ORIGINAL RESEARCH PAPER

Medicine

EVALUATE THE UTILITY OF LUNG ULTRASOUND AS A DIAGNOSTIC TOOL IN PATIENTS WITH ACUTE RESPIRATORY FAILURE.

KEY WORDS: BLUE protocol, lung ultrasound, acute respiratory failure

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ABSTRACT

OBJECTIVES To evaluate the utility of the lung ultrasound using the BLUE protocol as a diagnostic tool and analyze all clinical, investigational data of patients and compare the provisional diagnosis made using the lung ultrasound with the final diagnosis. **METHODS** An observational study to evaluate the utility of lung ultrasound using the BLUE protocol as a diagnostic tool in patients with acute respiratory failure admitted to our Respiratory Intensive Care Unit during a period of August 2014 to December 2015 where 100 patients were included in the study. Three items were assessed: lung sliding, artifacts (horizontal A lines or vertical B lines indicating interstitial syndrome), alveolar consolidation, and / or pleural effusion. Venous scan to screen for deep venous thrombosis was done wherever required. Ultrasound equipment used was GE-LOGIQe. It has both the convex and the ECHO probes. The diagnosis obtained by the thoracic ultrasonography with limited echocardiography was compared with clinical diagnosis arrived by the ICU team at the end of the hospital stay. **RESULTS** The mean age of the patients was 65.1±15.08 years. While the mean age in our study was almost similar to that seen in the BLUE protocol (68 years), the difference seen in gender distribution was owed mainly to the large sample size of the previous studies. In our study, Pneumonia was observed in 34% patients with A profile plus PLAPS being the most common finding followed by B' profile and A/B profile. Exacerbations due to COPD/Asthma/ILD accounted for 32% of the total patients in our study with A profile without PLAPS being the commonest pattern on lung ultrasound in patients of COPD/Asthma followed by B profile in patients of ILD. Lung ultrasound does not diagnose COPD/Asthma exacerbations, but rather by ruling out other causes of acute respiratory failure it arrives at the possible diagnosis of COPD/Asthma exacerbations. Pulmonary odema was observed in 23% of patients with B profile without PLAPS being the commonest finding. 9% patients had pneumothorax and A' profile with a posterolateral lung point was present in all the cases. Absence of sliding is not specific as it can be present in other conditions also. The presence of lung point is a very specific finding for the diagnosis of pneumothorax. Both the patients of Pulmonary embolism had A profile with deep vein thrombosis on venous scan. Regardless of the initial profile (A or B), the lower limb Doppler ultrasonography should be done. **CONCLUSION** Majority of our patients presenting with acute respiratory failure in the RICU were males, mostly elderly, in the age group of 60 years and above with significant comorbidities. Our study has demonstrated the excellent diagnostic yield of lung ultrasound using the BLUE protocol as a diagnostic tool for the evaluation of patients with acute respiratory failure. The results obtained in our study were similar and comparable with the studies done in developed countries and this modality can be used with ease and confidence in the evaluation of acute respiratory failure in the Indian settings by non radiologists ICU physicians.

INTRODUCTION

Diagnostic ultrasonography is a diagnostic modality that uses ultrasound sound waves with frequency greater than the upper limit of the human hearing range to image the organ structures in the body. Briefly, a pulse of ultrasound waves is sent from the ultrasound transducer into the tissues and the reflected echoes are displayed as images. Over the last 50 years, several inherent advantages of ultrasonography had led to its widespread use in medical imaging. These advantages include absence of radiation, real time acquisition of images, ease of learning, lower cost, portability, repeatability, no requirement for patient transport, less time consuming and many more.

The utility of ultrasound in clinical practice by non radiologists is well attested in diverse branches like Obstetrics and Gynaecology, Surgery, Emergency Medicine, Pulmonary Medicine, Critical Care, Cardiology, Ophthalmology, Anaesthesiology, Urology etc. Focused emergency ultrasound has been utilized to diagnose acute life-threatening conditions, guide invasive procedures, and also treat emergency medical conditions and has ultimately improved the care of countless patients all over the world.

Lung Ultrasound

Despite the increasing use of ultrasonography, lung was excluded from its purview mainly due to the traditional dogma that ultrasound is of limited utility in air filled structures. The presence of air may cause a complete reflection of the ultrasound beam, preventing the creation of direct image of pulmonary parenchyma. Series of

publications since 1990s began to challenge this misconception and demonstrated that ultrasound can be of value in lung pathologies other than pleural disease. With its distinct advantages and ease of learning, increasingly physicians from specialties other than radiology and cardiology began using it as a bedside tool in the evaluation of the heart and the lung. The scientific bodies in different specialities have issued guidelines for the use of ultrasound in their concerned specialities.

Blue protocol devised by the pioneer of lung ultrasound Dr Daniel Lichtenstein [11], which was designed to evaluate patients presenting with acute respiratory failure. In the lead study published in 2008, it was found that the BLUE protocol had a 89% sensitivity and 97% specificity for diagnosis of asthma or COPD, 97% sensitivity and 95% specificity for cardiogenic pulmonary odema, 81% sensitivity and 97% specificity for pulmonary embolism, 81% sensitivity and 100% specificity for pneumothorax, 89% sensitivity and 94% specificity for pneumonia. The use of the BLUE protocol resulted in overall diagnostic accuracy of 90.5%.

METHODS

The study was an observational, single center case series evaluating critically ill adult patients with acute respiratory failure, admitted to the critical care unit of the department of Pulmonary, Critical Care and Sleep Medicine, Metro Multispeciality Hospital Noida. The findings from the lung ultrasound and ECHO examination performed within 20 minutes of admission were analyzed, without interfering with usual care. Three items were evaluated: lung sliding, artifacts (horizontal A lines or vertical B lines indicative of interstitial syndrome), alveolar consolidation, and / or pleural effusion. Routine investigations like Hemoglobin, Total leucocyte count, Serum Bilirubin, SGOT, SGPT, Serum Proteins, Serum Urea, Serum Creatinine, Serum LDH, Arterial Blood Gas and Chest X-ray were done for all patients. Besides biochemical, radiological, microbiological and pathological investigations were ordered, depending on the specifics of the case. Radiological investigation included CT chest, CT pulmonary angiogram. Specialized investigations were done if a certain diagnosis was suspected. Examples include, Serum BNP for cardiac failure and Serum D-dimer for pulmonary embolism. Comprehensive echocardiography done by an experienced cardiologist department was obtained in certain cases.

Chest ultrasound

The current study includes studies done by ultrasound machine Logiq e (GE Medical Systems, Co. Ltd), Model No: 5199704 with a 4C-RS wide band convex array transducer with a 2 – 5.5 MHz imaging frequency band-width. GE-LOGIQe has three probes, a linear probe of 12 MHz, a curvilinear probe of 4 MHz and a cardiac probe of 3 MHz.

Table 1: Lung Profiles

Lung ultrasound profiles in Acute Respiratory Failure	
Condition	**Lung Ultrasound Findings**
Pneumonia	AB profile, or consolidation or A profile with posterior alveolar syndrome pleural syndrome or both
Acute hemodynamic lung edema	B Profile
Obstructive lung disease (i.e, decompensated COPD or asthma	A profile without DVT
Pneumothorax	A profile with a lung point and no lung sliding
Pulmonary embolism	A profile with DVT

Statistical Analysis

All the data was analysed using the SPSS version 20 software. Categorical data analysed by the Pearson ChiSquare test and quantitative data was analysed by the one sample 't' test, and one way ANOVA. Correlation between two parameters was seen with Pearson's and Spearman's correlation. A 'P' value of less than 0.05 was considered as the level of significance for all statistical tests. The current study involved subjects with acute respiratory failure.

RESULTS

The present study is a retrospective observational study carried out on hundred patients with acute respiratory failure admitted in the Respiratory Intensive Care Unit, Department of Pulmonary, Sleep, Allergy and Critical Care Medicine at the Metro Centre for Respiratory Diseases, Metro Hospital Noida, carried out on the basis of available hospital records. All patients of age more than 18 years of either gender excluding pregnant and ARDS patients were included in the study.

Of the hundred patients included in the study, 72 (72%) were male and 28 (28%) female .Age of the subjects in this study ranged from 23 to 92 years with a mean of 65.10 ± 15.08 years. There was a relatively high representation between 61 to 70 years.

I) Co-morbidities: Out of a total of hundred patients evaluated in this study, 28(28%) patients had Diabetes Mellitus (Type 2), 50 (50%) patients had hypertension, 28(28%) had Coronary Artery Disease while 22(22%) had poor left ventricular systolic function, 10 (10%) had hypothyroidism. 9(9%) had other co-morbidities eg: chronic kidney disease (n=4), chronic liver disease (n=1), anxiety disorder (n=1), delirium (n=1), laryngeal cancer (n=1), parkinsons disease (n=1).

ii) Previously diagnosed lung diseases: Out of hundred patients, 58 patients were already diagnosed cases of COPD, 15 were of asthma, 1 of bronchiectasis, 7 of ILD. 1 patient was diagnosed with Obesity hypoventilation syndrome (OHS), 2 with Obstructive Sleep Apnea syndrome (OSA). 3 patients gave a history of pulmonary tuberculosis (Old PTB), while 3 patients gave history of old tubercular effusion (Old TB effusion). Only 1 patient was a diagnosed case of bronchial asthma who had old pulmonary tuberculosis.

Out of a total of hundred patients, 34(34%) patients had pneumonia, 32(32%) had exacerbation of the underlying disease, 23(23%) had pulmonary odema, 9(9%) had pneumothorax and 2(2%) had pulmonary embolism.

DISCUSSION

Lung ultrasound has become a standard investigation tool in the assessment of critically ill patients with acute respiratory failure. BLUE protocol established for use in acute respiratory failure is one of the popular protocols presently in use. We had enrolled 100 patients, an adequate sample size to evaluate our hypothesis. While 72% of the study population are males, 28% of them are females. The population is fairly distributed among different age categories except an increased numbers in 61 to 70 years category. The mean age of the patients was 65.1±15.08 years. While the mean age in our study was almost similar to that seen in the BLUE protocol (68 years), the difference seen in gender distribution was due mainly to the large sample size of the former studies.

The distribution of the final diagnosis made by the team was analyzed. Pneumonia constituted 34% of the final diagnosis followed by Exacerbation 32%, Pulmonary oedema 23%, Pneumothorax 9%, Pulmonary embolism 2%. The sensitivity and specificity of the lung ultrasound in acute respiratory failure for various diagnoses was calculated. The lung ultrasound in our study had a sensitivity of 88% and specificity of 92% for pneumonia, sensitivity of 81% and specificity of 94% for Exacerbation. Sensitivity of 96% and specificity of 99% for pulmonary oedema. Sensitivity of 100% and specificity of 100% for pneumothorax. Sensitivity of 100% and specificity of 99% for pulmonary embolism.

Table 2: Comparison of our data with Lichtenstein et al (59)

	Present Study		Lichtenstein et al	
Diagnosis	**Sensitivity**	**Specificity**	**Sensitivity**	**Specificity**
Pneumonia	88%	92%	89%	94%
Exacerbation	81%	94%	89%	97%
Cardiogenic Pulmonary edema	96%	99%	97%	95%
Pneumothorax	100%	100%	88%	100%
Pulmonary Embolism	100%	99%	81%	99%

Limitations

The limitations of our study include the relatively small sample size. Some of the patients were transferred from other departments and other hospitals with partial work up previously made which can be accessed from the discharge summaries. Hence our ultrasound examination merely confirms the previous diagnosis or suspected diagnosis. Besides we have included many patients with acute on chronic respiratory failure, though the BLUE protocol was initially designed only for acute respiratory failure.

CONCLUSION

Majority of our patients presenting with acute respiratory failure in the RICU were males, mostly elderly, in the age group of 60 years and above with significant comorbidities.

Our study has demonstrated the excellent diagnostic yield of lung ultrasound using the BLUE protocol as a diagnostic tool for the evaluation of patients with acute respiratory failure.

The results obtained in our study were similar and comparable with the studies done in developed countries and this modality can be used with ease and confidence in the evaluation of acute respiratory failure in the Indian scenario by non radiologists ICU physicians.

Acknowledgement: None
Conflicts of interest: None
Source of funding: None

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