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Original Research Article

Accuracy of lung ultrasound score in predicting the need for surfactant therapy in preterm neonates (less than 34 weeks)

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ABSTRACT

Background: Lung ultrasound is a useful bedside tool in assessing different respiratory conditions of neonate. It is an emerging method in guiding clinicians to predict the need for surfactant administration in RDS neonates.
Methods: This study included 75 neonates less than 34 weeks requiring any form of respiratory support. Lung ultrasound score (LUS) was done initially at birth followed at 6-12 hours of life. Surfactant administration was based on clinical assessment.
Results: The LUS at birth (mean (SD): 8.5±2.93) and LUS at 6-12 hours of life (mean (SD): 6.2±3.06) showed a significant association with the requirement of surfactant administration and re-administration. Wilcoxon Sign rank test showed a significant decrease in the LUS score at 6-12 hours from LUS at birth. Also, the study shows that requirement of CPAP had positive correlation with LUS at birth and LUS at 6-12 hours.
Conclusions: The study shows significant association of LUS at birth and requirement of surfactant administration. Also, there is correlation between LUS at birth and LUS at 6-12 hours helping in predicting need for repeat dose of surfactant.

Keywords: Lung ultrasound score, Preterm neonates, Surfactant

INTRODUCTION

Point of care ultrasound of the lung is an emerging tool in the clinical care of neonates. It is well known that Lung ultrasound (LUS) is a very useful bedside tool which not only helps in diagnosing various neonatal conditions but also in assessing the severity of the disease, judging the response to treatment and predicting the outcome of various neonatal diseases.[1]

LUS also helps in identifying and differentiating lung diseases, such as respiratory distress syndrome (RDS), transient tachypnea of the newborn (TTN), pneumothorax, pleural effusion, meconium aspiration syndrome (MAS), pneumonia, atelectasis.[2] LUS has a been a very useful tool in the management of RDS. It is well known that Lung ultrasound scores help in assessing the need for surfactant therapy in RDS.[2,3] To study the accuracy of Lung Ultrasound Score (LUS) in predicting the need for surfactant therapy in preterm neonates (less than 34 weeks).

Our primary objective is to assess the accuracy of LUS in predicting the need for surfactant therapy. Secondary objectives include identifying correlation between LUS and severity of disease and comparing it with Chest Xray and to study the number of days on respiratory support during the NICU stay, assess correlation between LUS1 and LUS2 and also in predicting the need for 2nd dose of surfactant therapy.

METHODS

Study design

It is a prospective observational non-blinded study. We included hemodynamically stable newborns, less than 34 weeks, requiring respiratory support at birth (in form of Heated Humidified High Flow Nasal Cannula (HHHFNC), Continuous Positive Airway Pressure (CPAP), Non-invasive Ventilation (NIV), Mechanical invasive ventilation or High Frequency Oscillation Ventilation (HFO), irrespective of the need for surfactant administration. The need for respiratory support was based clinically on Silvermann Anderson Score and respiratory distress. Newborns with any congenital malformations or chromosomal anomalies or structural abnormalities were excluded. Hemodynamically unstable newborns were also excluded. Written informed consent was taken from the parents of the neonates included in the study. Ethical approval was not required for this study.

Study place

The study was conducted in a tertiary level NICU at Arpan Newborn Care Centre, Ahmedabad, Gujarat.

Study duration

The study was conducted over a period of 7 months from June 1, 2024 to December 31, 2024.

Data collection

Data was collected across 7 months from June 1, 2024 to December 31, 2024.

Sampling procedure

All the eligible neonates admitted to the NICU were assessed with the LUS. LUS was done with a Vivid-i general electric's ultrasound machine using linear probe of frequency 12 MHz. LUS was performed by four neonatal trainee fellows who were well trained with the LUS. Lung ultrasound was evaluated based on the 6-region approach - right anterior area, right lateral area, right posterior area, left anterior area, left lateral area, left posterior area. Lung Ultrasound Scores were given based on the previous published literature (Figure 1), 0 for presence of A-lines only, 1 for presence of ≥3 B-lines, 2 for presence of compact or confluent B-lines, 3 for presence of any consolidation area.[1]

A LUS scan perfoma was prepared (Appendix 1) and the details for each neonate was entered in the perfoma. The first LUS was done within 2 hours of birth. The second LUS performed at 6-12 hours of birth. The echo images were saved and then analyzed and scored by two trained clinicians one neonatologist and one neonatal trainee fellow / investigator. Surfactant administration was based on clinical assessment, regardless of the LUS, Chest X-ray and blood gas analysis and FiO2 requirement. We used InSurE technique of instilling surfactant. The surfactant used was Survanta (Beractant) which was given at 100 mg/kg dose (4 ml/kg). All neonates requiring respiratory support had a Antero-posterior Chest X-ray within 2 hours of birth as a unit protocol.

Statistical analysis

The statistical analysis was done using SPSS® 26.0 software. Categorical variables were expressed as frequency (percentage) and compared using the chi-squared test or Fisher's exact test, as needed. Continuous variables were expressed as mean (SD). Chi-square tests were performed for categorical variables. Wilcoxon signed-rank test was used to show the difference between LUS at birth and LUS at 6-12 hours. Also, Spearman coefficient test was used to correlate LUS with different modes of respiratory support. Receiver operating characteristic (ROC) analysis was used to evaluate the reliability of the LUS score in predicting the need for surfactant administration and re-administration. Area under the curve (AUC) and reliability data were reported with 95% confidence interval (CI). p-value of<0.05 was considered significant.

RESULTS

In the study, a total of 90 patients were enrolled, but 3 babies were excluded due to chromosomal anomalies (Figure 2). In another 12 babies, study was discontinued due to death of the baby (7 patients) or Discharge Against Medical Advice (DAMA) (5 patients). Hence a total of 75 were finally studied and followed up for further analysis.

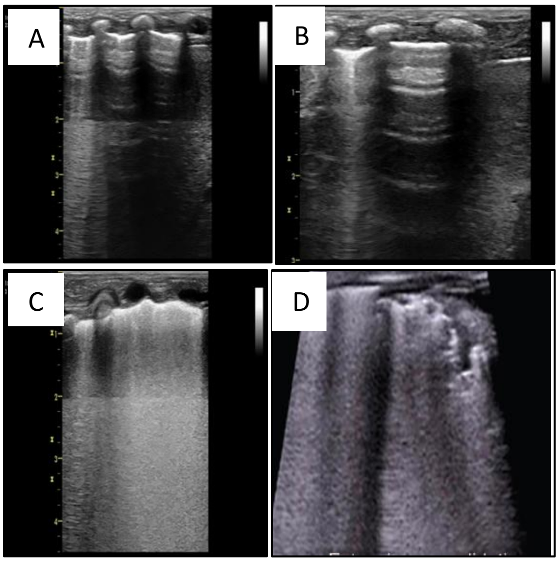

Figure 1: Scoring of LUS-(A) 0 score: Presence of A-lines, (B) 1 score: Presence of≥3 B-lines, (C) 2 score: Presence of compact or confluent B-lines, (D) 3 score: presence of any consolidation area.

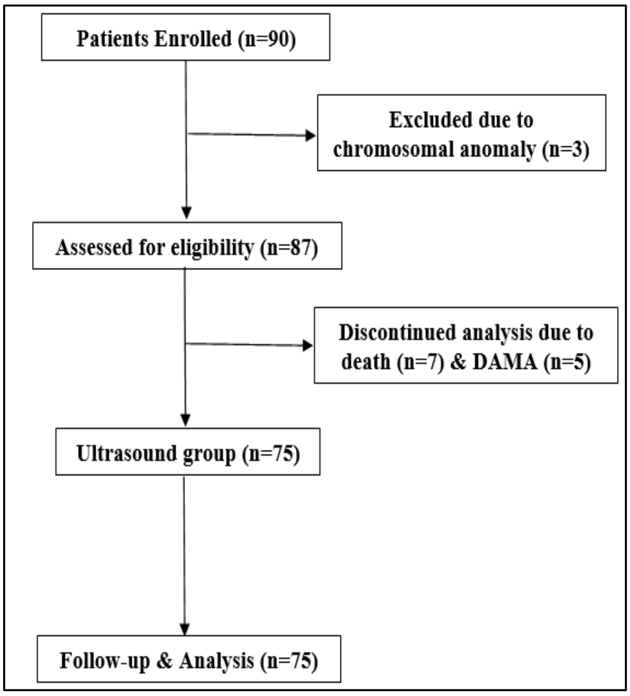

Figure 2: Flow of recruitment of the study.

Table 1 summarizes the baseline characteristics of the study. The mean (SD) Gestational Age was 29.7±2.2 weeks and the mean (SD) Birth weight was 1.39±0.42 kg. A total of 49 babies (65%) received complete 2 doses of antenatal corticosteroids and 29 mothers (39%) received antenatal magnesium sulphate. Surfactant administration was required in 47 babies (63%) out of which 40 babies (85%) received only a single dose and 7 babies (15%) required 2 doses of surfactant. The mean (SD) LUS done at birth was 8.5±2.93 and mean (SD) LUS done at 6-12 hours of birth was 6.2±3.06. The LUS at birth and LUS at 6-12 hours of life showed a significant association with the requirement of surfactant administration (Table 2 and Table 3).

Wilcoxon Sign rank test was used to demonstrate the difference between LUS at birth and LUS at 6-12 hours (Table 4). It showed a significant decrease in the LUS score at 6-12 hours from LUS at birth. The ROC analysis for LUS (at birth) yielded an area under curve of 0.842 (95% confidence interval, 0.76-0.93, p<0.05). LUS (at birth) equal to greater than 7 showed a sensitivity and specificity of 83% and 61% respectively for the need of treatment with surfactant. It showed significant association between LUS at birth and need for surfactant administration. The ROC analysis (Table 5) for LUS (At 6-12 hours) yielded an area under curve of 0.801 (95% confidence interval, 0.70-0.89, p<0.05). LUS (At 6-12 hours) equal to greater than 7 showed a sensitivity and specificity of 51% and 96% respectively for the need of re-treatment with surfactant. It showed significant association between LUS at 6-12 hours and need for surfactant re-administration.

In our study, the total days of ventilation (Mean±SD) was 4.31±7.0 days. The duration of HHHFNC (Mean±SD) was 1.77±1.97 days and CPAP (Mean±SD) was 2.12±2.39 days. Invasive Mechanical ventilation (Mean±SD) was required for 6.28±6.6 days. Table 6 shows that requirement of CPAP positively correlated with LUS (at birth) and LUS (At 6-12 hours) which was statistically significant (p<0.05). However, HHHFNC, NIV and invasive ventilation did not significantly correlate with LUS (at birth) and LUS (at 6-12 hours) (p>0.05). The PEEP levels and LUS have not been compared here. Also, LUS results were similar to chest X-ray findings in nearly 95% of the babies. ABG analysis including the SaO2/FiO2 ratio and lactate levels were not done in all patients, hence correlation between them and number of surfactant doses was not studied. At 6-12 hours of birth, LUS was statistically significantly decreased compare at birth (median 6 Vs 8, p<0.05).

Table 1: Baseline characteristics of the study participants.

Variable		Number (n=75)
Gestational age (mean±SD)		29.7±2.2
Birth weight (mean±SD)		1.39±0.42
Gender	Male	43
	Female	32
Birth weight	SGA	10
	AGA	59
	LGA	6
ANS	Complete	49
	Incomplete	19
	Not given	7
$MgSO_4$	Given	29
MOD	Not Given	46
	LSCS	72
Total days of ventilation Mean±SD	VD	3
	Overall (n=75)	4.31±7.0

Continued.

Variable		Number (n=75)
(n=9)	HHHFNC (n=35)	1.77±1.97
	CPAP (n=73)	2.12±2.39
	NIV (n=8)	6.09±9.83
	Invasive Ventilation	6.28±6.6
Surfactant	HFO (n=1)	1.5
	Given	47
Dose of surfactant	Not given	28
	Single dose	40
LUS (mean±SD)	Two doses	7
	At birth	8.5±2.93
PDA	At 6-12 HOL	6.2±3.06
	Yes	23
	No	52
Probable diagnosis	RDS	61
	Pneumonia	8
	TTN	6
X-ray	Matched	71
	Not matched	4

Table 2: Association of requirement of surfactant with LUS (at birth) (n=75).

Surfactant required	LUS at birth				P value
	≤8 (n=39)		>8 (n=36)		
	N	%	N	%	
Yes	15	38.5	32	88.9	0.001
No	24	61.5	4	11.1	

*-Chi-square test

Table 3: Association of requirement of surfactant with LUS (at 6-12 HOL) (n=75).

Surfactant required	LUS at 6-12 HOL				P value
	≤8 (n=58)		>8 (n=17)		
	N	%	N	%	
Yes	30	51.7	17	100	0.001
No	28	48.3	0	0.0	

*-Chi-square test

Table 4: Comparison of LUS1 and LUS2 (n=75).

Duration	Median	P value
LUS 1	8	0.001*
LUS 2	6	

*-Wilcoxon Sign rank test

Table 5: ROC and AUC of LUS (at birth) and LUS (at 6-12 hours) Vs surfactant requirement (n=75).

	AUC	95% CI	P value	Sensitivity	Specificity
LUS (At Birth)	0.842	0.76-0.93	0.0001	83%	61%
LUS (At 6-12 hours)	0.801	0.70-0.89	0.0001	51%	96%

AUC=Area under curve, CI=Confidence interval

Table 6: Correlation of LUS (at birth) with value of HHHFNC, CPAP, NIV and invasive ventilation (n=75).

Method of ventilation	Correlation with LUS (at birth)	P value	Correlation with LUS (At 6-12 Hours)	P value
HHHFNC	-0.263	0.13	-0.066	0.71
CPAP	0.276	0.01	0.359	0.002

Continued.

Method of ventilation	Correlation with LUS (at birth)	P value	Correlation with LUS (At 6-12 Hours)	P value
NIV	0.108	0.8	0.247	0.56
Invasive Ventilation	0.492	0.18	0.576	0.1

*Spearman Coefficient

DISCUSSION

The use of LUS is gradually gaining interest. Lung Ultrasound is a quick and easy bedside tool that helps in differentiating various diseases and predicting the course of illness and their management. Various studies have tried to compare the efficacy of LUS with chest X-ray in terms of predicting early options for treatment of lung pathologies.

Most of the LUS studies done till date have had a mean gestational age of around 30-32 weeks. In our study, the mean gestational age is less than 30 weeks (16 babies (21%) of the total sample size were less than 28 weeks, with a lowest gestational age of 25+4 weeks). Many studies have shown correlation between LUS and the need for surfactant therapy.

This study highlights the application of LUS in early administration of surfactant compared to Chest X-ray. To our knowledge, this is the first study done with a reasonably large sample size with a mean gestational age less than 30 weeks and mean birth weight of less than 1.4 kg. This study also shows association of LUS with requirement of 2nd dose of surfactant administration. Here we have also shown used a Wilcoxon signed-rank test to show a significant comparison between LUS at birth and LUS at 6-12 hours after birth. Our study findings have been consistent with many former studies published regarding this matter.

Perri et al, studied LUS changes in RDS patients before surfactant, 2 hours and 12 hours after surfactant administration and concluded that LUS done after 2 hours of surfactant administration can be used to identify babies who will not require a second surfactant treatment dose.[2] The ROC analysis showed area under curve of 0.80 (95% confidence interval, 0.76-0.85, $p<0.001$). LUS done at 2 hours of≥7 showed a sensitivity of 94%, a specificity of 60%, a negative predicted value of 95% and a positive predicted value of 56% for the need of retreatment with surfactant. No difference was found in LUS profiles before and 2 hours after surfactant administration ($p=0.16$) while LUS profiles are significantly changed after 12 hours from the surfactant treatment ($p<0.001$). A significant difference was also found between LUS profiles 2 hours and 12 hours after surfactant treatment ($p<0.001$).

Vardar et al, also aimed to study the accuracy of Lung Ultrasound in predicting the need for surfactant therapy in preterm infants with RDS.[4] They used LUS to analyze the severity of RDS. They used a cut-off LUS value of 4 to predict the need for surfactant. They concluded that LUS accurately predicted the severity of RDS, the need for surfactant and CPAP failure.[5-8] Cattarossi et al, evaluated changes in LUS patterns in neonates with RDS who received surfactant therapy.[9]

Another study, Javier et al, also aimed to investigate LUS in premature newborns with respiratory distress syndrome for early surfactant therapy (within first 3 hours of birth) rather than using FiO2 criteria.[10] This randomized trial divided the babies into 2 groups: ultrasound group, in which surfactant was administered based on LUS score and/or FiO2 threshold and the control group, guided by FiO2 only. The study concluded that surfactant therapy allowed for an earlier surfactant therapy, reduced oxygen exposure early in life and a better oxygenation after the treatment compared to FiO2 criteria. A similar study, Raschetti et al, also interpreted early surfactant administration with LUS rather than FiO2.[11]

Lung ultrasound not only helps in recognizing the need for surfactant administration but also helps in identifying different lung pathologies which do not require surfactant and point out the cause for respiratory support, hence guiding in the management and prognosis of the patient. Further studies can be done to also assess any correlation of LUS with secondary parameters like pH, blood lactate levels and SaO2/FiO2 ratio. Possibility of development of BPD in preterm neonates can also be assessed in future studies.

We did not study about the rate of ventilation failure with different modes. We could not compare LUS with CPAP failure. Also, as we did not do blood gas analysis in all babies, we could not correlate LUS with pH levels, lactate levels and SaO2/FiO2 ratio. Also blinding was not done as the investigator was aware about ultrasound findings. Further studies can be done to follow up the babies for changes of BPD.

CONCLUSION

LUS is believed to be a very safe and a quick bedside method to use. This study shows a significant association of LUS at birth and requirement of surfactant administration. Also, this study shows correlation between LUS at birth and LUS at 6-12 hours which helped in predicting the need for a repeat dose of surfactant.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Verma A, Paul A, Tekleab AM, Lodha A, Lui K, Maheshwari A, et al. Lung ultrasound in neonates: an emerging tool for monitoring critically ill infants. Lung. 2023;2(1):56-9.
2. Perri A, Tana M, Riccardi R, Iannotta R, Giordano L, Rubortone SA, et al. Neonatal lung ultrasonography score after surfactant in preterm infants: a prospective observational study. Pediatric Pulmonol. 2020;55(1):116-21.
3. Brat R, Yousef N, Klifa R, Reynaud S, Aguilera SS, De Luca D. Lung ultrasonography score to evaluate oxygenation and surfactant need in neonates treated with continuous positive airway pressure. JAMA Pediatrics. 2015;169(8):151797-9.
4. Vardar G, Karadag N, Karatekin G. The role of lung ultrasound as an early diagnostic tool for need of surfactant therapy in preterm infants with respiratory distress syndrome. American J of Perinatol. 2021;38(14):1547-56.
5. De Martino L, Yousef N, Ben-Ammar R, Raimondi F, Shankar-Aguilera S, De Luca D. Lung ultrasound score predicts surfactant need in extremely preterm neonates. Pediatrics. 2018;1;142(3):56.
6. Corsini I, Parri N, Ficial B, Dani C. Lung ultrasound in the neonatal intensive care unit: Review of the literature and future perspectives. Pediatric Pulmonol. 2020;55(7):1550-62.
7. Gregorio-Hernández R, Arriaga-Redondo M, Pérez-Pérez A, Ramos-Navarro C, Sánchez-Luna M. Lung ultrasound in preterm infants with respiratory distress: experience in a neonatal intensive care unit. European J Pediat. 2020;179:81-9.
8. Shafer GJ, Suresh GK. Does lung ultrasound score predict the need for surfactant in extremely preterm neonates. Acta Paediatrica. 2019;10;108(5):973-.
9. Copetti R, Cattarossi L, Macagno F, Violino M, Furlan R. Lung ultrasound in respiratory distress syndrome: a useful tool for early diagnosis. Neonatol. 2008;15;94(1):52-9.
10. Rodriguez-Fanjul J, Jordan I, Balaguer M, Batista-Muñoz A, Ramon M, Bobillo-Perez S. Early surfactant replacement guided by lung ultrasound in preterm newborns with RDS: the ULTRASURF randomised controlled trial. European J of Ped. 2020;179:1913-20.
11. Raschetti R, Yousef N, Vigo G, Marseglia G, Centorrino R, Ben-Ammar R, et al. Echography-guided surfactant therapy to improve timeliness of surfactant replacement: a quality improvement project. The J of pediatrics. 2019;212:137-43.

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