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Original Research Article

Comparing prognostic value of lung ultrasound scores in predicting outcome of shock patients: an observational study

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ABSTRACT

Background: Shock is a common causes of mortality in ICU. Several scoring systems have been developed to grade the severity of illness. These systems are moderately accurate in predicting survival. Several scoring systems like APACHE, SOFA,SAPS, MODS etc have been used to risk stratify patients in ICU. The lung ultrasound score (LUSS) has been regarded as semi quantitative score to measure lung aeration loss. LUSS can be compared to scoring systems like acute physiology and chronic health evaluation II (APACHE II) and sequential organ failure assessment (SOFA).
Methods: Our study was a prospective observational study. 100 patients who fulfilled the inclusion criteria for shock were included. Their APACHE II scores at admission and 24 hours were calculated. Similarly, SOFA scores at 24 and 48 hours post admission were calculated. Lung ultrasound examination was done at four regions of chest and scores noted. All the three scores were statistically analyzed for length of hospital stay, ICU stay, ventilator days and the outcome.
Results: Out of 100 cases satisfying the inclusion and exclusion, it was observed that high lung ultrasound scores were associated with increased mortality and number of days on mechanical ventilator. This association was statistically significant. Findings also correlated with high APACHE II and SOFA scores. All the above findings were statistically significant.
Conclusions: High lung ultrasound scores at admission were directly related with mortality and increased number of days on mechanical ventilator.

Keywords: Critical care ultrasound, ICU, Lung ultrasound score, Shock

INTRODUCTION

Respiratory distress and failure is commonly observed in patients with fulminant or impending shock. Accumulation of fluid or cytokine storm, interstitial infiltrate results in wet lung leading to acute respiratory distress syndrome. This Extra vascular fluid accumulation in lung interstitium and alveoli results in decreased diffusion of oxygen. Early bedside diagnosis of ARDS may guide therapy, which can help in improving outcome.[1-9] The need for a bedside, non-invasive diagnosis for the determination of extra vascular fluid accumulation lung in septic shock is desirable. APACHE score and SOFA score has been used as a non-invasive method for prognostication. However, these scores require calculation of multiple variables and are done at periodic intervals like at admission and at 24-48 hours. Lung ultrasound represents a bed side, point of care, non-invasive, less cumbersome diagnostic test for prognostication in septic shock patients.

Lung ultra sonography (LUS) evaluates B-lines in various zones of lung and assesses for congestion in lung. It is the sum of scores of four zones to measure the aeration of lung caused by pneumonia, atelectasis, pleural effusion and lung edema.[10,11]

APACHE score

Acute physiologic assessment and chronic health evaluation II (APACHE II) score introduced in 1985 is a prognostication scale which takes into consideration various clinical, laboratory parameters including age and chronic health condition.

SOFA score

The sequential organ failure assessment score is used to determine the extent of a person's organ function or failure. It takes into consideration the P/F ratio, presence of hypotension, renal and liver function tests, platelet count, GCS levels.

The mortality rate rises to as high as 50% if the SOFA score increases in the first 48-96 hours of admission. LUSS can be compared to the routinely used scoring systems in ICU, namely acute physiology and chronic health evaluation 2 (APACHE 2) and Sequential Organ Failure Assessment (SOFA) for predicting outcomes in critically ill patients.[3]

Aim

To investigate the value of the lung ultrasound scores in ICU shock patients and its association with the outcome as compared to APACHE II and SOFA scoring systems.

Primary objectives

To study the relationship of lung ultrasound scores in shock in predicting outcomes like mortality, length of ICU stay, length of hospital stays, length of days spent by the patient on mechanical ventilator.

Secondary objective

To evaluate the capacity of utility of lung ultrasound in shock patients in guiding fluid therapy, monitor the development of new consolidation or ARDS depending on the lung score.

METHODS

Study design

This was a comparative observational study.

Study place

The study was conducted in Department of critical care medicine, Vijaya Hospital, Chennai.

Study duration

The study duration was from July 2020 to November 2021.

Selection of study participants

100 patients admitted with shock to emergency ward were evaluated for inclusion in the study if the following criteria were satisfied.

Inclusion criteria

Age>18 years, both male and female, patients meeting the criteria for shock.[22-24] SBP<90 mm of hg or MAP<65 mm of hg, cold and clammy skin, urine output<0.5 ml/kg/hr, lactate>2 mmol/l were included.

Exclusion criteria

Age<18 years, pregnancy, congenital heart disease, patients /Attenders refusing to be enrolled were excluded from the study.

Procedure

After obtaining ethical committee approval from our Institutional Review Board (IRB), 100 consecutive patients who satisfied the inclusion criteria were enrolled into the study.

A written informed consent was obtained from each patient or their surrogate. APACHE II score at admission and 24 hours were calculated. Similarly, SOFA score at 24 hours and 48 hours post admission were noted. All Patients underwent lung ultrasound examination by the primary investigator to prevent any subjective variations.

Evidence based recommendations for point of care lung ultrasound using a complete eight zone lung examination to evaluate LUSS was performed.[19] Each hemithorax was divided into four quadrants by anterior axillary line and line at the level of nipple. The anterior chest Areas 1 and 2 denote upper anterior and lower anterior. Areas 3 and 4 denote upper lateral and basal lateral chest areas respectively.[10-12] Each zone was scored according to lung ultrasound pattern as follows. The worst ultrasound pattern observed in each zone is recorded and used to calculate the sum of the scores (Total score 24). The lung ultrasonic data of the patient was calculated to assess the outcome. In the study, the patient's demographics, clinical characteristics, prognosis and LUSS as part of the indicators were also noted. The outcome of the patient were divided into four LUSS quartiles.

Similarly, the APACHE II score of the patients were recorded at admission and at 24 hours. SOFA score also recorded at 24 hours and 48 hours post admission. This score was compared to LUSS (lung ultrasound score system) using statistical analysis. Other outcome predictors like length of hospital stay, ICU stay, need for

mechanical ventilation were also noted. Relevant blood investigations were done to calculate SOFA and APACHE II score and recorded accordingly. Other co-morbidities of the patient like diabetes mellitus, hypertension, coronary artery disease, chronic kidney disease, etc were noted.

Statistical methods and analysis

Statistical analysis is going to done by the statistical software STATA 11.0. Continuous variables will be representing as 'Mean (SD)' and categorical variables are representing as 'Frequency (percentage)'. Chi-square test or Fisher's exact tests will be used to assess differences in categorical data. The p value of<0.05 will be considered as significant.

RESULTS

A total 100 patients were enrolled during the study. Out of which 28 were female and 72 were male. No patients were excluded from the study after enrolment. The mean age distribution of the patient was between 59.32±14.54. Majority (43%) of them belonged to the age group of 66-80 years as seen in Table 2.

All the patients were even compared for their co morbidities. 83% of patients had type II diabetes mellitus followed by hypertension, CAD, CKD and COPD. Age and co morbidities of the patients were demographically compared. It was found that majority of the patients were a known case of type II diabetes mellitus and systemic hypertension and it was statistically significant. Gender of the patients and co-morbidities were compared demographically. There was no statistical significance observed in them. All types of shock were included in study and depicted in Table 3, out of which 58% of patients were affected with septic shock. There was no statistically significant difference between several types of shock included.

There is no co-relation between the APACHE II score and Length of stay in hospital or ICU stay. Table 5 explain significant association between the APACHE II score (at admission and 24 hours) Vs length of stay in hospital and ICU stay. There is a positive correlation between the number of days spent by the patient on mechanical ventilator Vs APACHE II score (at admission and 24 hours).

There was a significant association between the APACHE score (at admission and 24 hours) Vs number of days spent by the patient on mechanical ventilator and mortality. Table 8 shows the significant association between total lung ultrasound scores with ICU stay and number of days spent by patient in mechanical ventilator. The table 9 depicts the primary outcome of patients with total lung ultrasound score (discharge v/s death).

Table 1: Scored according to lung ultrasound pattern.

Score	Description
0	The presence of lung sliding with A lines or fewer than two isolated B lines
1	Multiple well defined B lines (B 1)
2	Multiple coalescent B lines (B 2)
3	Tissue pattern characterised by dynamic air bronchograms (lung consolidation B 3)

Table 2: Sex distribution and age characteristics of participants.

Age (in years)	%
Less than 35	5 (5)
36 to 50	21 (21)
51 to 65	27 (27)
66 to 80	43 (43)
Gender	
Female	28 (28)
Male	72 (72)

Table 3: Clinical characteristics of study participants.

Co-morbidities	Gender		Total	P value
	Female	Male		
DM	21 (25.30%)	62 (74.70)	83 (100%)	0.184
HTN	15 (30%)	35 (70%)	50 (100%)	0.656
CAD	7 (23.33%)	23 (76.67%)	30 (100%)	0.496
CKD	6 (30%)	14 (70%)	20 (100%)	0.824
COPD	3 (60%)	2 (40%)	5 (100%)	0.102

Table 4: Shock distribution.

Shock	N (%)
Cardiogenic shock	28 (28)
Septic shock	59 (59)
Hypovolemic shock	9 (9)
Neurogenic shock	2 (2)
Spinal shock	1 (1)
Obstructive shock	1 (1)

Table 5: Length of hospital stay.

	Length of hospital stay (in days)	ICU (in Days)	Ventilator (in days)
Mean (SD)	7.88±4.64	5.52±3.84	3.52±3.65
Median	6.5	5	3
Range	1.5 to 23	1.5 to 23	0 to 21

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Table 6: Correlation for APACHE Score at admission & 24 hrs.

	r	P value at admission	P value at 24 hrs
Length of stay in hospital	-0.0513	0.6119	0.2638
ICU stay (in days)	0.1831	0.0682	0.1078
Mortality	-0.3655	<0.0002*	<0.0001*
Ventilator days	0.3494	<0.0004*	<0.0005*

Table 7: Correlation for SOFA score at 24 hrs.

	r value at 24hrs	P value at 24 hrs	r value at 48 hrs	P value at 48 hrs
Length of stay	-0.0049	0.9617	-0.0285	0.7808
ICU stay (in days)	0.2662	<0.0074*	0.2521	<0.0123
Mortality	-0.3850	<0.0001*	-0.4824	<0.0001*
Ventilator days	0.3875	<0.0001*	0.3962	<0.0001*

*statistically significant

Table 8: Correlation right and left LUS score.

	r value of right LUS	P value of right LUS	r value left LUS	P value of left LUS
Length of stay	-0.0689	0.4958	-0.0377	0.7095
ICU stay (in days)	0.1929	0.0545	0.198	0.0483
Mortality	-0.5280	<0.0001*	-0.4974	<0.0001*
Ventilator days	0.3236	<0.0010*	0.3240	<0.0001*

*statistically significant

Table 9: Correlation of total lung ultrasound score.

	r	P value
Length of stay	-0.0611	0.5458
ICU stay (in days)	0.1917	0.0560
Ventilator Days	0.3226	<0.0011*

*statistically significant

Table 10: Mortality and ventilator days spent.

Outcome	Mean (SD)	Median	Range	P value
Discharged	12.96 (4.57)	14	3 to 21	<0.001*
Death	17.69 (2.65)	18	5 to 21	

*There was a statistically significant association between mortality and ventilator days spent (p value <0.005).

DISCUSSION

Shock severity is mainly graded by mean arterial pressure and lactate levels. Several scoring systems have been used for stratifying patients. They can be broadly divided into organ specific or generic scores. APACHE, MPM, SAPS, MODS scoring systems are the common generic scoring systems used in ICU. They are usually used to define the disease severity and for prognostication of the patient.

APACHE and SOFA scoring systems can be used to predict the mortality and outcome of patients. The superiority of APACHE II over SOFA score in predicting mortality is debatable. A study in 2007 showed APACHE II is a good tool in predicting outcome in ICU patients.[38]

However, further research had shown no difference in calibration and discrimination between APACHE II and SOFA scoring systems. Lung ultrasound (LUS) is increasingly used as a bedside tool in critical care practice for volume status, pocus and in detecting fluid in lung. It is an emerging technology used to diagnose not only pleural effusion and pneumothorax but also assessing aeration loss, any lung pathology, extra vascular lung water index (EVLWI). LUS offers an ease to assess lung therapeutics, aeration and alter ventilator settings and guide management at bedside.

The LUSS can be used in guiding the prognosis of the patient, identification of pathological changes, in guiding fluid therapy etc.[13-16] In our study, the demographic data were compared for age, gender and the co-morbidities and different types of shock. Out of the 100 patients studied, 57% were discharged from hospital and 43% expired.

We observed that higher APACHE II scores at admission and at 24 hours post admission correlated with the increased number of days spent by the patient on mechanical ventilator (p value<0.0004, <0.0005) and high mortality (p value<0.0002, < 0.0001). This correlation was found to be statistically significant (p value<0.05).[32] Our study also demonstrated that a higher SOFA scores at 24 hours and 48 hours post admission were associated with high mortality rates and increased number of days spent by patient on mechanical ventilator. The association was found to be statistically significant (p value<0.05).

However, we also observed that higher SOFA scores at 24 hours were associated with increased ICU stay (p value<0.0074). This statistically significant association was not observed for SOFA score at 48 hours. The appropriate intervention and organ support offered during treatment can explain the insignificant p value of SOFA score at 48 hours post admission for length of ICU stay.

However, we did not find any statistically significant difference between APACHE (at admission and 24 hours post admission) and SOFA score (at 48 hours post admission) in terms of length of hospital and ICU stay. Our study also demonstrated that when high total (right and left) lung ultrasound scores were calculated for mortality and ventilator days spent by patient; there was statistically significant difference present (p value<0.005). In our study, we had compared the lung ultrasound scores with APACHE II and SOFA scores. All the three were independently related to mortality as well as increased number of days spent by patient on mechanical ventilator. There was a statistically significant difference associated with all of them.

Limitations in this study include the small sample size of 100, failing to show statistically insignificant changes in terms of length of hospital stay and ICU stay. The second limitation could be the high mortality of 47%, which directly lead to decrease in hospital stay and ICU length of stay and hence statistically insignificant changes. The third limitation of our study is we included all types of shock. Early and definitive intervention in cardiogenic shock results in improved outcome and decreased length of hospital and ICU stay.

CONCLUSION

Higher lung ultrasound scores at admission were directly related with mortality and worse outcome. Higher lung ultrasound scores at admission were also associated with increased length of ventilator days in mechanically ventilated patients. These findings were comparable with high APACHE II and SOFA scores. There were no statistically significant differences in length of hospital stay and length of days spent in ICU.

Recommendations

Lung ultrasound examination to be done in critically ill patients. We recommend calculation of lung ultrasound scores for shock patients for prognostication. We recommend lung ultrasound examination for determining the aeration and guiding fluid therapy in critically ill patients. High quality prospective randomised control trials featuring a larger cohort of population are necessary in developing a standardized lung ultrasound scoring system to further consolidate our results.

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REFERENCES

1. Via G, Storti E, Gulati G, Neri L, Mojoli F, Braschi A. Lung ultrasound in the ICU: from diagnostic instrument to respiratory monitoring tool. Minerva Anestesiol. 2012;78(11):1282-96.
2. Brusasco C, Santori G, Bruzzo E, Trò R, Robba C, Tavazzi G, et al. Quantitative lung ultrasonography: a putative new algorithm for automatic detection and quantification of B-lines. Crit Care. 2019;23(1):288.

3. Miglioranza MH, Picano E, Badano LP, Sant'Anna R, Rover M, Zaffaroni F, et al. Pulmonary congestion evaluated by lung ultrasound predicts decompensation in heart failure outpatients. Int J Cardiol. 2017;240:271-8.
4. Bataille B, Riu B, Ferre F, Moussot PE, Mari A, Brunel E, et al. Integrated use of bedside lung ultrasound and echocardiography in acute respiratory failure: a prospective observational study in ICU. Chest. 2014;146(6):1586-93.
5. Wang XT, Liu DW, Zhang HM, Chai WZ. Integrated cardiopulmonary sonography: a useful tool for assessment of acute pulmonary edema in the intensive care unit. J Ultrasound Med. 2014;33(7):1231-9.
6. Xia Y, Ying Y, Wang S, Li W, Shen H. Effectiveness of lung ultrasonography for diagnosis of pneumonia in adults: a systematic review and meta-analysis. J Thorac Dis. 2016;8(10):2822-31.
7. Lichtenstein DA, Lascols N, Mezière G, Gepner A. Ultrasound diagnosis of alveolar consolidation in the critically ill. Intensive Care Med. 2004;30(2):276-81.
8. Parlamento S, Copetti R, Di Bartolomeo S. Evaluation of lung ultrasound for the diagnosis of pneumonia in the ED. Am J Emerg Med. 2009;27(4):379-84.
9. Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: a severity of disease classification system. Crit Care Med. 1985;13(10):818-29.
10. Soummer A, Perbet S, Brisson H, Arbelot C, Constantin JM, Lu Q, et al. Lung Ultrasound Study Group. Ultrasound assessment of lung aeration loss during a successful weaning trial predicts postextubation distress. Crit Care Med. 2012;40(7):2064-72.
11. Caltabeloti F, Monsel A, Arbelot C, Brisson H, Lu Q, Gu WJ, et al. Early fluid loading in acute respiratory distress syndrome with septic shock deteriorates lung aeration without impairing arterial oxygenation: a lung ultrasound observational study. Crit Care. 2014;18(3):91.
12. Naqvi IH, Mahmood K, Ziaullaha S, Kashif SM, Sharif A. Better prognostic marker in ICU - APACHE II, SOFA or SAP II! Pak J Med Sci. 2016;32(5):1146-51.
13. Sperandeo M, Carnevale V, Muscarella S, Sperandeo G, Varriale A, Filabozzi P, et al. Clinical application of transthoracic ultrasonography in inpatients with pneumonia. Eur J Clin Invest. 2011;41(1):1-7.
14. Forte, D., Ranzani, O., Stape, N. APACHE II and SOFA scores for intensive care and hospital outcome prediction in oncologic patients. Crit Care. 2007;11:93.
15. Narasimhan M, Koenig SJ, Mayo PH. A Whole-Body Approach to Point of Care Ultrasound. Chest. 2016;150(4):772-6.
16. Bouhemad B, Brisson H, Le-Guen M, Arbelot C, Lu Q, Rouby JJ. Bedside ultrasound assessment of positive end-expiratory pressure-induced lung recruitment. Am J Respir Crit Care Med. 2011;183(3):341-7.
17. Zagli G, Cozzolino M, Terreni A, Biagioli T, Caldini AL, Peris A. Diagnosis of ventilator-associated pneumonia: a pilot, exploratory analysis of a new score based on procalcitonin and chest echography. Chest. 2014;146(6):1578-85.
18. Bouhemad B, Liu ZH, Arbelot C, Zhang M, Ferarri F, Le-Guen M, et al. Ultrasound assessment of antibiotic-induced pulmonary reaeration in ventilator-associated pneumonia. Crit Care Med. 2010;38(1):84-92.
19. Volpicelli G, Elbarbary M, Blaivas M, Lichtenstein DA, Mathis G, Kirkpatrick AW, et al. International Liaison Committee on Lung Ultrasound (ILC-LUS) for International Consensus Conference on Lung Ultrasound (ICC-LUS). International evidence-based recommendations for point-of-care lung ultrasound. Intensive Care Med. 2012;38(4):577-91.
20. Rhodes A, Evans LE, Alhazzani W, Levy MM, Antonelli M, Ferrer R, et al. Surviving Sepsis Campaign: International Guidelines for Management of Sepsis and Septic Shock: 2016. Intensive Care Med. 2017;43(3):304-77.
21. Rivers E, Nguyen B, Havstad S, Ressler J, Muzzin A, Knoblich B, et al Early Goal-Directed Therapy Collaborative Group. Early goal-directed therapy in the treatment of severe sepsis and septic shock. N Engl J Med. 2001;8;345(19):1368-77.
22. Vincent JL, Rhodes A, Perel A, Martin GS, Della Rocca G, Vallet B, et al. Clinical review: Update on hemodynamic monitoring--a consensus of 16. Crit Care. 2011;15(4):229.
23. Cecconi M, De Backer D, Antonelli M, Beale R, Bakker J, Hofer C, et al. Consensus on circulatory shock and hemodynamic monitoring. Task force of the European Society of Intensive Care Medicine. Intensive Care Med. 2014;40(12):1795-815.
24. Nguyen HB, Rivers EP, Knoblich BP, Jacobsen G, Muzzin A, Ressler JA, et al. Early lactate clearance is associated with improved outcome in severe sepsis and septic shock. Crit Care Med. 2004;32(8):1637-42.
25. Chung FT, Lin HC, Kuo CH, Yu CT, Chou CL, Lee KY, et al. Extravascular lung water correlates multiorgan dysfunction syndrome and mortality in sepsis. PLoS One. 2010;5(12):15265.
26. Kuzkov VV, Kirov MY, Sovershaev MA, Kuklin VN, Suborov EV, Waerhaug K, et al. Extravascular lung water determined with single transpulmonary thermodilution correlates with the severity of sepsis-induced acute lung injury. Crit Care Med. 2006;34(6):1647-53.
27. Martin GS, Bernard GR; International Sepsis Forum. Airway and lung in sepsis. Intensive Care Med. 2001;27(1):63-79.
28. Fernández-Mondéjar E, Guerrero-López F, Colmenero M. How important is the measurement of extravascular lung water? Curr Opin Crit Care. 2007;13(1):79-83.
29. Via G, Lichtenstein D, Mojoli F, Rodi G, Neri L, Storti E, et al. Whole lung lavage: a unique model for

ultrasound assessment of lung aeration changes. Intensive Care Med. 2010;36(6):999-1007.
30. Lichtenstein DA. BLUE-protocol and FALLS-protocol: two applications of lung ultrasound in the critically ill. Chest. 2015;147(6):1659-70.
31. Naqvi IH, Mahmood K, Ziaullaha S, Kashif SM, Sharif A. Better prognostic marker in ICU - APACHE II, SOFA or SAP II! Pak J Med Sci. 2016;32(5):1146-51.
32. Clerk AM. Lung Ultrasound Score for Prognosticating Ventilator-associated Pneumonia (VAP): Evidence and Wisdom. Indian J Crit Care Med. 2024;28(11):991-2.
33. Govil D, Pachisia AV. Seeing is Believing: The Import of Lung Ultrasound! Indian J Crit Care Med. 2022;26(8):894-5.

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