiratory distress. Each included subject was submitted to history taking, complete clinical examination and laboratory investigations including complete blood count and chest radiograph & US images. **Results:** In the present work, there was no significant difference among sex distribution and mode of delivery but male sex and cesarean sections are the predominant in each group. The reasons for respiratory distress from the clinical diagnosis were respiratory distress syndrome (n = 22), transient tachypnea of newborn (n = 23) and pneumonia (n = 5). The chest radiograph diagnosis of respiratory distress was RDS in 22 neonates, transient tachypnea of newborn in 24 neonates, pneumonia in 2 neonates and RDS or pneumonia in 2 neonates. Overall from the clinical scenario and radiological findings, the final diagnosis was RDS in 24 neonates, TTN in 24 neonates and pneumonia in 2 neonates. The ultrasound diagnosis of respiratory distress was RDS in 24 neonates, TTN in 24 neonates and pneumonia in 2 neonates. **Conclusion:** This study shows a clear superiority of lung ultrasound over the chest x-rays for the diagnosis of RDS, TTN and pneumonia. Chest Ultrasound cannot replace standard chest X-ray in detecting severity of neonatal RDS because of its tendency to overestimate RDS.

Key words: Point of care ultrasonography, chest x-ray, RDS, TTN, pneumonia

INTRODUCTION:

Respiratory distress is one of the most common reasons of admission to the neonatal intensive care unit. Fifteen percent of term infants and 29% of late preterm [(1)]. Respiratory distress in the newborn is recognized as one or more signs of increased work of breathing, such as tachypnea, nasal flaring, chest retractions, or grunting. If the newborn cannot sustain the extra work of breathing to meet its respiratory needs, respiratory failure follows. This failure may manifest as impaired oxygenation (cyanosis) or ventilation (respiratory acidosis) [(2)]. Transient tachypnea of newborn (TTN), respiratory distress syndrome (RDS) and Pneumonia are the most common etiologies of respiratory distress in newborn. Due to their similar clinical presentations, it is often difficult to differentiate one from the other [(3)]. RDS is the most common cause of respiratory distress in newborn. It occurs almost primarily in preterm infants and its incidence inversely proportional to gestational age and birth weight. It occurs due to deficiency, inactivation or dysfunction of pulmonary surfactant [(4)]. It occurs in 60-80% of infants less than 28 week of gestational age, in 15-30% of those between 32 and 36 weeks, in about 5% beyond 37 weeks, and rarely at term [(5)]. Transient tachypnea of the newborn (TTN) is a parenchymal lung disorder characterized by pulmonary edema resulting from delayed resorption and clearance of fetal alveolar fluid [(6)]. Neonatal pneumonia is a serious respiratory infectious disease caused by a variety of microorganisms, Group B Streptococcus accounts for most cases. Reported frequencies of neonatal pneumonia range from 1 to 35 %, the most commonly **quoted** figures being 1 percent for term infants and 10 percent for preterm infants [(7)]. Radiographs are considered gold standard in understanding the etiology of RD in newborns. However excess exposure to radiation in a growing neonate in early part of life may have long term consequences. So there is a need for a non-invasive, bedside test, more baby friendly, and even if repeated multiple times is safe for the newborn. ultrasound chest appears to be the ideal choice diagnostic tool in etiology of respiratory distress in newborn [(3)]. Point-of-care ultrasound refers to the use of

Received: 11/9/2018
Accepted: 21/9/2018

portable ultrasonography at a patient's bedside for diagnostic purposes which has the following characteristics: a well-defined purpose linked to improving patient outcomes, focused and goal-directed, findings are easily recognizable, easily learned, quickly performed and performed at the patient's bedside [8].

The aim of this study was to detect the efficacy of use of point of care ultrasonography versus x-ray imaging in identifying the etiology of respiratory distress in neonates.

PATIENTS AND METHODS:

This cross-sectional study included a total of 50 neonates with respiratory distress as defined by tachypnea (RR >60/min), retractions and/or grunting recruited from NICU Department, Al-Azhar University Hospitals, New Damietta. Approval of the ethical committee and a written informed consent from all the subject parents were obtained. This study was conducted between August 2017 to April 2018 in two days' work per week, according to the circumstances of each unit and presence of suitable patients with accepted inclusion criteria.

Inclusion criteria: Age: less than 24 hours, both sexes, all neonates with respiratory distress as defined by tachypnea (RR >60/min), retractions and/or grunting were considered eligible for the study and a neonate was included if he/she underwent x-ray chest and ultrasound (PoC-USG) within 4 h of admission to NICU.

Exclusion criteria: Other causes of RD e.g. CNS as hydrocephalus, CVS as congenital heart disease and respiratory system other than RDS, TTN and pneumonia, Apparent signs suggesting chromosomal abnormalities and major malformations and prenatal asphyxia.

Studied neonates were classified depending on gold standard diagnosis (X-ray and clinical) into three groups; group1:RDS, group2: TTN and group3: pneumonia.

Criteria (clinical and X-ray) for diagnosing different groups of respiratory distress:

Group 1 (RDS):

Clinical course: Onset of RD within the first few hours of life, gestation less than 34 weeks and progressive RD.

-Mild: Down score and Silverman Anderson score 3-6

-Severe: Down score and Silverman Anderson score ≥6

X-ray:

- Mild RDS: hypovolemic lung reticulogranular mottling or without air bronchograms.

-Severe RDS: bilateral confluent opacification of lungs.

Group 2 (TTN):

Clinical course: Respiratory distress onset at birth and progressively decreasing with time.

X-ray: prominent peri-hilar vascular markings, edema of the inter-lobar septae, fluid in the fissures and hyperinflation.

Group 3 (Pneumonia):

Clinical course: onset of respiratory distress soon after birth and presence of risk factors such as PPROM, maternal fever, foul smelling liquor and UTI in the mother.

X-ray: patchy or asymmetrical opacities.

LUS criteria for each group:

Group1(RDS):

-Mild RDS: lung consolidation limited to subpleural region with or without air bronchogram, associated with pleural line abnormalities (coarse thickened pleural line).

-Severe RDS: expanded lung consolidation with obvious airbronchogram, associated with pleural line abnormalities.

Group 2 (TTN):

• Normal pleural line.

• presence of predominant B-lines, which can be very compact B-lines in the inferior pulmonary fields and less compact B-lines in the superior fields (double lung point) in both lungs, or bilateral presence of numerous non-compact B-lines indicating interstitial engorgement.

Group 3 (Pneumonia):

Lung consolidation showing sub-pleural echo poor or tissue like region with blurred margins or wedge-shaped borders with sonographic air bronchograms which are hyperechoic linear elements representing air in bronchioles that appear within the hypoechoic consolidated lung.

The radiologist was interpreting the chest radiograph and USG images independently & was blinded to patient details.

Each enrolled neonate in this study was subjected to the following:

1. **Full history taking**: Full maternal history was taken including: age, parity, gravidity, and previous abortions, still births, neonatal deaths, and acute and/or chronic

medical problems. Detailed perinatal history was obtained including antenatal history, drug intake, antepartum hemorrhage, premature rupture of membranes, duration of labor, mode of delivery, Apgar score at 1&5 minutes as well as methods and duration of resuscitation. Family history: Consanguinity and similar conditions in other siblings.

2. **Thorough clinical examination**: Neurological, chest, cardiac and abdominal examination. Measurements including weight, length, head circumference and abdominal circumference. Assessment of the gestational age using New Ballard Score. Assessment of severity of RD by using Down score and Silverman Anderson score. Vital signs: temperature, pulse, respiratory rate and blood pressure.
3. **Investigations**

A. *Laboratory: CBC & CRP*

B. *Radiological*:

- Chest X-ray.
- Ultrasound chest

Ultrasound chest (USG) and chest x-ray (CXR) were done within a maximum gap of not more than 4 h between them. Chest x-ray was taken in antero-posterior (AP) view and digitalized. If surfactant was given, it was always after obtaining a CXR and an ultrasound chest. Reading of the radiograph for immediate management was done by the treating neonatologist. Final interpretation of CXR was done by the radiologist for the study purpose who was blinded to the patient details.

Ultrasound chest was performed by the research associate using a linear probe of frequency 7.5MHz and transthoracic approach. The transthoracic approach included the sequence of views (anterior chest in vertical and transverse views, mid-axillary vertical and transverse views) recorded from both right and left sides of the chest.

Statistical analysis of data:

Data were fed to the computer and analyzed using IBM SPSS (statistical package for social science) software package version 20.0**.** **(**Armonk, NY: IBM Corp**).** Qualitative data were described using number and percent. The Kolmogorov-Smirnov test was used to verify the normality of distribution Quantitative data were described using range (minimum and maximum), mean, standard deviation and median. Significance of the obtained results was judged at the 5% level.

The used tests were Chi-square test: For categorical variables, to compare between different groups, **Monte Carlo correction**: Correction for chi-square when more than 20% of the cells have expected count less than 5, **F-test (ANOVA)**: For normally distributed quantitative variables, to compare between more than two groups, and Post Hoc test (Tukey) (LSD) for pairwise comparisons and **Kruskal Wallis test**: For abnormally distributed quantitative variables, to compare between more than two studied groups, and Post Hoc (Dunn's multiple comparisons test) for pairwise comparisons.

RESULTS

In the present work, there was no significant difference among sex distribution and mode of delivery but male sex and cesarean sections are the predominant in each group. The reasons for respiratory distress from the clinical diagnosis were respiratory distress syndrome (n = 22), transient tachypnea of newborn (n = 23) and pneumonia (n = 5). The chest radiograph diagnosis of respiratory distress was RDS in 22 neonates, transient tachypnea of newborn in 24 neonates, pneumonia in 2 neonates and RDS or pneumonia in 2 neonates. Overall from the clinical scenario and radiological findings, the final diagnosis was RDS in 24 neonates, TTN in 24 neonates and pneumonia in 2 neonates. The ultrasound diagnosis of respiratory distress was RDS in 24 neonates, TTN in 24 neonates and pneumonia in 2 neonates.

The results of this study were demonstrated in tables from (1) to (12).

Table (1): Comparison between the different studied groups according to demographic data

	Total (n= 50)		Final diagnosis						Test of sig.	p
			RDS (n= 24)		TTN (n= 24)		pneumonia (n= 2)			
	No.	%	No.	%	No.	%	No.	%		
Sex										
Male	38	76.0	18	75.0	19	79.2	1	50.0	χ^2=1.314	^{MC}p= 0.602
Female	12	24.0	6	25.0	5	20.8	1	50.0		
Gestation age (weeks)										
Min. – Max.	27.0 – 41.0		27.0 – 34.0		38.0 – 40.0		39.0 – 39.0			
Mean ± SD.	35.32 ± 4.56		31.29 ± 3.32		39.04 ± 0.86		39.0 ± 0.0		F=65.208	<0.001*
Median	38.0		31.0		39.0		39.0			
Sig.bet.Grps			p_1<0.001*,p_2<0.001*,p_3=1.000							

The table showed that the studied neonates were 76% male and 24% females with a mean gestational age 35.32 wks. *Group 1 (RDS):* 75% male and 25% females with a mean gestational age 31.29 wks. *Group 2 (TTN):* 79.2% male and 20.8% females with a mean gestational age 39.04 wks. *Group 3 (Pneumonia):* 50% male and 50% females with a mean gestational age 39wks.

Table (2): Comparison between the different studied groups according to weight

	Total (n= 50)	Final diagnosis			F	p
		RDS (n= 24)	TTN (n= 24)	pneumonia (n= 2)		
Weight (kg)						
Min. – Max.	1.08 – 3.80	1.08 – 2.90	2.50 – 3.80	2.80 – 3.0		
Mean ± SD.	2.36 ± 0.72	1.74 ± 0.53	2.92 ± 0.28	2.90 ± 0.14	49.091*	<0.001*
Median	2.60	1.90	2.90	2.90		
Sig. bet. Grps		p_1<0.001*,p_2=0.001*,p_3=0.997				

The table showed that the weight of studied neonates ranged between 1.08kg and 3.80kg with a mean weight of 2.36kg. There is no significant difference between group2 and group3 but group1(RDS) is significant lower in weight than other groups.

Table (3): Comparison between the different studied groups according to obstetric history and mode of delivery

	Total (n= 50)		Final diagnosis						χ^2	^{MC}p
			RDS (n= 24)		TTN (n= 24)		Neonatal pneumonia (n= 2)			
	No.	%	No.	%	No.	%	No.	%		
Obstetric history										
PROM	10	20.0	8	33.3	1	4.2	1	5.0		
UTI	1	2.0	0	0.0	0	0.0	1	50.0		
Pre-eclampsia	3	6.0	3	12.5	0	0.0	0	0.0	21.197*	<0.001*
Irrelevant	36	72.0	13	54.4	23	95.8	0	0.0		
Mode of delivery										
Cesarean	37	74.0	19	79.2	17	70.8	1	50.0	1.463	0.461
Vaginal	13	26.0	5	20.8	7	29.2	1	50.0		

This table revealed that no significant difference between three groups as regard mode in delivery but cesarean is the predominant mode of delivery in studied cases. Also revealed that significant difference between three groups as regard obstetric history as PROM in 20%, UTI in 2%, pre-eclampsia in 6% and irrelevant in 72% from all studied groups.

Table (4): Diagnosis of the studied cases according to clinical, x ray and US (n= 50)

	RDS		TTN		Pneumonia		Pneumonia or RDS	
	No.	%	No.	%	No.	%	No.	%
Clinical diagnosis	22	44.0	23	46.0	5	10.0	0	0.0
X ray diagnosis	22	44.0	24	48.0	2	4.0	2	4.0
US diagnosis	24	48.0	24	48.0	2	4.0	0	0.0
Final diagnosis	24	48.0	24	48.0	2	4.0	0	0.0

The table showed that the reasons for RD were from:

- clinical diagnosis of RDS 44%, TTN 46% and Pneumonia 10%.

- chest radiograph diagnosis of RDS in 48%, TTN in 44%, Pneumonia 4% and RDS or pneumonia in 4% infant.
-The ultrasound diagnosis of RDS in 48%, TTNB in 48% and Pneumonia in 4%. Overall from the clinical scenario and radiological findings, the final diagnosis was RDS in 48%, TTNB in 48% and pneumonia in 4%.

Table (5): Distribution of the studied cases according to x ray (n= 50)

X ray	No.	%
RDS		
Low volume	22	91.7
Reticulogranular opacity	14	58.3
White lung	8	33.3
Air bronchogram	15	62.5
TTN		
Hyper inflated	19	79.2
Fluid in fissures	8	33.3
Prominent interstitial or peri hilar markings	15	62.5
Neonatal pneumonia		
Hyper inflated	1	50.0
Diffuse opacity	1	50.0
Lobar opacity	1	50.0
Air bronchogram	1	50.0

The table showed chest radiography findings in each group:

Group 1 (RDS): Low lung volume in 91.7%, Reticulogranular opacity in 58.3%, White lung in 33.3% and air bronchogram in 62.5% from all cases of group1.

Group 2 (TTN)*:* Hyper inflated in 79.2%, Fluid in fissures in 33.3% and prominent interstitial or peri hilar markings in 62.5% from all cases of group 2.

Group 3 (Pneumonia): Hyper inflated in 50%, Diffuse opacity in 50%, Lobar opacity in 50% and air bronchogram in 50% from all cases of group3.

Table (6): Distribution of the studied cases according to ultrasound findings (n= 50)

Ultrasound	No.	%
RDS		
Pleural lines abnormalities	24	100.0
Absent A lines	22	91.7
Alveolar-interstitial syndrome	10	41.7
Regular sub pleural consolidation	11	45.8
Regular expanded consolidation	13	54.2
Air bronchogram	16	66.7
TTN		
Absent A lines	9	37.5
Predominant B lines	24	100.0
Double lung point	15	62.5
Alveolointerstial syndrome	1	4.2
Neonatal pneumonia		
Pleural lines abnormalities	2	100.0
Alveolar-interstitial syndrome	1	50.0
Irregular subpleural consolidation	2	100.0
Air bronchogram	2	100.0

The table showed chest ultrasound findings in each group:

Group 1 (RDS): Pleural lines abnormalities in 100%, Absent A lines in 91.7%, Alveolar-interstitial syndrome in 41.7%, Regular sub pleural consolidation in 45.8%, Regular expanded consolidation in 54.2% and
air bronchogram in 66.7% from all cases of group1.

Group 2 (TTN)*:* Absent A lines in 37.5%, Predominant B lines in 100%, Double lung point in62.6% and alveolar-interstitial syndrome in 4.2% from all cases of group2.

Group 3 (Pneumonia): Pleural lines abnormalities in 100%, Alveolar-interstitial syndrome in 50%, Irregular subpleural consolidation in 100% and air bronchogram in 100% from all cases of group3.

Table (7): The sensitivity and specificity of lung consolidation in diagnosing RDS

Lung consolidation*	RDS	Others**	Total	Sensitivity ((a/a+c)	Specificity (d/b+d)
Present	24 (a)	0 (b)	24 (a+b)	100%	100%
Not present	0 (c)	26 (d)	26 (c+d)	-	-
Total	24 (a+c)	26 (b+d)	50 (a+b+c+d)	-	-

*with regular margins **other groups (TTN& pneumonia)

This table demonstrated that the sensitivity and specificity of lung consolidation with regular margins in diagnosing RDS are 100%.

Table (8): The sensitivity and specificity of AIS in diagnosing RDS

AIS*	RDS	Others**	Total	Sensitivity (a/a+c)	Specificity (d/b+d)
Present	10 (a)	2 (b)	12 (a+b)	41.7%	91.3%
Not present	14 (c)	24 (d)	38 (c+d)	-	-
Total	24 (a+c)	26 (b+d)	50 (a+b+c+d)	-	-

*alveolar-interstitial syndrome

**other groups (TTN& pneumonia)

This table demonstrated that the sensitivity and specificity of AIS in diagnosing RDS are 41.7% & 91.3% respectively.

Table (9): The sensitivity and specificity of predominant B lines in diagnosing TTN

Predominant B lines	TTN	Others*	Total	Sensitivity (a/a+c)	Specificity (d/b+d)
Present	24 (a)	0 (b)	24 (a+b)	100%	100%
Not present	0 (c)	26 (d)	26 (c+d)	-	-
Total	24 (a+c)	26 (b+d)	50 (a+b+c+d)	-	-

*other groups (RDS& pneumonia)

This table demonstrated that the sensitivity and specificity of predominant B lines in diagnosing TTN are 100%.

Table (10): The sensitivity and specificity of DLP in diagnosing TTN

DLP*	TTN	Others**	Total	Sensitivity (a/a+c)	Specificity (d/b+d)
Present	15(a)	0 (b)	15 (a+b)	62.5%	100%
Not present	9 (c)	26 (d)	35 (c+d)	-	-
Total	24 (a+c)	26 (b+d)	50 (a+b+c+d)	-	-

*double lung point

**other groups (RDS& pneumonia)

This table demonstrated that the sensitivity and specificity of DLP in diagnosing TTN are 62.5% & 100% respectively.

Table (11): The sensitivity and specificity of lung consolidation in diagnosing pneumonia

Lung consolidation*	pneumonia	Others**	Total	Sensitivity (a/a+c)	Specificity (d/b+d)
Present	2 (a)	0 (b)	24 (a+b)	100%	100%
Not present	0 (c)	26 (d)	26 (c+d)	-	-
Total	2 (a+c)	26 (b+d)	50 (a+b+c+d)	-	-

*with irregular margins

**other groups (RDS&TTN)

This table demonstrated that the sensitivity and specificity of lung consolidation with irregular margins in diagnosing pneumonia are 100%.

Table (12): correlation between clinical, CXR and US in diagnosis of mild and severe RDS group (n=24)

	Clinical	CXR	US

	Score*		
Mild	16 (57.7%) 3-6	16 (57.7%)	11 (42.3%)
Severe	8 (38.1%) ≥6	8 (38.1%)	13 (61.9%)

*Down score, Silverman Anderson score

This table revealed good correlation between CXR and clinical classification of RDS severity, while US exaggerate the condition in 5 cases and considered them as severe RDS.

DISCUSSION

In recent years, *LUS* has strengthened its role in the evaluation of many neonatal diseases including RDS, TTN and congenital pneumonia [9]**.** This supported by the fact that neonates have a thinner thoracic wall and smaller width of the thorax and lung volume, which enables a better image quality and visualization of almost the entire surface of the lungs when compared to the adult population [10]**.** Chest ultrasonography has emerged in recent years as a very promising technique for the high sensibility in the detection of different lung and pleural pathological states [11]**.** The present study was designed to determine the diagnostic test performance of point of care ultrasonography for the etiology of RD in neonates when combination of radiological and clinical criteria is considered as the gold standard for etiological diagnosis to decrease the use of x-ray and its hazardous effects. In the present study, the sex distribution in group1(RDS) was 18 males (75%) and 6 females (25%), this was in agreement with **Mlay and Maitji** [12] who found that RDS is more in males than females. **The sex** distribution in group 2 (TTN) was as follow: 19 males (79.2%) and 5 females (20.8%), this was in agreement with **Costa et al** [13] who found that TTN is more in males than females (2.3:1). The sex distribution in group 3 (Pneumonia): 1 male (50%) and 1 female (50%), this was not in agreement with **Costa et al** [13] who found that Pneumonia is more in males than females (1.9:1). This difference may be due to small number of patients in the pneumonia group. Our results revealed that there is no significant difference between the three groups as regard **sex** and this was in agreement with **Harish *et al.*** [3]**.** The present study revealed significant difference between three groups for **birth weight** and **gestational age** (P <0.001). Mean birth weight for group 1(RDS) was 1.74 kg when other groups 2,3 (TTN and Pneumonia) were 2.90 kg. Mean gestational age for group 1 (RDS) was 31 weeks when other 2 groups (TTN and Pneumonia) were 39 weeks. This finding was in accordance with the study done by **Liu and Tong** [14] on 99 preterm infants (69 infants were diagnosed with TTN and 30 were diagnosed with RDS) with mean gestational age (31.9 ± 2.2) weeks and birth weight (1661± 501g) showed that preterm infants with RDS are characterized by younger gestational age and lower birth weight. The present study revealed no significant difference between three groups for **mode of delivery** (P =0.461). This finding agreed with the study done by **Liu and Tong** [14] on 99 preterm infants (69 infants were diagnosed with TTN and 30 were diagnosed with RDS), revealing no significant difference of caesarean section between the RDs and TTN group (P = 0.025). Regarding the **mode of delivery** in group1 (RDS) in our study, 5 patients (20.8%) were delivered vaginally and 19 patients (79.2%) were delivered by section, thus RDS was found to be significantly increased among caesarean deliveries. In agreement with the study done by **Levine et al** [15] who found that newborn delivered by cesarean section have a fivefold increase in the incidence of respiratory disorders than those delivered vaginally. Regarding the **mode of delivery** in group2(TTN) in our study, 7 patients (29.2%) were delivered vaginally and 17 patients (70.8%) were delivered by section, thus TTN was found to be significantly increased among caesarean deliveries. In agreement with the study done by **Chandrasekhar** [16] on 100 consecutive born neonates with respiratory distress reported that cesarean delivered newborns were associated with severe respiratory distress in newborns. There is no significant difference between three groups among **mode of delivery,** in agreement with **Costa *et al* .**[13] who found that cesarean in 62.1% in pneumonic group and 54% in TTN group with non-significant value.

The present study revealed significant difference between three groups for **obstetric history** as PROM in 20%, UTI in 2%, pre-eclampsia in 6% and irrelevant in 72% from all studied groups. All cases of pneumonia associated with 50% UTI and 50% PROM, this was in agreement with **Costa *et al* .**[13] who

found that pneumonic group has five-fold infectious risk than TTN group.

In our study, the clinical course did not match the CXR findings in 3 neonates. This discrepancy was most often in patients with clinical diagnosis of pneumonia. Clinical diagnosis of pneumonia was made as the neonates had predisposing risk factors and had onset of respiratory distress soon after birth, this was in agreement with **Harish *et al.*** [3] who depend for clinical diagnosis of pneumonia on risk factor and onset of respiratory distress. In our study, one of them diagnosed by CXR and LUS as TTN while other two cases diagnosed by CXR as pneumonia or RDS and differentiated by LUS as RDS. As regard study of **Harish *et al.*** [3] on 63 neonates and found 6 cases diagnosed clinically as pneumonia. One of them diagnosed by CXR and LUS as TTN, four of them diagnosed by CXR and LUS as TTN and the last one diagnosed by CXR as pneumonia or RDS then differentiated by LUS as RDS. According to the findings of ultrasound in our study, the main features of RDS are Pleural lines abnormalities in 100%, Absent A lines in 91.7%, Alveolar-interstitial syndrome in 41.7%, Regular sub pleural consolidation in 45.8% in mild RDS while in severe RDS associated with regular expanded consolidation in 54.2% and air bronchogram in 66.7% from all cases of group1. Regarding chest radiography findings in group 1 (RDS) revealed that mild RDS was present in 16 (66.7%) patients while severe RDS was present in 8(33.3%) patients. In our study, clinical diagnosis for detection severity of RDS done by Down score & Silverman Anderson score match X-ray findings. As regarding the comparison between chest radiography finding and chest ultrasonography findings in group 1 (RDS): LUS revealed that mild RDS was present in 11(45.8%) patients while severe RDS was present in 13(54.2%) patients, these results mean ultrasonography tends to overestimate the diagnosis of RDS i.e. some mild RDS cases by chest X-ray diagnosed as severe while all severe cases by chest X-ray diagnosed as severe by ultrasound. This finding agreed with the study done by **Abdelsadek *et al.*** [17] who found that some mild RDS cases by chest X-ray diagnosed as severe by LUS while all severe cases by chest X-ray diagnosed as severe by LUS, these results mean LUS tends to overestimate the diagnosis of RDS. Also in agreement with our findings **liu *et al.*** [18] stated that the most important indicator of RDS in LUS is lung consolidation which can be seen in all RDS patients, but the extent and scope of the consolidation varies with severity of RDS. Consolidation in mild cases limited to sub pleural present as focal and small scale and air bronchogram may not be visible. In contrast area of consolidation appears significant expanded in severe RDS, with air bronchogram becoming more obvious but the criteria of inclusion in his study was different from our study where they used the clinical diagnosis while we used the combination of both clinical and CXR to include our cases. In our study, the sensitivity and specificity of lung consolidation with regular margins in diagnosing RDS are 100%. The sensitivity and specificity of AIS in diagnosing RDS are 41.7% & 91.3% respectively. The study done by **Jing *et al.*** [19] found that lung consolidation with air bronchogram have sensitivity 83.3% & specificity100% and AIS have sensitivity 100% &specificity 0%.

According to our findings of ultrasound in group2 (TTN), the main features of TTN are presence of normal pleural lines and presence of predominant B lines in all TTN cases (100%) are important differentiating features of TTNB from RDS. Predominant B lines in 100%, Double lung point in 62.6%, Absent A lines in 37.5%, and alveolar-interstitial syndrome in 4.2% from all cases of group2, this was in agreement with **Harish *et al.*** [3] who stated that absence of pleural thickening and presence of predominant B lines are important differentiating features of TTNB from RDS. In their study, Predominant B lines were appreciated in all infants (100%) of TTN but double lung point was seen in only 12 of the 33 infants with TTN (36%).

In our study, the sensitivity and specificity of predominant B lines in diagnosing TTN are 100%. The sensitivity and specificity of DLP are 62.5% & 100% respectively. The sensitivity and specificity of AIS are 4.2% & 57% respectively. The study done by **Jing *et al.*** [19] found that presence of DLP is the specific sonographic characteristic of TTN; both the sensitivity and specificity are100%. There are no double lung points among healthy newborn infants or with other pulmonary diseases, such as RDS and pneumonia. In agreement with our study**, Jing *et al* .**[18] stated that the primary ultrasonic feature of RDS is lung consolidation

with air bronchograms without DLP, while the most specific ultrasonic feature of TTN is DLP without lung consolidation. Therefore, LUS is not only useful to diagnose TTN and RDS but also valuable to differentiate TTN from RDS. According to our findings of LUS in group3 (Pneumonia): the main features of Pneumonia are pleural lines abnormalities in 100%, Irregular subpleural consolidation in 100%, air bronchogram in 100% and Alveolar-interstitial syndrome in 50% from all cases of group3. The main diagnostic differentiating LUS feature for diagnosis in our study is lung consolidation showing sub-pleural echo poor or tissue like region with blurred margins or wedge-shaped borders, this was in agreement with **Jing *et al*** .[18] who stated that the typical ultrasonic image features of pneumonia are hypoechoic areas of varying size and shape, irregular and serrated margins, heterogeneous echo texture, air bronchograms, dynamic air bronchograms and pleural effusion. In our study, the sensitivity and specificity of lung consolidation with irregular margins in diagnosing pneumonia are 100%. The sensitivity and specificity of AIS are 50% & 77.1% respectively. In agreement with our study**, Kurepa *et al.*** [20] stated that lung consolidation with irregular margins has 100% sensitivity and 100% specificity for the diagnosis of neonatal pneumonia**.** In considering these results, we must take in consideration that the main limitation of this study is the small number of patients in the pneumonic group that might have limited the power to differentiate pneumonic group from other groups. Therefore, on the basis of these limitations, we believe that larger studies are necessary to confirm our findings.

CONCLUSION

The present study shows a clear superiority of lung ultrasound over the chest x-rays for the diagnosis of RDS, TTN and pneumonia. Given the ultrasonography performance for the diagnosis of RDS, TTN and pneumonia, lung ultrasound could replace chest x ray as the first-line imaging investigation. Chest Ultrasound cannot replace standard chest X-ray in detecting severity of neonatal RDS because of its tendency to overestimate RDS, but useful for its exclusion. Chest Ultrasound may be considered as screening, diagnosing and follow up method for diagnosis of RDS.

REFERENCES

1. **Edwards MO, Kotecha SJ and Kotecha S (2013):** Respiratory distress of the term newborn infant. Paediatr Respir Rev.,14(1):29–36.
2. **Suzanne R, Chuanpit Mand Michelle B** (2014): Respiratory Distress in the Newborn. DOI: 10.1542/pir.35-10-417.
3. **Harish R, Tejo P, Srinivas M and Sreeram S (2017):** Diagnostic performance of point of care ultrasonography in identifying the etiology of respiratory distress in neonates. Indian Journal of Pediatrics, DOI :10.1007/s12098-016-2288-7.
4. **Huiqing S** , **Falin X and Hong** X**(2013):** Characteristics of Respiratory Distress Syndrome in Infants of Different Gestational Ages. Lung Journal, 191:425-433.
5. **Mally PV, HendricksKD and Bailey S (2013)**: Incidence and etiology of late preterm admissions to the neonatal intensive care unit and its associated respiratory morbidities when compared to term infants. American Journal of Perinatology, 30(5):425-431.
6. **Liem JJ, Huq SI, Ekuma O, Becker AB and Kozyrskyj AL (2007):** Transient tachypnea of the newborn may be an early clinical manifestation of wheezing symptoms. J Pediatric, 151(1):29-33.
7. **Frederick J, Kaskel F and Leonard G (2013):** Fluid and Electrolytes in Pediatrics. A Comprehensive Handbook book; part 2; Disorders in calcium, magnesium and phosphorus homeostasis. https://www.amazon.com/Fluid-Electrolytes-Pediatrics-Comprehensive.../161779410
8. **Kendall JL, Hoffenberg SR and Smith RS (2007):** History of emergency and critical care ultrasound. The evolution of a new imaging paradigm. Crit Care Med., 35(5):126-130.
9. **Liu J (2014):** Lung ultrasonography for the diagnosis of neonatal lung disease. J Matern Fetal Neonatal Med., 27(8): 856–861.
10. **Bedetti G, Gargani L and Mottola G (2006)**: Evaluation of ultrasound lung comets by handheld echocardiography. Cardiovascular ultrasound, 4:34.
11. **Meziere G, Lascols N, Biderman P, Goldstein I and Tenoudji M (2005):** Ultrasound diagnosis of occult pneumothorax. Doi.org/10.1097/01.CCM.0000164542.86954.
12. **Mlay GS and Maitji KP (2000):** Respiratory distress syndrome among neonates admitted

at Matimbili medical center. Journal of Trop Pediatr Get., 46(6):303-307.

13. **Costa S, Gustavo R, Andreia L and Hercília G (2012):** Transient tachypnea of the newborn and congenital pneumonia. The Journal of Maternal-Fetal and Neonatal Medicine, 25(7): 992–994.
14. **Liu S and Tong X (2015):** The clinical comparative study of preterm respiratory distress syndrome and transient tachypnea of newborn. US National Library of Medicine, 53(2):104-8.
15. **Levine EM, Ghai V, Barton JJ and Strom CM (2001):** Mode of delivery and risk of respiratory diseases in newborns.https://www.ncbi.nlm.nih.gov/pubmed/11239653
16. **Chandrasekhar R, Manchu M and Vijaya L (2016):** Clinical study of respiratory distress in newborn. International Journal of Contemporary Pediatrics. DOI:10.18203/2349-3291.ijcp20162364.
17. **Ahmad A, Mohamed D and Osama A (2016)**: Lung ultrasound as early diagnostic tool in neonatal respiratory distress syndrome. Egyptian Journal of Chest Diseases and Tuberculosis, 65: 377–382.
18. **Liu J, Liu F, Liu Y, Wang HW and Feng Z (2014):** Lung ultrasonography for the diagnosis of severe neonatal pneumonia. Chest Journal, 146(2): 383–388.
19. **Liu J, Cao HY and Liu Y (2013):** Lung ultrasound for the diagnosis of neonatal respiratory distress syndrome. https://www.ncbi.nlm.nih.gov/pubmed/23751583
20. **Kurepa D, Zaghloul D, Watkins L and Liu J (2017):** Neonatal lung ultrasound exam guidelines. Journal of Perinatology, Doi:10.1038/jp.2017.140.