LUNG ULTRASONOGRAPHIC PATTERNS OF PNEUMONIA IN PEDIATRIC PATIENTS WITH RESPIRATORY SYMPTOMS ADMITTED AT MUHIMBILI NATIONAL HOSPITAL AND MUHAS ACADEMIC MEDICAL CENTRE.

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Department of Radiology and Imaging

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By

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Dissertation submitted in (partial) fulfillment of the Requirement for Degree of Master of Medicine (Radiology) of

Muhimbili University of Health and Allied Sciences
October 2019

CERTIFICATION

The undersigned certify that he has read and hereby recommend for acceptance of Dissertation entitled ***"Lung ultrasonographic patterns of pneumonia in pediatric patients with respiratory symptoms admitted at Muhimbili National hospital and MUHAS academic medical centre"*** in fulfilment of the requirement for the degree of Master of Medicine (Radiology) of Muhimbili University of Health and Allied Sciences

_____

Dr Musa Balowa

(Supervisor)

Date: _____

DECLARATION AND COPYRIGHT

I, Erick Michael, declare that this **dissertation** entitled **"Lung ultrasonographic patterns of pneumonia in pediatric patients with respiratory symptoms admitted at Muhimbili National hospital and MUHAS academic medical centre"** 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_____

ACKNOWLEDGEMENTS

First of all, I thank God, the Almighty for keeping me healthy enough to be able to complete this work.

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DEDICATION

This dissertation is dedicated to

My lovely Family

My beloved wife Jonesta V Mbuguje for her tender loving care and support during my studies

And our lovely sons Bravo and Joe E.Mbuguje

ABSTRACT

Background: Pneumonia is a form of acute lower respiratory tract infection caused by viruses, bacteria and fungi and is the leading cause of death in children aged below 5 years worldwide and more occurs in developing countries. This study aimed at assessment of lung ultrasonographic findings of pneumonia among pediatric patients with respiratory symptoms pneumonia

Methodology: This is descriptive cross-sectional, hospital based study enrolled 110 children with respiratory symptoms suspected of pneumonia undergone lung ultrasound. US was used for imaging and image evaluation was done by PI and Radiologist after reaching conscious. Analysis was done using Statistical package for social sciences (SPSS) version 23.Descriptive analysis was done using frequency and proportional for categorical variables and mean (standard deviation) for continuous variables. The main outcomes sonographic findings were computed as proportions of cases positive by LUS .The diagnostic ability was computed as outcome of the sensitivity, specificity and positive predictive value of standard clinical diagnoses compared to LUS as the gold standard. Chi-square P-value of <0.05 was considered statistically significant at 95% CI.

Results: Of a hundred and ten children; majority 91 (82.7%) were below five years; and majority were male 79 (71.8%) Pneumonia was slightly non-significantly more in children aged below five years (65.9% vs. 63.2%, p=0.56).

Most children presented with cough 106(96.4%), fever 104(94.5%) and difficulty in breathing 92(83.6 %). More than half of children had clinical diagnosis of pneumonia 58 (52.7%).

Difficulty in breathing was significantly associated with pneumonia (70.7% vs. 38.9%, p-value=0.010). However Fever (67.3%vs33.3; p=0.179), cough (67.0 % vs. 33%; p=0.118), lethargy (0% vs. 100%; p= 0.145) and vomiting everything (100% vs. 0%; p=0.387) were not significantly associated with pneumonia.

Seventy two (65.5%) of children had LUS findings of pneumonia. Majority of patients (58.2%) had significant B lines, less than one third (29.1%) had consolidation and one fifth

(20.9%) had pleural effusion. Lung ultrasonographic patterns associated with pneumonia were significant B-lines (p=0.000) and consolidation (p=0.00).

Among 72 children with LUS findings of pneumonia only 52 were diagnosed clinically as having pneumonia sensitivity of 72.2%, Specificity 84.2%, Positive Predictive Value of 89.7%, and Negative predictive value of 61.5%, P-Value 0.00)

Conclusion: Pneumonia diagnosis by LUS was significantly more than by clinical diagnosis, with Clinician performance in the diagnosis of pneumonia as compared to LUS had a sensitivity=72.2%,specificity 84.2%, Positive Predictive Value of 89.7%, and Negative predictive value of 61.5%, P-Value 0.00). Pneumonia by LUS was significantly associated with difficulty in breathing (70.7% vs. 38.9%, p-value=0.010), Significant B lines (p=0.000) and consolidation (p=0.000).

Recommendations: LUS is superior to clinical diagnosis in detecting pneumonia and can be used or aid clinician in the diagnosis of pneumonia in paediatrics. Large similar study to be conducted with large sample size and include health facilities at different all levels of health care delivery to show the generalizable magnitude of performance of clinician against LUS in the diagnosis of pneumonia.

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LIST OF ABBREVIATIONS

CT	COMPUTED TOMOGRPHY
CXR	CHEST X RAY
LAL	LEFT ANTERIOR LOWER
LAU	LEFT ANTERIOR UPPER
LLL	LEFT LATERAL LOWER
LLU	LEFT LATERAL UPPER
LPL	LEFT POSTERIOR LOWER
LPU	LEFT POSTERIOR UPPER
LUS	LUNG ULTRASOUND
MAMC	MUHAS ACADEMIC MEDICAL CENTRE
MNH	MUHIMBILI NATIONAL HOSPITAL
RAL	RIGHT ANTERIOR LOWER
RAU	RIGHT ANTERIOR UPPER
RLL	RIGHT LATERAL LOWER
RLU	RIGHT LATERAL UPPER
RPL	RIGHT POSTERIOR LOWER
RPU	RIGHT POSTERIOR UPPER
SPSS	STATISTICAL PACKAGE FOR SOCIAL SCIENCES
TSH	TANZANIA SHILLINGS

DEFINITION OF TERMS

1. Anterior Posterior dimension (AP) -Dimension relating to both front and rear.
2. Anthropometry measurements- Measurements of the size, weight and proportions of the human body
3. CT -Radiography in which three dimensional image of a body structure is constructed by computer from a series of plane cross-sectional images made along an axis
4. Echogenicity -Extent to which a structure gives rise to reflections of ultrasonic waves
5. Echogenic-Structure intensely reflecting sound waves rather than transmitting them in ultrasound
6. Hypoechoic-Structure that reflect relatively few of the ultrasound waves.
7. MRI-Medical imaging technique that uses magnetic field and radio waves to create detailed images of the organs and tissues within the body.
8. Plain radiography-Medical imaging of body using x-rays
9. Ultrasound-Type of imaging that uses high frequency sound to visualize organs and structure inside the body.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Pneumonia is a form of acute respiratory infection that affects the lungs by causing inflammation of the lung parenchyma by microbial agents[1]. Pneumonia is caused by a number of infectious agents, including viruses, bacteria and fungi which determines severity, onset of disease and mortality.[2–4] Pneumonia follows upper respiratory tract infections including nose, pharyngitis and otitis media. Epiglottis separates the upper and lower respiratory tract, where by the lower respiratory tract is termed as sterile.[2,3,5] There are natural body mechanism (reflex coughing /immune responses). [2,6–9] which prevent the spread of infection from the upper to the lower respiratory tract, when these protective mechanisms are defeated, the infections of lower tract occurs. The infection of lower respiratory tract includes infection of the larynx, trachea bronchial bronchioles and alveoli's causes pneumonia.[2,7,9–11].

Lower respiratory tract infections are leading cause of death in children aged below 5 years worldwide [10] pneumonia is responsible for 1.6 million deaths and it occurs more in developing countries[12]. The prevalence of acute respiratory infection among children in is 5% in demographic health survey of 2015-16year.[13]

Early detection, proper management including referral and treatment of pneumonia reduces case fatality hence generally reduces the global burden of pneumonia.[7] Detection of pneumonia among children is usually done clinically and imaging such as chest radiography, ultrasound or computed tomography can aid in the diagnosis of subtle cases or to determine other causes of chest abnormalities.[11,12,14,15]

Currently LUS is not included officially in diagnosis of pneumonia in children and adults; however,LUS is a very simple, rapid, portable, repeatable to perform it and ,does not utilize ionizing radiation. [16–18][19][14] The use of non-ionizing radiations is very important to children and infants as they have a high risk of cancer development from radiation exposure as compared to other age groups.[20] The use of LUS is of high consideration in determining chest

abnormality as it has proved to yield good results in showing bronchiolitis and pneumonia. [18]; and has shown good outcomes superior to CXR when CT scan is taken as gold standard. [16,17]

Also LUS has been useful for diagnosis of pneumonia in wards and emergency conditions yielding the same results as CT in some studies. [19][14]

Lung ultrasound is safe, can be done as a bedside investigation and uses acoustic artifacts which sonographically assesses the lungs and chest wall to determine several conditions affecting lung parenchyma, pleura and chest wall.[19]

Pneumonic lung on ultrasound can present with one or more of the following characteristics or patterns namely consolidation, [14,16,21–31] pleural effusion, [21–29,31–33], significant B-lines [14,22,24–27,31,33–36], pleural line abnormality, [21,25–27] lung pulse [27] and also may present with A lines. [16,25,27,28,31]

LUS consolidation characteristics for pneumonia are tissue like sign with shredding sign, [14,16,21–29,31], or consolidation with dynamic air bronchograms or fluid bronchograms, [26,31,37–40] or both air and fluid bronchograms.[26,27]

Consolidations with shredding sign and dynamic air or fluid bronchogramsare very specific for pneumonia [14,21–24,26,27,30,31,35,36,40] ; its presence signify alveolar syndrome which can also be called alveolar pneumonia. [2,32,41]

Consolidations that are not characteristic for pneumonia present with diffuse lobar or tissue like sign without shredding sign and no dynamic air or fluid bronchograms this is characteristic of atelectasis.[32,37,41]

LUS can also be used in the diagnosis of interstitial pneumonia by observing B-line characteristic patterns. B‑ lines are LUS discrete laser like vertical hyperechoic reverberation artifacts that arise from the pleural line extending to the bottom of the screen without fading, and moving synchronously with lung sliding. A characteristic region is defined by the presence of three or more B‑ lines in a longitudinal plane between two ribs with either

unilateral coalescent or crowded B-lines or bilateral non-homogenous coalescent or closely spaced B-lines .[14,26,37,38,42–48)]

Multiple B line which are not characteristic for interstitial pneumonia are bilateral homogeneous closely spaced (≤3 mm) or coalescent B‑ lines which are characteristic of pulmonary edema [14,37,44)] or less than 3 and in the last intercostal space of the inferior zones in a longitudinal plane.[14,37,44)]

Pleural effusion, characteristic for pneumonia in LUS is anechoic or hypoechoic fluid, with or without floating debris[14,16,32,37,49)]; the fluid usually is small in amount, mostly unilateral with or without internal echoes .[32,37,41,47,48,50,51)] Pleural effusion which is less likely to be due to pneumonia or caused by other causes includes large amount of effusion and bilateral presentation.[18,32,38,47,48,50–55)] LUS has 93% diagnostic accuracy for detecting pleural effusion than auscultation 63% or normal CXR 47%.[34,56–58)]

A LUS characteristic for a normal lung is seen when the pleura appears as a regular echogenic line moving continuously during respiration. Beyond the pleura, the lung is filled with air and does not allow further visualization of normal lung parenchyma. The large change in acoustic impedance at the pleura–lung interface results in horizontal artifacts, defined as A-lines, that are seen as a series of echogenic parallel lines distally and are equidistant from one another.[46)(37)]

The aim of this study is to define sonographic patterns of children diagnosed with pneumonia and to evaluate correlation between clinical diagnosis and ultrasound findings during admission.

1.2 Literature review

The diagnosis of pneumonia in children is currently mainly from patients presentations and physical examination, CXR is reserved for severe cases. CT scan is however used as a gold standard but its use has limitations due to high radiation doses. [9,59]

Different studies has shown that diagnosis of pneumonia is mainly by use of the WHO case management algorithm[9]; and on its use clinicians have sensitivity variation in children ranging from 69.6% to 94% and specificity ranging from 39%-98%. [6,8,11,14,60]

LUS sensitivity reported to range from 92% to 100% ,specificity 64% to 100% with more than 90% accuracy in diagnosing pneumonia when compared to clinical diagnosis using either CXR or CT as a gold standard.[31,48,61–66] Ameta-analysisfound high LUS sensitivity in diagnosing pneumonia with sensitivity of 95% and specificity of 93%. [64]However, LUS sensitivity is higher in children than in adults whereby in one meta-analysis sensitivity was 96% (95%CI,94%-97%), specificity 93% (95%CI,90%-96%) PPV 15.3(95%CI,6.6-35.3%).[66]

LUS is not one of the imaging modality used routinely to diagnose pneumonia despite that recent studies have shown that LUS is a reliable tool in both children and adults.[67][40][68]The same finding reported by other studies showed that LUS has a high sensitivity and specificity in diagnosing children suspected to have pneumonia with sensitivity, specificity,PPV and NPV, accuracy of 93.4%, 100% and 95.7% respectively.[69] Despite these findings the use of ultrasound is increase in clinical settings although recent International Conference stated that "LUS is a reliable method for evaluating pneumonia in adults and children,it is recommended when a patient needs to be assed using imaging technology CXR should be used first.[15]

Diagnosis of pneumonia is based on clinical presentation with respiratory rate,plus auscultation ,[70] CXR is not routinely used in the diagnosis of pneumonia. [15][71]Usage of clinical signs like, rapid breathing and chest wall in drawing is well established.[72–74]

It has been shown that tachypnea has high a sensitivity 74% with acceptable specificity 67% (p=0.00008), followed by chest wall in drawing sensitivity 71%, specificity 59% (p=0.004) however when present together they increase the specificity 69% with decrease in sensitivity

68%(p=0.0004).[75] However difficulty in breathing has been reported as a major useful clinical sign in diagnosing pneumonia.[75], there is no other clinical symptom or sign by itself or in combination shows better performance. [75] However the performance of a clinical sign depends mostly on Gold standard used, LUS, CXR or CT. Where by pneumonic changes in CXR revealed after 24-48hrs after the onset of disease which may explain the increase in false positive in the earlier stages.[75]Other studies reported difficulty in using tachypnea in children under two months of age, [76] with infants having unspecific signs for pneumonia diagnosis.[70]

LUS consolidation presents two characteristic signs tissue like sign and shred sign.[77] When combined is called acute alveolar consolidation and it increases its sensitivity from 90% to 100% and specificity from 98% to 100% when compared by CT as a gold standard in diagnosing pneumonia.[78][27]

Lung consolidation with dynamic air bronchograms is the most important LUS finding in diagnosing pneumonia but not specific for pneumonia because can be seen in other conditions like infection, pulmonary embolism, lung cancer, metastasis, compression atelectasis, obstructive atelectasis and lung contusion.[27,48,79–84] However the presence of multiple lenticular branching echoes which moves with breathing signifies patent air ways which helps to rule out atelectasis.[85][86]

Lung consolidation is a good indicator in children with pneumonia.[24,67,69,87–89] Lung consolidation with dynamic air bronchograms has sensitivity of 83.3% to 94% and specificity of 98% to 100%. [48][90]

Lung consolidation with dynamic air bronchograms was reported to range from 22.2% to 100% p=0.001 in different studies and it is significantly associated with the presence of pneumonia.[27][63][91][63] However in one lung consolidation (i.e. liver like sign) it was not significantly associated with presence of pneumonia(p= 0.54)(21).LUS had the ability to detect consolidation confined to one lobe (in 73,3% of cases) and in more than one lobe (in 22.2% of cases) (p=0.001).[61,63,91]

Pneumonia on LUS is significantly associated with significant B-lines especially when coalesced and focal or bilaterally inhomogeneous.[27,48,61,63,89] Significant B lines pattern is seen ranging from 44% to 99.9% among patients with pneumonia. [25,61,85,89,92] Sensitivity of significant B lines in diagnosing pneumonia is almost 100% with p value <0.001. (48)(27)[63] However somestudies shown than significant B lines can be seen in other diseases but the clinical presentation is different from that of pneumonia such as pulmonary edema.[27,80,82,83] Hence the specificity of B- line sign is very low to exclude presence of pneumonia.[48]

LUS has been reported to have a high ability in detecting parapneumonic pleural effusion because of its ability to detect even small amount of effusion and also allowing it to characterize its contents.[85] Despite pleural effusion being frequently associated with infectious process and non-infectious disease.[25]

LUS has the same ability to detect small amount of pleural effusion as CT with sensitivity and specificity approximately 100%.[2,93–95]

Pleural effusion is observed in between 3.5% to 66.6% of pneumonic patients.[25,27,31,48,61,63,85] However between 19.5%(p=0.00019) to 20%(p=0.01) of patients with pleural effusion are significantly associated with presence of pneumonia.[31][27] There are few studies which found that there is no significant association between pleural effusion and pneumonia (p=0.870).[61]

Presence of the lung pulse sign in pneumonic patients had been observed to range from 13% to 30%. [27][61] Lung pulse sign has been observed in neonatal pneumonia [27]; however lung pulse may also be seen in severe respiratory distress syndrome[48]; obstructive atelectasis its severity depends on the severity of atelectasis.[48][84]

Lung pulse sign has a sensitivity of 50% and specificity of 100% for pneumonia.[48] However it is showed not significant associated with pneumonia(p=0.649)

Pleural line abnormality is reported to have sensitivity of 100% and specificity of 45% in diagnosing pneumonia.[48][89] However lung pulse sign has been shown that it is d not significantly associated with pneumonia in some studies

.

Almost all patients with pneumonia has normal lung sliding sign in different scanned regions .[14,17,21–27,30,31,35,36] Also a range from 0.1% to 11% of patients with pneumonia have normal A-lines in all scanned regions. [25,27,31,35,36]

1.3 Statement of problem

Pneumonia is responsible for 1.6 million child death worldwide and more occurs in developing countries including Tanzania.[12] In Tanzania acute respiratory infection occur in 5% of children.[13]

Early detection, proper management including referral and treatment of pneumonia reduces late complications of pneumonia hence generally reduces the global burden of pneumonia.[7]

Since in the diagnosis of pneumonia LUS is comparable to CT which is gold standard. [16][17] Currently pneumonia diagnosis rely only on clinical presentations, with CXR reserved for severe cases. There is limited use of CT scan in children due to high dose of radiation [15][9]; then the use of LUS in the diagnosis and follow up of children with pneumonia can be instituted has no ionizing radiation and it has the ability to document abnormalities than clinical examination and CXR. [9,15,18,19]

1.4 Conceptual framework

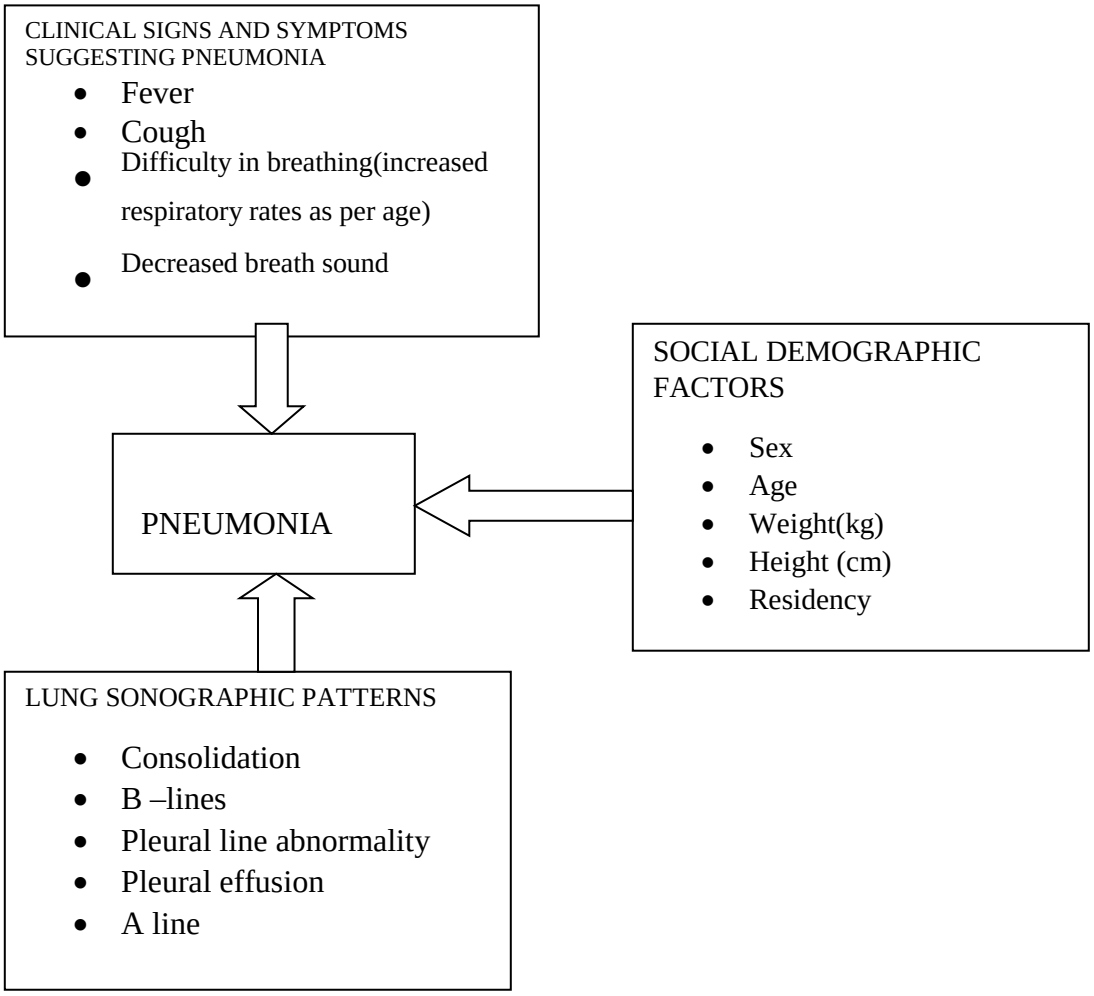


Figure 1: Conceptual frame work

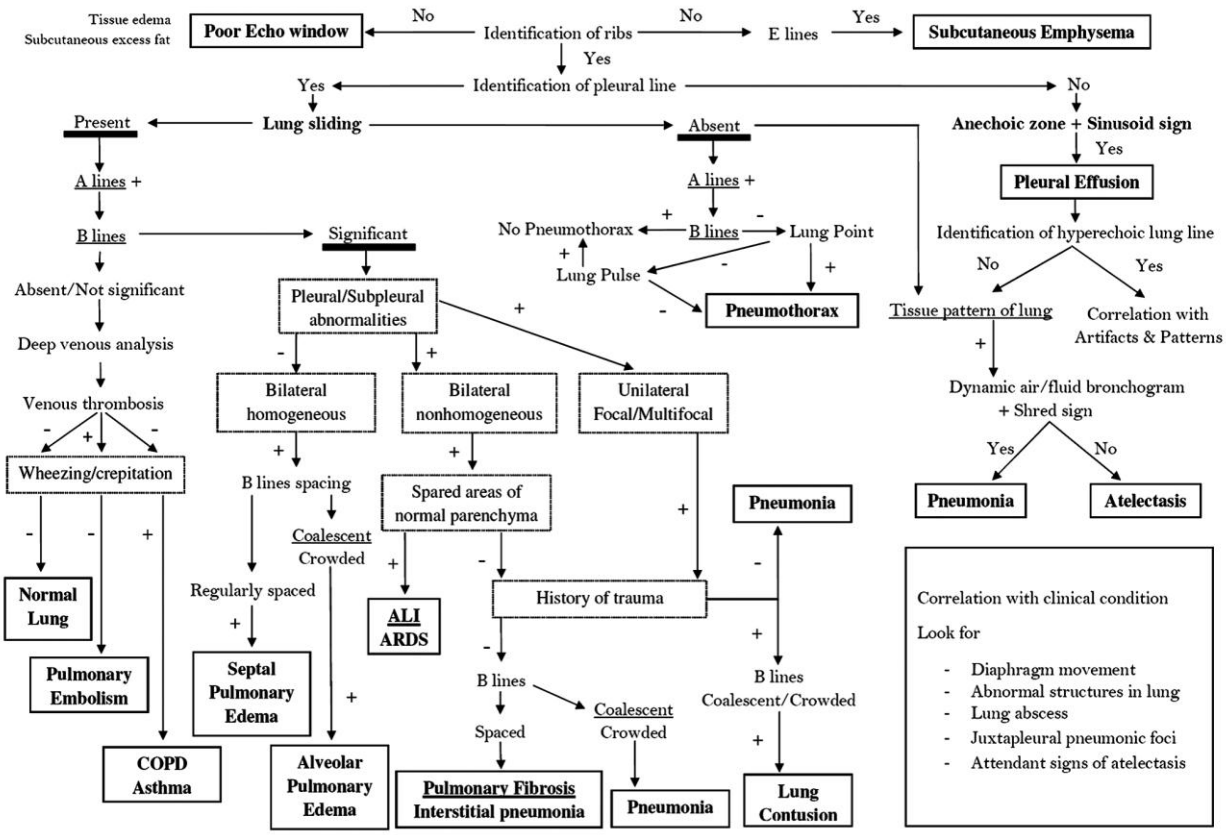


Figure 2: Protocol for LUS

Lung profiles

1. Presence of three or more B lines in at least one region indicates pneumonia
2. Lung consolidation with shredding sign indicates pneumonia
3. Lung consolidation with lung sliding and air or fluid bronchograms indicates pneumonia
4. Unilateral pleura effusion with internal echoes or septate indicates pneumonia
5. Unilateral pleural effusion with mild anechoic fluid indicates pneumonia

1.5 Rationale

Pneumonia is a common respiratory infection affecting 5% of children in Tanzania; and it is associated with morbidity and mortality. If not detected early it can be associated with septicemia and even central nervous, infections.[13] The main stay for the diagnosis of pneumonia has been mainly by clinical examination and when necessary radiological and laboratory investigation are been performed. Although many studies have shown LUS to have good accuracy on detecting lung disease but LUS has not been commonly used as a tool in the pneumonia diagnosis.[15][9]

Therefore the aim of this study is to define Sonographic patterns of pneumonia in pediatric patients with respiratory symptoms and to determine diagnostic performance of clinical diagnosis as compared to using LUS during admission. The study is going to establish baseline data to be used in future research planning in Radiology, to stimulate the usage of LUS in detecting pneumonia in children

1.6 Research questions

1. What are lung ultrasonographic patterns of pneumonia in pediatric patients with respiratory symptoms
2. What is the diagnostic performance of clinical diagnosis as compared to using LUS in diagnosing pneumonia among pediatric patients with respiratory symptoms

1.7 OBJECTIVES

1.7 .1 Broad objective

To determine the lung ultrasonographic patterns of pneumonia in pediatric patients with respiratory symptoms admitted at MNH and MAMC in Dar es Salaam from September 2018 to February 2019

1.7. 2 Specific objectives

1. To describe the social demographic characteristic of Pediatric patients with respiratory symptoms admitted at MNH and MAMC in Dar es Salaam from September 2018 to February 2019
2. To describe the lung ultrasonographic patterns of pneumonia in pediatric patients with respiratory symptoms admitted at MNH and MAMC in Dar es Salaam from September 2018 to February 2019
3. To determine diagnostic performance of clinical diagnosis as compared to LUS diagnosis in pneumonia among pediatric patients with respiratory symptoms admitted at MNH and MAMC in Dar es Salaam from September 2018 to February 2019

CHAPTER TWO

2.0 Methodology

2.1 Study design

The study is a cross-sectional hospital based study.

2.2 Study duration

The study was conducted from September 2018 to February 2019

2.3 Study area

The study was conducted at Pediatric wards and Radiology Department of MNH and MAMC These are the highest government tertiary referral hospitals in Tanzania. The hospitals have all required medical specialties including Pediatric and Radiology and Imaging departments.

The Radiology and Imaging Department of MNH and MAMC have all major imaging modalities including MRI, CT, Ultrasound, Fluoroscopy, Mammography and plain radiography. At MNH there are 8 staff Radiologists and MAMC are 8 university Radiologists and adequate staff Radiographers. This LUS was conducted within the pediatric ward (i.e. as bed side).

2.4 Study population

The study population was all pediatric patients with respiratory symptoms admitted at MNH and MAMC in Dar es Salaam from September 2018 to February 2019

2.5 Inclusion criteria

Inclusion criteria was all pediatric patients diagnosed with pneumonia and admitted in pediatric wards with

(1) Clinical signs and symptoms suggesting pneumonia (cough, tachypnea, crackles and/ or decreased breath sounds, fever with or without chills, chest pain)

(2) Age between one year and sixteen year olds (which is the maximum age allowed in our pediatric department);

2.6 Exclusion criteria

Patients with the following conditions were excluded from the study.

1. Chronic lung disease like bronchial asthma, cystic fibrosis, bronchiectasis
2. Congenital disease of cardiac ,lung or airway
3. Receiving antibiotic treatment for any reason prior to onset of illness
4. Hemodynamically unstable for LUS
5. Parents or guardian refused to participate in the study

2.7 Patients involved

All patients who fulfilled the inclusion criteria and those who parent/guardian signed the consent form.

2.8 sample size

The proportion was 48.9% obtained from the study conducted in Pediatric Department of Menoufia University Hospital, Egypt.[63]

The sample size calculated from Fisher's formula**;**

$n=Z^2P\ (100-P)/E^2$

Where: n= sample size,

Z = (1.96)

P = proportion 48.9%

95% confidence interval will be used.

E = margin error 10%

Therefore $n= (1.96)^2 \times 48.9\ (100 – 48.9)/ (10)^2 = 96$

I will sample an extra 5% to account for possible non-response

n’ =n x adjusted factor f

Adjusted factor =100/100-5

n’= 96 x (100/100-5)

Thus the sample size in this study is 101 children.

2.9 Sampling technique

Simple convenient random sampling was used where each member of the population was assigned a number, after which numbers were selected randomly

2.10 Data collection

Collection of data was done through structured questionnaire which was filled by the Investigator. The images were interpreted by the Principal Investigator and Specialist Radiologist/s. Data was recorded upon reached consensus. Data collected included of patient's age, sex and clinical symptoms. Also Data will include patient's stay in the hospital

Sonographic features collected include the following patterns:

1. Normal pattern, defined as normal lung sliding with or without A-lines.
2. Presence of focal multiple or confluent B-lines.
3. Pleural line abnormalities, defined as irregular appearance of the pleural line.
4. Presence of sub pleural lung consolidations, defined as sub pleural echo-poor or tissue-like region, with blurred margins, with or without air-bronchograms (internal hyperechoicpunctiform or linear elements).
5. Pleural effusion, defined as anechoic or hypoechoic fluid, with or without floating debris

2.11 Imaging and evaluation

Transthoracic LUS examinations were performed with commercially available ultrasound machines (Philips, cleaver vue 350, Eindhoven, Best, The Netherlands and Siemens, accusing 150, Frankfurt, Germany**)** equipped with a high resolution linear probe with frequencies ranging from 6 to 12 MHz. Prospectively using semi structured questionnaire filled by PI.US was used for imaging and image evaluation was done by PI and Radiologist after reaching conscious

Patients were examined in prone or supine position depends on the age of the child. Each hemi thorax was divided into six zones two anterior, two laterals and two posterior. LUS examination consisted of both longitudinal and transeverse sections. On the anterior chest, transversal sections was obtained by positioning the probe transeverse to the chest, from the second to the fifth intercostal space, whereas longitudinal sections were obtained by

positioning the probe longitudinally to the chest, along the parasternal, mid-clavicle, anterior axillary and mid-axillary lines. The selected setting for the ultrasound probe was the same as that used for soft tissue analysis, with a maximum depth of 8 cm. This setting allowed scanning around the entire lung area.[79][81][96]

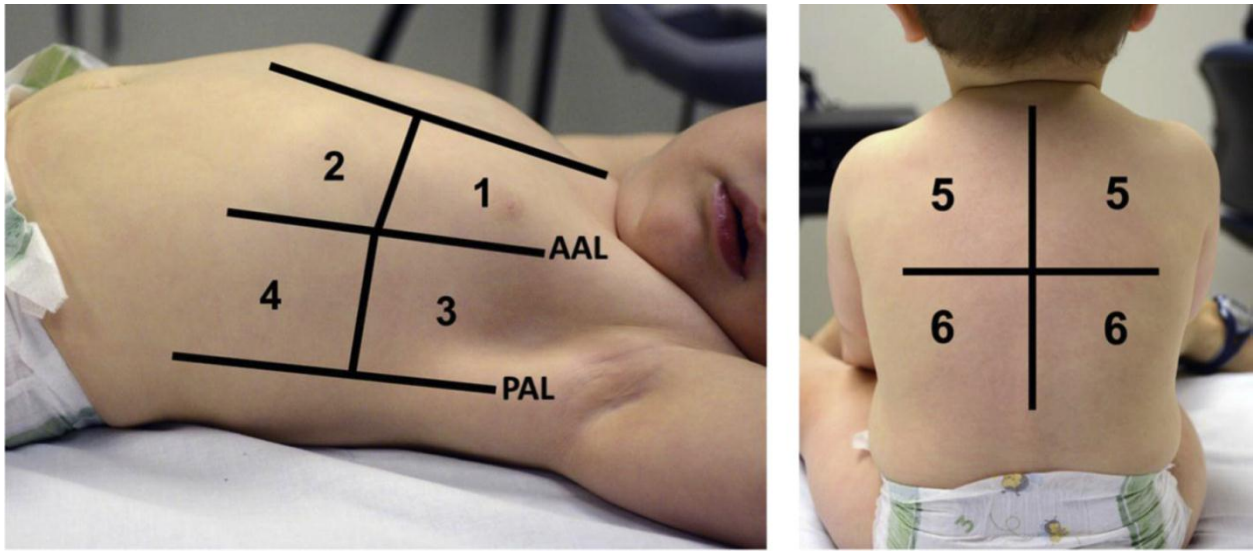


Figure 3: Demonstrates lung zones used for scanning zone, and orientation

1 – anterior superior 2 – anterior inferior 3 – lateral superior 4 – lateral inferior 5 – posterior superior 6 – posterior inferior

Zones 1to 4 were evaluated with the patient supine or upright, depending on patient age, comfort, and cooperation.

If the patient can sit up, zones 5 and 6 were evaluated with the patient upright. If the patient cannot sit up, then zones 5 and 6 were evaluated with the patient in a lateral decubitus position. To move the scapulae out of the way for imaging zone 5, the patient's arms were raised or shoulders shrugged.

Images were labeled for side (right or left), zone, and orientation.[96][81][79]

LUS INTERPRETATIONS

SONOGRAPHIC PATTERN OF NORMAL LUNG

In a normal lung the pleura appears as a regular echogenic line moving continuously during respiration. Beyond the pleura, the lung is filled with air and does not allow further visualization of normal lung parenchyma. The large change in acoustic impedance at the pleura–lung interface results in horizontal artifacts, defined as A-lines, that are seen as a series of echogenic parallel lines distally and are equidistant from one another.[46]

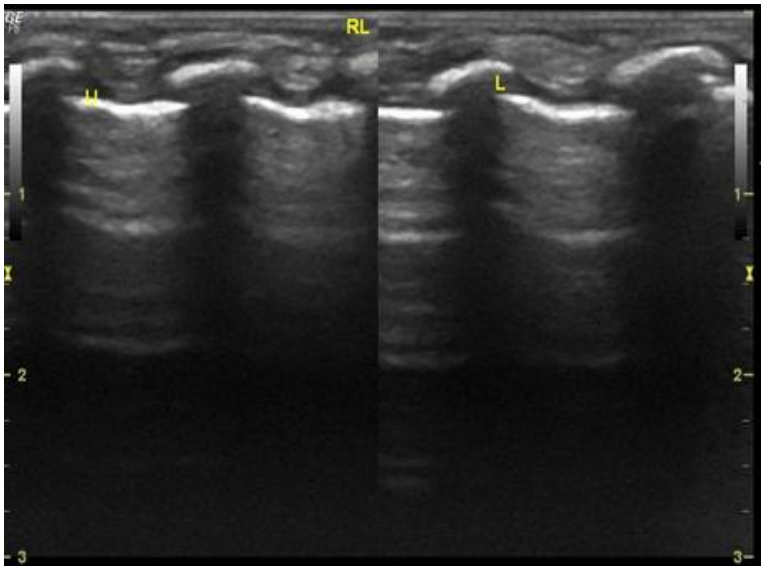


Figure 4: Two months old male baby with fever and cough, LUS showed the echogenic line representing the normal pleura, and the horizontal artifacts, called A-lines. Normal lung

INTERSTITIAL SYNDROME

The diseased lung due to thickening of peripheral interlobar septa lines is replaced by other artifacts which are perpendicular to the pleural line. These artifacts are called B lines. Interstitial syndrome is when three or more B lines are seen in longitudinal view between two ribs and present in two or more zones excluding the last intercostal space of the inferior zones.[46]

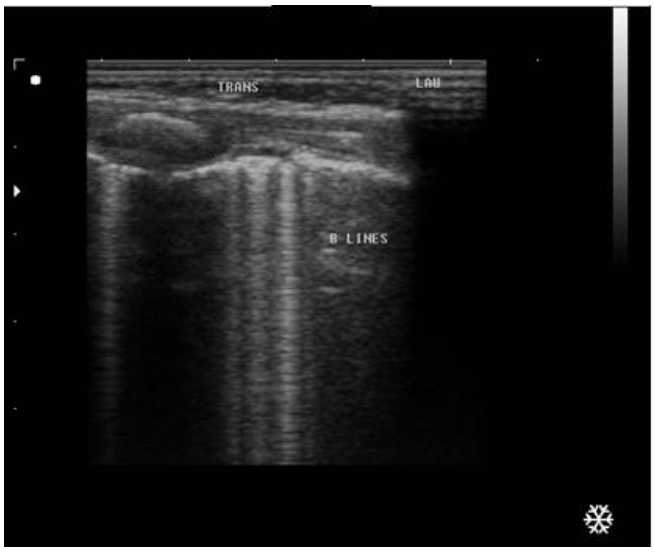


Figure 5: Three months old male baby with fever cough and difficulty in breathing, sonography shows more than three discrete laser-like vertical hyperechoic reverberation artifacts that arise from the pleural line (significant B lines).

This patient was clinically and ultrasonographicaly diagnosed with pneumonia

CONSOLIDATION

When alveolar air space replaced by exudates from infectious disease then lung parenchyma allows sounds wave to pass and form an image like other parenchymatous organs (i.e. Liver).Consolidation is characterized by presence of hypo or anechoic images with loss of normal pleural line and irregular boarder of pleural line that is distinct from the lung line. Addition features are dynamic punctuate hyperechoic images (indicating air bronchograms).[17]

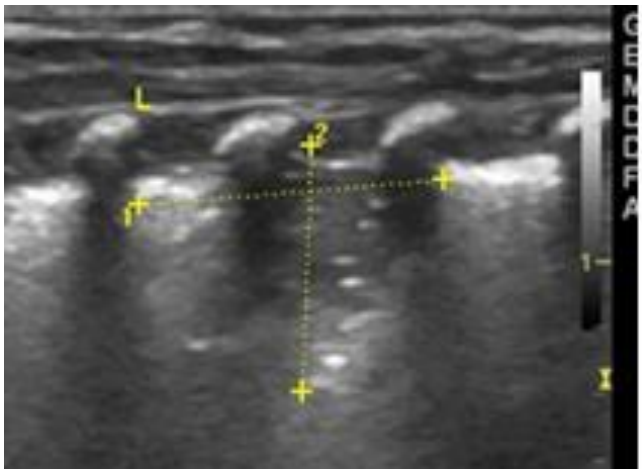


Figure 6: Seven months aged male with fever and cough LUS showed Sub pleural consolidation. This patient's pneumonia was missed by clinical diagnosis but it was picked by LUS.

PLEURAL EFFUSION

Pleural effusion, characterized by anechoic or hypoechoic fluid, with or without floating debris.[16]

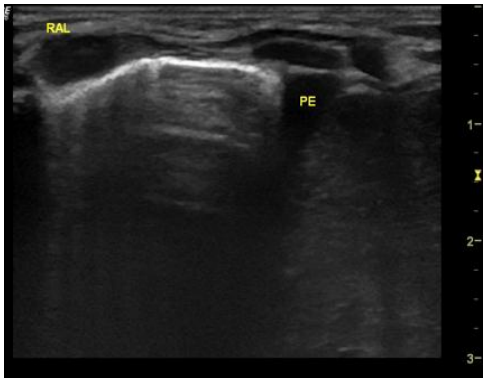


Figure 7 (a) Four 4months old boy with fever, cough and difficulty in breathing no danger sign reported. Minimal pleural effusion was seen which was not picked by clinical diagnosis. However both clinical and LUS diagnosed to have pneumonia

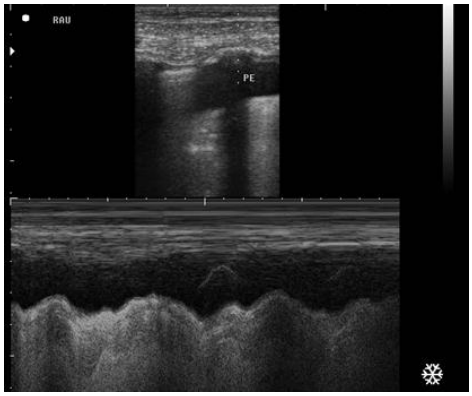


Figure 7 (b) Twelve 12 months' old female baby fever, cough, difficulty in breathing and lethargy. Ultrasonographic showed the massive right pleural effusion which was not documented clinically despite that they had no diagnosis of pneumonia US also concluded not to be pneumonia

ATELECTASIS

This is considered when homogenous well demarcated hypoechoic or hyperechoic consolidation along with non-dynamic air bronchograms.[46]

PNEUMOTHORAX

Main lung ultrasonographic signs of pneumothorax are absence of lung sliding, absence of B-lines and evidence of "lung point". Air between parietal and visceral pleura does not allow seeing the movement of the visceral pleura on the parietal pleura which is the anatomical mechanism of echographic lung sliding. For the same reason, since B-lines originate from visceral pleura, they cannot be seen in presence of pneumothorax.[43]

2.12 Data analysis plan

All questionnaires were coded and entered in a computer program using Statistical package for social sciences (SPSS) software version 23. Data was cleaned before analysis.

Descriptive analysis was done using frequency and proportional for categorical variables and mean (standard deviation) for continuous variables.

The main outcomes were computed as proportions of cases positive by LUS

The diagnostic ability was computed as outcome of the sensitivity, specificity and positive predictive value of standard clinical diagnoses compared to LUS as the goldstandard.Chi-square test was used to compare between age, gender symptomatology, clinical diagnosis and LUS findings

Data collected from questionnaire were organized in data sheets within labeled files and then kept in safe shelf and electronic external hard drive to ensure confidentiality, privacy and prevent accidental or malicious damage and theft. Researcher may share or publish the stored data. Statistical tests were performed on study variables where by frequency tables and cross tabulations were performed on independent and depended variables.

2.13 Ethical consideration.

The researcher introduced himself to the subjects and parent's or guardian of subjects who are regarded as children. Explanation and purpose about the study was made then by consent form. The interview was done in a private room. The researcher and the Radiologist were doing the interpretations of the images. Patient's information and image findings were be kept confidential.

2.14 Ethical clearance

The proposal was presented to the department of Radiology, Muhimbili University of Health and Allied Sciences. Ethical clearance was obtained from the Research and Publication committee of the MUHAS. Permission to conduct the study at MNH was also given.

2.15 Study limitation and mitigation

1. Findings are limited to highly specialize tertiary hospital, therefore cannot be generalized to the community setting.
2. LUS cannot identify whether consolidations converge in more distal parenchyma areas hence can miss consolidations that do not reach the pleura.

CHAPTER THREE

3.0 RESULTS

Table 1. Demographic characteristics among pediatric patients with respiratory symptoms.

Demographic characteristics	Frequency **N=110**	Percentage **%**
Sex		
Male	79	**71.8**
Female	31	28.2
Age		
Below 5 years	91	**82.7**
5 years and above	19	17.3

A total of one hundred and ten (110) pediatric patients suspected to have pneumonia were involved in the study. The study sample had age ranging from 1month to 156 months of age, with median and modal age of 18 and 2 months respectively. Majority of patients were aged below 5 years 91 (82.7%) and 19(17.3%) were aged 5 years and above.

Majority of patients were males 79 (71.8%) and 31(28.2%) were females.

Table 2. Pneumonia on lung ultrasonography by socio-demographic characteristics among patients with respiratory symptoms

	Pneumonia on Lung ultrasonography				
Socio-demographic characteristics	**Yes**	**No**	**Total**	**X^2**	**p-value**
Sex	**N=72(%)**	**N=38(%)**	**N=110(%)**		
Male	52 (65.8)	27 (34.2)	79 (100.0)	0.017	0.533
Female	20 (64.5)	11 (35.5%)	31 (100.0)		
Age group	**N=72(%)**	**N=38(%)**	**N=110(%)**		
Below 5 years	60(65.9)	31(34.1)	91(100.0)	0.54	0.506
Aged 5 years and above	12(63.2)	73(6.8)	19(100.0)		

Majority of children with pneumonia were aged below five years and pneumonia was slightly non-significantly more in children aged below five years (65.9% vs. 63.2%, p=0.56)

Table 3. Percentage distributions of clinical symptoms among patients with respiratory symptoms

Clinical presentation	Frequency N=110	Percentage %
Fever	104	**94.5**
Cough	106	**96.4**
Difficulty in breathing	92	83.6
Lethargy	2	1.8
Convulsion	11	10.0
Vomiting everything	1	0.9%

The most common clinical presentation were cough 106(96.4%), fever 104(94.5%) and the least were danger signs including convulsion, vomiting everything and lethargy 14(12.7%);

Table 4. Clinician performance on pneumonia diagnosis among patients with respiratory symptoms

	Pneumonia diagnosis by Lung ultrasonography				
Pneumonia by clinical diagnosis	Yes **N=72(%)**	No **N=38(%)**	Total **110(%)**	X^2	P value
Yes	52(72.2)	6	58	31.77 9	0.00
No	20	32(84.2)	52		

Among 110 pediatric patients with chest symptoms 52 (89.70%) were diagnosed positive by both clinical and LUS (Sensitivity of 72.2%, Positive Predictive Value PPV 89.7%, P- value

0.00) and 32(84.2%) were tested negative for clinical diagnosis and Lung ultrasound diagnosis (Specificity 84.2%. Negative predictive value PNP 61.5%, P-Value 0.00).

Table 5. Percentage distribution of Lung ultrasonography patterns among patients with respiratory symptoms

Lung ultrasonographic patterns	Frequency N=110	Percentage %
Consolidation	32	29.1
Consolidation with dynamic air or fluid bronchograms	31	28.2
Consolidation with dynamic air bronchograms	31	28.2
Significant B-lines (3 or more lines)	64	**58.2**
A lines	32	29.1
Pleural effusion	23	20.9
Sub pleural consolidation	21	19.1
Irregular pleural line	17	15.5
Pneumothorax	14	12.7
Consolidation with dynamic fluid bronchograms	3	2.7
Lung point	2	1.8
Lung pulse	2	1.8
Consolidation with adynamic air or fluid bronchograms	1	0.9

Majority of patients 64(58.2%) had significant B lines, less than one third 32(29.1%) had consolidation and one fifth 23(20.9%) had pleural effusion. 32(32%) had A lines. The least pattern was consolidation with adynamic air or fluid bronchogram (0.9%)

Table 6. Pneumonia on lung ultrasonography by clinical presentation among patients with respiratory symptoms.

CLINICAL SYMPTOMS	Pneumonia diagnosis by Lung ultrasonography Yes	No	Total	X^2	p-value
Difficulty in breathing	**N=72(%)**	**N=38(%)**	**110(%)**		
Yes	65(70.7)	27(29.3)	92(100.0)	6.717	**0.01**
No	7(38.9)	11(61.1)	18(100.00)		
Fever	**N=72(%)**	**N=38(%)**	**110(%)**		
Yes	70(67.3)	34(32.7)	104(100.0)	2.896	0.179
No	2(33.3)	4(66.7)	6(100.0		
Cough	**N=72(%)**	**N=38(%)**	**110(%)**		
Yes	71(67.0)	35(33.0)	106(100.0)	3.004	0.118
No	1(25.0)	3(75.0)	4(100.0)		
Danger signs (Convulsion, lethargy and vomiting everything)	**N=72(%)**	**N=38(%)**	**110(%)**		
Yes	8(57.1)	6(42.9)	14(100.0)	0.987	0.611
No	64(66.7)	32(33.3)	96(100.0)		
Convulsion	**N=7(%)**	**N=6(%)**	**13(%)**		
Yes	7 % (63.6)	4(36.4)	11(100.0)	3.909	0.142
No	0(0.00	2(100.0)	2(100.0)		
Lethargy	**N=8(%)**	**N=6(%)**	**14(%)**		
Yes	0(0.0)	2(100.0)	2(100.0)	3.86	0.145
No	8(66.7)	4(33.3)	12(100.0)		
Vomiting everything	**N=7(%)**	**N=6(%)**	**13(%)**		
Yes	1(100.0)	0(0.0)	1(100.0)	1.899	0.387
No	6(50.0)	6(50.0)	12(100.0)		

Difficulty in breathing (70.7% vs. 38.9%, p-value=0.010) was significantly associated with pneumonia. Fever (67.3%vs33.3; p=0.179), cough (67.0 % vs. 33%; p=0.118), lethargy (0% vs. 100 %; p= 0.145.)Vomiting everything (100% vs 0%; p=0.387) were not significantly associated with pneumonia.

Table 7. Pneumonia on lung ultrasonography by ultrasonography patterns among pediatric patients with respiratory symptoms

Lung ultrasonography patterns	Pneumonia diagnosis by Lung ultrasonography			X^2	p-value
	Yes	No	Total		
Significant B line	**N=72(%)**	**N=38(%)**	**110(%)**		
Yes	64(100.0)	(0.0)0	64(100.0)	80.773	**0.00**
No	8(17.4)	38(82.6)	46(100.0)		
Consolidation with dynamic air or fluid bronchograms	**N=72(%)**	**N=38(%)**	**110(%)**		
Yes	31(100.0)	0(0.0)	31(100.0)	22.781	**0.000**
No	40(51.3)	38(48.7)	78(100.0)		
Pleural effusion	**N=72(%)**	**N=38(%)**	**110(%)**	8.594	**0.003**
Yes	21(91.3)	2(8.7)	23(100.0)		
No	51(58.6)	36(41.4)	87(100.0)		
Side of pleural effusion	**N=21(%)**	**N=2(%)**	**23(%)**		
Unilateral	19(95.0)	1(5.0)	20(100.0)	9.701	**0.021**
Bilateral	2(66.7)	1(33.7)	3(100.0)		
Pleural effusion echogenicity	**N=21(%)**	**N=2(%)**	**23(%)**		
Anechoic	7(77.8)	2(22.0)	9(100.0)	9.79	**0.007**
Internal echoes	14(100.0)	0(0.0)	14(100.0)		
Lung pulse	**N=72(%)**	**N=38(%)**	**110(%)**		
Yes	2(100.0)	0(100.0)	2(100.0)	0.987	0.611
No	70(64.8)	38(35.2)	108(100.0)		
Lung slide	**N=72(%)**	**N=38(%)**	**110(%)**		
Yes	59(70.2)	25(29.8)	84(100.0)	3.596	**0.05**
No	13(50.0)	13(13.0)	26(100.0)		

Significant B-lines (100% vs 17.4%, p=0.000) and consolidation with air or fluid bronchograms (100%vs 51.3%., p=0.000) were LUS findings were strongly associated with pneumonia

Unilateral pleural effusion (95.0% vs.66.7% p-value 0.021) was associated with pneumonia. Where by presence of Lung pulse (100% vs.66.4%, p-value 0.611) were not significantly associated with pneumonia

Pleura effusion with internal echoes (100% vs.77.8% p-value 0.007) was associated with pneumonia.

CHAPTER FOUR

4.0 DISCUSION

Currently diagnosis of pneumonia in children is mainly from patient's presentations and physical examination, CXR is reserved for severe cases. CT scan is however used as a gold standard but its uses have limitations due to high radiation doses. [9,59]

In the present studya total of one hundred and ten (110) pediatric patients were involved in the study with clinical symptoms suspicion of pneumonia. The age ranged from 1month and 156 months, with median and modal age of 30.95, 18.00 and 2 months respectively. Majority of patients were aged below 5 years 91 (82.7%) and 19(17.3%) were aged 5 years and above. Majority of patients were males 79 (71.8%) and 31(28.2%) were females (Table 1).

In the present study pneumonia was seen more in children below five years 60(65.9) (Table 1.1). This finding is similar in previous studies. [10][12][13][45][23]Whereby children below five years were more affected with pneumonia. The reason could be lack of mounting significant immune response against microbial organisms and lack of cough reflex. [2,6–9]

In the present study showed that the most common clinical presentation were cough 106(96.4%), fever 104(94.5%) and difficulty in breathing (83.6%) and the least signs were convulsion, vomiting and lethargy 14(12.7%) (Table 2).Pneumonia occurred significantly more in children with difficulty in breathing than in those without difficulty in breathing (70.7% vs. 38.9%, p-value=0.010) (Table 5).This finding is similar with previous study where by difficulty in breathing was reported as a major useful clinical sign in diagnosis of pneumonia.[75] However this finding is different from other studies where by difficulty in breathing was not the major presentation [75][76]; this is because it is difficult to use difficulty in breathing in pneumonia diagnosis among infants below two months of age. [70][76] However clinical presentation is more complicated especially in areas with endemicity of HIV, malnutrion, tuberculosis or malaria whereby these diseases may have the same presentation. Hence clinical presentation alone cannot signify pneumonia but giving high suspicious of the disease.[12][3][60]

In the present study clinical diagnosis of pneumonia has Sensitivity of 72.2%, Positive Predictive Value PPV of 89.7%, and specificity of 84.2%(P- value 0.00)(Table 3). This is similar to previous studies whereby LUS had a high sensitivity, specificity and negative predictive value in diagnosing pneumonia compared to clinical diagnosis.[48][61][31][62][63][64][65][66] The high accuracy of LUS can be explained by its ability even to detect small pneumonic changes.[26]

In the present study significant B line swere the major LUS pattern seen 64(582%) (Table 4). Pneumonia on LUS was significantly associated with significant B-lines especially when coalesced and focal or bilaterally inhomogeneous (100.0% vs17.4%, p= 0.021).(Table 6) This is similar to previous studies where by coalesced and focal or bilaterally inhomogeneous significant B-lines were associated with pneumonia.[48][27][61][89][63] Also this is in keeping with previous studies where bilateral homogeneous significant B-lines were not associated with pneumonia but were mainly due to pulmonary edema due to cardiac failure,[50][44][50] or congenital cardiac disease.[51][4] However few studies have shown unilateral significant B-lines can be associated with pulmonary edema especially when the patient is lying on one side for a long time. [47][53]

In the present study consolidation with dynamic air or fluid bronchograms was observed in 31(28.2%) (Table 4).Lung consolidation with air or fluid bronchograms(100%vs 51.3%., p=0.000) were strongly associated with pneumonia(Table 4).This is in keeping with previous studies. [27][63][91][63] However is its finding is different from previous study which found out that consolidation with shredding sign was not associated with pneumonia(21); however the differences observed could be due to small sample size in the previous study. [21]

In our study pneumonia on LUS was significantly associated with unilateral pleural effusion (95.0% vs66.7%, p-value 0.021) (Table 6). This is similar to previous studies where by unilateral pleural effusion was associated with lobar pneumonia.[25][85][48][27][61][31][63] Also this is in keeping with previous studies where bilateral pleural effusion was not associated with pneumonia ,[97] and bilateral pleural effusion was mainly due to pulmonary edema due to cardiac failure,[50][44][50] or congenital cardiac disease. [51][4]

In the present study normal findings (A lines) were seen in 32(29.1%) participants of the patients, (Table4). This finding is slightly different from other studies whereby they found that A lines were lower than this.[25,27,31,35,36] The differences observed could be explained by the inclusion criteria of the participant whereby they included all pediatric patients with suspected with pneumonia while in the previous studies they reported only those confirmed with pneumonia.[25,27,31,35,36]

CHAPTER FIVE

5.0 CONCLUSION

LUS is superior to clinical diagnosis in detecting pneumonia among pediatric patients with respiratory symptoms. LUS had a sensitivity=72.2%, specificity 84.2%, Positive Predictive Value of 89.7%, and Negative predictive value of 61.5%, P-Value 0.00). Pneumonia by LUS was significantly associated with difficulty in breathing (70.7% vs. 38.9%, p-value=0.010). Significant B lines (p=0.000) and consolidation (p=0.000) are LUS findings associated with pneumonia.

5.1 RECOMMENDATIONS

1. LUS can be used or aid clinician in the diagnosis of pneumonia.

2. Large similar study to be conducted with large sample size and include all referral, regional, district and primary health facilities to show the generalizable magnitude of sensitivity and specificity of clinician against LUS in the diagnosis of pneumonia.

REFERENCES

1. Kabra SK, Lodha R, Pandey RM. Antibiotics for community acquired pneumonia in children. Cochrane Database Syst Rev [Internet]. 2006;(3). Available from: http://doi.wiley.com/10.1002/14651858.CD004874.pub2
2. Duffin, J. (1993). Pneumonia. In K. Kiple (Ed.), The Cambridge World History of Human Disease (pp. 938-942). Cambridge: Cambridge University Press. doi:10.1017/CHOL9780521332866.171
3. Mulholland K. Childhood pneumonia mortality-a permanent global emergency. Lancet. 2007;370(9583):285–9.
4. Cattarossi L. Lung ultrasound: Its role in neonatology and pediatrics. Early Hum Dev [Internet]. 2013;89(SUPPL.1):S17–9. Available from: http://dx.doi.org/10.1016/S0378-3782(13)70006-9
5. Macdonald G. Harrison's Internal Medicine, 17th edition. - by A. S. Fauci, D. L. Kasper, D. L. Longo, E. Braunwald, S. L. Hauser, J. L. Jameson and J. Loscalzo. Intern Med J [Internet]. 2008;38(12):932–932. Available from: http://doi.wiley.com/10.1111/j.1445-5994.2008.01837.x
6. Simoes E a. F, Cherian T, Chow J, Shahid-Salles S a., Laxminarayan R, John TJ. Acute Respiratory Infections in Children. Dis Control Priorities Dev Ctries [Internet]. 2006;483–97. Available from: http://www.ncbi.nlm.nih.gov/books/NBK11786/
7. Sazawal S, Black RE. Effect of pneumonia case management on mortality in neonates, infants, and preschool children: A meta-analysis of community-based trials. Lancet Infect Dis. 2003;3(9):547–56.
8. March MDFBP, Sant'Anna CC. Signs and symptoms indicative of community-acquired pneumonia in infants under six months. Braz J Infect Dis [Internet]. 2005;9(2):150–5. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16127591
9. World Health Organization, Department of Maternal NC and AH, World Health Organization. Revised WHO classification and treatment of pneumonia in children at health facilities: evidence summaries. [Internet]. 2014. 34 p. Available from: http://www.ncbi.nlm.nih.gov/books/NBK264162/

10. WHO, UNICEF. Global Action Plan for Prevention and Control of Pneumonia (GAPP) Technical Consensus statement. Bull World Health Organ. 2009;86(5):1–23.
11. Ayieko P, English M. Case Management of Childhood Pneumonia in Developing Countries. Pediatr Infect Dis J [Internet]. 2007;26(5):432–40. Available from: http://content.wkhealth.com/linkback/openurl?sid=WKPTLP:landingpage&an=00006454-200705000-00013
12. Graham SM, English M, Hazir T, Enarson P, Duke T. Challenges to improving case management of childhood pneumonia at health facilities in resource-limited settings. Bull World Health Organ. 2008;86(5):349–55.
13. Ministry of Health Zanzibar, National Bureua of Statistics Dar es Salaam, Office of Chief Government Statitician Zanzibar, ICF, USAID, UNICEF, et al. Tanzania Demographic and Health Survey and Malaria Indicator Survey (TDHS-MIS) 2015-16. Dar es Salaam, Tanzania, Rockville, Maryl USA [Internet]. 2016;172–3. Available from: https://www.dhsprogram.com/pubs/pdf/FR321/FR321.pdf
14. Chavez MA, Naithani N, Gilman RH, Tielsch JM, Khatry S, Ellington LE, et al. Agreement Between the World Health Organization Algorithm and Lung Consolidation Identified Using Point-of-Care Ultrasound for the Diagnosis of Childhood Pneumonia by General Practitioners. Lung. 2015;193(4):531–8.
15. Harris, M., Clark, J., Coote, N., et al. British Thoracic Society guidelines for the management of community acquired pneumonia in children: Update 2011. Thorax [Internet]. 2011;66(SUPPL. 2):ii1–23. Available from: http://www.embase.com/search/results?subaction=viewrecord&from=export&id=L362794403 http://dx.doi.org/10.1136/thoraxjnl-2011-200598 http://findit.library.jhu.edu/resolve?sid=EMBASE&issn=00406376&id=doi:10.1136/thoraxjnl-2011-200598&atitle=British+Thorac
16. Caiulo VA, Gargani L, Caiulo S, Fisicaro A, Moramarco F, Latini G, et al. Lung Ultrasound Characteristics of Community-Acquired Pneumonia in Hospitalized Children. Pediatr Pulmonol. 2013;287(March 2012):280–7.

17. Copetti R, Cattarossi L. Diagnosi ecografica di polmonite nell'età pediatrica. Radiol Medica. 2008;113(2):190–8.
18. Iuri D, De Candia A, Bazzocchi M. Valutazione del quadro polmonare nei pazienti pediatrici con sospetto clinico di polmonite: apporto dell'ecografia. Radiol Medica. 2009;114(2):321–30.
19. Francisco Neto MJ, Rahal Junior A, Vieira FAC, Silva PSD da, Funari MB de G. Advances in lung ultrasound. Einstein (São Paulo). 2016;14(3):443–8.
20. Miller RW. Special susceptibility of the child to certain radiation-induced cancers. In: Environmental Health Perspectives. 1995. p. 41–4.
21. Amin H. Role of transthoracic ultrasound in the diagnosis of some chest diseases. Egypt J Chest Dis Tuberc [Internet]. 2016;65(4):851–8. Available from: http://dx.doi.org/10.1016/j.ejcdt.2016.03.007
22. Guerra M, Crichiutti G, Pecile P, Romanello C, Busolini E, Valent F, et al. Ultrasound detection of pneumonia in febrile children with respiratory distress: a prospective study. Eur J Pediatr. 2016;175(2):163–70.
23. Schenck EJ, Rajwani K. Ultrasound in the diagnosis and management of pneumonia. Vol. 29, Current Opinion in Infectious Diseases. 2016. p. 223–8.
24. Reali F, Sferrazza Papa GF, Carlucci P, Fracasso P, Di Marco F, Mandelli M, et al. Can lung ultrasound replace chest radiography for the diagnosis of pneumonia in hospitalized children? Respiration. 2014;88(2):112–5.
25. 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.
26. Ianniello S, Piccolo CL, Buquicchio GL, Trinci M, Miele V. FIRST-LINE DIAGNOSIS OF PEDIATRIC PNEUMONIA IN EMERGENCY: LUNG ULTRASOUND (LUS) IN ADDICTION TO CHEST-XRAY (CXR) AND ITS ROLE IN FOLLOW-UP Compliance with Ethical Standards. 2015;(I). Available from: http://cyber.sci-hub.tw/MTAuMTI1OS9ianIuMjAxNTA5OTg=/10.1259%40bjr.20150998.pdf

27. Liu J, Liu F, Liu Y, Wang HW, Feng ZC. Lung ultrasonography for the diagnosis of severe neonatal pneumonia. Chest [Internet]. 2014;146(2):383–8. Available from: http://dx.doi.org/10.1378/chest.13-2852

28. Boursiani C, Tsolia M, Koumanidou C, Malagari A, Vakaki M, Karapostolakis G, et al. Lung Ultrasound as First-Line Examination for the Diagnosis of Community-Acquired Pneumonia in Children. Pediatr Emerg Care [Internet]. 2017;33(1):62–6. Available from: https://www.ncbi.nlm.nih.gov/pubmed/28045846%0Ahttp://ovidsp.tx.ovid.com/ovftpdfs/FPDDNCLBPEIEOE00/fs046/ovft/live/gv023/00006565/00006565-201701000-00018.pdf

29. Pagano A, Numis FG, Visone G, Pirozzi C, Masarone M, Olibet M, et al. Lung ultrasound for diagnosis of pneumonia in emergency department. Intern Emerg Med. 2015;10(7):851–4.

30. Iorio G, Capasso M, De Luca G, Prisco S, Mancusi C, Laganà B, et al. Lung ultrasound in the diagnosis of pneumonia in children: proposal for a new diagnostic algorithm. PeerJ [Internet]. 2015 [cited 2018 Jan 17];3(4):e1374. Available from: http://pediatrics.aappublications.org/content/pediatrics/135/4/714.full.pdf

31. Yadav KK, Awasthi S, Parihar A. Lung Ultrasound is Comparable with Chest Roentgenogram for Diagnosis of Community-Acquired Pneumonia in Hospitalised Children. Indian J Pediatr. 2017;84(7):499–504.

32. Rambhia SH, D'Agostino CA, Noor A, Villani R, Naidich JJ, Pellerito JS. Thoracic Ultrasound: Technique, Applications, and Interpretation. Vol. 46, Current Problems in Diagnostic Radiology. 2017. p. 305–16.

33. Yilmaz HL, Özkaya AK, Sarı Gökay S, Tolu Kendir Ö, Şenol H. Point-of-care lung ultrasound in children with community acquired pneumonia. Am J Emerg Med. 2017;35(7):964–9.

34. Vignon P, Chastagner C, Berkane V, Chardac E, François B, Normand S, et al. Quantitative assessment of pleural effusion in critically ill patients by means of ultrasonography. Crit Care Med. 2005;33(8):1757–63.

35. Caiulo VA, Gargani L, Caiulo S, Fisicaro A, Moramarco F, Latini G, et al. Lung ultrasound characteristics of community-acquired pneumonia in hospitalized children. Pediatr Pulmonol. 2013;48(3):280–7.

36. Contantinia Boursiani, MD,* Maria Tsolia, MD, PhD,† Chrysoula Koumanidou, MD, PhD *, Aikaterini Malagari, MD, PhD,‡ Marina Vakaki, MD, PhD,* Georgios Karapostolakis, MD *, Argyro Mazioti, MD, PhD,‡ and Efthymia Alexopoulou, MD P. Lung Ultrasound as First-Line Examination for the Diagnosis of Community-Acquired Pneumonia in Children. Pediatr Emerg Care [Internet]. 2017;33(1):62–6. Available from: http://journals.labiomed.org:2205/sp-3.26.1a/ovidweb.cgi?WebLinkFrameset=1&S=GMJAFPCGNCDDDGHPNCGKDHGCJJGKAA00&returnUrl=ovidweb.cgi%3F%26Full%2BText%3DL%257cS.sh.22.23%257c0%257c00006565-201701000-00018%26S%3DGMJAFPCGNCDDDGHPNCGKDHGCJJGKAA00&directlink=ht

37. 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.

38. Lichtenstein DA, Mezière GA. Relevance of lung ultrasound in the diagnosis of acute respiratory failure the BLUE protocol. Chest. 2008;134(1):117–25.

39. Ramsingh D. Lung Ultrasound in the Critically Ill. Anesth Analg [Internet]. 2017;16(2):1. Available from: http://insights.ovid.com/crossref?an=00000539-900000000-97264

40. Parlamento S, Copetti R, Di Bartolomeo S. Evaluation of lung ultrasound for the diagnosis of pneumonia in the ED. Am J Emerg Med [Internet]. 2009;27(4):379–84. Available from: http://dx.doi.org/10.1016/j.ajem.2008.03.009

41. Vollmer I, Gayete Á. Ecografía torácica [Internet]. Vol. 46, Archivos de Bronconeumologia. Elsevier; 2010. p. 27–34. Available from: http://dx.doi.org/10.1016/S1579-2129(10)70006-9

42. Bourcier J-E, Paquet J, Seinger M, Gallard E, Redonnet J-P, Cheddadi F, et al. Performance comparison of lung ultrasound and chest x-ray for the diagnosis of

pneumonia in the ED. Am J Emerg Med. 2014;32(2):115–8.

43. Cattarossi L. Lung ultrasound: Its role in neonatology and pediatrics. Early Hum Dev [Internet]. 2013;89(SUPPL.1):S17–9. Available from: http://dx.doi.org/10.1016/S0378-3782(13)70006-9
44. Dietrich CF, Mathis G, Blaivas M, Volpicelli G, Seibel A, Wastl D, et al. Lung B-line artefacts and their use. J Thorac Dis. 2016;8(6):1356–65.
45. Lichtenstein D, Mézière M, Philippe B, Agnès G, Olivier B. The Comet-tail Artifact An Ultrasound Sign of Alveolar-Interstitial Syndrome. Am J Respir Crit Care Med. 1997;156:1640–6.
46. LICHTENSTEIN D, MÉZIÈRE G, BIDERMAN P, GEPNER A, BARRÉ O. The Comet-tail Artifact. Am J Respir Crit Care Med [Internet]. 1997;156(5):1640–6. Available from: http://www.atsjournals.org/doi/abs/10.1164/ajrccm.156.5.96-07096
47. Picano E, Frassi F, Agricola E, Gligorova S, Gargani L, Mottola G. Ultrasound lung comets: A clinically useful sign of extravascular lung water. J Am Soc Echocardiogr. 2006;19(3):356–63.
48. Liu J. Lung ultrasonography for the diagnosis of neonatal lung disease. J Matern Fetal Neonatal Med [Internet]. 2014;27(8):856–61. Available from: http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?dbfrom=pubmed&id=24028601&retmode=ref&cmd=prlinks%5Cnpapers3://publication/doi/10.3109/14767058.2013.844125
49. Cattarossi L. Lung ultrasound: Its role in neonatology and pediatrics. Vol. 89, Early Human Development. 2013;89(SUPPL.1):S17–9. Available from: http://dx.doi.org/10.1016/S0378-3782(13)70006-9
50. Baker K, Mitchell G, Thompson AG, Stieler G, Rippey J. Lung ultrasound in heart failure: Lessons from re-analysis of Lung Ultrasound 2011 database. Australas J ultrasound Med. 2015;18(1):10–8.
51. Gargani L. Lung ultrasound: A new tool for the cardiologist. Vol. 9, Cardiovascular Ultrasound. 2011;1-9

52. Usta E, Mustafi M, Ziemer G. Ultrasound estimation of volume of postoperative pleural effusion in cardiac surgery patients. Interact Cardiovasc Thorac Surg [Internet]. 2010;10(2):204–7. Available from: https://academic.oup.com/icvts/article-lookup/doi/10.1510/icvts.2009.222273

53. Via G. Lung ultrasound in the ICU: from diagnostic instrument to respiratory monitoring tool. Lung India [Internet]. 2015;32(3):250–7. Available from: http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?dbfrom=pubmed&id=25983411&retmode=ref&cmd=prlinks%5Cnpapers2://publication/doi/10.4103/0970-2113.156245

54. Yang P. Value of Sonography in Determining the Nature of Pleural. 2005;1–5. Available from: papers2://publication/uuid/B8961703-A717-4BA8-A2E9-04DC651F9F29

55. Roch A, Bojan M, Michelet P, Romain F, Papazian L, Auffray J. Usefulness of Ultrasonography in Predicting Pleural Effusions > 500 mL in Patients Receiving Mechanical Ventilation Usefulness of Ultrasonography in Predicting Pleural Effusions > 500 mL in Patients Receiving Mechanical Ventilation *. 2007; Downloaded From: http://journal.publications.chestnet.org/pdfaccess.ashx?url=/data/journals/chest/22020/ on 06/26/2017: 224–232

56. Ünlüer E, Karagöz A. Bedside lung ultrasound versus chest X-ray use in the emergency department. Interv Med Appl Sci [Internet]. 2014;6(4):175–7. Available from: http://www.akademiai.com/doi/abs/10.1556/IMAS.6.2014.002

57. Trinavarat P, Riccabona M. Potential of ultrasound in the pediatric chest. Eur J Radiol [Internet]. 2014;83(9):1507–18. Available from: http://dx.doi.org/10.1016/j.ejrad.2014.04.011

58. Eibenberger KL, Dock WI, Ammann ME, Dorffner R, Hörmann MF, Grabenwöger F. Quantification of pleural effusions: sonography versus radiography. Radiology [Internet]. 1994;191(3):681–4. Available from: http://pubs.rsna.org/doi/10.1148/radiology.191.3.8184046

59. WHO. Pocket Book of Hospital Care for Children: Guidelines for the Management of Common Childhood Illnesses. Guidel Manag common illnesses [Internet]. 2013;125–

43. Available from:
http://www.who.int/maternal_child_adolescent/documents/9241546700/en/

60. Palafox M et al. Diagnostic value of tachypnoea in pneumonia defined radiologically. Arch Dis Child. 2000;82:41–5.

61. Children CP, Boursiani C, Tsolia M, Koumanidou C. Lung Ultrasound as First-Line Examination for the Diagnosis of pediatric community-acquired pneumonia. Pediatr Emerg Care 2017;33(1):62–6.

62. Bourcier J, Paquet J, Seinger M, Gallard E, Redonnet J, Cheddadi F, et al. American Journal of Emergency Medicine Performance comparison of lung ultrasound and chest x-ray for the diagnosis of pneumonia in the ED ☆. Am J Emerg Med [Internet]. 2014;32(2):115–8. Available from: http://dx.doi.org/10.1016/j.ajem.2013.10.003

63. Salah R, Zayat E, Bahbah WA, Abd W, Mousa E. Lung Ultrasonography Versus Chest X Ray for Diagnosing Pneumonia in Children with Fever and Respiratory Distress : A Prospective Blind Study. American Journal of Pediatrics 2018;4(1):15–20.

64. Chavez MA, Shams N, Ellington LE, Naithani N, Gilman RH, Steinhoff MC, et al. Lung ultrasound for the diagnosis of pneumonia in adults : a systematic review and meta-analysis. Respiratory Research. 2014;1–9.

65. Samson F, Gorostiza I, González A, Landa M. Prospective evaluation of clinical lung ultrasonography in the diagnosis of community-acquired pneumonia in a pediatric emergency department. European Journal of Emergency Medicine 2016;1–6.

66. Pereda MA, Chavez MA, Hooper-miele CC, Gilman RH. Lung Ultrasound for the Diagnosis of Pneumonia in Children : A Meta-analysis. American Academy of Pediatrics.2015;135(4).

67. Cattarossi RCL. Ultrasound diagnosis of pneumonia in children Diagnosi ecografica di polmonite nell ' età pediatrica. 2008;190–8.

68. Reissig A, Kroegel C. Sonographic diagnosis and follow-up of pneumonia: A prospective study. Respiration. 2007;74(5):537–47.

69. Korczy P. Lung ultrasound in the diagnosis and monitoring of community acquired pneumonia in children. Respiratory Medicine. The Brazilian Journal of Infectious

Diseases.2015; 1-6

70. Fátima M De, Pombo B. Signs and Symptoms Indicative of Community-Acquired Pneumonia in Infants under Six Months. 2005;9:150–5.
71. Bradley JS, Byington CL, Shah SS, Alverson B, Carter ER, Harrison C, et al. Executive Summary : The Management of Community-Acquired Pneumonia in Infants and Children Older Than 3 Months of Age : Clinical Practice Guidelines by the Pediatric Infectious Diseases Society and the Infectious Diseases Society of America. Clinical Infectious Diseases.2011;53:617–30.
72. Cherian T, Simoes E, John TJ, Steinhoff MC. FOR THE DIAGNOSIS OF ACUTE LOWER RESPIRATORY TRACT INFECTION distinguishing. The Lancet.1986;125–8.
73. Rao YK, Midha T, Kumar P, Tripathi VN, Rai OP. Clinical predictors of hypoxemia in Indian children with acute respiratory tract infection presenting to pediatric emergency department. World J Pediatr. 2012;8(3):247–51.
74. Zar HJ, Jeena P, Argent A, Gie R, Madhi SA. Diagnosis and management of community-acquired pneumonia in childhood – South African Thoracic Society guidelines. South Afr J Epidemiol Infect.2009;24(1).
75. Palafox M, Guiscafré H, Reyes H, Muñoz O, Martínez H. Diagnostic value of tachypnoea in pneumonia defined radiologically. Arch Dis Child. 2000;41–5.
76. Marks MK, South M, Carlin JB. Reference ranges for respiratory rate measured by thermistry (12-84 months). Archives of Disease in Childhood.1993;569–72.
77. Report C. Bedside lung ultrasound versus chest X-ray use in the emergency department. Interventional Medicine & Applied Science. 2014;6(4):175–7.
78. Lichtenstein DA, Mezi G. Ultrasound diagnosis of alveolar consolidation in the critically ill. Intensive Care Med .2004;276–81.
79. Volpicelli G, Silva F, Radeos M. Real-time lung ultrasound for the diagnosis of alveolar consolidation and interstitial syndrome in the emergency department.
    European Journal of Emergency Medicine 2010, 17:63–72
    Keywords:

80. Lichtenstein DA. The “ lung pulse ”: an early ultrasound sign of complete atelectasis. Intensive Care Medicine 2003;2187–92.
81. Volpicelli G, Elbarbary M, Blaivas M, Lichtenstein DA, Mathis G, Kirkpatrick AW, et al. International evidence-based recommendations for point-of-care lung ultrasound. In: Intensive Care Medicine. 2012. p. 577–91.
82. Raimondi F, Migliaro F, Sodano A, Veropalumbo C, Borrelli AC, Lama S, et al. OF PEDIATRICS Point-of care lung ultrasound in the NICU : uses and limitations of a new tool. Ital J Pediatr [Internet]. 2014;40(Suppl 2):A25. Available from: http://www.ijponline.net/content/40/S2/A25
83. Paper O. Lung Ultrasound in Respiratory Distress Syndrome : A Useful Tool for Early Diagnosis. Neonatology 2008;52–9.
84. Elia F, Verhovez A, Molino P. Lung ultrasound in the reexpansion of pulmonary atelectasis. Intern Emerg Med (2011) 6:461–463
85. Trinci M, Miele V. JR FS JR. British Institute of Radiology 2015;(I). 1-19
86. Nazerian P, Volpicelli G, Vanni S, Gigli C, Betti L, Bartolucci M, et al. American Journal of Emergency Medicine Accuracy of lung ultrasound for the diagnosis of consolidations when compared to chest computed tomography ☆ , ☆☆ , ★ , ★★. Am J Emerg Med [Internet]. 2015;33(5):620–5. Available from: http://dx.doi.org/10.1016/j.ajem.2015.01.035
87. Guerra M, Crichiutti G, Pecile P, Romanello C, Busolini E, Valent F, et al. Ultrasound detection of pneumonia in febrile children with respiratory distress : a prospective study. 2015;
88. Jones BP, Tay ET, Elikashvili I, Sanders JE, Paul AZ, Nelson BP, et al. Feasibility and Safety of Substituting Lung Ultrasonography for Chest Radiography When Diagnosing Pneumonia in Children A Randomized Controlled Trial. Chest [Internet]. 2016;150(1):131–8. Available from: http://dx.doi.org/10.1016/j.chest.2016.02.643
89. Levent H, Ka A, Sar S, Tolu Ö, Hande Ş. American Journal of Emergency Medicine Point-of-care lung ultrasound in children with community acquired pneumonia ☆.American Journal of Emergency Medicine 2017;35:964–9.

90. Community-acquired F. Lung Ultrasound in the Diagnosis and Follow-up of community-Acquired Pneumonia.Chest 2013;(October 2012):142(4):965–72
91. Sartori S, Tombesi P. World Journal of Radiology. 2010;2(6):203–14.
92. Caiulo VA, Gargani L, Caiulo S, Fisicaro A, Moramarco F, Latini G, et al. Lung Ultrasound Characteristics of Community-Acquired Pneumonia in Hospitalized Children. Pediatric Pulmonology 2013;287(March 2012):280–7.
93. Eibenberger L, Dock I, Ammann E. Quantification of pleural effusion:Sonography versus Radiography1994;191. :681–684.
94. Lichtenstein D, Goldstein I, Mourgeon E, Cluzel P, Ph D. Comparative Diagnostic Performances of Auscultation , Chest Radiography , and Lung Ultrasonography in Acute. Anesthesiology 2004;(1):9–15.
95. Tirdia PR, Vajpayee S, Singh J, Gupta RK. Accuracy of lung ultrasonography in diagnosis of community acquired pneumonia in hospitalized children as compared to chest x-ray. International Journal of Contemporary Pediatrics 2016;3(3):1026–31.
96. Ellington LE, Gilman RH, Tielsch JM, Steinhoff M, Figueroa D, Rodriguez S, et al. Computerised lung sound analysis to improve the specificity of paediatric pneumonia diagnosis in resource-poor settings: Protocol and methods for an observational study. BMJ Open. 2012;2(1).
97. Saraogi A. Lung ultrasound : Present and future. Lung India 2015;32(3). 250-257

APPENDICES

Appendix 1 Questionnaire

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES

SCHOOL OF MEDICINE-DEPARTMENT OF RADIOLOGY

P. O BOX 65001 MUHIMBILI

DAR ES SALAAM

TANZANIA

Identity number…….

Part 1

1. Age in months ……..
2. Sex 1. Male 2. Female

Part 2

At time of admission which symptoms did the patient present

Fever YES NO

Cough YES NO

DIB YES NO

Danger signYES NO

If YES

Lethargy, YES NO convulsion, YES NO vomiting everything YES NO

Part 3

How long child is in the ward (days)……

How long is on Pneumonia treatment (days)….

Part 4

Does CX ray taken before YES NO

If YES what were the results……

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	IF NO GO QN 14
9	Tissue like sign	1. Yes	2. No	
10	Shredding sign	1. Yes	2. No	
11	AdynamicAirbronchogram	1. Yes	2. No	
12	AdynamicFluidbronchogram	1. Yes	2. No	
13	Dynamic air bronchograms	1. Yes	2. No	
14	Dynamic air/fluid bronchograms	1.YES	2 NO	
14	Pleural line	1. Yes	2. No	
15	Pleural line characteristic	1. Smooth	2. Irregular	
16	Characteristics of pleura surface	1. Thin	2. Thick	
17	Sinusoid sign	1. Yes	2. No	
18	Pleural effusion	1. Yes	2. No	IF NO GO QN 20

19	Side of pleural effusion	1. right	2.Left 3.Bilateral	
20	Characteristics of pleural effusion	1. Anechoic	2. Internal echoes	
21	Pleural/sub pleural abnormalities	1. Yes	2. No	
SUMMARY OF DIAGNOSIS:				
	1. Normal Chest LUS		1. Yes	2.No
	2. Subcutaneous emphysema		1. Yes	2.No
	2. Pneumothorax		1. Yes	2.No
	1. Pleural effusion		1.YES	2.No
	1. Alveolar Pneumonia		1. Yes	2.No
	2. Atelectasis		1.Yes	2. No
	3. Lung contusion		1. Yes	2. No
	3. Septal pulmonary edema		1. Yes	2. No
	3. Alveolar pulmonary edema		1. Yes	2. No
	3. ARDS		1. Yes	2. No
	3. Interstitial pneumonia		1. Yes	2. No
	3. Empyema		1. Yes	2. No
	3. Haemothorax		1. Yes	2. No
	3. Asthma		1. Yes	2. No

Appendix II 0Modified protocol for LUS diagnosis l

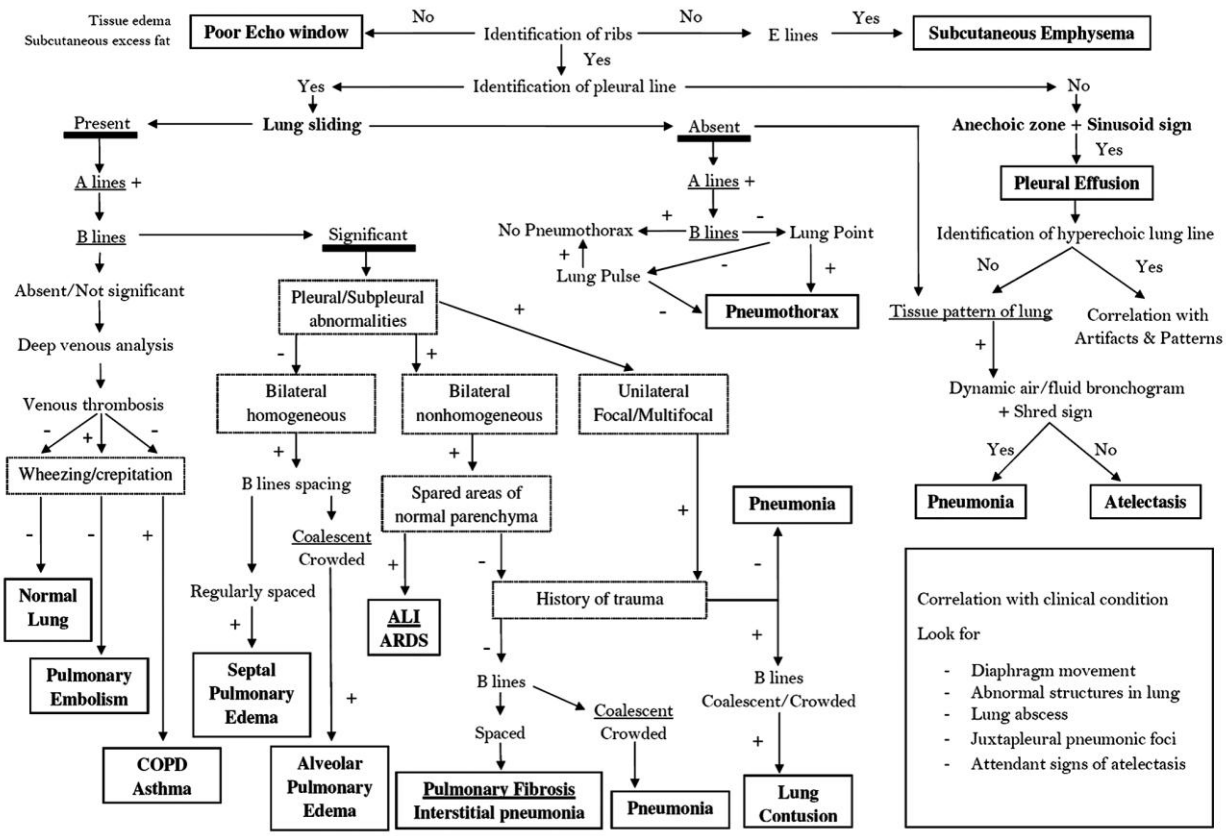
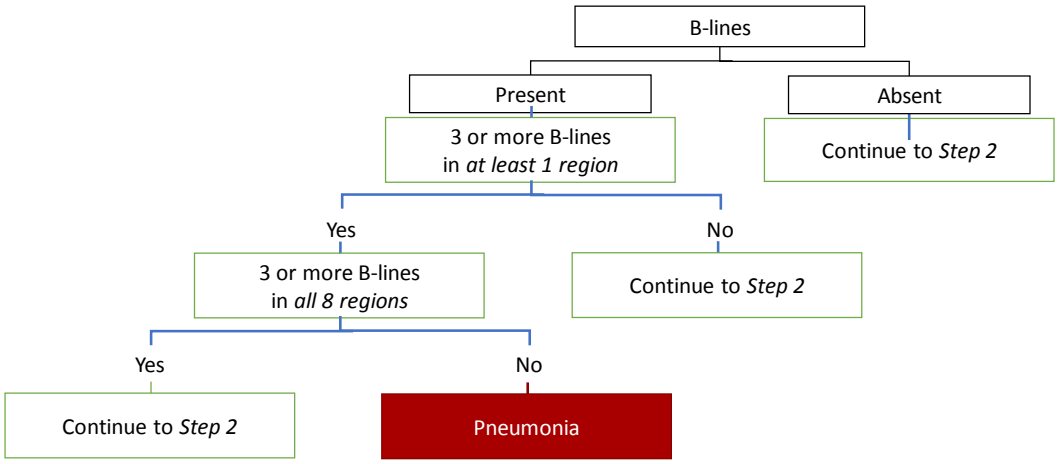


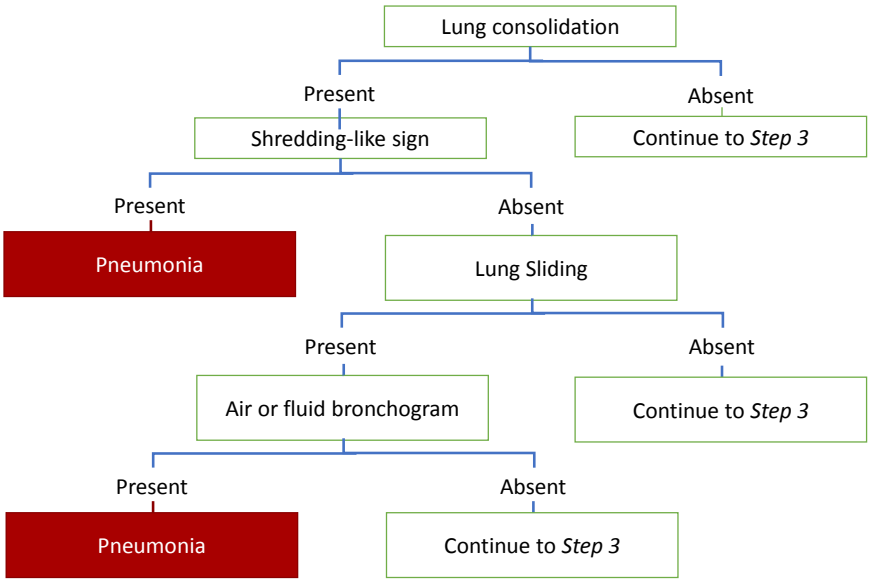
Figure 10 Modified protocol for LUS (37)

Appendix II.1 LUS protocol for diagnosis of Childhood Pneumoniaasmodified by Dr Musa Balowa, lecturer, Department of Radiology and Imaging-MUHAS in Pneumonia misdiagnosed study

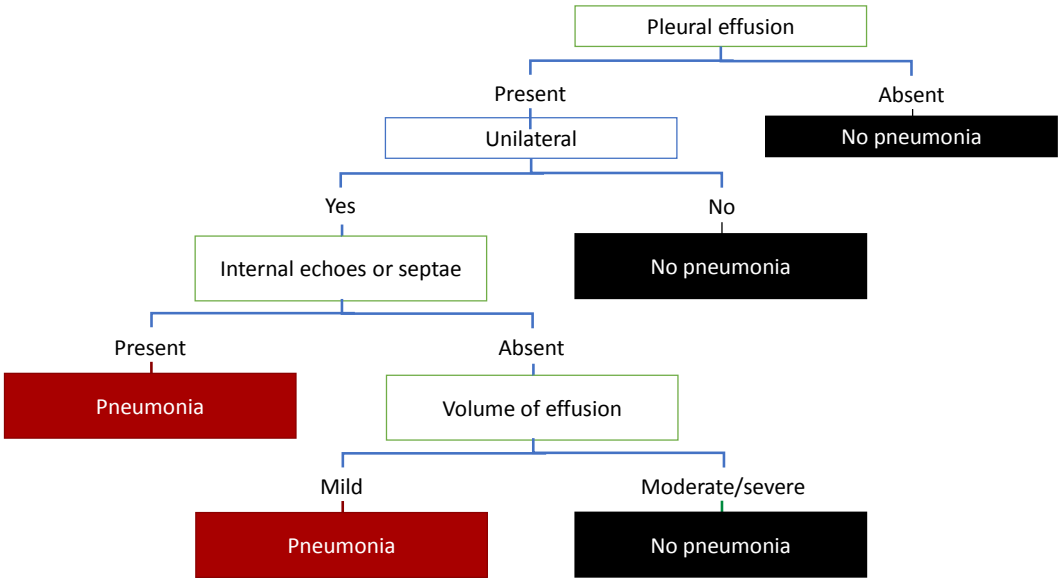
Step 1: Look for B-lines



Step 2: Look for lung consolidation



Step 3: Look for pleural effusion



Appendix III Consent Form (English Version)

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES

DIRECTORATE OF RESEARCH AND PUBLICATIONS, MUHAS

ID-NO……

Consent to Participate in a Study

My name is Dr. Erick Michael, I am conducting a study on sonographic patterns of lungs in pediatric patients clinically diagnosed with pneumonia admitted at Muhimbili National hospital

Study Purpose

The study is conducted as partial fulfillment of the requirements of Mmed Radiology at MUHAS. The Findings from my study will help pediatrician to use LUS as a diagnostic and follow up tool in children diagnosed with pneumonia during admission

How to be involved

The Researcher will introduce himself to the subjects and parent's or guardian of subjects who are regarded as children. Explanation and purpose about the study will be made then a request by consent form.

Confidentiality

The information obtained from you will be confidential. No name will appear on any document of this study instead Identification numbers will be used.

Participation and right to Withdraw

Involvementin this study is voluntary. You can participate or refuse to participate from this study. Refusal to participate from this study will not interfere with your management.

Benefits

The information that you provide will help us to gather lung sonographic findings that will help with clinical management,prediction of disease in risk group and follow-up of prognosis in children diagnosed with pneumonia.Thus the study outcomes will help to improve patients' management thus improve quality of life**..** Ultrasound is a safe medical imaging which uses sound waves to visualize body structures. It does not produce harmful radiation hence no risks to the patients

Contact Personally

If you ever have questions about this study, you should contact the Principal Investigator, **Dr.Erick Michael, Muhimbili University of Health and Allied Sciences, P. O. Box 65001, Dar es Salaam. Tel. 0764 497 642**

OR in case you have questions about your rights of participation in this study you may contact Dr Bruno Sunguya Chairperson of the Senate Research and Publications Committee,

P. O. Box 65001 DSM. Telephone:+255 022 2152489

Dr. Musa Balowawho is the supervisor of this study

Tel. +255 788 002 506

Participant agrees ……..

I ……. have read the contents in this form. My questions have been answered. I am willing to participate in this study.

Signature of participant ……Date…….……

Signature of Researcher ……..Date…….

Appendix IV Consent Form (Swahili Version)

CHUO KIKUU CHA SAYANSI ZA AFYA MUHIMBILI

KURUGENZI YA TAFITI NA UCHAPISHAJI

FOMU YA RIDHAA

Namba ya utambulisho ---

Ridhaa ya kushiriki kwenye utafiti

Jina langu ni **Dr. Erick Michael** nafanya utafiti wenye lengo la kuangalia monekano wa mapafu kulinganisha na ugonjwa wa Nimonia kwa ultrasound miongoni mwa watoto waliolazwa kwa ugonjwa wa Nimonia katika Hospitali ya Taifa ya Muhimbili.

Madhumuni ya Utafiti huu ni pamoja na kutimiza sehemu ya matakwa ya shahada ya uzamili ya matibabu kitengo cha vipimo vya mionzi Chuo Kikuu cha Afya na Sayansi ya Tiba Muhimbili. Hali kadhalika kupata muonekano wa mapafu ambao waweza kama chanzo cha tafiti zaidi kiradiolojia na kutumika katika matibabu na kufuatilia mwenendo wa hali ya wagonjwa wa Nimonia

Jinsi ya kushiriki

Mzazi au Mlezi ukikubalii kushiriki kwa mtoto wako katika utafiti huu,utasailiwa alafu utatakiwa kujibu maswali kutoka kwenye dodoso lililoandaliwa alafu kipimo kitafuata.

Usiri

Taarifa zote zitakazokusanywa kupitia dodoso hili zitakuwa ni siri. Jina lako halitatumika badala yake tutatumia namba ya utambulisho.

Uhuru wa kushiriki na haki ya kujitoa

Kushiriki kwenye utafiti huu ni hiari. Unaweza kushiriki au kukataa kushiriki na hii haitakuondolea haki ya kupata matibabu yako.

Ultrasound ni kipimo salama cha kimatibabu kinachotumia mawimbi ya sauti kuona viungo vya ndani vya mwili.Kipimo hiki hakitoi mionzi hatarishi

Nani wa kuwasiliana naye

Kama una maswali kuhusiana na utafiti huu, wasiliana na mtafiti mkuu,

Dr.Erick Michael. Simu ya kiganja +255 764 497 642,

Chuo Kikuu cha Afya na Sayansi ya Tiba Muhimbili, S. L. P. 65001, Dar es Salaam. Simu

AU kama una maswali zaidi kuhusu haki zako za ushiriki katika huu utafiti waweza wasiliana na

Dr Bruno Sunguya. Mwenyekiti wa kamati ya Utafiti na Uchapishaji, S.L.P 65001,

Dar es Salaam. Simu +255 022 2152489 AU

Dr. Musa BalowaAmbaye ni msimamizi wangu wa utafiti huu

Simu ya kiganja +255 788 002 506

Kama umekubali kushiriki weka sahihi

Mshiriki nimekubali …….....

Mimi..... nimesoma maelezo ya fomu hii nimeyaelewa na nimekubali kushiriki katika utafiti huu.

Sahihi ya mshiriki…… Tarehe ya kutia sahihi…….....

Sahihi ya mtafiti…… Tarehe ya kutia sahihi…….

Appendix V Ethical Clearance

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES
OFFICE OF THE DIRECTOR OF POSTGRADUATE STUDIES

P.O. Box 65001
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Ref. No. DA.287/298/01A/ 29th August, 2018

Dr.Erick Michael
MMed. Radiology
MUHAS.

RE: APPROVAL OF ETHICAL CLEARANCE FOR A STUDY TITLED: "THE SONOGRAPHIC PATERNS OF LUNGS IN PEDIATRIC PATIENTS DIAGNOSED WITH PNEUMONIA ADMITTED AT MUHIMBILI NATIONAL HOSPITAL AND MUHAS ACADEMIC MEDICAL CENTRE"

Reference is made to the above heading.

I am pleased to inform you that, the Chairman has, on behalf of the Senate, approved ethical clearance for the above-mentioned study. Hence you may proceed with the planned study.

The ethical clearance is valid for one year only, from 27th August, 2018 to 26th August 2019. In case you do not complete data analysis and dissertation report writing by 26th August, 2019, you will have to apply for renewal of ethical clearance prior to the expiry date.

Dr. Emmanuel Balandya
ACTING: DIRECTOR OF POSTGRADUATE STUDIES

cc: Director of Research and Publications
cc: Dean, School of Medicine