Lung ultrasonographic findings among adult patients with respiratory symptoms admitted in ICU at Muhimbili National Hospital

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LUNG ULTRASONOGRAPHIC FINDINGS AMONG ADULT PATIENTS WITH RESPIRATORY SYMPTOMS ADMITTED IN ICU AT MUHIMBILI NATIONAL HOSPITAL

By

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A Dissertation Submitted In Partial Fulfillment of the Requirement for the
Degree   of Master of Medicine (Radiology) of the
Muhimbili University of Health and Allied Sciences
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CERTIFICATION

The undersigned certify that he has read and hereby recommend for acceptance by the Muhimbili University of Health and Allied Sciences a dissertation entitled *"Lung ultrasonographic findings in patients with respiratory symptoms admitted in ICU at Muhimbili National Hospital"* in (partial) fulfillment of the requirement for the degree of Master of Medicine (Radiology) of Muhimbili University of Health and Allied Sciences.

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DR. BALOWA MUSA

(Supervisor)

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Date

DECLARATION AND COPYRIGHT

I, **MWANJIA KISINZAH**, declare that this **dissertation** entitled *"Lung ultrasonographic findings in adult patients with respiratory symptoms admitted in ICUat Muhimbili National Hospital"*is my own original work and that it has not been presented and will not be presented to any other university for similar or any other degree award.

Signature_____Date_____

ACKNOWLEDGMENT

DEDICATION

To my Adorable parents Mr. and Mrs. Abdallah R. Kisinzah, for your wonderful care, love, encouragement, and support.

To my beloved family MyEndless love husband Dr. Emmanuel Igoro for your unconditional love, care and support,beloved son and daughter,Ibrahim and Faith respectively your love means the world to me.

ABSTRACT

Background: Lung ultrasound is a bedside, noninvasive investigation tool used by radiologists, radiographers, pulmonary physicians, in Emergency and ICU departments for aiding diagnosis and treatment of pulmonary parenchyma, pleural and thoracic cage disease conditions. The study aimed at determining lung ultrasonographic findings in patients admitted to ICU with respiratory symptoms.

Methodology: We conducted a descriptive cross-sectional study on patients presenting with respiratory symptoms at the ICU of a tertiary hospital. The Principal Investigator performed lung ultrasound according to lung ultrasound protocol. The findings were discussed with the radiologist to reach consensus. The clinical diagnosis was subsequently compared to ultrasonographic findings. A structured questionnaire was used for demographic, clinical and ultrasonographic data recording. Statistical package for social sciences (SPSS) version 23 was used for data analysis and a p-value of 0.05 was considered statistically significant.

Results: The study enrolled a total of 52 patients, most of them were males (67.3%), and Females accounted for (32.7%). The majority of the patients were below 60years of age (75.0%), while those above were(25.0%).Most of the patients with respiratory symptoms in the ICU had a working clinical diagnosis of pulmonary edema(57.7%), followed by Pneumonia(51.9%).While on lung ultrasound, most of the patients in the ICU had pneumonia(55.8%)which wasfollowed by pulmonary edema(46.2%).

The most occurring lung ultrasound pattern observed was lung sliding (90.4%), followed by significant B-lines(3 or more lines) (82, 7%).The predominant findings ofpulmonary edema on lung ultrasound were: Significant B-line (55.8%, vs. 44.2% P value =0.002), Coalesced B-line (80.0%, vs. 20.0%, P-value =0.00), Bilateral B-line (57.1%, vs.42.9% P-value 0.001),

The predominant findings of pneumonia on lung ultrasound were: Tissue like sign with air bronchogram and shredding (100.0%, vs. 0.00%, P-value=0.00),

Unilateral B-line appears with higher significance in diagnosing pneumonia (100.0% vs. 0.00 P-value=0.00).

Conclusion:

This study has shown that, lung ultrasound is a useful imaging modality in diagnosing instant and of bed side pathological conditions of (pleural and pulmonary parenchyma) which cause respiratory symptoms in patients admitted in ICU.

Majority of patients admitted in ICU were males (67.3%). And large number of them were below 60years of age (75.0%),

The most occurring lung ultrasound diagnosis was pneumonia (55.8%), followed by pulmonary edema (46.2%), Significant B-line has relation with pulmonary edema on lung ultrasound diagnosis.

Tissue like sign with airbronchogram and shredding has relation with Pneumonia on lung ultrasound diagnosis.

Recommendation
- Emphasis on further studies with large sample size regarding lung ultrasound is highly recommended.
- Lung ultrasound is safe and efficient imaging tool recommended for diagnosis of lung conditions.
- The study can be used as the baseline for further researches and implementation of the modality at tertiary hospital and the country.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AAL	Anterior Axillary Line
ARF	Acute respiratory failure
BLUE	Bedside Lung Ultrasound in Emergency
CCE	Critical care echocardiography
CCUS	Critical care ultrasound
ICU	Intensive Care Unit
LUS	Lung Ultrasound
MAMC	Muhimbili Academic Medical Centre
MHN	Muhimbili National Hospital
PAL	Posterior Axillary line
PLAPS	Posterior alveolar or pleural syndrome
PLEFF	Pleural effusion
PSL	Parasternal Line
PTX	Pneumothorax
TUS	Thoracic ultrasound
USS	Ultrasound
COPD	Chronic obstructive pulmonary disease

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DEFINITION OF KEY TERMS

Lung ultrasound: is the basic application of critical ultrasound (using sonographic lung artifacts) as a loop associating argent to reach a diagnosis with immediate therapeutic decisions.

Intensive care unit: Is a designated unit within a hospital which is specially staffed and equipped to provide observational care and treatment of patients with actual or potentially life-threatening illness or injury from which recovery is possible.

A medical ventilator or simply ventilator: Is a machine designed to provide mechanical ventilation by moving breathable air into and out of the lungs, to deliver breathes to a patient who is physically unable to breathe or breathing insufficiently.

A-lines: Is a horizontal artifacts arising from the pleural line at regular intervals.

B-lines: Is a comet tail artifacts arising from the pleural line, hyperechoic laser beam like, long without fading, erasing A-lines and moving with lung sliding

Significant B-line: The presence of three or more B-lines per rib interspace in a longitudinal plane.

Coalesced B-line:Multiple and diffuse vertical B-lines per rib interspace in a longitudinal plane.

CHAPTER ONE

1.0 INTRODUCTION AND BACKGROUND

Respiratory symptoms are very common among patients in intensive care units, with variable causes from pneumonia, pulmonary edema, heart failure, respiratory failure, asthma, etc. Investigation and management of underlying chest conditions among these patients are very critical, and most of the times ICUpatients require no significant movements. Lungultrasound (LUS) isvery useful in the investigation of patients in ICU setting. Ultrasonography uses non-ionizing radiation, it is portable so it can be used at the bedside, its diagnostic accuracy close to CT for chest diseases, therefore it can be used when an urgent diagnosis is needed to help with an instant therapeutic decision[1,2].

LUS is useful in the diagnosis of most chest soft tissues, pleural and pulmonary parenchymal diseases. It can be used in the diagnosis of most acute and chronic conditions such as subcutaneous emphysema, pleural effusion, pneumothorax, pneumonia, pulmonary edema, interstitial lung disease, lung abscesses, lung masses, lung contusion, lung infarction and pulmonary fibrosis [3,4].

Lung ultrasound is easy, fastto perform, portable, reiterate, non-ionizing, independent from specific acoustic windows, and therefore suitable for a meaningful assessment in many different settings, both for inpatients and outpatients, acute and chronic conditions[3]. Throughout the years' ultrasound had a variety of uses from determining the amount of pleural effusion, pus and ascites to guiding tapping and drainage, It can also be used in guiding rehydration therapy[5–7]. With all these uses LUS has become progressively important in many different clinical settings, such as the intensive care unit, emergency department, cardiology, pulmonology and nephrology wards[8].

LUS imaging technique is very important in the diagnosis and treatment of critically ill patients, especially in the procedure like drainage of lung empyema and in localized pneumothorax where direct visualization of the lungs is required[9].

LUS usesacoustic artifacts which appear as lines of particular properties which are used in Sonographic assessment to investigate several conditions affecting lung parenchyma, pleura and chest wall [10].

A-Lines represents reverberations artifacts and occurs as horizontal, parallel lines at the same distance from each other, these are normally seen in the healthy lung, These lines can be erased on the affected part of the lung as a result that part will appear with either B-lines or enhanced as in case of pneumothorax[10,11]

B-lines are long wide bands of hyperechoic artifacts that have been correlated to the beam of a flashlight which is fanning out from the lung wall interface. It's similar to a small water-rich structure surrounded by air. B-lines can appear in a healthy individual or in a noninfectious part of the lung, they appear equal or less than three in number and they are separated apart by 7mm. The B-lines only reflect the presence of water in the lungs, but it do not isolate the cause if it is cardiogenic or inflammatory. Severe interstitial edema is shown by closely arranged B-lines while the widely separated ones indicate moderate interstitial edema[12]. The involvement of the septal or alveolar edema is shown by the presence of B-lines either separated or coalesced. Identifications of multiple and diffuse vertical B-lines in lung ultrasound strongly advocates Alveolar interstitial syndrome(AIS)[13–16].

Lung consolidation, the affected part or segment of the lung, appears hepatized (echoic with regular trabeculations) with dynamic air or fluid bronchogram sign bounding it. Airbronchogram move with respiration to signify alveolar consolidation. Pneumonic infiltrate is also characterized by irregular, serrated and somehow blurred margins[17,18]. Atelectasis also appears as consolidation but is differentiated from consolidation because of its association with loss of volume and it shows no movement with respiration [11].

Lung point involves visualizing a point where the visceral pleura (lung) begins to separate from the parietal pleura (chest wall) at the margins of pneumothorax. However, in absence of pneumothorax, the two pleural layers slide along each other creating a series of comet tail artifacts on ultrasound which are referred to as a sliding sign, when air sits in between these two layers no sliding sign is observed, this is seen and called 'absent sliding sign'. Therefore visualization of lung point sign is highly specific forpneumothorax[19,20].

Pleural effusion is a build –up of extra fluid between the tissue that lines the lungs and the chest. Ultrasound can easily detect as small as 5mls of pleural effusion; it can also reveal septations that distinguish between exudate and transudate [21].

Pulmonary edema is the results of imbalance of hydrostatic and oncotic pressure in the capillaries with increased capillary permeability, which causes fluid to get out of the capillaries and accumulate in the tissues. Septal pulmonary edema is due to fluid in the interstitium causing septal thickening while alveolar pulmonary edema is due to fluid in the alveoli. The cause can be cardiogenic or non-cardiogenic. Most of the patients admitted to ICU due to difficulty in breathing presents with pulmonary edema[22,23].Septal pulmonary edema on lung ultrasound present with homogenously separated comet tail artifacts (i.e. SignificantB-line) which are more than 3 in a scanned lung zone. Alveolar pulmonary edema on lung ultrasonography present with diffuse, homogenous and bilateral more than 3 comet tail artifacts (i.e. B-lines) in the scanned lung zone. Also, thoracic ultrasound can easily diagnose pulmonary edema whether cardiogenic or non-cardiogenic[24–26].

Pneumonia is a lung disease characterized by inflammation of the air spaces in the lung, most commonly due to an infection, caused by bacterial, viral or fungi. Anyone at any age can be affected with pneumonia although it is much more common in elderly with chronic medical conditions or those with weakened immune conditions. It occurs in three subsets, community-acquired pneumonia, nosocomial pneumonia and that occur in immune-compromised patients populations[27]. Pneumonia in lung ultrasound presents with 'tissue pattern' of the lung with dynamic air or fluid bronchograms with or without 'shred sign' or it can present with bilateral non-homogenous or unilateral coalescent B-lines[28,29].

Critically ill patients need rapid precise and coherent imaging techniques to diagnose pathology and for follow up on their treatment.Lung ultrasound (LUS) can be performed quickly and easily in critically ill patients. It gives Sonographic artifacts(findings)such as A-lines, B-lines and many others in which by identifying them promptdiagnosis can be made at the bedside.Without theneed of waiting for the examination to be read by the Radiologist. Sonographer or trained physician can do it and get the diagnosis at bedside[5–7]. It has higher diagnostic accuracy than physical examination and chest radiography combined[30]. It

intensifies safety by avoiding ionizing radiation and the need for probable dangerous transfers within the hospital[31]. The Lung ultrasound technique can be used to diagnose several conditions such as pneumonia, acute respiratory failure, pulmonary embolism, pulmonary edema, chronic obstructive lung disease, and asthma just to mention a few(2).

1.2 LITERATURE REVIEW
Socio-demographic

Patients admitted to medical ICU vary in terms of age and sex[32,33]. Previous studies done in urban areas found that more males than females admitted in ICU units with elderly are more than a young age group[34,35], however, another study shows females admitted in ICU were presenting more with co-morbidities[36].

Most common diseases necessitating ICU admission in developing countries are infectious diseases, withsevere pneumonia, blood infections and urinary tract infections on top[37]; Other studies found that non-communicable diseases are on the rise with pulmonary edema from cardiogenic and noncardiogenic causes affecting the majority of patients, in conditions like chronic kidney diseases[38].

Lung ultrasonographic diagnosis in ICU patients is reached by following an establishedlung scanning protocol (algorithm),in order to come up with differential diagnosis, there are number of signs /artifacts which are recognized, these signs/artifacts are as follows: Bat signfor (pleural line), A-linefor horizontal artifacts, B-lines and lung rockets forinterstitial syndrome. Tissue-like sign,shred sign for pneumonia,quad sign, sinusoidal sign for pleural effusion,lung point for pneumothorax[19,39].

Interpretation of lung artifacts depends on the findings which are, predominant A-line or B-line, location as unilateral or bilateral and presence or absence of lung sliding. A-lines are seen in patients with asthma, COPD and those with pneumothorax. however normal lung sliding is seen in Asthma and COPD[40].

Presence of abnormal predominant B-line or consolidation and if localized to one zone or side of the chest the differential diagnosis is limited to localized alveolar interstitial disease such as pneumonia, infarction, and atelectasis. In the case of multiple B-lines and bilateral,pulmonary edema and ARDS should be considered[40].

The most occurring lung ultrasound diagnosis in ICU are pulmonary edema, pneumonia, pneumothorax, pleural effusion, lung contusion, these lung ultrasounddiagnosis can be reached by following a simplified 8 zone protocol on scanning.For the case of pulmonary edema involves the presence of significant, homogeneous, bilateral separated B-line 7mm apart in case of septal pulmonary edema, however in case of alveolar pulmonary edema coalesced B-line 3mm apart are identified[22,41].

B-line characteristics are fundamental in differentiating the type of pulmonary parenchyma water or inflammatory involvement[24–26]. B-line characteristics can be used to determine the cause of difficulty in breathing among symptoms. In most cases significant B-linesare consistent with pulmonary edema[24,25] However significant B-lines can be present in other disorders[23,42]. A significant B-line on one side (unilaterally) may indicatepneumonia; lung infarction; pulmonary contusion; and atelectasis[5,43], Usually presence of bilateral B-lines excludes pneumonia [13]; however it signifies interstitial lung disease or pulmonary edema [23,42]. Pulmonary edema is usually associated with coalesced or diffuse significant B-lines[44]. while the presence of separated B- lines excludes pulmonary edema and is associated with interstitial lung disease [45].

In a study done by Eugenio picano et al pulmonary edema presented with diffuse B-lines whether due to cardiogenic or non-cardiogeniccauses [44]. Primarily pulmonary edema usually involves PLAPS seen in 21.5% of all cases [5,44,46]; however, it sometimes involves lower halves in 1.15% [5,44,46].

 Pulmonaryedema is the most prominent feature in patients with heart failure with reduced ejection fraction and those with methadone intoxication, all of these patients were admitted in

medical ICU and lung ultrasound was used to diagnose their condition. Studies show the prevalence of pulmonary edema in those patients ranged from 75% to 83%[47,48].

Pneumonia

The incidence of pneumonia in ICU varies according to care and diagnostic technique, it ranges from 9% to 24%[49,50]Pneumonia in LUS usually presents with consolidation (tissue-like sign) with shredding associated withor without dynamic air or fluid bronchogram which help to distinguish it with atelectasis. Studies have shown LUS has the sensitivity of detecting consolidation ranging from 94% to 98%[19,51]; while other studies have shown that consolidation with air bronchogram is observed in the range of 60% to 90% in all cases of pneumonia[17,52]. Those presented with consolidation/tissue-like sign only in lung bases(posterior inferior region) were observed in 44(52%) of total patients in the study[39,53]. B-lines in lung ultrasound can appear in normal lung, the most prominent areas are the lateral basal areas, and the percentage of occurrence ranging from 18% to 22%[13,54]. Unilateral focal B-line has been observed surrounding the consolidation mostly on the affected part of the lung.in 20% of all cases of pneumonia in previous studies [13,17,54].

Another study showed patients with pneumonia presents with consolidation (tissue-like sign),shred sign and anterior predominant B-line associate with lung sliding in 75 cases out of 83 cases of pneumonia, those presented with abolished lung sliding were only 6[5,44].

The presence of air bronchogram which moves with respiration helps to differentiate between the consolidation and atelectasis.if there is static or no air bronchogram the diagnosis atelectasis than pneumonia, while dynamic air bronchogram make the diagnosis of pneumonia[31,55].

Pleural effusionis the common finding inpatient admitted in ICU secondary to either heart failure, atelectasis, pneumonia, hydrothorax, or hypoalbuminemia [56].Studies show that the prevalence of pleural effusion varies from 41 to 62% followingnosography on admission and after 24 hours[1,50,57].

On lung ultrasound scanning it is relevant to classify effusion volume into small, moderate or large by measuring the effusion depth of more than 4-5cm in its widest point signify the volume is more than 1000 ml, this is used as the rule of thumb as it is difficult to measure exactly the depth by ultrasound[55].

A study done by E. Prina shows the presence of pleural effusion, consolidation with fluid-air bronchogram suggestive of an infectious cause. This also indicates it's an exudate type of effusion[8].

Sinusoid sign observed on M-mode (movement of collapsed lung in the fluid) is very important to rule out if the anechoic appearance observed on lung ultrasound is pleural effusion or solid lesion. Astudy done by Laing and Filly shows that 20% of the anechogenic images on the pleura was solid lesions and not pleural effusion[8].

Pneumothorax: This isthecondition which mostly develops secondary to other pulmonary diseases in ICU patients, its frequency of occurrence is estimated to be 6% of all patients in ICU,[30].Studies show the incidence of pneumothorax range from 0.01% to 14%[30,39].

Absence of lung sliding is an ultrasonographic sign for the diagnosis of pneumothorax,when combined with the 'stratosphere sign' observed in M-mode is suggestive of pneumothorax[8],

A study done by Lichtenstein et al shows that 41(100%) patients with proven pneumothorax appeared with Absent anterior lung sliding[58].

Presence of 'lung point sign' in pneumothorax has a positive predictive value of 100% in the absence of massive Pneumothorax[8].

1.3 PROBLEM STATEMENT

Chest infections in ICU have a high prevalence ranging from 51% to 69% and most of them need emergency and accurate investigations and management[38,59]. A chest x-ray has been used for a long time but it has low sensitivity compared to LUS[60]. LUS is a recent imaging modality with a number of advantagesover x-rays such as non-ionizing radiation,can be done at the bedside,non-invasive can be repeated as necessaryand it is able to diagnose a number of diseases accurately. Its portability which makes its use in ICU patients comfortable, less technical and easy to the user. However, this technique (LUS) is not yet implemented at Muhimbili National Hospital (MNH) as the first modality of choice. The knowledge about LUS is still very minimal in our local set-up.

Therefore, this study seeks to establish the use of LUS as the modality of choice in diagnosing different diseases in ICU patients presenting with respiratory symptoms.

1.4 RATIONALE

The use of LUS in patients with respiratory symptomsin ICU is of most important as some of the symptoms such as shortness of breath is emergency, so an urgent and accurate diagnosis is of paramount important. The LUS can be done at bedside and the results obtained, followed by patient management. Follow-up serial scanning can be done if there is a need as thismodality has no radiation,with all its advantages this modality is yet to be taken as the first modality of choice for imaging ICU patients with chest symptoms, at our local set-up. The purpose of this study is to establish the use of LUS as modality of choice in diagnosing chest diseases using statistical evidence as support.As the study has not done in Tanzania it canbe used as the baseline reference in further studies at National Hospital (MNH) as well as the whole country.

1.5 RESEARCH QUESTION

1. What are the common lung Ultrasonographic findings in patients with chest symptomsadmitted in ICU at Muhimbili National Hospitals?

2. What are the social demographic data of adult patients with respiratory symptoms admitted in ICU at MNH?

3. What are the Lung Ultrasonographic diagnosis patterns among adult patients with respiratory symptoms admitted in ICU at MNH?

4. What is the frequency of lung ultrasound diagnoses in adult patients with respiratory symptoms admitted in ICU at MNH?

5. What is the relation of pneumonia and lung ultrasonographic characteristics among adult patients with respiratory symptoms admitted in ICU at MNH?

6. What is the relation of pulmonary edema and lung ultrasonographic findings among patients with respiratory symptoms admitted in ICU at MNH?

1.6 OBJECTIVES

1.6.1 BROAD OBJECTIVES

1. To determine the lung Ultrasonographic findings among adult patients with chest symptoms admitted in ICU at MN, from December 2018 to may 2019.

1.6.2 SPECIFIC OBJECTIVES

1. To determine Social demographic data of adult patients with respiratory symptoms admitted in ICU at MNHfrom December 2018 to May 2019.

2. To determine Lung Ultrasonographic diagnosis patternsamongadult patients with respiratory symptoms admitted in ICU at MNH from December 2018 to May 2019.

3. To determinethe frequency of lung ultrasound diagnosesin adult patients with respiratory symptoms admitted in ICU at MNHfrom December 2018 to May 2019.

4. To determine the relation of pneumonia and lung ultrasonographic characteristics among adult patients with respiratory symptom admitted in ICU at MNHfrom December 2018 to May 2019.

5. To determine the relation of pulmonary edema and lung ultrasonographic findings among patients with respiratory symptoms admitted in ICU at MNHfrom December 2018 to May 2019.

CHAPTER TWO

2.0 METHODOLOGY

2.1 Type of study

- The study was a descriptive cross-sectional hospital-based study.

2.2 Study duration

- The study was conducted from December 2018 to May 2019

2.3 Study area

Muhimbili National Hospital (MNH)

The study was done at MNH located in Dar es Salaam city, the commercial capital of Tanzania. The city has five municipal councils (Kinondoni, Ubungo, Kigamboni, Temeke, and Ilala) and is the largest and oldest city in Tanzania. Muhimbili National Hospital is the largest tertiary care, government-owned and run hospital in Tanzania, it serves as a national referral hospital and an instructional teaching hospital for Muhimbili University of Health and Allied Sciences (MUHAS).

- The study was conducted at INTENSIVE CARE UNIT of Muhimbili national hospital(MNH)
- Muhimbili National hospital has medical, surgical ICU's, both have the total number of 33 beds, medical ICU has 15 beds and surgical has 18beds.
- Medical ICU of MNH has a total number of 26 nurses (diploma and degree holder),
- 1intensivist and 3 registrars. Surgical ICU has 34 nurses (certificate, diploma, and degree) 11 attendants, 3 registrars, and 5 specialists.
- MNH ICU hasultrasound machine(GE LOGIC 5, Singapore) with 3 active transducer ports,Linear array 10 MHz, convex array 3 MHz and cardiac sector transducer 3 MHz
- Images were taken and automatically recorded in the ultrasound machine, printed on thermal paper for use in the study.

2.4 study population

- The study included all adult patients admitted in the medical and surgical ICU at MNH with respiratory symptoms.

2.5 technique

The setting

As suggested by Lichtenstein any kind of ultrasound machine and **the transducer** can be used to scan chest,though micro-convex has several advantages for a chest scan and more sensitive for detection of pleural effusion,in its absence abdominal probe (convex)can be used [1,40]

In ICU we used the eight region examination (omitting the posterior zones), on lateral and anterior chest searching for the interstitial syndrome like pulmonary edema and other lung pathologies like Pneumonia, COPD, Pulmonary embolism and Pneumothorax[11].

Scanning of the anterior and lateral chest was done on both hemithorax (right and left) from second to fourth intercostal space and from Parasternal to Axillary line. The contents of the lung, in particular, the proximity between air and water present in the organ causes artifacts, whose interpretation is the basis of LUS. These signs displayed sufficient specificity, constancy, and reproducibility that gives identification of the clinical picture[61].

Figure 1: Ultrasound scan defines the investigation of the anterior chest wall (zone 1) in a supine patient, zone 2 lateral wall; zone 3 Postural lateral chest wall using a short transducer.(Lichtenstein DA et al,2008).

Scanning technique

LUS can be performed on the whole chest, just by laying the transducer in the intercostal spaces, avoiding the ribs. The transducer was positioned both longitudinally, perpendicular to the ribs, and obliquely, along the intercostal spaces. The longitudinal approach allows visualization of the so-called "bat-sign". In a longitudinal view, the bat sign identifies the upper and lower ribs (the wings of the bat) and, a little deeper, the pleural line (the back of the bat). The oblique approach allows visualizing a larger part of the pleural line, which is not interrupted by the rib shadows.
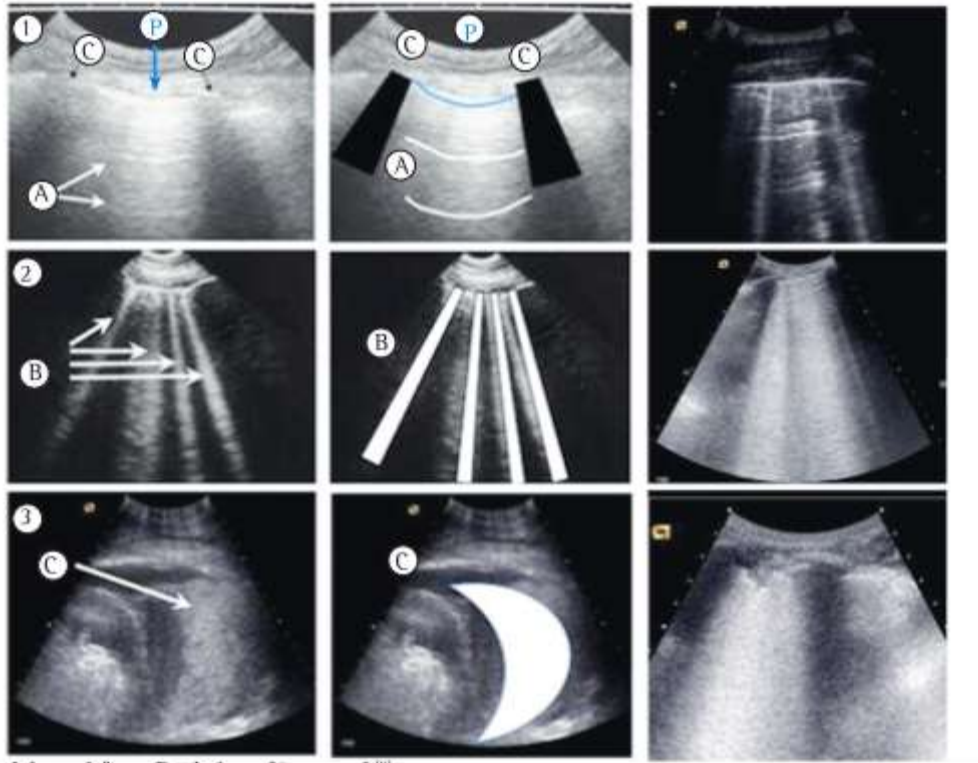
Figure 2: Lung ultrasound finding on left, the center is a schematic presentation, on the right is illustrative examples. P: pleural line, c: ribs, A: A-lines, B: B-lines, C: pulmonary consolidation

- **Panel one: Normal lung aeration** – (A-lines): white (hyperechoic) horizontal lines that are static and appear at regular intervals.
- **Panel two: Partial loss of lung aeration** – (B-lines): hyperechoic vertical artifacts that move in synchrony with the respiratory cycle.
- **Panel three: Total loss of lung aeration** – (consolidation): consolidation image appearing as a tissue structure containing white points consisting of lung parenchyma.

For the courtesy of F.Dexhaimer et al 2015.

2.6 Inclusion criteria

Adult patients above 18 years admitted in ICU**, whose close relative has signed consent to be involved in the study.**

A patient with chest complains such asCough, difficulty in breathing (shortness of breath), chest pain.

2.7 Exclusion criteria

Patients with chest symptoms not able to be scanned due to the operational procedure, burn injury or chest trauma.

2.8 Sampling method

Convenient non-probability sampling was used.

2.9 Sampling size

The sample size calculated from Fisher's formula;

$N = Z^2/E^2 p (100 - P)$

Where N = sample size

Z= (1.96)

P= prevalence 3.4% study done in Greece Interstitial pulmonary disease[62].

Confidence interval 95% will be used.

E= Marginal error 5%

Therefore N=**$1.96^2/0.05^2$ x 0.034(1-0.034)**

=1,536.64 x 0.034(0.9966)

= 52

Sample size will be 52 patients.

2.10 Data collection

Data collection was done byPrinciple Investigator, Scanning and interpretation of the images acquiredthen filling the structured questionnaire. Images were recorded in the ultrasound machine memory and printed on thermal paper.

Data collected included the patient's social-demographic data, the reason for being admitted in ICU, and clinical diagnosis.

Sonographic findings include A-lines, B-lines, Sliding sign, Lung points, Squad sign, and other findings was considered in the questionnaire.

2.11 Imaging and evaluation

Patients underwent lung ultrasound as bedside investigation, using ultrasound machines(GE LOGIC 5 Singapore, Singapore), with convex array 3MHz at MNH medical and surgical ICU. Imaging findings were evaluated by the Principal Investigator and Radiologist working together. The final diagnosis was reached on a consensus.

2.12 Data analysis

Data collection was obtained by scanning patients and recording the signs or artifacts from the patients using a structured questionnaire. Data analysis was done using the Statistical Package for Social Science (SPSS) Version 23. Lung ultrasound signs/artifacts gave the ultrasound diagnosis which we assessed their frequencies. Cross-tabulations were made to establish the frequenciesof different lung ultrasonographic artifacts and diagnosis. P-value of <0.005 was considered significant with 95% confidence interval.

2 .13 Ethical consideration

The researcher made self-introductory to the patientand explain the study also signing the consent form if the patient is conscious, for those unconscious patients the close relative was introduced to the study and required to sign the consent form on behalf of the patient. Data obtained was handled with confidentiality and stored in a secured place.

2.14 Ethical clearance

The research proposal was presented to the Department of Radiology Muhimbili University of health and allied sciences (MUHAS). Ethical clearance was obtained from the research and publication committee of MUHAS; I sought an ethical clearance also from Muhimbili National Hospital for their permission to carry out the study using their premises.

2.15 Study limitations

- Lung ultrasound in ICU is dependent on patient's clinical status.
- Findings are limited to highly specialized tertiary hospital, therefore cannot be generalized to the community setting.

CHAPTER THREE

3.0 RESULTS

3.1 Demographic information

Table 1: Frequency distribution of demographic characteristicsamong patients with respiratory symptoms admitted in ICU who underwent lung ultrasonography from December 2018 to May 2019

	Frequency	Percentage
Demographic characteristics	**N=52**	%
Sex		
Male	35	**67.3**
Female	17	32.7
Age		
Below 60 years	39	**75.0**
60 years and above	13	25

A total of fifty-two (52) patients who were admitted in the Intensive care unit (ICU) were involved in the study. The study sample had ages ranging from 18 years to 95 years, with mean, median and modal age of 48.54, 46.50 and 30 years respectively. The majority of patients were aged below 60 years 39 (75.0%) and 13 (25.0%) were aged 60 years and above.

The majority of patients were males 32 (67.3%) and 17(32.7%) were females.

3.2 Admission diagnosis

Table 2: Frequency distribution of admission diagnosis*among patients with respiratory symptoms admitted in ICU who underwent lung ultrasonography from December 2018 to May 2019*

	Frequency	Percentage
ICU admission diagnosis	**N=52**	**(%)**
Pulmonary edema	30	**57.7**
Lung mass	1	1.9
Post laparotomy	3	5.8
Diabetes mellitus	8	15.4
Acute or Chronic Kidney Disease	3	5.8
Pneumonia	27	**51.9**
Pneumocystis jirovecii pneumonia	4	7.7
Cerebral vascular accident	9	17.3
Acute Respiratory Distress Syndrome	20	**38.5**
Septicemia	7	13.5
Polytrauma	1	1.9%
Hypertensive heart disease	8	15.4%

The majority of patients with respiratory symptoms admitted in ICU had a clinical diagnosis of pulmonary edema (57.7%) which was followed by pneumonia (51.9%).And acute respiratory distress syndrome (38.5%).

And about quota of the diagnosis in ICU involved Cerebral vascular accident (17.3%), less than quota of ICU diagnosis involved hypertensive heart disease and Diabetes mellitus each has(15.4%), The other clinical diagnosis includePneumocystis jirovecii pneumonia (7.7%), Acute or Chronic Kidney Disease and Post laparotomy each has (5.8%) respectively, and the least cases of all are that of Lung mass and trauma each comprise (1.9%).

3.3 Lung ultrasound patterns

Table 3: Frequency distribution of Lung ultrasonography patterns *among patients with respiratory symptoms admitted in ICU who underwent lung ultrasonography from December 2018 to May 2019*

	Frequency	Percentage
Lung ultrasonographic patterns	**N=52**	(%)
Lung point	9	17.3
Lung pulse	7	13.5
Significant B-lines (3 or more lines)	43	**82.7**
Lung sliding	47	**90.4**
Consolidation	18	**34.6**
Pleural effusion	1	1.9

All patients admitted in ICU with chest symptoms had at least one significant lung ultrasonographic finding.

Majority of ICU patients with chest symptoms had lung ultrasonographic presentation of lung slidingsign (90.4%),followed by significant B-line sign (82.7%), Slightly more than one third of patients had consolidation sign (34.6%) more than quota of the patients presented with lung point sign (17.3%), less than quota of the total patients in the study appeared with lung pulse (13.7%) and pleural effusion was only one patient(1.9%).

3.4 Lung ultrasound diagnosis

Table 4: Frequency distribution of diagnosis after lung ultrasonography *among patients with respiratory symptoms admitted in ICU who underwent lung ultrasonography from December 2018 to May 2019*

	Frequency	Percentage
Lung ultrasonographic diagnosis	**N=52**	(%)
Alveolar pulmonary edema	**24**	**46.2**
Interstitial pulmonary edema	0	0.0
Lung contusion	1	1.9
Pneumonia	**23**	**55.8**
Pneumothorax	**3**	**5.9**
Pleural effusion	1	1.9
Subcutaneous emphysema	1	1.9
Atelectasis	0	0.0

Majority of patients in ICU presented withpneumonia55.8%), and all had of Alveolar pulmonary edema(46.2%) , and three quota of the patient in ICU are those with Pulmonary edema(46.2%), (less than quota of ICU patients presents with Pneumothorax (5.9%), the least of all diagnosis in ICU are those of post-trauma with lung contusion (1.9%), pleural effusion(1.9%), and Subcutaneous emphysema (1.9%). and no one presented with Atelectasis.

3.5 Pneumonia by lung ultrasound with significant B-line characteristics

Table 5: Pneumonia on lung ultrasonography by lung ultrasonography Significant B-line characteristics*among patients with respiratory symptoms admitted in ICU who underwent lung ultrasonography from December 2018 to May 2019*

| Lung ultrasonographic findings B-lines characteristics | Pneumonia on Lung ultrasonography | | | X^2 | p-value |
	Yes	No	Total		
Significant B lines	N=23	N=29	N=52		
Yes	17 (39.5%)	26 (60.5%)	43 (100.0%)	2.221	0.131
No	6 (66.7%)	3 (33.3%)	9 (100.0%)		
Unilateral B-lines	N=23	N=29	N=52		
Yes	9 (100.0%)	0 (0.0%)	9 (100.0%)	13.7237	**0.000**
No	14 (32.6%)	29 (67.4%)	43 (100.0%)		
Bilateral B-lines	N=23	N=29	N=52		
Yes	14 (33.3%)	28 (66.7%)	42 (100.0%)	10.514	0.001
No	9 (90.0%)	1 (10.0%)	10 (100.0%)		
Coalesced B-lines	N=23	N=29	N=52		
Yes	14 (46.7%)	16 (53.3%)	30 (100.0%)	0.171	0.680
No	9 (40.9%)	13 (59.1%)	22 (100.0%)		
Separated B-lines	N=23	N=29	N=52		
Yes	9 (42.9%)	12 (57.1%)	30 (100.0%)	0.027	0.87
No	14 (45.2%)	17 (54.8%)	31 (100.0%)		
Homogeneous B-lines	N=23	N=29	N=52		
Yes	21 (42.9%)	28 (57.1%)	49 (100.0%)	0.650	0.420
No	2 (66.7%)	1 (33.3%)	3 (100.0%)		
Non-homogeneous B-lines	N=23	N=29	N=52		
Yes	21 (42.0%)	29 (58.0%)	50 (100.0%)	2.623	0.105
No	2 (100.0%)	0 (0.00%)	2 (100.0%)		

Pneumonia on LUS was significantly found in patients with unilateral B-lines among adult patients admitted in ICU (100.0% vs. 32.6%, P-value= 0.000).

Pneumonia on LUS was not-significantly found in patients with significant bilateral B-lines among patients admitted in ICU (33.3.0% vs. 90.0% P=0.001)

Pneumonia on LUS was not-significantly found in patients with coalesced significant B-lines among patients admitted in ICU (46.7% vs. 46.9%, P-value= 0.680).

Pneumonia on LUS was not-significantly found in patients with separated significant B-lines among patients admitted in ICU (42.9% vs. 45.2%, P-value= 0.870).

Pneumonia on LUS was not-significantly found in patients with homogeneous significant B-lines among patients admitted in ICU (42.9% vs. 66.7%, P= 0.420).

Pneumonia on LUS was not-significantly found in patients with non-homogeneous significant B-lines among patients admitted in ICU (42.0% vs. 100.0%, P= 0.105).

3.6 Pneumonia by lung ultrasound with tissue-like sign, air bronchogram characteristics

Table 6: Pneumonia on lung ultrasonography by lung ultrasonography tissue like sign (i.e. consolidation) and air or fluid bronchogram characteristics *among patients with respiratory symptoms admitted in ICU who underwent lung ultrasonography from December 2018 to May 2019*

Lung ultrasonographic findings tissue like sign (i.e. consolidation)	Pneumonia on Lung ultrasonography		Total	X^2	p-value
	Yes	No			
Dynamic air bronchogram	N=23	N=29	N=52		
Yes	10 (43.5%)	13 (56.5%)	23 (100.0%)	0.009	0.922
No	13 (44.8%)	16 (55.2%)	29 (100.0%)		
Dynamic air or fluid bronchogram	N=23	N=29	N=52		
Yes	18 (100.0%)	0 (0.0%)	18 (100.0%)	34.711	**0.000**
No	5 (14.7%)	29 (85.3%)	34 (100.0%)		
Tissue-like sign (consolidation) with shredding	N=23	N=29	N=52		
Yes	18 (100.0%)	0 (0.0%)	18 (100.0%)	34.711	**0.000**
No	5 (14.7%)	29 (85.3%)	34 (100.0%)		
Tissue-like sign (consolidation) with air or fluid bronchogram and shredding	N=23	N=29	N=52		
Yes	18 (100.0%)	0 (0.0%)	18 (100.0%)	34.711	**0.000**
No	5 (14.7%)	29 (85.3%)	34 (100.0%)		

Pneumonia on LUSwas not-significantly found in patients with dynamic air bronchogram(43.5% vs. 44.8%, P-value=0.922).

Pneumonia on LUS was strongly significant in patients with dynamic or fluid air bronchogram sign with tissue-like sign (consolidation), shredding signwitha tissue-like sign (consolidation) with air or fluid bronchogram and shredding, (100.0%,vs. 14.7%, P-value= 0.000).

3.7 Pulmonary edema by lung ultrasound with sign B-line characteristics

Table 7: Pulmonary edema on lung ultrasonography by lung ultrasonography Significant B-line characteristics *among patients with respiratory symptoms admitted in ICU who underwent lung ultrasonography from December 2018 to May 2019*

Lung ultrasonographic findings B-lines characteristics	Pulmonary edema on Lung ultrasonography		Total	X^2	p-value
	Yes	No			
Significant (3 or more) B lines	N=24	N=28	N=52		
Yes	24 (55.8%)	19 (44.2%)	43 (100.0%)	9.329	**0.002**
No	0 (0.00%)	9 (100.0%)	9 (100.0%)		
Unilateral B-lines	N=24	N=28	N=52		
Yes	0 (0.00%)	9 (100.0%)	9 (100.0%)	9.329	0.002
No	24 (55.8%)	19 (44.2%)	43 (100.0%)		
Bilateral B-lines	N=24	N=28	N=52		
Yes	24 (57.1%)	18 (42.9%)	42 (100.0%)	10.612	**0.001**
No	0 (0.00%)	10 (100.0%)	10 (100.0%)		
Coalesced B-lines	N=24	N=28	N=52		
Yes	24 (80.0%)	6 (20.0%)	30 (100.0%)	32.686	**0.000**
No	0 (0.00%)	22 (100.0%)	22 (100.0%)		
Separated B-lines	N=24	N=28	N=52		
Yes	0 (0.00%)	21 (100.0%)	21 (100.0%)	30.194	0.000
No	24 (77.4%)	7 (22.6%)	31 (100.0%)		
Homogeneous B-lines	N=24	N=28	N=52		
Yes	24 (49.0%)	25 (51.0%)	49 (100.0%)	2.729	0.148
No	0 (0.00%)	3 (100.0%)	3 (100.0%)		
Non-homogeneous B-lines	N=24	N=28	N=52		
Yes	0 (0.00%)	2 (100.0%)	2 (100.0%)	1.783	0.285
No	24 (48.0%)	26 (52.0%)	50 (100.0%)		

Pulmonary edema on LUS was significantly found in patients withsignificant (3 or more) B lines(55.8%, 0.00%. P 0.002).

Pulmonary edema on LUS was not-significantly found in patients with unilateral (0.00%, 55.8%, P 0.002).

Pulmonary edema on LUS was significantly found in patients with Bilateral B-lines (57.1%, vs.0.00%, P 0.00).

Pulmonary edema on LUS was significantly found in patients withcoalesced B-lies(80.0%, vs.0.00%, P 0.000).

Pulmonary edema on LUS was not-significantly foundin patients with separated B-lines (0.00%, vs.77.4%, P 0,000)

Pulmonary edema on LUS was not-significantly found in patients with homogeneous B-lines (49.0%, vs.0.00%, P 2.729)

Pulmonary edema on LUS was not-significantly found in patients withNon-homogeneous (0.00%, vs.48.0%, P 0.285)

CHAPTER FOUR

4.0 DISCUSSION

This is cross section hospital-basedstudy enrolled 52 patients admitted in ICU with the respiratory symptoms, the primary aim of this study was to find lung ultrasonographic patterns in patients with respiratory symptoms admitted in ICU, and relation of the pulmonary edema, pneumonia withlung ultrasound characteristics.

Our study shows in (table 1) patients admitted in ICU were moremales 67.35% than females, the findings are the same as the study done in Manitoba-Canada which showed in the ICU admissions, males were more than female.And the majority of them were below the age of 60years (75.0%) compared to those above 60 years(25.0%). However in a study by Garland A et al more elders were admitted in ICU due to co morbidities. Another difference is the sample size was 12,193 and duration of study was 4years. This current study had sample size of 52 participants for duration of 6 months[34,36].

Admissions diagnosis among patients with respiratory symptoms admitted in ICU, the leading diagnosis is the pulmonary edema (57.7%), among all 52 patients in the study, followed by pneumonia(51.9%) in this includes all types of pneumonia in adults, acute respiratory symptoms comprises of (38.5%),diabetes mellitus and hypertensive heart disease each has (15.4%), the findings are the same as study done by Ali Ugur anal et al 2015,which showedthe most common ICU diagnosis is the hemodynamic instability(48.6%), respiratory failure (27.9%), hypertension(46.8%), the reason for this discrepancy in percentage is the difference in sample size (108 patients) and the mean age of the patients was 77.51, so most of them were elderly patients and larger sample size[63].

Lung ultrasonography gives two main findings(table 3) normal lung findings which are A-lines and lung sliding, and pathological findings which are B-lines, lung point, consolidation and signs of pleural effusion, our study shows that B-line sign (82.7%) is the most prevalent finding and occurs on the anterior chest,which is the same findings in the other study which shows single B-line in lateral zone is normal but multiple B-line on anterior lung is abnormal[11].

A study done by K. Doerschug et al shows multiple B-lines are Sonographic sign of lung interstitial syndrome specifically pulmonary edema. B-pattern sign presents in 100% of patients with acute pulmonary edema, 8% are patients with acute chronic obstructive pulmonary disease[11]. In Table 3Our study shows B-line occurs in 82.7% which is the same findings as in previous studies as the most occurring lung ultrasound pattern the difference in percentage is because in the present study we took acute and chronic cases in which pulmonary edema resolves its signs within 24/hours after starting medication.

Consolidation, as observed in table 3, is the second most common pattern in patients with respiratory symptoms in ICU (34.6%) the findingis different from a study done by Daniel Lichtenstein et al 2009 which showed consolidation appeared to be 98.5% among all cases of pneumonia in patients admitted in ICU. The difference in observation is due to the fact that the study was done on patients with proven pneumonia with a sample size of 52 as in our study. Lung ultrasound was done to prove the presence of consolidation, however in our study there is a mixture of cases and not only pneumonia[64].

Diagnosis following lung ultrasound in patients admitted in ICU with respiratory symptoms our study shows Alveolar pulmonary edema is the second mostfinding (46.2%) as shown in table 4, in a previous study done by Sacche-i-ti et al, supports the findings of the present study, by showing patients who were admitted in ICU from Emergency department most of them presented with pulmonary edema[65].

Pneumonia is the most common lung ultrasound diagnosis in patients admitted in ICU with the respiratory symptoms from table 4,according to the present study (55.8%) among all scanned patient, the results show discrepancy when compared to the previous study done by G.Dandagi et al 2010, which showed the prevalence of nosocomial pneumonia ranges from 9%-20% in patients admitted in ICU and the variation in the findings were due to: they were looking at patients with nosocomial pneumonia only excluding other types of pneumonia. While in the present study were looking at all types of pneumonia this lead to increase number of cases in the present study[49].

A study done by M. Hew et al 2016 in ICU patients showed the prevalence of pneumonia is higher than that of cardiogenic pulmonary edema, the difference in findings from the present

study is because they were dealing with only cardiogenic pulmonary edema and in this study all patients in ICU with respiratory symptoms included[66].

Pneumonia on lung ultrasound with B-line characteristics as table 5 shows unilateral B-line has higher significance value of (100.0% vs. 32.6% P-value= 0.00) which means unilateral B-line with other lung Sonographic signs like consolidation is suggestive of pneumonia, in which the present study findings are supported by the study done by P. Wallbridge et al 2018 which showed the presence of focal B-lines with other Sonographic signs like consolidation is suggestive of pneumonia[67,68].

Other signs on lung ultrasound diagnosis of pneumonia are tissue like sign (consolidation) with shredding, the sign has higher significance in this diagnosis(100.0%, vs. 14.7% P-value=0.00) the sign has also high sensitivity90% and specificity 98% for the diagnosis of pneumonia, the findings are the same as the present study which shows high significance on diagnosing pneumonia[64].

Tissue-like sign with dynamic air bronchogram and shredding sign has a higher significant value also on diagnosis of pneumonia (100.0%, 14.7% P-value=0.00), once the consolidation is seen with air bronchogram is diagnostic of pneumonia and the presence of dynamic air bronchogram exclude the presence of lung atelectasis and in addition at differentiating consolidation caused by pneumonia the lung volume remains the same, while in atelectasis the lung volume decreases. A study done by E.Unluer et al 2014, showed that patients with consolidation and air bronchogram constitute 60% of all patients with pneumonia. The difference in findings can be contributed to the inclusion criteria factor, they took only patients with dyspnea, in contrary to our study we have taken all patients with respiratory symptoms[11,28,64].

Pulmonary edema on lung ultrasound with ultrasonographic findings of significant B-line(3 or more) has higher significance on diagnosing pneumonia as the results from table 7 show (55.8% vs. 0.00% P-value=0.002). This finding is consistent with the oneon a study done by J.Martindale et al 2010 which showed the presence of pathological (significant)B-line is suggestive of pulmonary edema[23].

Bilateral B-line sign is highly significance in lung ultrasound diagnosis of pulmonary edema (57.1 vs.0.00% P-value 0.00) this means B-line sign can be found on a single scanned zone of each hemithorax so long its significant and bilateral its suggestive of pulmonary edema[16]. Coalesced B-line is highly significant sign in diagnosing pulmonary edema by lung ultrasound (80.0% vs. 0.00% P-value= 0.00),this show once B-lines appeared with coalesced with other characteristics as appeared above like significant and bilateral,in addition, this third characteristic is suggestive of pulmonary edema,These findings are consistent with the previous findings in a study done by E.Picano et al 2016 which show the same findings[16].

CHAPTER FIVE

5.0: Conclusion and recommendation

5.1: CONCLUSION

In ICU admitted patient's majority were males (67.3%) than females (32.7%).

Those who had positive ultrasound findings more were below 60years of age(75.0%) and those above 60years were(25.0%).

The most occurring lung ultrasound diagnosis was pneumonia(55.8%), followed by pulmonary edema(46.2%)

Generally, most occurring lung ultrasound patterns are lung sliding 42(90.4%), and significant B-line(3or more lines) (82.7%).

Pulmonary edema on lung ultrasound diagnosis presents with significant B-line(55.8%, vs. 0.00% P-value 0.002), Coalesced B-line(80.0%, vs. 0.00%, P-value 0.000) and bilateral B-line (57.1% vs. 0.00% P-value=0.001).

Pneumonia by lung ultrasound presents with, tissue-like sign with air bronchogram and shredding has higher significance (100.0%, vs. 0.00% P-value=0.000).

Unilateral B-line has higher significance in diagnosing pneumonia (100.0%,vs. 0.00% P-value=0.000).

5.2: RECOMMENDATIONS

We call for more studies regarding lung ultrasound in different departments like EMD, Internal medicine as patients with chest symptoms can present with different lung conditions.

Further studies are needed in each specific condition for more quantification and comparison with the current modalities which are used now in ICU like x-ray, CT scan.

Lung ultrasound is a safe and efficient imaging tool recommended for the diagnosis of lung conditions.

Results in this study support the use of lung ultrasound as the modality of choice in patients with respiratory symptoms admitted in the intensive care unit.

The study can be used as the baseline for further researches for more improvement.

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ANNEX AND APPENDICES:

Annex 1.
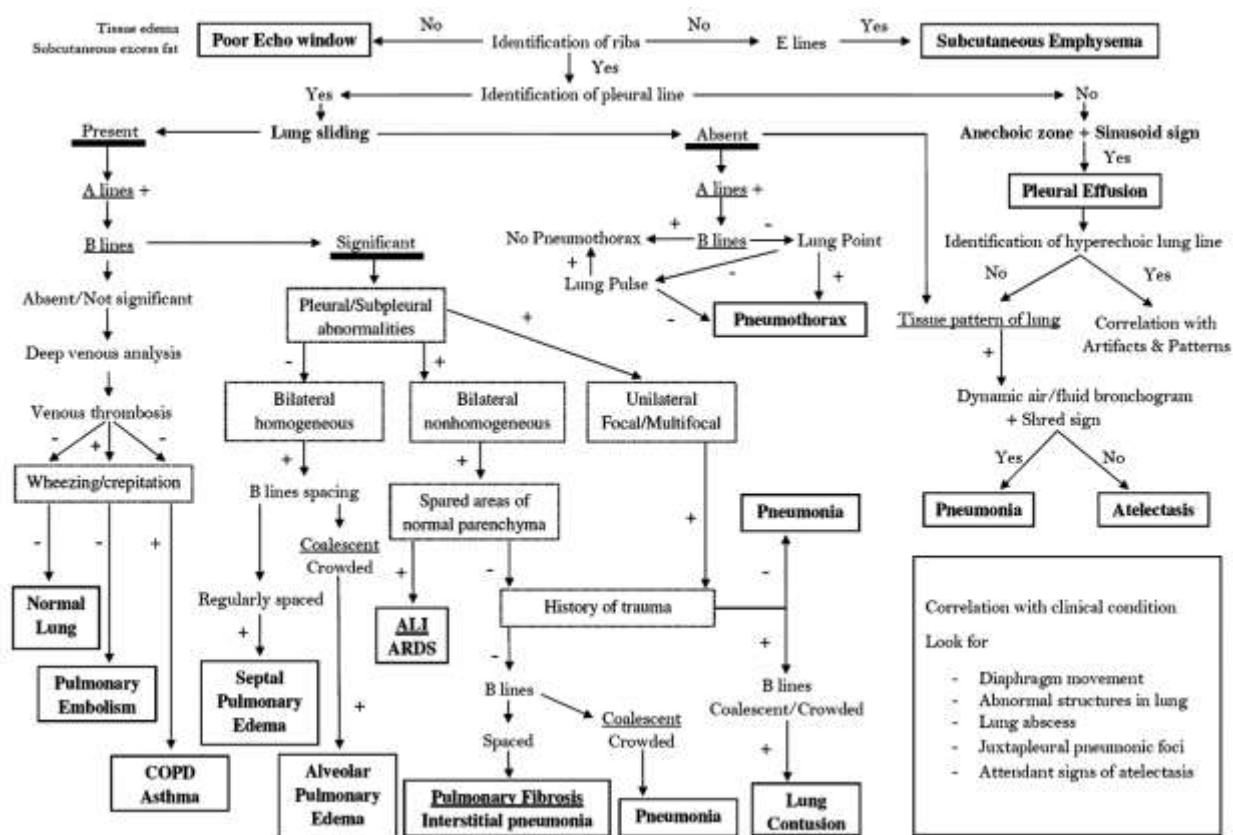
Figure 3:Algorithm chart showing lung ultrasound artifacts and diagnosis(for the courtesy of DA Lichtenstein)

Figure 4: Patient presented with shortness of breath, on lung ultrasound appeared with significant Coalesced B-line, and had ultrasound diagnosis of Alveolar pulmonary edema (Images acquired from ICU MNH).

Figure 5: The image of polytrauma patient with shortness of breath, lung ultrasound shows hemorrhagic pleural effusion (Images acquired from ICU-MNH)

Figure 6: patient presented with shortness of breath, lung ultrasound shows tissue like sign consistence with pneumonia (Images acquired from ICU-MNH)

Appendix 1:Questionnaire and Checklist

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCE

SCHOOL OF MEDICINE-DEPARTMENT OF RADIOLOGY

P.O.BOX 65001

DAR ES SALAAM
Identity number…………

Part A:Patient's social demographic data
 Age……………years
Sex (a)F   (b)M
Risk factors
  Occupation…………
   Cigarette smoking………
   Exposure to allergens…..

Part B: Top ten diseases in patients with respiratory symptoms in ICU

       1.Pneumonia

       2.Respiratory failure

       3.Interstitial lung disease

       4.Pulmonary edema

       5.Chronic kidney disease/ End-stage renal disease

6. Sickle cell disease with chest symptoms

Patient's (clinical) Working diagnosis………………………………

Part C. Ultrasound findings and diagnosis

S/No	Parameter	Description		Location
1.	Identification of ribs	1. Yes	**2. No**	
1	A-lines	1. Yes	**2. No**	
2	Lung point	**1. Yes**	2. No	
3	Lung pulse	3. Yes	**4. No**	
4	B-lines	**1. Yes**	5. No skip to Q. 7	
5	No of B lines……….	1. Less than 3	**2. 3 or more**	
6	B-line characteristics	1. Separated	2. Coalesced	
7	Lung sliding	1. Yes	**2. No**	
8	Consolidation	**1. Yes**	2. No	
9	Tissue-like sign	**1. Yes**	2. No	
10	Shredding sign	**1. Yes**	2. No	
11	Air bronchogram	1. Yes	2. No	
12	Fluid bronchogram	1. Yes	2. No	
13	Dynamic air/fluid bronchogram	1. Yes	2. No	1. …………………… 2……………………
14	Pleural line	1. Yes	2. No	
15	Pleural line characteristic	1. Smooth	2. Irregular	
16	Characteristics of the pleural surface	1. Thin	2. Thick	
17	Sinusoid sign	**1. Yes**	2. No	
18	Pleural effusion	**1. Yes**	2. No	
19	Characteristics of pleural effusion	1. Anechoic	**2.** Internal echoes	
	Pleural/subpleural abnormalities	1. Yes	2. No	
20	Bilateral pleural abnormalities	1. Yes	2. No	
21	Spared areas of normal	1. Yes	2. No	

	lung parenchyma		
	Summary of diagnosis		
	1. Subcutaneous emphysema	1. Yes	2. No
	2. Pneumothorax	1. Yes	3. No
	2. Pleural effusion	4. Yes	5. No
	3. Pneumonia	6. Yes	7. No
	4. Atelectasis	8. Yes	9. No
	5. Lung contusion	10. Yes	11. No
	6. Septal pulmonary edema	12. Yes	13. No
	7. Alveolar pulmonary edema	14. Yes	15. No
	8. ARDS	16. Yes	17. No
	9. Interstitial pneumonia	18. Yes	19. No
	10. Empyema	20. Yes	21. No
	11. Haemothorax	22. Yes	23. No
	12. Asthma	24. Yes	25. No
	SCAN PLANES	**Abbreviations**	
	Right anterior upper	RAU	
	Right anterior lower	RAL	
	Right lateral upper	RLU	
	Right lateral lower	RLL	
	Right posterior upper	RPU	
	Right posterior lower	RPL	
	Left anterior upper	LAU	
	Left anterior lower	LAL	
	Left lateral upper	LLU	
	Left lateral lower	LLL	
	Left posterior upper	LPU	
	Left posterior lower	LPL	
	All Zones	ALL	

APPENDIX II**: Consent form (English Version**)

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCE

DIRECTORATE OF RESEARCH AND PUBLICATIONS, MUHAS

ID-NO………

Consent to participate in a study

My   name   is   Dr.   Mwanjia   Kisinzah: I   am   conducting   a   study   on   LUNG ULTRASONOGRAPHIC

 FINDINGSIN ADULT PATIENTS WITH RESPIRATORY SYMPTOMS ADMITTEDIN ICUAT MNH.

Study purpose

The study was conducted as partial fulfillment of the requirements of Radiology at MUHAS. The study was also conducted to show how lung ultrasound is important in ICU patients as the first modality of choice.

How to be involved

Patients will sign the informed consent form or the close relative will sign on behalf of the patient according to the patients' situation.

Confidentiality

The information obtained will be confidential unless the need arises to be shared with doctors in ICU, the dr. will be advised to order the investigation so that can get the results and serve patient. No name will appear on any documents of this study instead identification numbers will be used.

Participation and the right to withdraw

Involvement in this study was voluntary. You can participate or refuse to participate in this study. Refuse to participate in this study not interfere with your management.

Benefits

The findings we got will help us to implement and improve this modality in our setup and the country as a whole.

Contact Personally

If you have any question about this study, you should contact the Principal Investigator, Dr. Mwanjia Kisinzah Muhimbili University of health and allied science

P.o. box 65001 Dar es Salaam. Telephone 0756539003

Or in case you have questions about your rights of participation in this study you may contact Dr. Joyce Masalu- chairperson of the Senate Research and publications Committee,

P.o. Box 65001 DSM.

Dr. BalowaMussa who is the supervisor of this study: Tel +255 788002506

Participants agree…………………

I……………………………………….have read the contents in this form. And understand.

I am willing to participate in this study.

Signature of participants…………………………..Date…………………..

Signature of researcher…………………………….Date…………………..

Appendix II: Consent Form (Swahili Version)
IdhiniyaKushiriki:

Sehemu A:

Utambulisho

Mimi ni Dr. MwanjiaKisinzah,Mwanafunziwa Chuo kikuu cha Afya cha Muhimbili (MUHAS) IdarayaRadiolojia, NachukuashahadayauzamiliyaRadiolojia (MMED) ninafanyautafitijuuMuonekanowamapafukwakutumiakipimo cha Ultrasound kwawagonjwawenyedalilizashidayanjiayaupumuajiwaliolazwawodiyawagonjwamahututihosp italiyataifa Muhimbili.

HivyounakaribishwaushirikikwenyeutafitihuuambaounaangaziaMuonekanowamapafukwakut umiakipimo cha Ultrasound kwawagonjwawenyedalilizashidayanjiayaupumuajiwaliolazwawodiyawagonjwamahututihosp italiyataifa Muhimbili. Karibuushirikikatikautafitihuu.

Dhumuni la Utafiti

Dhumuni la utafitihuunikutathimininakuonyeshanikwakiwangoganikipimo cha Ultrasound yamapafukinawezaakuonyeshaugonjwauliopokatikamapafu,faidazakutumiakipimohikibadalay avinginevilivyokuwavikitumika(x-ray na CT scan) kamachaguo la kwanza , vile vilekusaidiakuanzamatumiziyahikikipimokwawagonjwawaliolazwawodiyawagonjwamahututi , hospitalinanchinzima. AidhataarifahizizitamsadiamtafitikuhitimushahadayakeyauzamivuyaRadiolojia.

TaratibuzaUtafiti
Taarifamuhimuzinazohitajikakutokakwakozitaingizwakwenyefomumaalumyakukusanyiataaarif a.Taarifahizozinahusudalilimbalimbaliambazozinaashiriamgonjwakuwaanatatizokatikamapafu , piamgonjwaanawezahitajikufanyakipimo(Ultrasound yamapafu)zaidiyamaramoja, kwaajiliyakufatiliamatibabu.

AtharinaFaidazaKushirikikwenyeUtafiti

Hakunaatharizozotezinazowezakujitokeza. Vile vilekwakushirikikwenyeutafitihuuutafaidishataifanahospitalikwaujumlakufanikishakuanzisha matumiziyakipimohichiwodizawagonjwamahututi, hospitaliyataifa Muhimbili nanchinikote.

Siri

Taarifazotezitakazokusanywazitajazwakwenyefomumaalumnazitakuasiri, Jinalako au nambayakoyasimuzitatumikakwamadhumuniyamatibabunakufuatiliamaendeleoyako.

TaarifazaMshiriki

Ushirikiwakokwenyeutafitihuuniwahiari, unawezakushiriki au kutoshiriki,Aidhaunawezakujiondoakushirikinahautaathirimatibabuyako

Endapounahitajikupatamaelezokuhusuhakizako au taarifa, wasilianana Dr MwanjiaKisinzah, 0756539003 au DrBalowa Musa Balowa. wachuokikuu cha Afyanatiba Muhimbili kitengo cha Radiolojia. Kama unaswlilolotekuhusuhakiyakokamamshirikiwasilianana Dr. Joyce Masaluambayenimkurugenziwabodiyautafitichuokikuu cha AfyanaTiba Muhimbili, kwa S.L.P 65001 numbayasimu +255222152489 Dar es Salaam.