Original Research Paper

Anaesthesiology

A STUDY ON EFFECTIVENESS OF LUNG ULTRASOUND IN COMPARISON WITH CHEST X-RAY IN DIAGNOSIS OF LUNG CONSOLIDATION.

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ABSTRACT Acute pneumonia is considered as a fatal infectious disease which frequently leads to sepsis and septic shock. Community acquired Pneumonia CAP is the most commonly encountered type of pneumonia. Nosocomial pneumonia is pneumonia that develops in patients admitted to hospital for more than 48 hours The current study aimed to evaluate the efficacy of lung ultrasound in diagnosing community-acquired pneumonia (CAP) and Ventilator associated Pneumonia (VAP) in comparison with chest X-ray (CXR). The primary objectives are to study the efficacy of lung ultrasound in the diagnosis and follow-up of CAP as well as in VAP in our ICU versus the standard chest Xrays taken in all Tertiary care hospital ICUs leading to repeated Xray exposures and reduced efficacy to follow up of treatment recieved. In Conclusion Initial Lung Ultrasound proved to be more sensitive in the diagnosis of CAP/VAP associated Lung Consolidation vs CXR, Lung ultrasound was more sensitive (71.88% vs. 98.28%) and accurate (77.50% and 96.25%) than CXR for lung consolidation diagnosis in CAP and VAP patients, for follow up reporting both showed equal efficacy, with superior advantage of USG as it avoided repeated radiation exposures to patients which is seen with CXR. Hence overall efficacy is more of Lung Ultrasound for lung consolidation in pts with CAP and VAP in both initial diagnosis and follow up in ICU setup as seen in study results.

INTRODUCTION

Acute pneumonia is considered as a fatal infectious disease which frequently leads to sepsis and septic shock. Community acquired Pneumonia CAP is the most commonly encountered type of pneumonia. Nosocomial pneumonia is pneumonia that develops in patients admitted to hospital for more than 48 hours. It is dreaded complication which chiefly affects the critically ill patients in a hospital. Ventilator associated pneumonia (VAP) is a pneumonia that develops in a patient mechanically ventilated for at least 48 hours. VAP is second most common nosocomial infection in many ICUs often accounting for one third of the total nosocomial infections. Nowadays, lung ultrasound can be used in the diagnosis of many chest diseases such as pneumothorax, cases of pneumonia, pleural effusions, and pulmonary contusions. In context with the above topic we know that routinely in all ICU setups CXRs are being used to diagnose Lung consolidation in VAP and CAP pts as well as for follow up multiple chest xrays are being used to diagnose treatment response of these pts leading to multiple xray exposures. The current study aimed to evaluate the efficacy of lung ultrasound in diagnosing community-acquired pneumonia (CAP) and Ventilator associated Pneumonia (VAP) in comparison with chest X-ray (CXR). The primary objectives are to study the efficacy of lung ultrasound in the diagnosis and follow-up of CAP as well as in VAP in our ICU versus the standard chest Xrays taken in all Tertiary care hospital ICUs leading to repeated Xray exposures and reduced efficacy to follow up of treatment received.

Ethical Approval:

MATERIAL & METHODS:

Study Design: The present study is a prospective clinical observational study.

Patient population size:

Conducted on 80 consecutive patients with suspected CAP or VAP who were admitted to the Intensive care unit. (TICU).

All patients admitted to our Intensive care unit were evaluated for associated pneumonias by standard CXR followed by Chest Ultrasound and follow up were also done with CXR and Ultrasound to compare the efficacy of both.

Inclusion criteria:

Patients whose age > 18 years and those who were presenting with symptoms of chest infection (e.g. Dyspnea, cough, expectoration, fever, tachypnea and tachycardia) will be included in the study.

Exclusion criteria:

Patients who deny consent to participate in the study.

Data Collection:

Data is collected using semi-structured Proforma. Detailed history including the age, sex, date of admission to the ICU, date of indoor admission, underlying clinical condition, co-morbidities, H/o smoking and chronic alcohol consumption, at ICU admission and the underlying medical illness was noted.

Materials: Portable Xray Machine.
Portable USG Machine.

Both of which are available in our ICU.

Sample size calculation:
Sample size was calculated using the formula:
$$n = [z^2 p(1-p)]/d^2$$
Where: Z = table value of alpha error from Standard Normal Distribution table (0.95)
Power (p) = 80%   Precision error of estimation (d) = 5.5%
$$n = [0.95 \times 0.95 \times 0.8 (0.2)] / 0.055 \times 0.055 = 47.7$$

Hence a sample size of 80 patients was considered adequate for our study.

Statistical Analysis:
is conducted with the statistical package for the social science system version SPSS 20.0. Continuous variables are presented as Mean ± SD or median (IQR) for non-normally distributed data. Categorical variables are expressed as frequencies and percentages. The comparison of normally distributed continuous variables between the groups are performed using Student's t test else Mann Whitney U test will be used for Non-normal distribution data. Nominal categorical data between the groups are compared using Student t-test, Chi-squared test, Fisher's exact test or as appropriate. For all statistical tests, a p value less than 0.05 is taken to indicate a significant difference. Results are graphically represented where deemed necessary. Graphical representation will be done in MS Excel 2010.

RESULTS:
A hospital based prospective, clinical, observational study was conducted with 80 patients to evaluate the efficacy of lung ultrasound in the diagnosis and follow-up of Community acquired Pneumonia (CAP) as well as in Ventilator associated pneumonia (VAP) in ICU

1. Correlation between Positive Initial CXR findings and demographic data

The chest X-rays findings were positive for consolidation in 26 (66.7%) female, 23 (58.9%) diabetic patients and 2 (5.1%) smokers. The number of female patients with CAP was significantly higher compared to male patients (66.7% vs. 33.3%) as per Chi-Square test (p<0.05). There was statistically significant difference between diabetic and non-diabetic patients (58.9% vs. 41.1%; p<0.05) whose chest X-rays were positive for consolidation.

Table 1: Correlation between Positive Initial CXR findings and demographic data

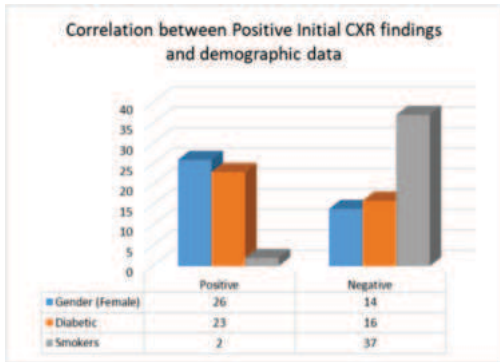| Parameters	Positive		Negative		p value
	N	%	N	%	
Gender (Female)	26	66.7%	14	33.3%	<0.05
Diabetic	23	58.9%	16	41.1%	<0.05
Smokers	2	5.1%	37	94.9%	>0.05

Figure 1:

2. Correlation between Positive Initial Lung Ultrasound findings and demographic data
The lung ultrasound findings were positive for consolidation in 46 (80.7%) female, 49 (85.9%) diabetic patients and 38 (66.7%) smokers. The number of female patients with CAP was significantly higher compared to male patients (80.7% vs. 19.3%) as per Chi-Square test (p<0.05).

There was statistically significant difference between diabetic and non-diabetic patients (85.9% vs. 14.1%; p<0.05), smokers and non-smokers (66.7% vs. 33.3%; p<0.05) whose lung ultrasound were positive for consolidation.

Table 2: Correlation between Positive Initial Lung Ultrasound findings and demographic data

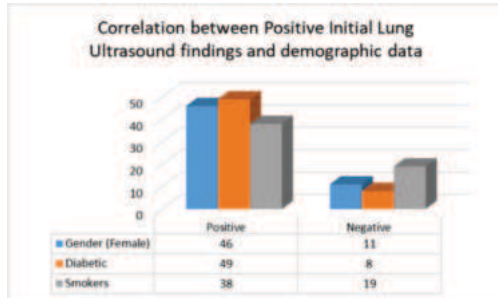| Parameters	Positive		Negative		p value
	N	%	N	%	
Gender (Female)	46	80.7%	11	19.3%	<0.05
Diabetic	49	85.9%	8	14.1%	<0.05
Smokers	38	66.7%	19	33.3%	<0.05

Figure 2:

3. Correlation between Initial CXR, Lung Ultrasound findings and CAP
Initial chest X-ray and lung ultrasound findings were correlated with the diagnosis of CAP. Chest X-ray showed a moderate correlation with CAP diagnosis (correlation coefficient = 0.614; p<0.001) while lung ultrasound showed a strong correlation (correlation coefficient = 0.887; p<0.001) with CAP diagnosis.

Table 3: Correlation between Initial CXR, Lung Ultrasound findings and CAP

Community-acquired Pneumonia		
Initial CXR findings	Correlation coefficient	0.614
	p value	<0.001
Initial Lung Ultrasound findings	Correlation coefficient	0.887
	p value	<0.001

4. Accuracy of Chest X-ray vs Lung Ultrasound
Initial CXR findings diagnosed CAP in 39 (48.75%) patients, while initial lung ultrasound diagnosed CAP in 57 (71.25%) patients. Lung ultrasound was more sensitive (71.88% vs. 98.28%) and accurate (77.50% and 96.25%) than CXR.

Table 4: Accuracy of Chest X-ray vs Lung Ultrasound

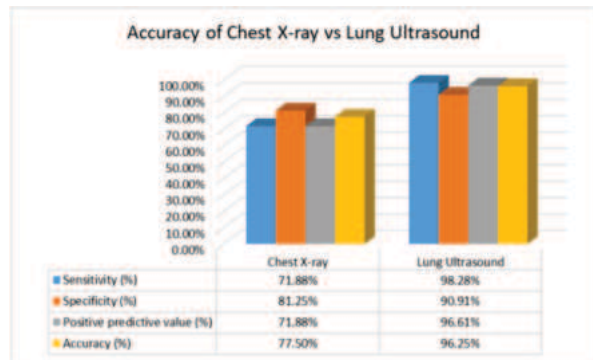|	Chest X-ray	Lung Ultrasound
Sensitivity (%)	71.88%	98.28%
Specificity (%)	81.25%	90.91%
Positive predictive value (%)	71.88%	96.61%
Negative predictive value (%)	81.25%	95.24%
Accuracy (%)	77.50%	96.25%

Figure 3:

5. Correlation between Initial CXR, Lung Ultrasound findings and Demographic data

Both initial CXR and lung ultrasound findings correlated with female gender, diabetes status and smoking status.

Table 5: Correlation between Initial CXR, Lung Ultrasound findings and Demographic

		Chest X-Ray	Lung Ultrasound
Gender (female)	Correlation coefficient	-0.191	-0.294
	p value	<0.05	<0.001
Diabetes	Correlation coefficient	0.204	0.247
	p value	<0.05	<0.001
Smoking status	Correlation coefficient	-0.168	0.251
	p value	<0.05	<0.001

6. Correlation between Chest X-Ray and Lung Ultrasound findings after follow-up

The follow-up chest X-ray and lung ultrasound had strong correlation (correlation coefficient = 0.898; p<0.001).

Table 6: Correlation between Chest X-Ray and Lung Ultrasound findings after follow-up

CAP after follow-up		
CXR (follow-up)	Correlation coefficient	0.898
	p value	<0.001
Lung Ultrasound (follow-up)	Correlation coefficient	0.898
	p value	<0.001

Hence for follow up reporting both showed equal efficacy, with superior advantage of USG as it avoided repeated radiation exposures to patients which is seen with CXR.

DISCUSSION:

CAP and VAP is a leading cause of death. Effective treatment can markedly decrease mortality, which can be caused by this serious disease. Using the lung ultrasound in the emergency department and ICU Set up increase the efficacy and accuracy of CAP and VAP diagnosis.

Early and correct CAP and VAP diagnosis helps to start early and effective treatment. Hence, we can solve this serious issue or at least decrease the morbidity related to it.

In this study, we analysed the characteristic ultrasonography findings, Also we compared the diagnostic sensitivity, specificity, and accuracy of ultrasonography with those of chest X-ray in diagnosing pneumonia in the case of –ve CXR and +ve lung US.

Some studies have shown substantial variability in the interpretation of chest radiographs as well as the risk of cancer development after exposure to multiple radiations in early life.

Reissig A, Gramegna A, Aliberti S. The role of lung ultrasound in the diagnosis and follow-up of community-acquired pneumonia. *European journal of internal medicine.* reported the first prospective study of CAP diagnosis in adults using lung US with an excellent sensitivity of 94% and specificity of 98%.

Recently published papers confirm the high efficacy and sensitivity of lung US.

In Conclusion Initial Lung Ultrasound proved to be more sensitive in the diagnosis of CAP/VAP associated Lung Consolidation vs CXR, Lung ultrasound was more sensitive (71.88% vs. 98.28%) and accurate (77.50% and 96.25%) than CXR for lung consolidation diagnosis in CAP and VAP patients, for follow up reporting both showed equal efficacy,

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CONCLUSION:

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