"EFFECTIVENESS OF LUNG ULTRASONOGRAPHY IN THE EVALUATION OF NEONATAL PULMONARY DISEASE: A ONE YEAR HOSPITAL BASED OBSERVATIONAL STUDY"

By

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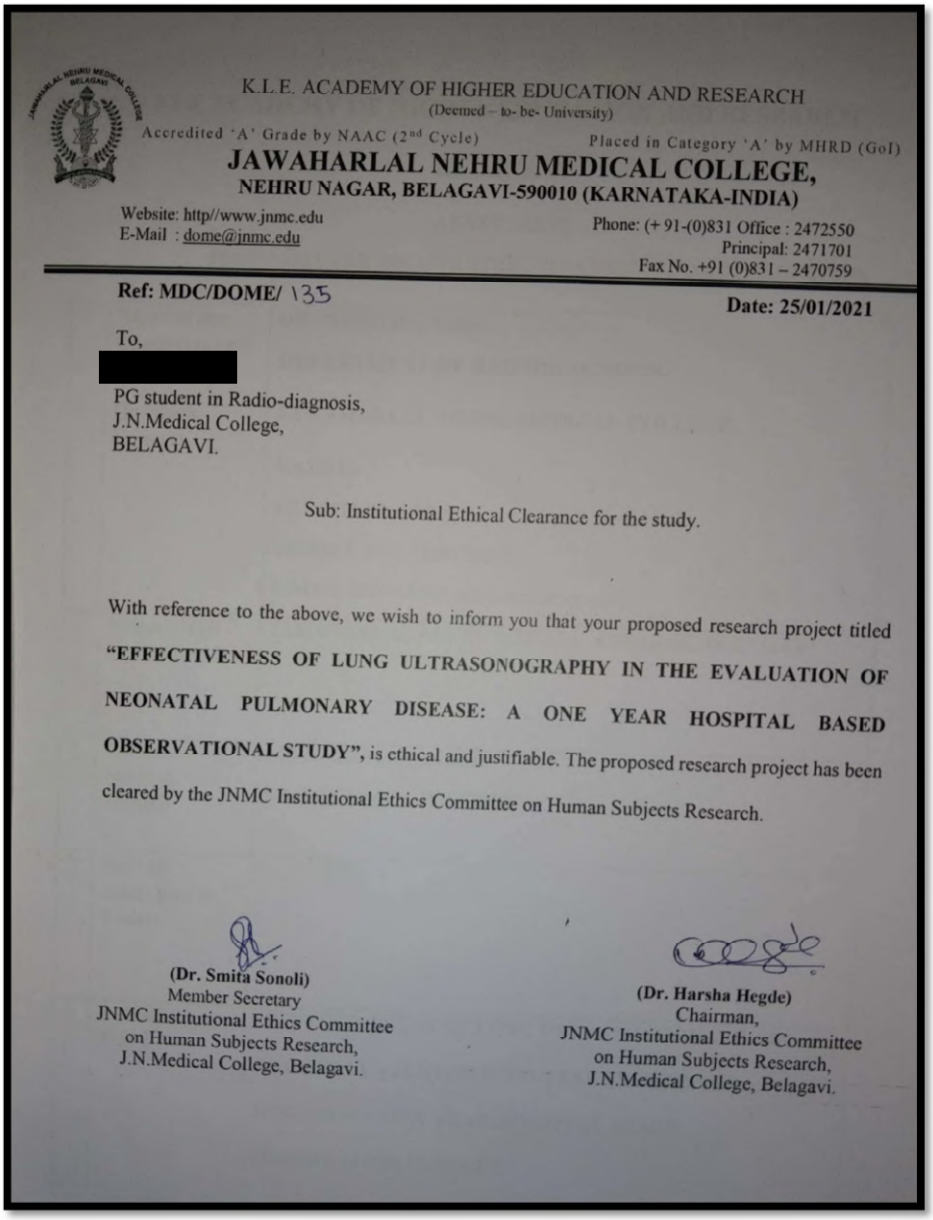

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Sub: Institutional Ethical Clearance for the study.

With reference to the above, we wish to inform you that your proposed research project titled **"EFFECTIVENESS OF LUNG ULTRASONOGRAPHY IN THE EVALUATION OF NEONATAL PULMONARY DISEASE: A ONE YEAR HOSPITAL BASED OBSERVATIONAL STUDY"**, is ethical and justifiable. The proposed research project has been cleared by the JNMC Institutional Ethics Committee on Human Subjects Research.

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LIST OF ABBREVIATIONS

USG	Ultrasonography
LUS	Lung Ultrasonography
CXR	Chest X-ray
RDS	Respiratory distress syndrome
MAS	Meconium aspiration syndrome
TTNB	Transient tachypnea of newborn
LSCS	Lower segment cesarean section
CPAP	Continuous positive airway pressure
BPS	Bronchopulmonary segments
NP	Nasal prongs
NICU	Neonatal Intensive Care Unit
SD	Standard deviation

ABSTRACT

INTRODUCTION: Respiratory conditions are the most common cause for admission to a NICU in term and preterm infants and comprise of around 33.3% of neonatal admissions at >28 weeks gestation. Chest radiography is considered as the gold standard for diagnosis of lung disease, but it unavoidably causes radiation damage to the neonate. Ultrasonography is non-invasive, non-ionizing, easily operable and performed in real time, making it an accurate, reliable technique for the diagnosis of neonatal lung diseases. Due to the lack of research on ultrasonography in Indian neonates with pulmonary diseases, this study was done to determine the role of ultrasound as a diagnostic tool in neonates with respiratory distress and decreasing the radiation exposure

MATERIAL & METHODS: The study was conducted on neonates with respiratory distress in the Neonatal Intensive Care Unit of KLE's Dr. Prabhakar Kore Hospital. (Respiratory distress in the neonate is diagnosed when one or more of the following is present; tachypnoea or respiratory rate of more than 60/ minute, retractions or increased chest in drawings on respirations (subcostal, intercostal, sternal, suprasternal) and noisy respiration in the form of a grunt, stridor or wheeze) [10] . Neonates admitted in the NICU with any cardiac diseases and other non-pulmonary diseases and neonates with congenital anomalies such as Congenital heart diseases, Congenital Diaphragmatic hernia, Tracheo-esophageal Fistula and Esophageal Atresia were excluded from the study.

Institutional Ethical Clearance from Institutional Ethics Committee for Human Subjects Research of Jawaharlal Nehru Medical College, Belagavi, Karnataka was obtained and an informed consent will from the parents of all the study subjects. The

above-mentioned study population who met the inclusion criteria and did not get excluded, was subjected to real-time grey-scale ultrasonography of the thoracic region in prone & supine positions using a 'MINDRAY – M7' machine equipped with a 7.5–12 MHz linear array transducer and performed within 48-72 hours of their admission. The ultrasonography findings were recorded from 8 areas of the lung field.

A pre-designed and pre-tested questionnaire was used to collect Demographic data, Medical history, Clinical Manifestations, Clinical examination and findings on Chest radiographs of the neonates along with the corresponding Ultrasonography findings. The findings on ultrasound was correlated with that of the chest radiography and later tabulated in Ms Excel.

RESULTS: Out of 51 neonates enrolled in the study, 23 neonates were diagnosed with respiratory distress syndrome, 11 neonates were diagnosed with transient tachypnea of the newborn, 5 neonates were diagnosed with meconium aspiration syndrome, 3 neonates were diagnosed with pneumonia and 2 neonates were diagnosed with pneumothorax. Lung ultrasound demonstrated a sensitivity of 92.7 % and specificity of 87.21 % as a diagnostic modality in our study.

CONCLUSION: Lung ultrasonography serves as an alternative diagnostic imaging modality to chest radiograph in detecting neonatal pulmonary diseases.

KEYWORDS: Respiratory distress syndrome, lung ultrasonography, neonatal pulmonary diseases

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INTRODUCTION

In both term and preterm infants, respiratory issues are the most frequent cause of admission to a neonatal unit[1]. With the exception of newborns with syndromes, those with congenital or surgical problems, respiratory issues account for about 33.3% of all neonatal admissions at greater than 28 weeks of gestation[2].

In the first few days after birth, newborns are vulnerable to a number of respiratory illnesses as their growing, fluid-filled foetal lungs adjust to life outside the womb. Therefore, in order to carry out the required treatments and enhance the prognosis, prompt and precise diagnosis is crucial.

The gold standard for diagnosing lung illnesses is chest radiography, but this procedure inevitably exposes the patient to irradiation harm[3]. Neonates are vulnerable to radiation because their rapidly dividing cells are unable to correct DNA damage. In order to diagnose neonatal lung disorders, there is a critical need for an imaging modality that is non-invasive, quicker, and less radiation-intensive. Several investigations have shown that ultrasonography is an accurate and reliable tool. Ultrasonography is a viable tool for use in neonatal critical care units because it is non-invasive, non-ionizing, simple to use, and the imaging is done in real-time [4].

This study was conducted to ascertain the usefulness of ultrasound as a diagnostic tool and in reducing radiation exposure in newborns with respiratory distress in the NICU of a tertiary hospital in India, due to the dearth of Indian researches on lung ultrasonography in neonates with pulmonary disorders.

OBJECTIVES

PRIMARY OBJECTIVE: To determine the accuracy and effectiveness of lung ultrasonography as a diagnostic tool in neonates with pulmonary diseases.

SECONDARY OBJECTIVE: To determine if Ultrasound based analysis can play an effective role in reducing radiation exposure in neonates with pulmonary diseases.

REVIEW OF LITERATURE

HISTORICAL BACKGROUND:

Ultrasound is an imaging modality that uses high-frequency sound waves i.e ultrasonic sound waves (>2KHz) to characterize tissue. The discovery of ultrasound dates back to the 19th century when the Curie brothers **Jacques** and **Pierre Curie** noted that electricity may be created in a crystal of quartz under mechanical vibrating . This phenomenon was termed the piezoelectric effect. The Dussik brothers in middle of twentieth century described the diagnostic properties of ultrasound and Joyner et al in 1967 studied utility of thoracic ultrasound for diagnosing pleural effusion[5,6].

Lichtenstein and Axler, the pioneer of lung ultrasonography, in the early ninetees evaluated the scientific principle of lung ultrasonography[7]. In 1968, a detailed study of the ultrasonic examination of the lungs was carried out by Ross et al[8] and in 2007, Lichtenstein gave clinical introduction and methodology for lung ultrasound[9].

Historically, lung ultrasonography has been a neglected area[10] due to perceived notions about the utility of this modality in air-filled structures. However, in the last few years, significant progress has been made in using ultrasonography as a valuable tool in evaluation of lung pathologies.

In recent times, the popularity of ultrasonography in emergency department, critical care and intensive care units is growing and is considered a valuable diagnostic tool in such settings. Growing application of lung ultrasonography in different settings. As this modality becomes an imaging staple, the diagnostic

radiologist should be fluent in lung US performance and interpretation to maintain relevance and assist the ordering clinician.

ANATOMY OF THORAX[11,12] :

The thorax is the region between the abdomen inferiorly and the root of the neck superiorly. It forms from the thoracic wall, its superficial structures - breast, muscles, and skin and the thoracic cavity. The lungs, the chief organ of respiration are situated in the thoracic cavity on either side of the heart and other mediastinal contents.

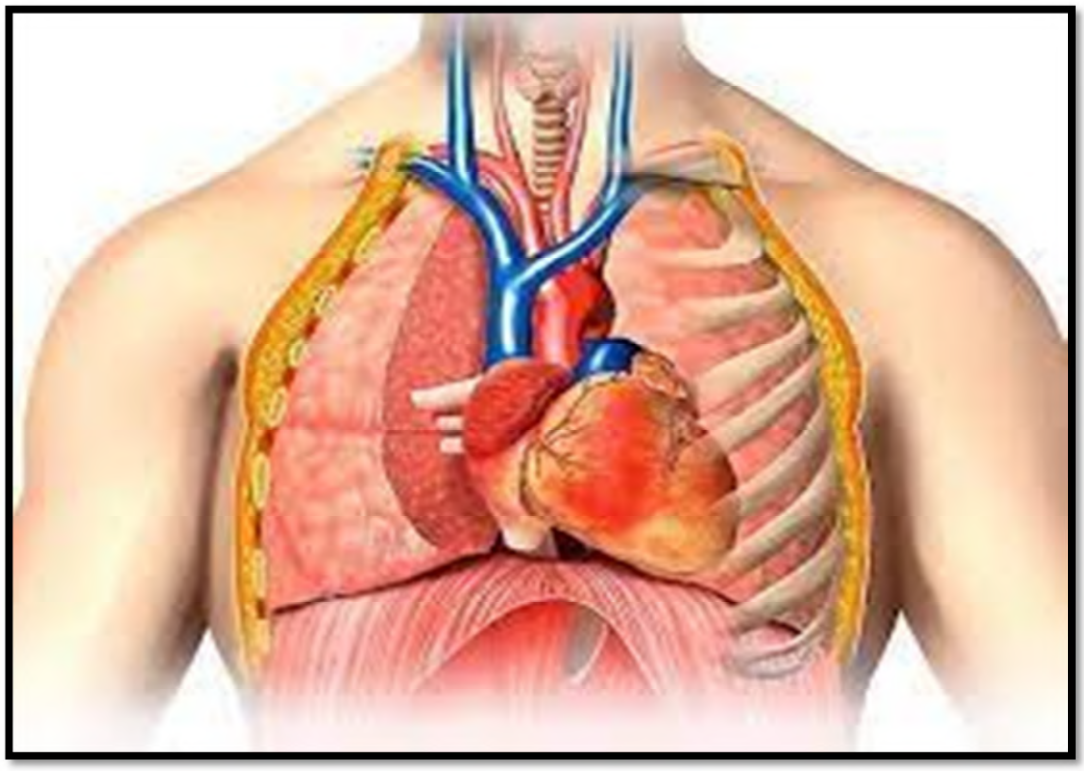


Fig.1: Diagrammatic illustration of Thorax

EMBRYOLOGY OF LUNGS[13]:

The embryonic period, the foetal period, and postnatal lung development are the three primary phases of lung development. Organogenesis of the lungs occurs at the embryonic stage. Postnatal lung development includes the stages of classical and continuing alveolarization, as well as of microvascular maturation, whereas foetal lung development consists of the pseudoglandular, canalicular, and saccular stages.

EMBRYONIC PHASE:

During the embryonic phase (26 days to 6 weeks gestation), an endoderm-lined outpouching or "lung bud" formed from the primitive foregut divides and forms dichotomous branches to form the early tracheobronchial tree. First, the primitive airways are surrounded by loose mesenchyme which derives its blood supply from the primitive systemic arteries. The pulmonary arteries develop from the sixth aortic arch near the end of the embryonic phase, puncture the mesenchyme, and eventually take the place of the systemic arteries.

PSEUDOGLANDULAR PHASE (6 –16 WEEKS GESTATION):

The pseudoglandular phase includes the development of the airways to the level of the terminal bronchioles. At gross examination, the external morphology of the immature lungs is similar to that of neonatal lungs at term. However, at microscopic examination, the bronchioles end blindly within primitive stroma, a histologic feature reminiscent of glandular tissue. Recently, the traditional understanding that only conducting airways are formed during this period of lung development has been challenged. Nevertheless, a deficient number of true alveolar saccules during this developmental stage prevents meaningful gas exchange, and extra-uterine survival is not possible.

CANALICULAR OR ACINAR PHASE (16 –28 WEEKS GESTATION) :

During this phase, multiple alveolar ducts arise from respiratory bronchioles. Alveolar ducts are lined by type II alveolar cells, which are capable of surfactant synthesis. Thin type I alveolar lining cells differentiate from type II cells. Towards the end of this developmental phase (24 –28 weeks), primitive distal saccules (primitive alveoli) begin to form through a process known as primary septation. Progressive thinning of the pulmonary interstitium allows gas exchange as the walls of proliferating capillaries and type I alveolar lining cells approximate.

SACCULAR PHASE (28 –34 WEEKS GESTATION):

The saccular phase is characterized by an increase in the number of terminal sacs, further thinning of the interstitium, robust proliferation of the capillary bed, and early development of true alveoli by secondary septation at about 32 weeks gestation.

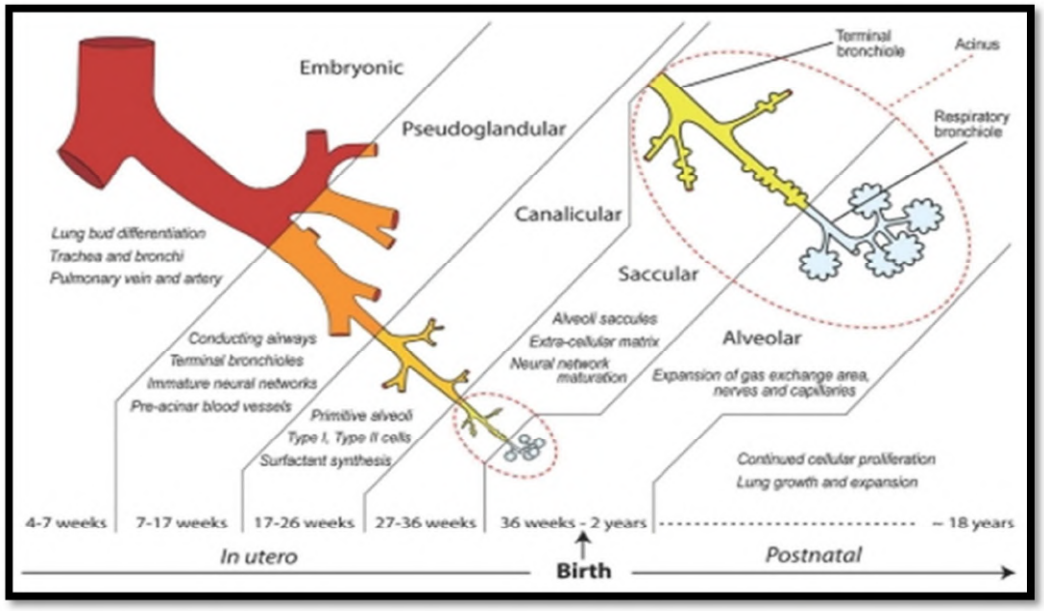


Fig 2. Diagrammatic illustration of embryology of lungs

ALVEOLAR PHASE

Prior to birth, immature alveoli appear as bulges from the sacculi which invade the primary septa. As the sacculi continue to increase in size, the protrusions in the primary septa become larger; these new longer and thinner septations are known as secondary septa and are responsible for the final division of the respiratory tree of sacculi into alveoli. Septation occurs at sites where there is increased fibroblast activity and secretion of collagen and elastin fibers into the interstitium. The process of alveolar division continues until 3 years of age, with the majority of divisions occurring within the first 6 months. To create a thinner diffusion barrier. The double-layer capillary network fuse into a single network, each one closely associated with two alveoli as maturation progresses.

Until the third year of life, enlargement of lungs is a consequence of the increasing number of alveoli; after this point, both the number and size of alveoli increases until the mature lungs form at around 8 years of age.

INFANT'S FIRST BREATH:

During the fetal period, the lungs are filled with a fluid secreted by the pulmonary epithelium combined with amniotic fluid that the fetus swallows. The volume of fluid is larger than the functional residual capacity. The fluid thereby exerts distension on the lungs and contributes to maintaining a certain lung volume. These factors combined with the breathing movements seen in fetuses as early as week 10 are major contributors to lung growth and development. The characteristic that marks the infant's first breath is the clearance of lung liquid from the lungs. This process begins with the onset of labor. Changes in intra-uterine space during labor vary with fetal posture and with that the fetal chest wall configuration: the transpulmonary

pressure increases and the amount of liquid in the lungs decreases. The fetus experiences a significant release of adrenaline during labor that promotes the pulmonary epithelium to stop secretion and start the reabsorption of fluid. Another important process is the fetus's journey through the distal birth canal which exerts compression and stretching of the fetus's thorax. It has been shown that infants born via cesarean section retain air to a lower extent at the end of their first breath. Liquid fills the airways until the infant draws its first breath and the inspiratory efforts play a critical role in liquid clearance.

NORMAL LUNG ANATOMY:

The two lungs are organs of respiration and lie on either side of the mediastinum surrounded by the right and left pleural cavities. Air enters and leaves the lungs via main bronchi, which are branches of the trachea.

RIGHT LUNG :

The right lung is divided into three lobes (superior, middle and inferior) by two fissures – an oblique and horizontal. The upper oblique fissure separates the inferior from the middle and superior lobes. The short horizontal fissure separates the superior and middle lobes.

The right oblique fissure extends posteriorly from the level of the fourth or fifth thoracic vertebra, passes through the hilum and ends just behind the anterior costophrenic angle. The horizontal fissure starts from the oblique fissure at the mid-axillary line and extends horizontally forwards to the anterior border of the lung, at the fourth costal cartilage. The horizontal fissure is seen on a frontal chest radiograph.

Normally, the lobes are freely movable against each other because they are separated, almost to the hilum, by invaginations of visceral pleura. The largest surface of the superior lobe is in contact with the upper part of the antero-lateral wall and the apex of this lobe projects into the root of the neck. The surface of the middle lobe lies mainly adjacent to the lower anterior and lateral wall. The costal surface of the inferior lobe is in contact with the posterior and inferior walls.

LEFT LUNG :

The left lung is smaller than the right lung and is divided into a superior and an inferior lobe by an oblique fissure. The tongue shaped projection of the left lung below the cardiac notch is termed as lingual. It corresponds to the middle lobe of the right lung.

The left oblique fissure is less vertical, commences posteriorly at the level of the fourth or fifth thoracic vertebra, passes through the hilum and crosses the inferior border of the lung approximately around 7.5 cm behind its anterior end.

The largest surface of the superior lobe is in contact with the upper part of the anterolateral wall, and the apex of this lobe projects into the root of the neck. The costal surface of the inferior lobe is in contact with the posterior and inferior walls.

BRONCHOPULMONARY SEGMENTS:

A bronchopulmonary segment is the area of lung supplied by a segmental bronchus and its accompanying pulmonary artery branch. Tributaries of the vein tend to pass intersegmentally between and around the margins of segments. Each bronchopulmonary segment is shaped like an irregular cone, with the apex at the

origin of the segmental bronchus and the base projected peripherally onto the surface of the lung.

There are 10 segments in right lung and 8 in left lung. The segments are named as follows:

Right lung :

Superior lobe: apical, posterior and anterior

Middle lobe: lateral and medial

Inferior lobe: Superior(apical), medial basal, anterior basal, lateral basal and postero-basal

Left lung :

Superior lobe : Apical, anterior and posterior

Lingular lobe : Superior and inferior lingular

Inferior lobe : Superior (apical), anterior basal, lateral basal and postero-basal

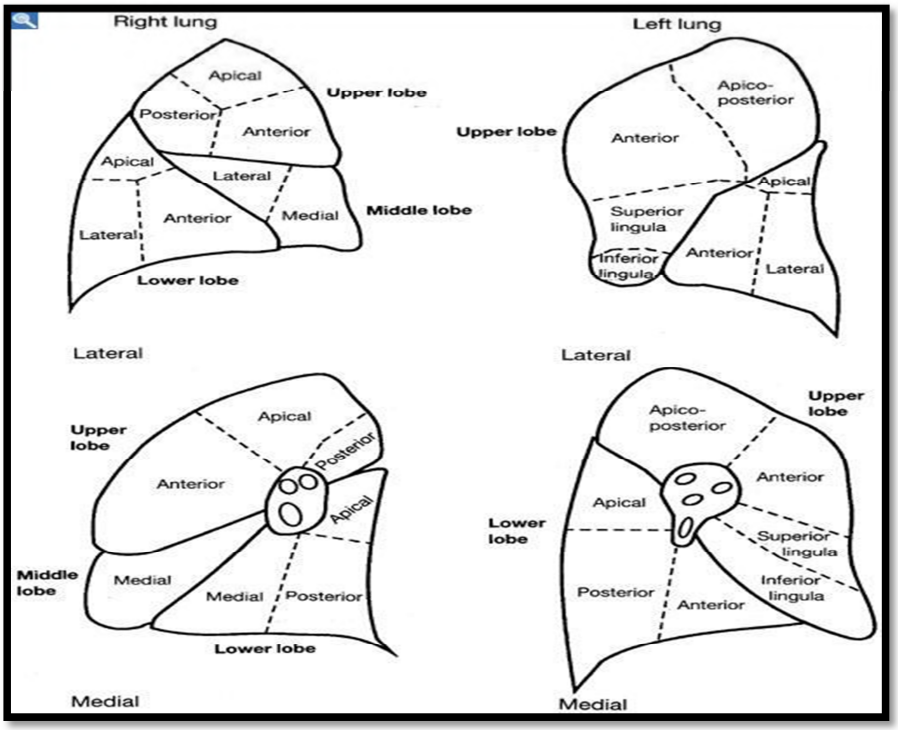


Fig 3. Diagrammatic illustration of bronchopulmonary segments of lungs

BRONCHIAL TREE:

Each main bronchus enters the root of a lung and passes through the hilum into the lung itself. The main bronchus divides within the lung into lobar bronchi (secondary bronchi), each of which supplies a lobe. On the right side, the lobar bronchus to the superior lobe originates within the root of the lung. The lobar bronchi further divide into segmental bronchi (tertiary bronchi), which supply bronchopulmonary segments.

Within each bronchopulmonary segment, the segmental bronchi give rise to multiple generations of divisions and, ultimately, to bronchioles, which further subdivide and supply the respiratory surfaces. The walls of the bronchi are held open by discontinuous elongated plates of cartilage, but these are not present in bronchioles.

PULMONARY HILA :

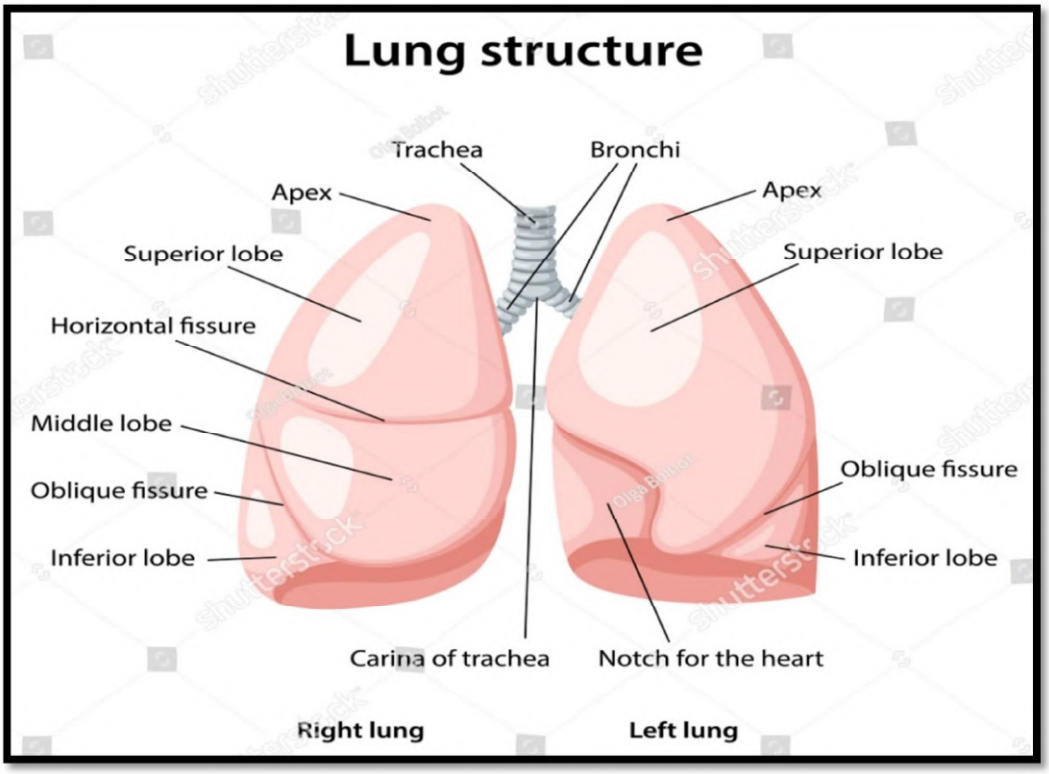
The pulmonary root connects the medial surface of the lung to the heart and trachea and is formed by a group of structures which enter or leave the hilum. These are the principal bronchus, pulmonary artery, two pulmonary veins, bronchial vessels, a pulmonary autonomic plexus, lymph vessels, bronchopulmonary lymph nodes and loose connective tissue, all of which are enveloped by a sleeve of pleura. The major structures in both roots are similarly arranged, so that the upper of the two pulmonary veins is anterior, the pulmonary artery and principal bronchus are more posterior and the bronchial vessels are most posterior.

VASCULAR SUPPLY AND LYMPHATIC DRAINAGE

The lungs have two circulatory pathways that are functionally different, namely pulmonary and bronchial. The pulmonary arteries convey deoxygenated blood from the systemic circulation to the alveoli and the pulmonary veins drain oxygenated blood from the lungs back to the left atrium. The bronchial vessels, which are a component of the systemic circulation, provide oxygenated blood to lung tissues.

The pulmonary artery divides into right and left branches, both of which proceed to the hilum of the lungs where they penetrate the lung tissue, separate into branches that lie dorsolateral to the segmental and subsegmental bronchi. The pulmonary capillaries are drained by two pulmonary veins, one from each lung. The pulmonary veins flow into the left atrium and transport oxygenated blood to the left ventricle for systemic circulation. The parasympathetic supply of the lung are derived from the vagus nerve. Sympathetic nerves are derived from the second to fifth spinal segments.

The lymphatics remove interstitial fluid and foreign particles. They run in the interlobar septa, draining via the deep lymphatics to the hilum. Normal lymphatics are not visualized but the thickening of the lymphatics and surrounding connective tissue produces Kerley lines which can be seen on the chest radiograph. The intrapulmonary Lymphatics drain directly Into Bronchopulmonary Nodes. Extensive intercommunications exits between different lymph node groups.



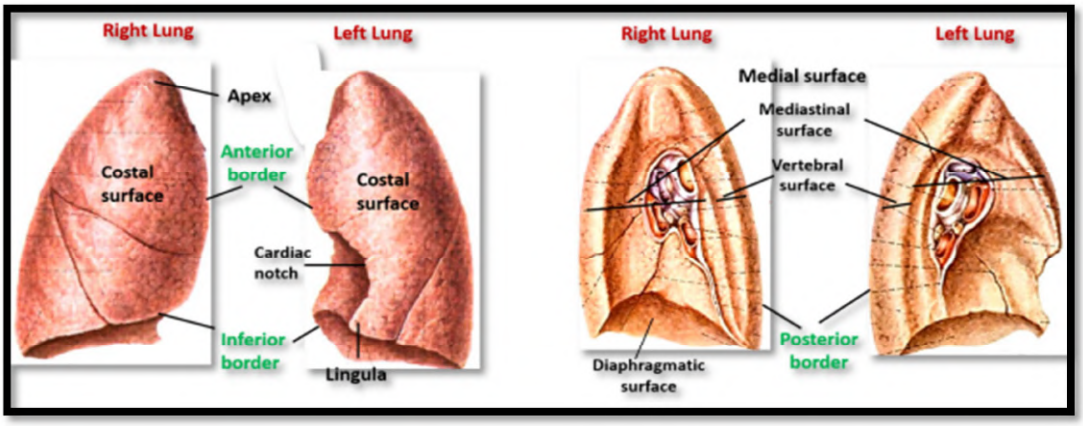


Fig 4. Diagrammatic illustration of anatomy of lungs

NEONATAL RESPIRATORY DISEASES

Respiratory distress syndrome, RDS

RDS is the most common cause of respiratory distress in premature infants, and is also known as hyaline membrane disease[15.16]. It has been established to correlate with structural and functional lung immaturity. It is described as respiratory distress in infants that sets in within a few hours of parturition. The incidence of RDS is inversely proportional to gestational length and has been estimated to range from 30% below gestational week 28 to5% in neonates born in a gestational week above 34 weeks[17,18]Surfactant deficiency was proven to be the cause of RDS as early as 1959. Insufficient amounts of surfactant cause small alveoli to deflate and larger alveoli to overinflate, which creates a mixed situation of atelectasis and overdistention[19]. In turn, atelectasis causes pulmonary vascular constriction, hypoperfusion and lung tissue ischemia. The name, hyaline membrane disease, is originated by the findings that insufficient amount of surfactant causes fibroblasts to invade the alveoli and alter the membranes thickness[20]. There are also components of pulmonary interstitial edema and cellular debris in these hyaline membranes. Thicker membranes compromise the alveolar exchange of oxygen and carbon dioxide and cause respiratory distress. Clinical symptoms of RDS are grunting, chest wall retractions, tachypnea, hypoxia and cyanosis in a premature infant immediately after birth[18]. Typical signs in a Chest-X-ray are homogenous infiltrates that are commonly called ground glass opacity and signs of atelectasis. The introduction of antenatal steroids and surfactant therapy has markedly increased the survival rate of infants suffering from RDS. Antenatal steroids decrease the incidence of RDS with approximately 50% and surfactant treatment reduces the severity of RDS, the progression of the disease and the incidence of death associated with RDS.

Transient tachypnea of the newborn

This condition is the second most common respiratory disease in premature infants. It is a benign condition that occurs when the timing of lung fluid clearance has failed and lung fluid remains in the lungs after parturition[21]. The risks of TTN are high in infants who are born precipitously, without active labor or with caesarean section. It is a condition that usually requires minimal intervention and resolves over a 24 to 72 hour period but may however cause severe morbidity such as hypoxia and respiratory distress and give rise to unnecessary use of antibiotics. The most typically occurring symptom is tachypnea at or within two hours of birth and chest x-ray can show signs of excess lung fluid such as diffuse infiltrates, surrounding the heart or intralobar fluid accumulations[22].

RADIOLOGICAL EVALUATION IN NEONATAL LUNG DISEASAES

Most neonatal lung disorders are diagnosed and managed exclusively on the basis of radiographs, and appropriate radiographic techniques vital to patient safety and diagnosis[23]. It is essential to use the ALARA (as low as reasonably achievable) principle when imaging with a modality that uses ionizing radiation, keeping radiation exposure as low as reasonably achievable[24]. This is accomplished through appropriate Collimation and shielding, using standardized exposure indexes to reduce the risk of dose creep that may occur when imaging with modern digital radiography systems, and limiting unnecessary examinations[25]. When using proper technique, estimated radiation doses to neonates in the neonatal ICU are low and are associated with very low estimated risk of developing radiation induced malignancy. The standard chest radiograph in the NICU consists of a single portable radiograph obtained in the anteroposterior projection, Additional views may be used in select situations. For

example, lateral decubitus radiographs may be used to confirm a suspected pneumothorax or to assess a layering pleural effusion, and oblique radiographs may help localize a finding relative to other thoracic structures. Most neonatal lung disorders can be diagnosed and managed with radiographs alone[26]. In select scenarios, including congenital lung malformations and cardiovascular abnormalities, cross-sectional imaging may provide essential additional clinical information, and CT may be indicated. Compared with radiographs, CT requires a relatively high radiation dose and should be considered only after carefully weighing the potential risks and benefits. Modern MDCT scanners are widely available and are able to image the entire neonatal thorax in a few seconds. Examinations can often be performed during sleeping, after feeding, with gentle immobilization and without sedation[27]. Because chest CT of the neonate is generally limited to the evaluation of congenital lung malformations and cardiovascular abnormalities, IV contrast agent is most often indicated. Technical parameters should be optimized to reduce radiation dose on the basis of patient weight and size, and examinations can most often be performed at very low tube voltage. In current practice, MRI is rarely used in the evaluation of neonatal lung disease, though newly developed MRI techniques using ultrashort sequences may provide a potential alternative to CT in the future.

LUNG ULTRASOUND

A-lines [28]

The basic normal artifact, called the A line is a horizontal line parallel to the pleural line on the screen. A lines are the expression of air, i.e., normal alveolar air or free air of a pneumothorax. The distance between two A lines is equal to the skin-pleural line distance.

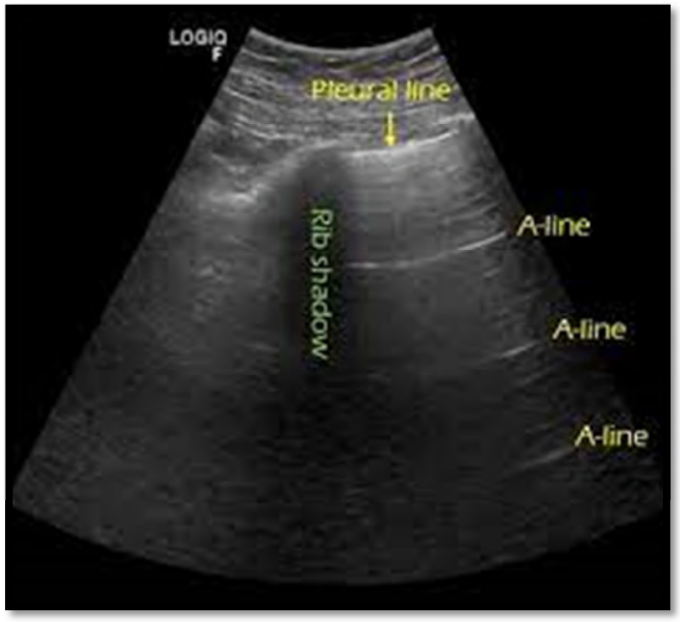


Fig 5. B-mode lung ultrasound demonstrating A-lines

The seashore sign (lung sliding) [29]

The lung is in permanent movement, This generates lung sliding, a kind of twinkling visible at the pleural line and spreading homogeneously below, generating in M-mode a standardized pattern, the seashore sign.

The normal pleural line shows a permanent movement which spreads homogeneously downwards. This results, in M-mode (right image), in a sandy pattern, arising exactly from the pleural line. Above the pleural line is a regular pattern, completely distinct from the sandy pattern seen below, The seashore sign is a simple way to display lung sliding on a frozen view.

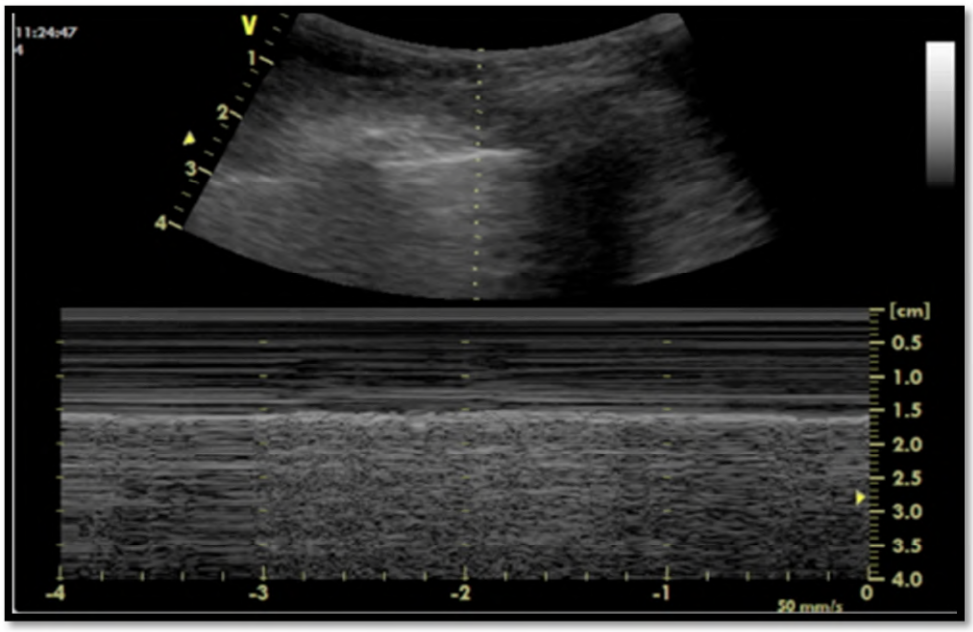


Fig 6. Seashore sign - B mode (upper image), M mode(lower image)

Pleural Effusion

The Quad sign

It is a static sonographic sign observed in pleural effusion. It consists of four lines representing the pleura, rib, fluid, and lung. This sign has a high sensitivity and specificity for pleural effusion, which when simple is itself anechoic.

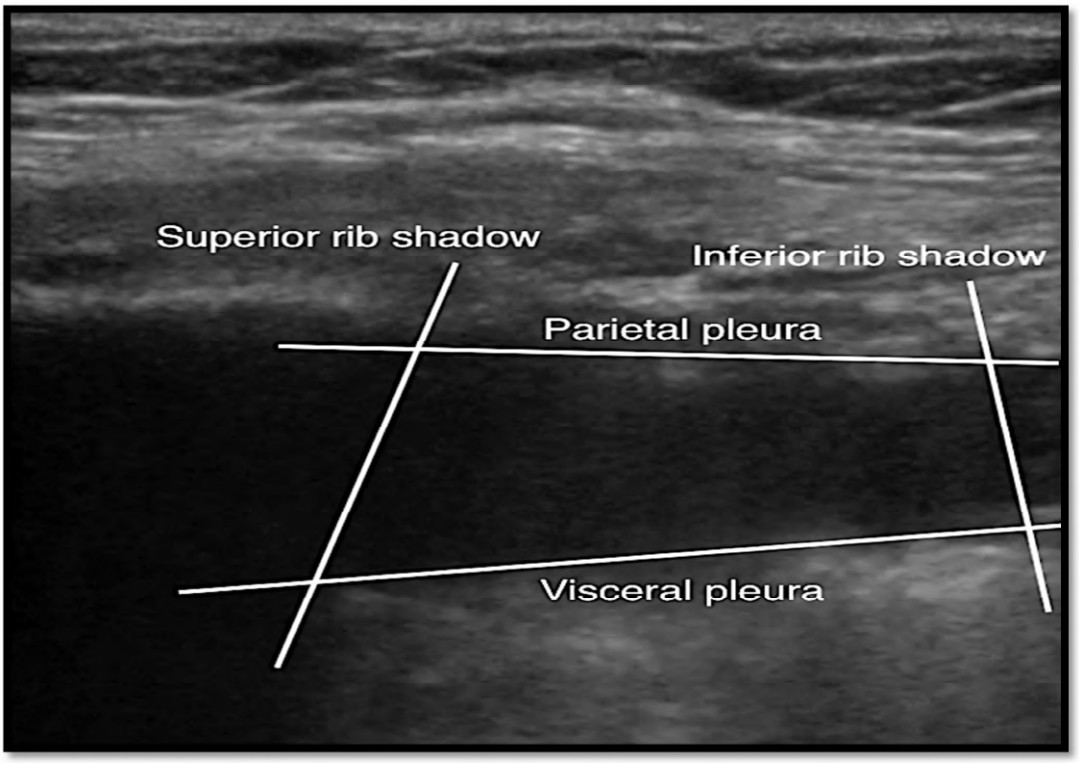


Fig 7. Quad sign

The Sinusoid sign

M-mode, showing the sinusoid sign. The lung line moves toward the pleural line on inspiration.

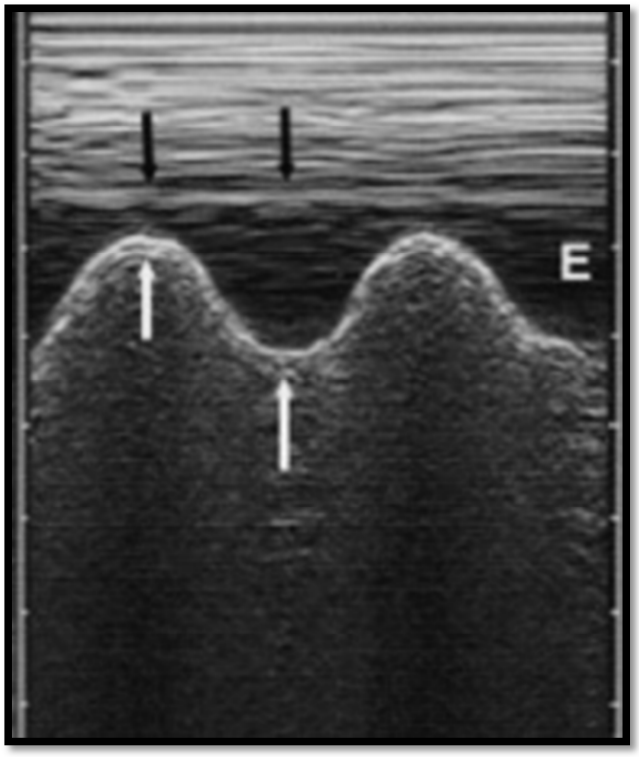


Fig 8. M mode - Sinusoid sign

Lung consolidation & The Shred Sign

Lung consolidation, long described through its classic tissue-1ike image, yields a standardized sign, the shred sign, which indicates that the deep limit of this image is irregular (shredded), as opposed to the smooth lung line of pleural effusions. Inspite of its anechoic tone (mimicking a pleural effusion), the deep limit is shredded. The shred sign is quite specific to lung consolidation.

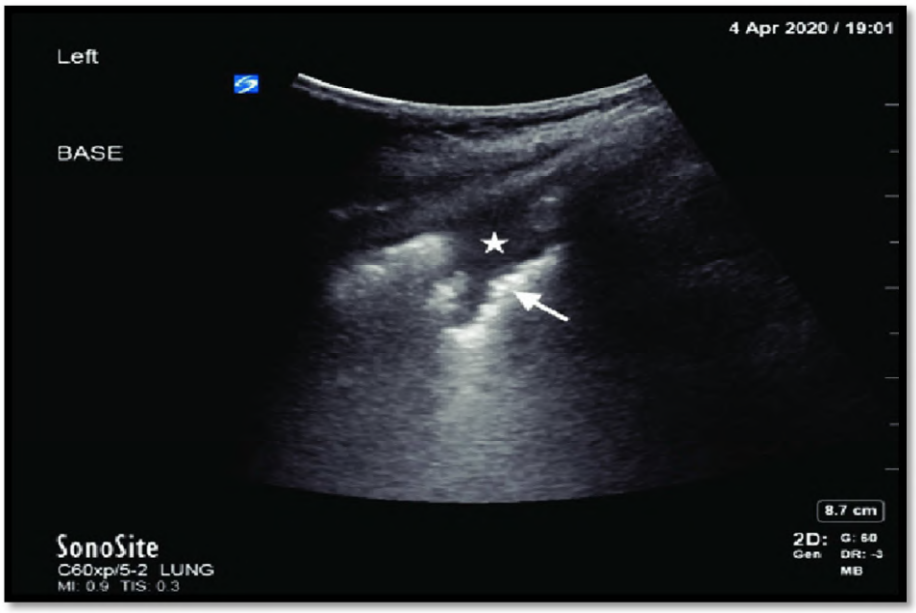


Fig 9. B mode - Shred sign

Pneumonia[34]

Pneumonia appears as a hypoechogenic area with poorly defined borders and compact underlying comet tail artifacts. Vertical artifacts in varying numbers are often seen in areas adjacent to the consolidation. The pleural line is less echogenic in the area affected by lung consolidation. Lung sliding is reduced or absent. In the case of large consolidations, branching echogenic structures representing air bronchograms are seen in the infected area. Air bronchograms can have intrinsic dynamic centrifugal movements due to breathing. This finding is called dynamic air bronchogram it attests to bronchial patency and rules out atelectasis[29].

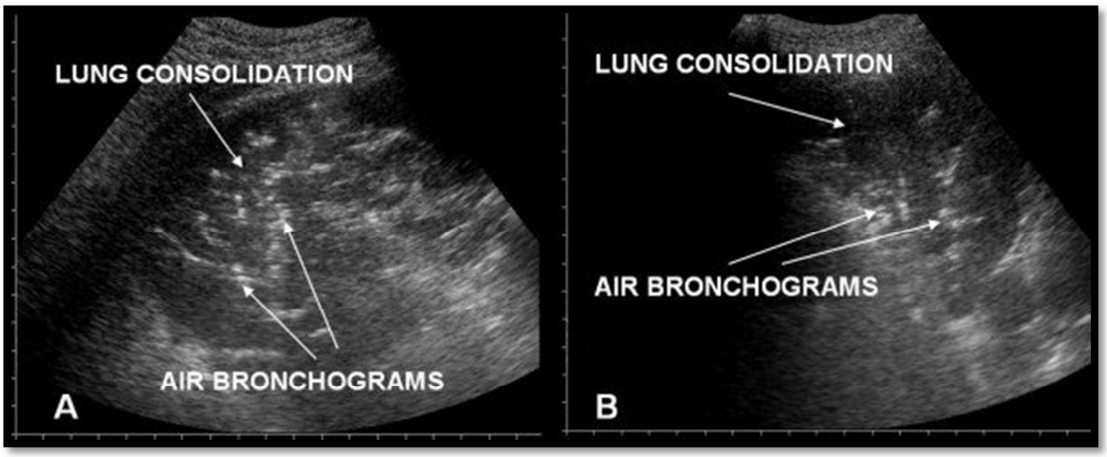


Fig 10. Lung ultrasonography demonstrating consolidation

Interstitial syndrome & B lines[30]

Interstitial syndrome is one of the most useful applications in the acutely ill patient. The air and fluid meeting is the source of major acoustic impedance gradient, Creates a persistent to-and-fro movement of the ultrasound beam at the sub pleural end of the interlobular septum. This generates a particular comet-tail artifact, the B-line. This sign is highly relevant in lung ultrasound in the critically ill. The B-line is a Comet- artifact, arising from the pleural line, spreading out without fading to the edge of the screen, well-defined, erasing the A-lines, and moving in concert With lung sliding. Three or more B-lines are called lung rockets.

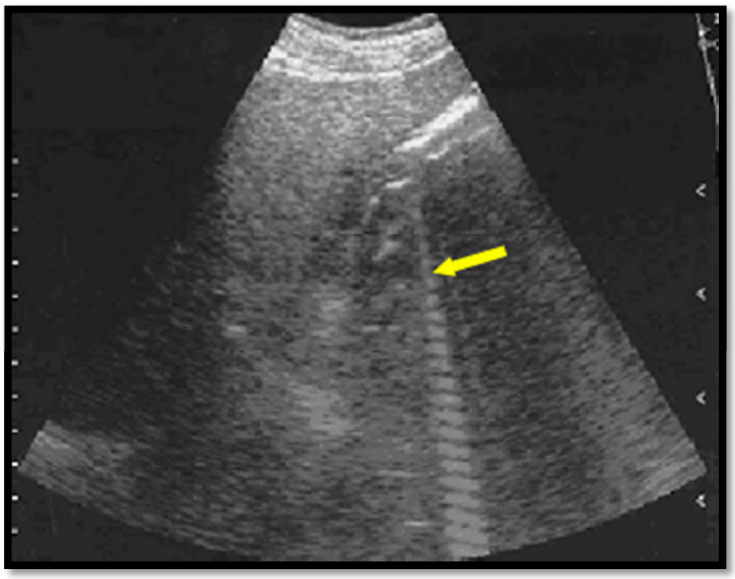


Fig 11 : B-line (Comet tail artifact)

Respiratory distress syndrome[27]

RDS in LUS is seen as generalized alveolar-interstitial syndrome (B lines echographic white lung), pleural line abnormalities (small subpleural consolidations, thickening, irregularity and coarse appearance) and partial to complete absence of areas with a normal pattern spared areas. On transverse intercostal scan of the chest in a newborn with RDS pleural lines appear irregular, and a hypoechoic area is visible at the subpleural level.

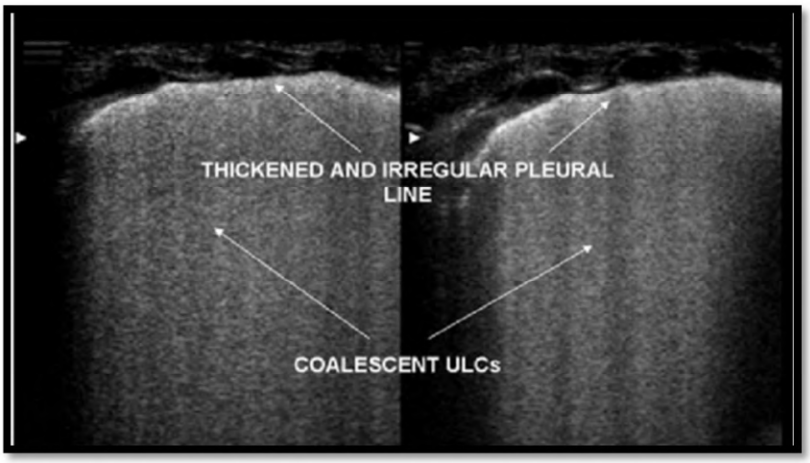


Fig 12: Respiratory distress syndrome

Meconium aspiration syndrome

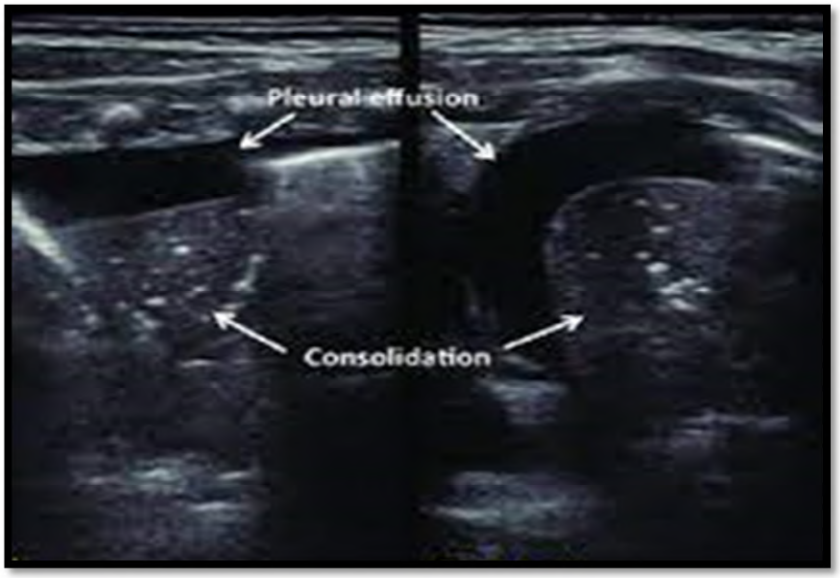


Fig 13: Meconium aspiration syndrome

The main lung ultrasonographic findings in patients with MAS are pulmonary consolidation with air bronchograms, pleural line anomalies and the disappearance of the A-line, atelectasıs[31]. In severe cases, pleural effusion and alveolar-interstitial syndrome or B-line in the non-consolidation areas with MAS[32].

Pneumothorax & The stratosphere sign[28, 33]

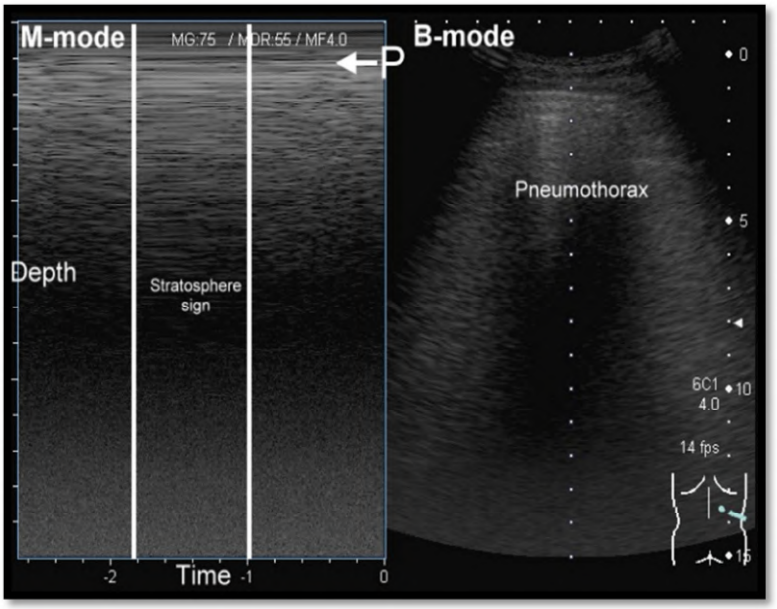


Fig 14: Pneumothorax & The stratosphere sign

The use of M-mode clearly shows the absolute absence of movement at the level of the pleural line. Abolished lung sliding and the A-line sign are highly Suggestive of pneumothorax, but not sufficient. Even one B-line promptly rules out pneumothorax. This is valuable when lung sliding is absent. Stratosphere Sign typically found in patients with pneumothorax. In the pleural line the lung sliding is abolished and the sand-like appearance beneath the pleural line is replaced by parallel lines which is termed stratosphere or barcode sign.

REVIEW OF STUDIES

Jing liu et al conducted a study in Beijing, China in 2012 in which they enrolled 117 neonates with clinically diagnosed Meconium Aspiration Syndrome (MAS) and 100 controls. They found that the sensitivity and specificity of Lung Ultrasound in diagnosing MAS was 100%. They concluded that ultrasonography can be used routinely to diagnose MAS in an accurate, reliable, convenient and non-invasive manner[32].

Francesco Raimondi et al conducted a study in 2016 in Italy, in which 42 infants were enrolled. They used chest radiograph as a reference standard throughout the study to evaluate the accuracy and sensitivity of Lung ultrasound in diagnosing pneumothorax. Lung Ultrasound accuracy in diagnosing pneumothorax was 100 % sensitivity and 100 % specificity. They concluded that lung ultrasound is an accurate method to diagnose pneumothorax in the suddenly decompensating neonate[33].

Jing Liu et al conducted a case-control study in China in 2012 in which they included 40 neonates with lung disease and 40 neonates with no lung disease. Findings of pleural line abnormalities, B-lines, Lung consolidation, air bronchograms, bilateral white lung, interstitial syndrome, lung sliding and lung pulse were recorded on bedside lung ultrasonography and compared between the groups. They concluded that Lung ultrasonography is a reliable tool for diagnosing neonatal pneumonia and is suitable for routine use in the neonatal ICU and may eventually replace chest radiography and CT scanning[34].

Happy K. sawires et al conducted a prospective case control study in 2015 in Egypt in which ninety premature newborns of both the genders with RDS and a control group of 40 premature newborns without respiratory distress were included.

They found that the sensitivity of LUS in the detection of RDS was 100% and its specificity was 52.5%. They concluded that LUS is superior to chest X-ray in the detection of complication of RDS, particularly consolidation, atelectasis and micro-abscesses[35].

Bober K et al in conducted a study in Poland on 131 neonates admitted to the NICU with respiratory distress. They concluded that the ultrasound examination is characterized by 100% sensitivity and 92% specificity in RDS. Ultrasound examination cannot replace chest X-ray in the respiratory failure work-up as it overestimates the diagnosis, but it can be useful in excluding RDS as a cause of respiratory insufficiency in newborns[36].

MATERIALS AND METHODS

SOURCE OF DATA:

A one-year Hospital based observational study conducted in the Neonatal Intensive Care Unit, on the neonates who met the inclusion criteria and did not get excluded from 1st January 2021 to 31st December 2021 at KLE's Dr. Prabhakar Kore Hospital and MRC, Belagavi, Karnataka, India.

METHOD OF COLLECTION OF DATA:

I. STUDY DESIGN: A one-year hospital based observational study.

II. STUDY PERIOD: 1st January 2021 to 31st December 2021

III. STUDY AREA: Neonatal Intensive Care Unit of KLE's Dr. Prabhakar Kore Hospital and MRC, Belagavi, Karnataka, India.

IV. SAMPLE SIZE: 51 neonates

$$n = \frac{z_\alpha{}^2 P(1-P)}{d^2}$$

Minimum Sample size was calculated using the following formula:

n = where P is the percentage of prevalence and d is the percentage likely difference in the prevalence.

For 5% level of the significance zα = 1.96.

(P= 77.10% and d=15% of P = 11.57%) 9

V. SAMPLING METHOD: Universal Random Sampling

VI. STUDY TOOL: Ultrasonography of the thoracic region in Neonates using Mindray M-7 Machine.

VII. INCLUSION CRITERIA:

All Neonates admitted to the Neonatal Intensive Care Unit of KLE's Dr. Prabhakar Kore Hospital with Respiratory Distress.

[Respiratory distress in the neonate is diagnosed when one or more of the following is present; tachypnoea or respiratory rate of more than 60/ minute, retractions or increased chest in drawings on respirations (subcostal, intercostal, sternal, suprasternal) and noisy respiration in the form of a grunt, stridor or wheeze] [10]

VIII. EXCLUSION CRITERIA:

1. Neonates admitted in the NICU with any cardiac diseases and other non-pulmonary diseases.
2. Neonates with congenital anomalies such as Congenital Heart Diseases, Congenital Diaphragmatic Hernia, Tracheo-esophageal Fistula and Oesophageal Atresia.

IX. ETHICAL CONSIDERATIONS:

Institutional Ethical Clearance from Institutional Ethics Committee for Human Subjects Research of Jawaharlal Nehru Medical College, Belagavi, Karnataka was obtained. Parents of all the research participants were given a consent form, informed about the risks and benefits involved in the research and regarding the voluntary nature of participation. Only the participants willing to sign the informed written

consent were included in the study. The confidentiality of the participants in this research was preserved.

X. PROCEDURE

A pre-designed and pre-tested questionnaire was used for the collection of data. Demographic data, Medical history, clinical manifestations, Clinical examination and findings on Chest radiographs of the neonates were documented along with the corresponding Ultrasonography findings. The findings on ultrasound were correlated with that of the chest radiography and later entered in Microsoft Excel.

X. EXAMINATION TECHNIQUE

The above-mentioned study population who met the inclusion criteria and did not get excluded, was subjected to ultrasonography of the thoracic region in supine, lateral and prone positions using a 'MINDRAY – M7' machine equipped with a 7.5–12 MHz high frequency linear array transducer. The ultrasonography findings were recorded from 6 areas of the lung field divided by anterior and posterior axillary lines. The neonates were examined on real-time two-dimensional grey scale and the images were stored securely on a portable storage drive. The Ultrasonography was performed within 48-72 hours of their admission into the NICU.

XI. STATISTICAL ANALYSIS

In the present cross-sectional study, the mean and standard deviation was determined for the continuous quantitative variables. For comparative purposes, the data was separated into two groups with respect to qualitative characteristics, such as

gender or other qualitative characteristics, the continuous variables were compared using appropriate methods, such as ANOVA, correlation, regression, etc., which were used as needed.

Discrete variables were represented by a median. Suitable graphs were used to depict the comparison.

The Median was interpreted by discrete variables. Effective graphs were used to represent the comparison which conveyed the categorical data in terms of prices, ratios, and percentages. The relation between the result, clinical and demographic characteristics were evaluated using either the Chi-square or the Fisher's exact test.

The value of p less than 5% (0.05) was considered important for all the tests.

RESULTS

STUDY POPULATION:

A one-year Hospital based observational study conducted in the Neonatal Intensive Care Unit on all neonates admitted to the Neonatal Intensive Care Unit of KLE's Dr. Prabhakar Kore Hospital with Respiratory Distress and those that did not get excluded from 1st January 2021 to 31st December 2021 at KLE's Dr. Prabhakar Kore Hospital and Medical Research Centre, Belagavi, Karnataka, India.

Table 1: Descriptive inspection of age distribution among the study group

(N =51)

Age distribution	N	%
1	18	35.3
2	16	31.3
3	17	33.3
Mean Age	**Mean**	**SD**
	1.979	0.731

In the present study, the study had most of the subjects from age of 1 – 3 days, the percentage of subjects of age as Day 1 is 35.3 % and mean age was 1.979 days

Graph 1: Pie chart depicting age distribution among study group

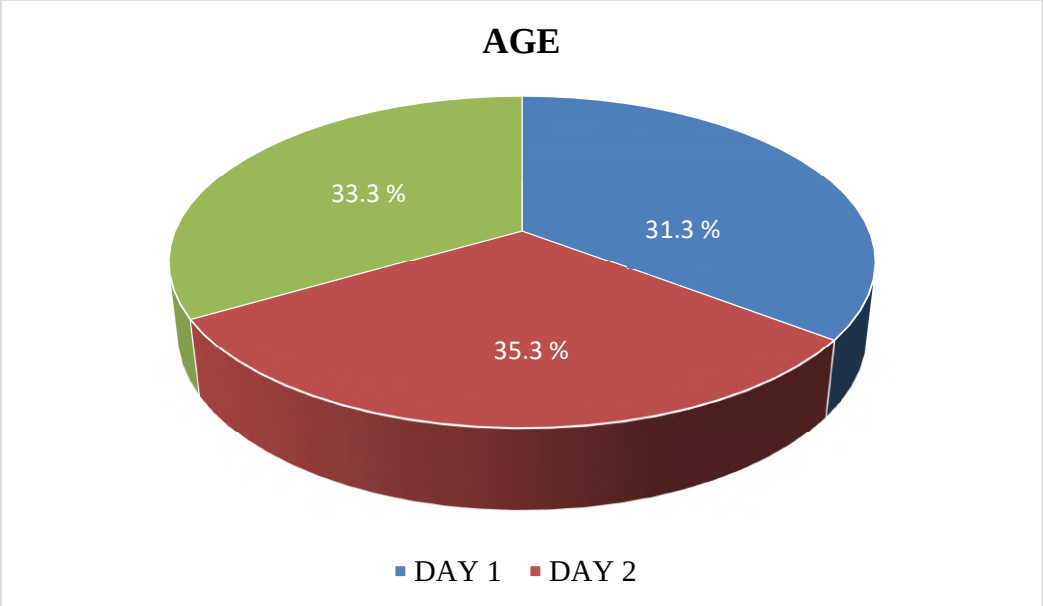


Table 2: Gender wise distribution among study group

Gender	Number	Frequency
Female	19	37.3
Male	32	62.7
Total	51	100.0

In our study, a total of 51 neonates were included, out of which 19 were females and 32 were males. In the current study, the percentage of male patients was more (62.71%) when compared to the female patients (37.3%).

Graph 2: Pie chart depicting gender wise distribution among study group

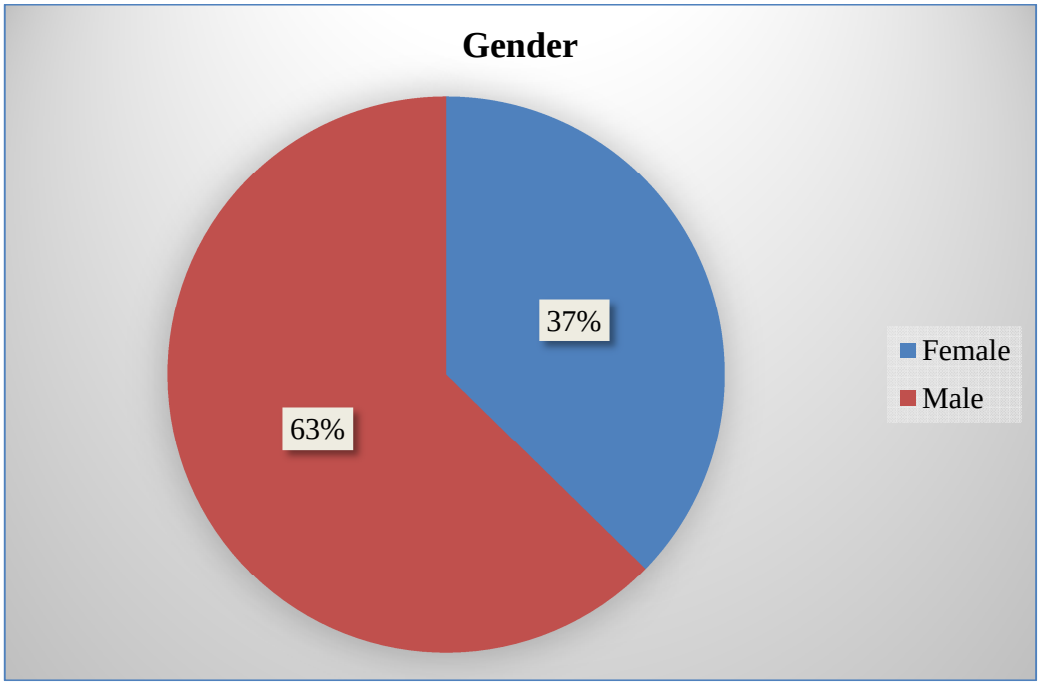


Table 3: Distribution with respect to blood group in study population

BLOOD GROUP	N	%
A	18	35.3
AB	3	5.9
B	11	21.6
O	19	37.3

In the current research, the percentage of babies with blood group A are more than any other group

Graph 3: Distribution with respect to blood group in study population

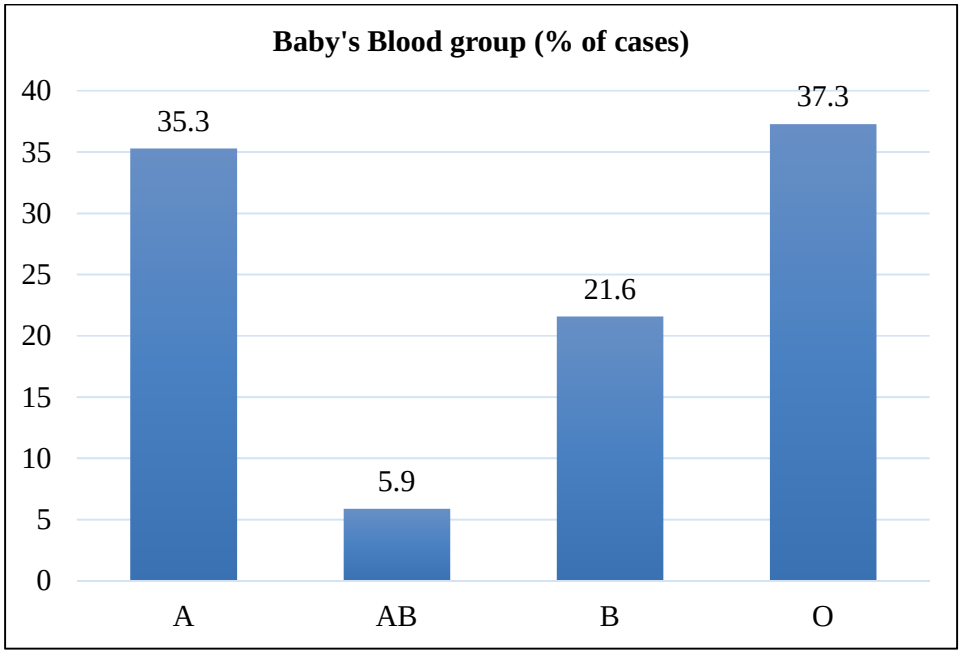


Table 4: Distribution with respect to neonatal birth weights among study population

BIRTH WEIGHT GROUP	N	%
AGA	12	23.5
ELBW	10	19.6
LBW	19	37.3
VLBW	8	15.7
VLBW, SGA	2	3.9

Most of the babies belonged to Low birth-weight category, followed by babies with appropriate weight for gestational age. Maximum and minimum birth weights in the study population were 3600 and 700 grams respectively.

Graph 4: Pie-chart showing distribution with respect to neonatal birth weight among study population

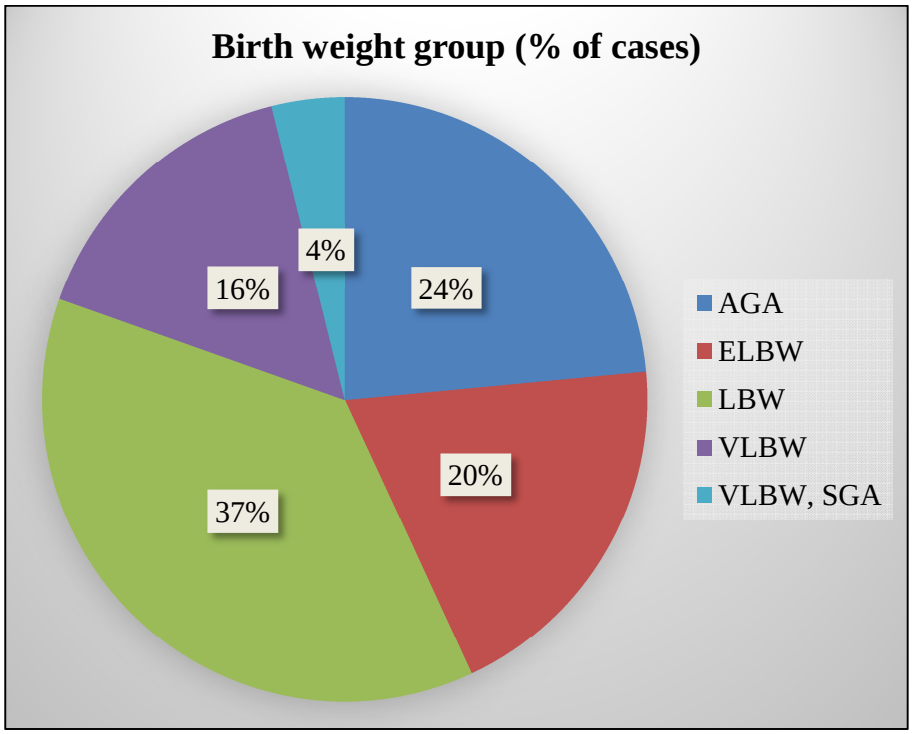


Table 5: Distribution of gestational age group among cases in study population

	N	%
EARLY PRETERM	9	17.7
EXTREME PRETERM	5	9.8
LATE PRETERM	20	39.2
TERM	17	33.3

Out of 51 neonates, Most of the neonates i.e. 20 belonged to late preterm gestational age category. Minimum gestational age was 27 weeks 5 days and maximum gestational age was 40 weeks 3 days.

Graph 5: Bar-graph depicting distribution of gestational age group among cases

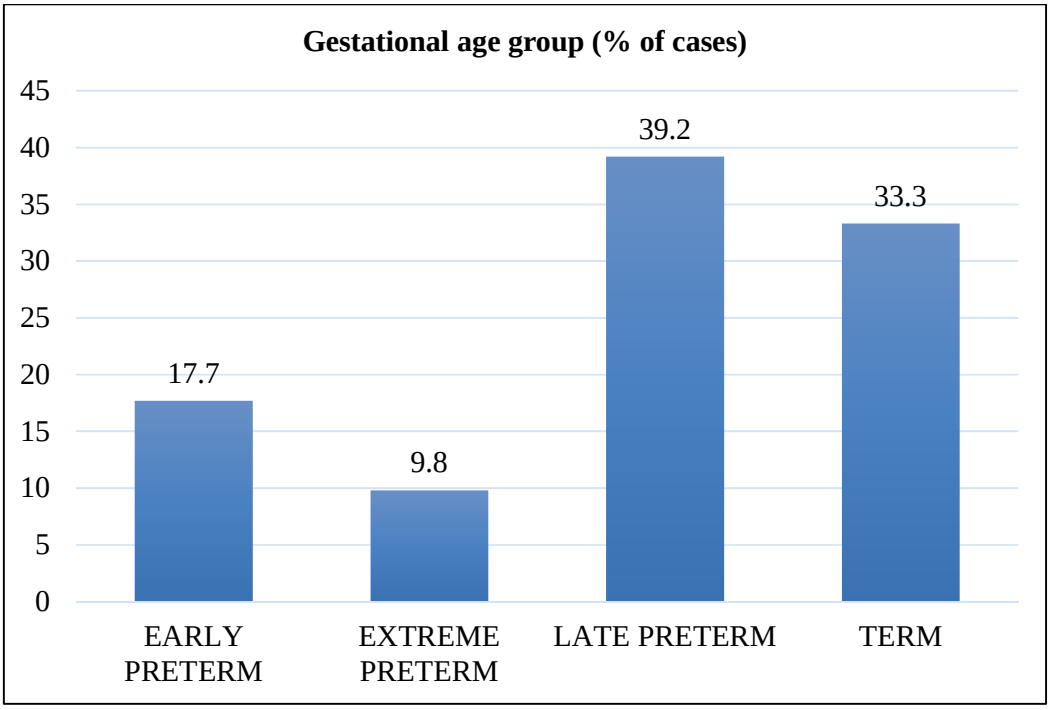


Table 6: Distribution of mode of O2 support used in the study group

	N	%
CPAP	29	56.9
NIL	17	33.3
NP	4	7.8
O2 (HOOD)	1	2.0

Postnatally, neonates who were admitted to the NICU with respiratory distress, Majority of the study subjects i.e. 56.9 % were on CPAP(Continuous positive airway pressure) mode of ventilation, 7.8 % received Oxygen via nasal prongs. 33.3 % of the study subjects were not put on any O2 support.

Graph 6: Bar-graph showing mode of Oxygen support among cases.

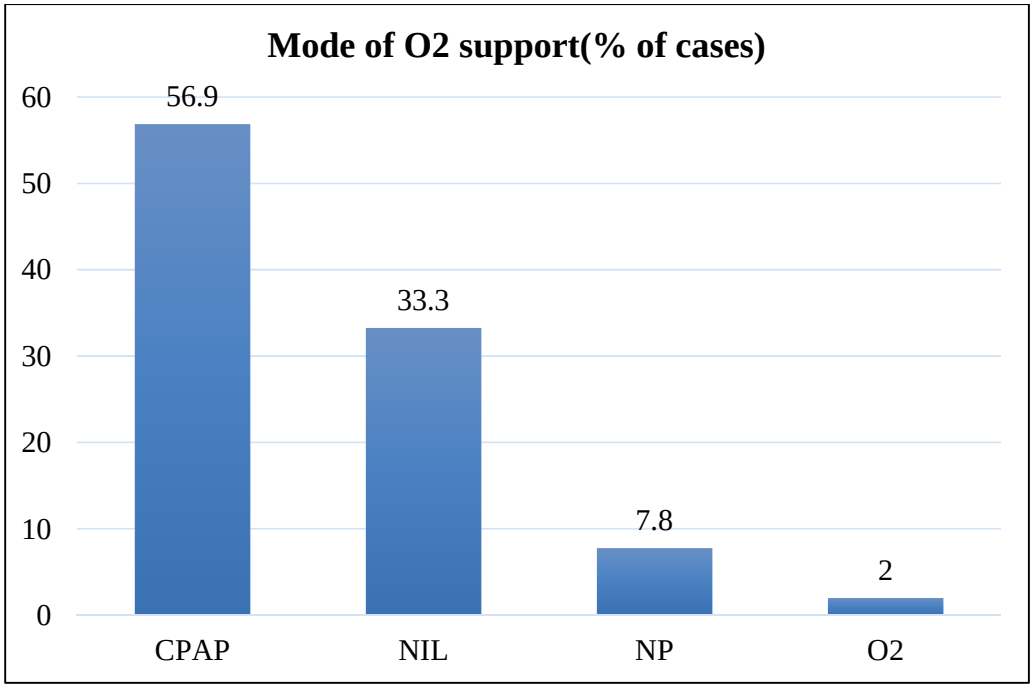


Table 7: Distribution of age group of mothers of study subjects

Mother's age	Frequency	Percent
≤ 20 years	4	7.8
21-25 years	24	47.1
26-30 years	15	29.4
> 30 years	8	15.7

Majority of the mothers, i.e. around 47.1 % belonged to the age group of 21-25 years. Maximum age was 35 years and minimum age was 19 years.

Graph 7: Bar-graph depicting distribution of age group of mothers of study subjects

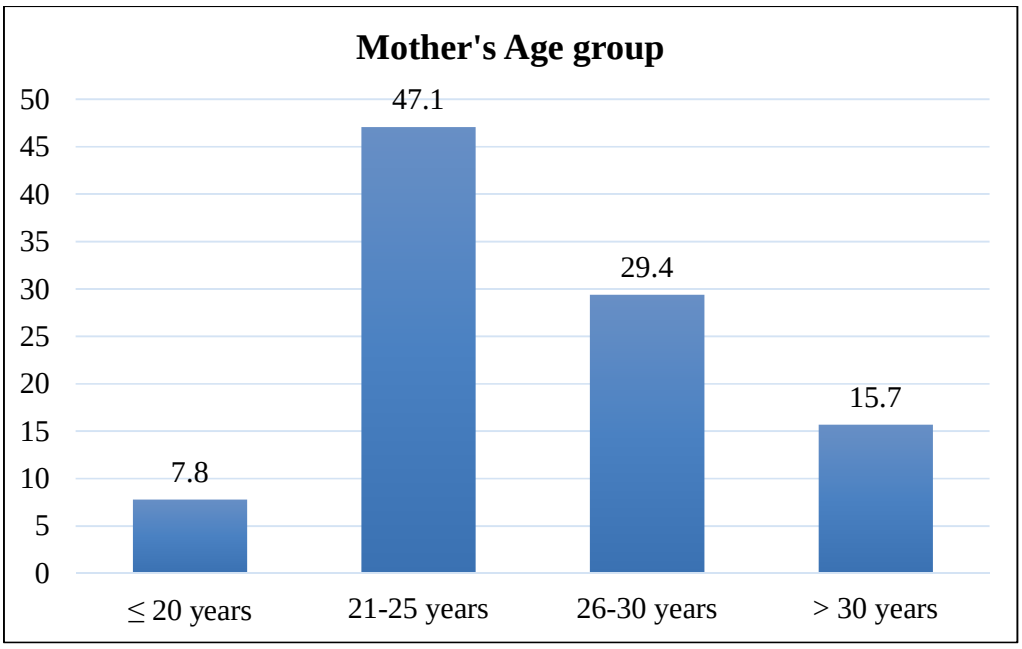


Table 8: Distribution of mother's blood groups in the study population

	N	%
A	16	31.4
A Neg	1	2.0
AB	1	2.0
B	16	31.4
B Neg	1	2.0
O	14	27.5
O Neg	2	3.9

In the present study, the percentage of mother with blood group A and B were equivalently distributed than other groups

Graph 8: Bar-graph showing distribution of mother's blood groups

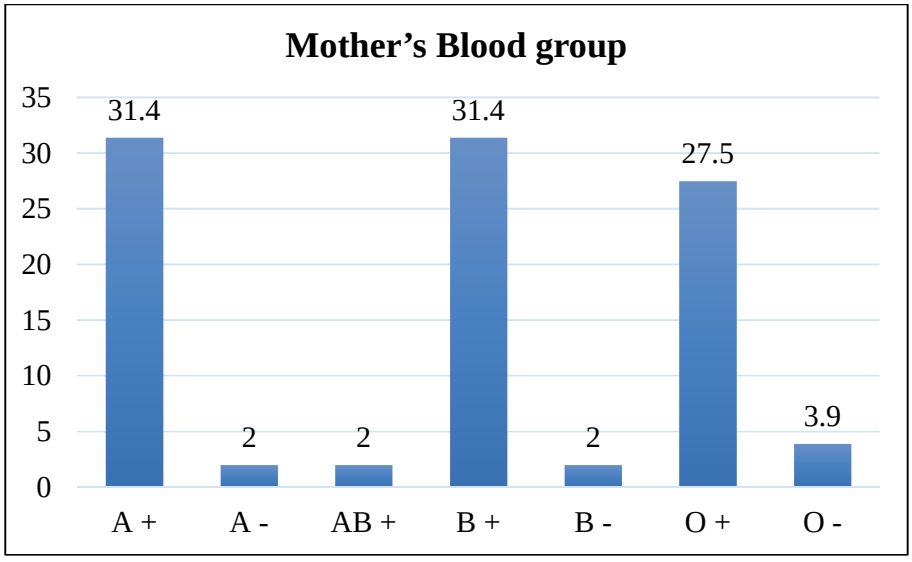


Table 9: Distribution of Gravidity among mothers of cases

	N	%
1.00	27	52.9
2.00	13	25.5
3.00	8	15.7
4.00	3	5.9

In the present study, the percentage of primigravida is predominantly more and comprises 52.9 % of the study population.

Graph 9: Pie-chart showing distribution of Gravidity among mothers of cases

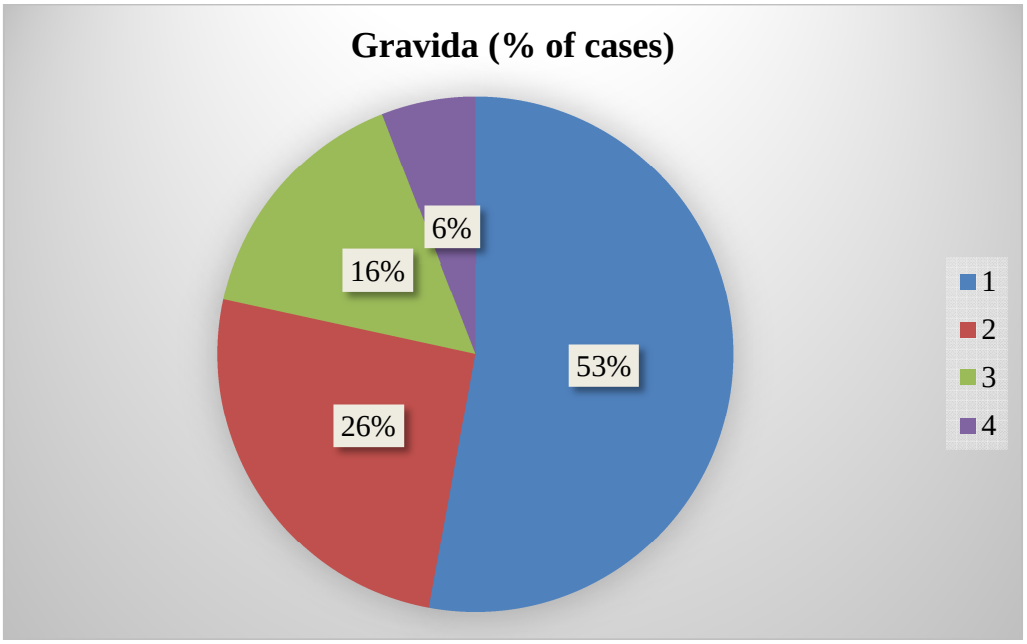


Table 10: Distribution of parity of mother of subjects in the study

Parity	N	%
1.00	45	88.2
2.00	5	9.8
3.00	1	2.0

Graph 10: Bar graph showing distribution of parity among mothers of cases

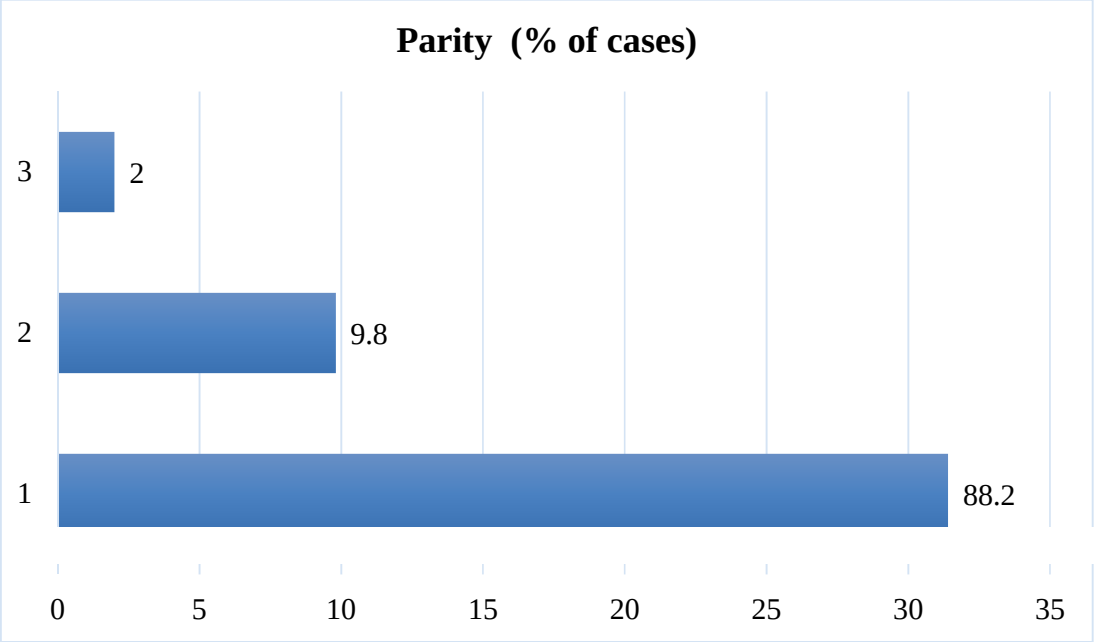


Table 11: Categories of complications in mother of subjects

	N	**%**
ABNORMAL LABOUR	7	13.7
ABNORMAL LABOUR, POLYHYDRAMNIOS	1	2.0
ABNORMAL PRESENTATION	1	2.0
CORD ABNORMALITY	1	2.0
CPPD	1	2.0
FETAL DISTRESS	2	3.9
NIL	**13**	**25.5**
OLIGOHYDRAMNIOS	2	3.9
OLIGOHYDRAMNIOS, CORD ABNORMALITY	1	2.0
PIH	9	17.6
PIH, PLACENTAL DISORDERS	1	2.0
PLACENTAL DISORDERS	2	3.9
POLYHYDRAMNIOS	1	2.0
RH INCOMPATABILITY	1	2.0
RH INCOMPATIBILITY	1	2.0
RH INCOMPATIBILITY, OLIGOHYDRAMNIOS	1	2.0
TWIN PREGNANCY	5	9.8
TWIN PREGNANCY, PIH	1	2.0

More than 25 % of the study subjects did not have any complication, followed by isolated Pregnancy induced hypertension which accounted for about 17.6 % among the mothers of study population.

Graph 11: Bar-graph showing distribution of complications among cases.

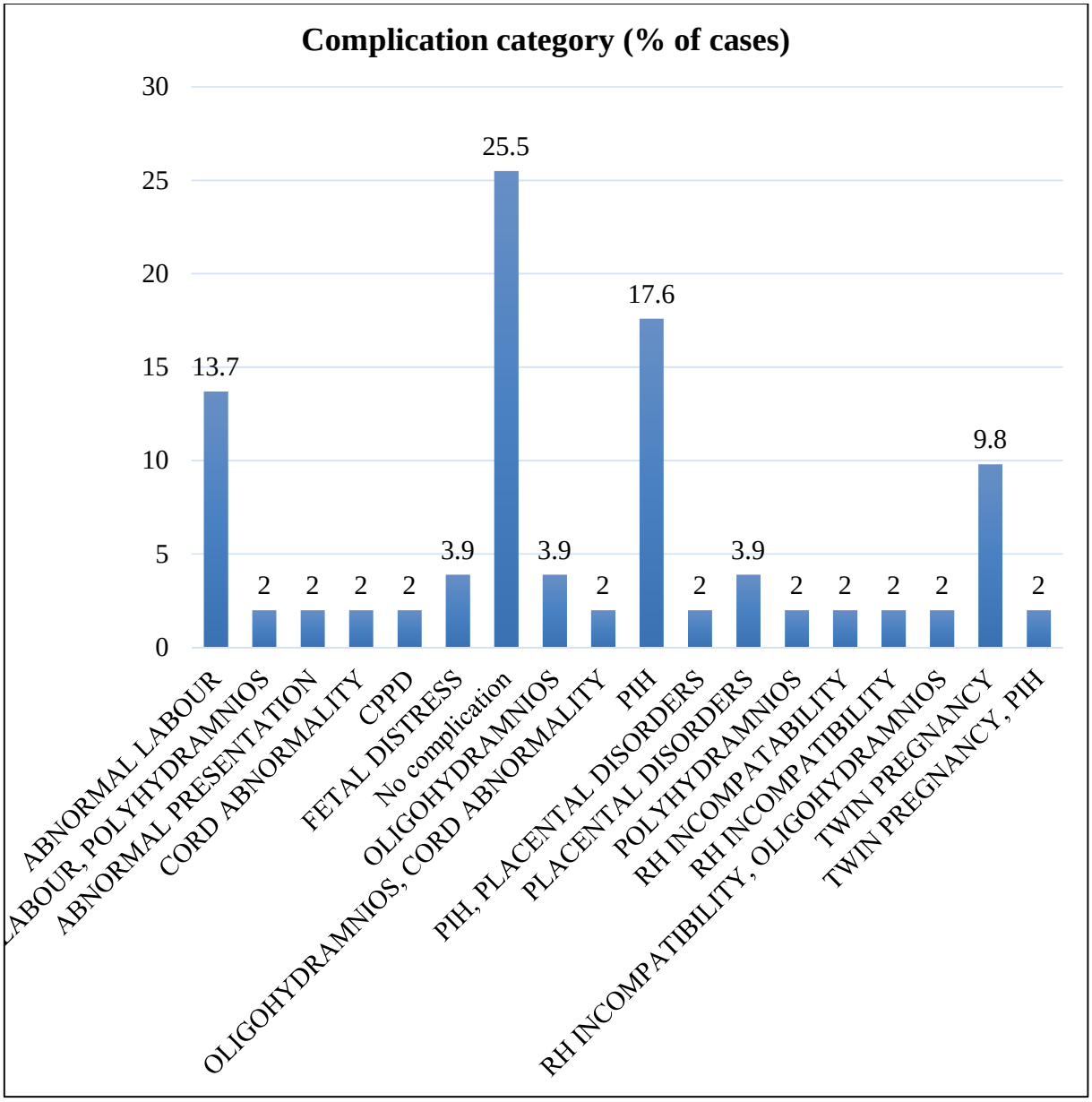


Table 12: Descriptive inspection of individual complication in mother of subjects

	N	%
ABRUPTIO PLACENTA	1	2.0
BREECH, CORD AROUND NECK	1	2.0
BREECH, OLIGO, CORD PROLAPSE	1	2.0
CHRONIC HYPERTENSION	1	2.0
FETAL DISTRESS, PV LEAK	1	2.0
GESTATIONAL HYPERTENSION	2	3.9
IMINENT ECLAMPSIA	1	2.0
LOW LYING PLACENTA	1	2.0
MSL WITH FETAL DISTRESS	1	2.0
NIL	13	25.5
OLIGOHYDRAMNIOS	2	3.9
PIH, AEDF	1	2.0
POLYHDRAMNIOS	1	2.0
PPROM	5	9.8
PPROM, POLYHYDRAMNIOS	1	2.0
PRE-ECLAMPSIA, HYPOTHYROIDISM	1	2.0
PRETERM LABOUR, PPROM	1	2.0
RH NEGATIVE	1	2.0

Rh NEGATIVE PREGNANCY	1	2.0
RH NEGATIVE PREGNANCY, OLIGOHYDRAMNIOS	1	2.0
SEVERE OLIGOHYDRAMNIOS	1	2.0
SEVERE PRE-ECLAMPSIA, AEDF, HYPOTHYROIDISM	1	2.0
SEVERE PRE-ECLAMPSIA, BREECH, ABRUPTION	1	2.0
SEVERE PRE-ECLAMPSIA, IUGR, HELLP	1	2.0
SHORT STATURE	1	2.0
THREATENED PRETERM	1	2.0
TRANSVERSE LIE	1	2.0
TWIN II – IUD	1	2.0
TWIN PREGNANCY	2	3.9
TWIN PREGNANCY, GESTATIONAL HYPERTENSION	1	2.0
TWIN PREGNANCY, PPROM	2	3.9

More than a quarter of the mothers of study subjects i.e. 25.5 % of the study population did not have any complications. The most common isolated complication was Prolonged Preterm Premature rupture of membranes which was present in 9.8 % of the study population.

Graph 12: Bar graph showing distribution of complications among cases.

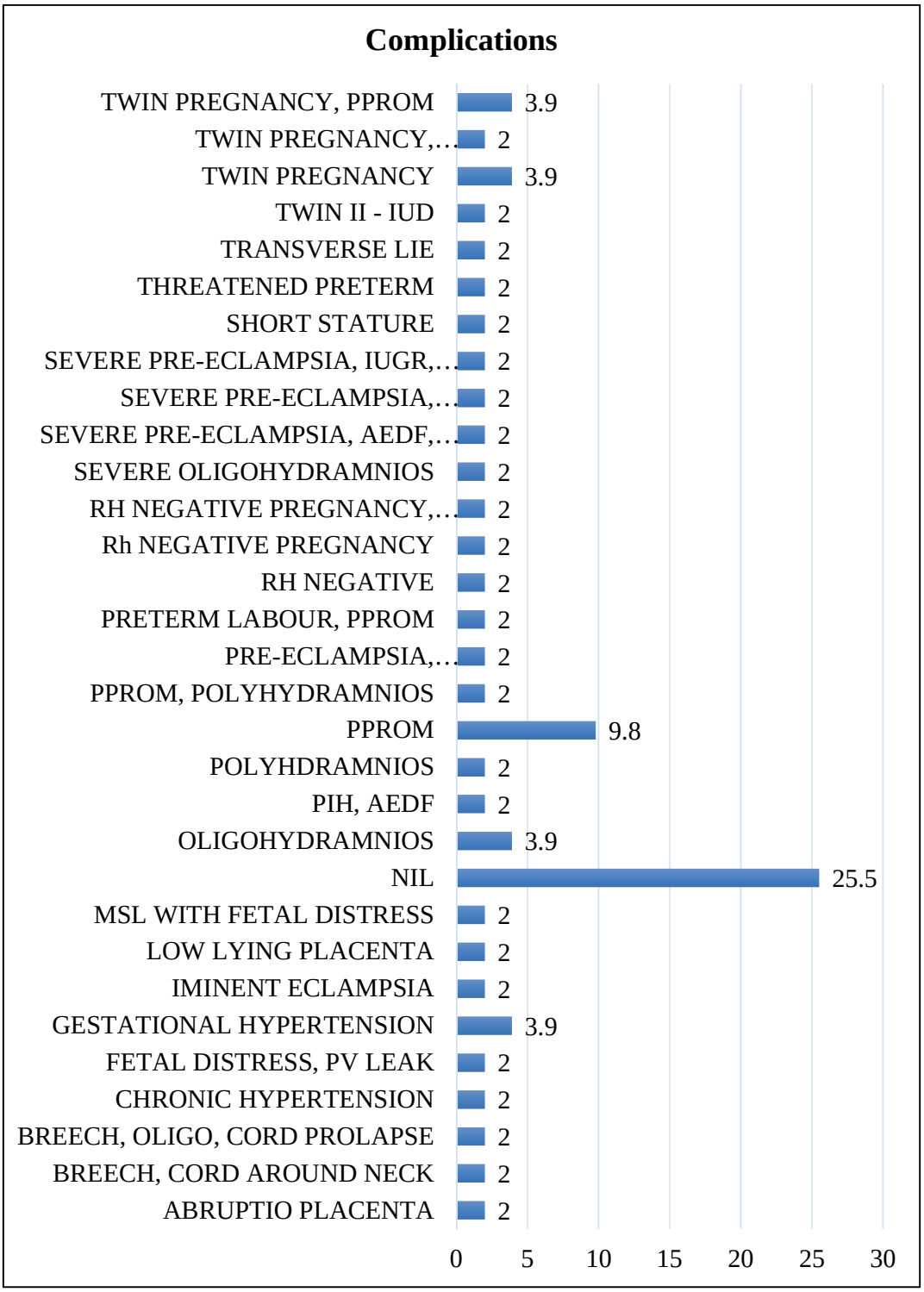


Table 13: Distribution of antenatal steroid therapy among cases

	N	%
NO	22	43.1
YES	29	56.9

Majority of the study subjects i.e 56.9 % had received antenatal steroid therapy. 43.1 % of the population did not receive any antenatal steroid therapy.

Graph 13: Pie-chart showing distribution of antenatal steroid therapy among cases

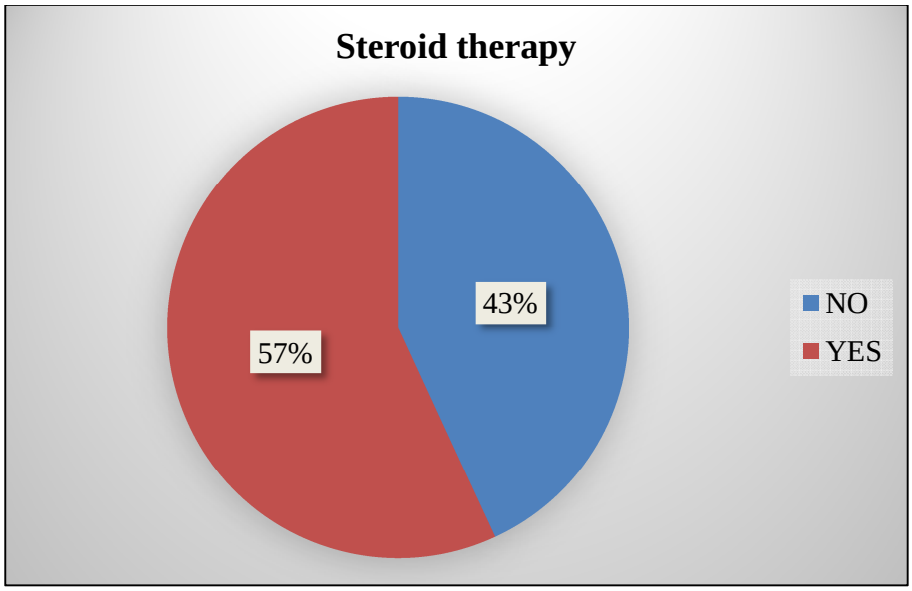


Table 14: Table of mode of delivery in mother of subjects

	N	%
LSCS	40	78.4
VACUUM/ VENTOUSE	2	3.9
VAGINAL	9	17.6

78.4 % of the study subjects were born via Caeserean section, while only 17.6 % of the subjects were born vaginally. 3.9 % of the study subjects had Ventouse as the mode of delivery

Graph 14: Bar graph showing distribution of mode of delivery among cases.

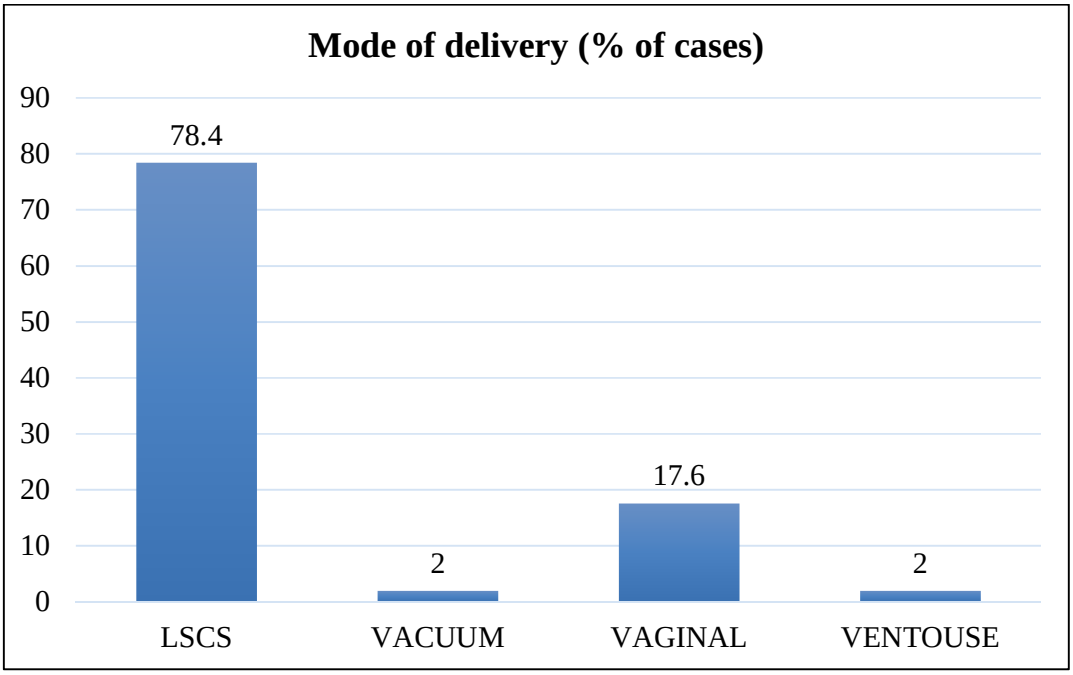


Table 15: Table of indication for LSCS in mother of subjects

	N	%
Not applicable	11	21.6
ABRUPTIO PLACENTA	2	3.9
AEDF	1	2.0
AEDF, HELLP	1	2.0
BREECH	1	2.0
FETAL DISTRESS	3	5.9
IMINENT ECLAMPSIA	1	2.0
LOW LYING PLACENTA	1	2.0
MSL WITH FETAL DISTRESS	1	2.0
OLIGOHYDRAMNIOS	3	5.9
PLACENTAL DISORDERS	1	2.0
POLYHYDRAMNIOS	1	2.0
PPROM - 36 HOURS	3	5.9
PREVIOUS LSCS	7	13.7
PV BLEED	1	2.0
PV LEAK	1	2.0
REVERSAL OF FLOW	1	2.0
SECOND STAGE ARREST	1	2.0

SEVERE PE, AEDF	1	2.0
THICK MSL, PREV LSCS	1	2.0
THIN MSL	1	2.0
TWIN PREG & PPROM	2	3.9
TWIN PREGNANCY	5	9.8

The most common indication of LSCS was Previous LSCS, as observed in 13.7 5 the study subjects, followed by twin pregnancy which comprised of 14%.

Graph 15: Bar graph summarizing Indication for LSCS in mother of subjects

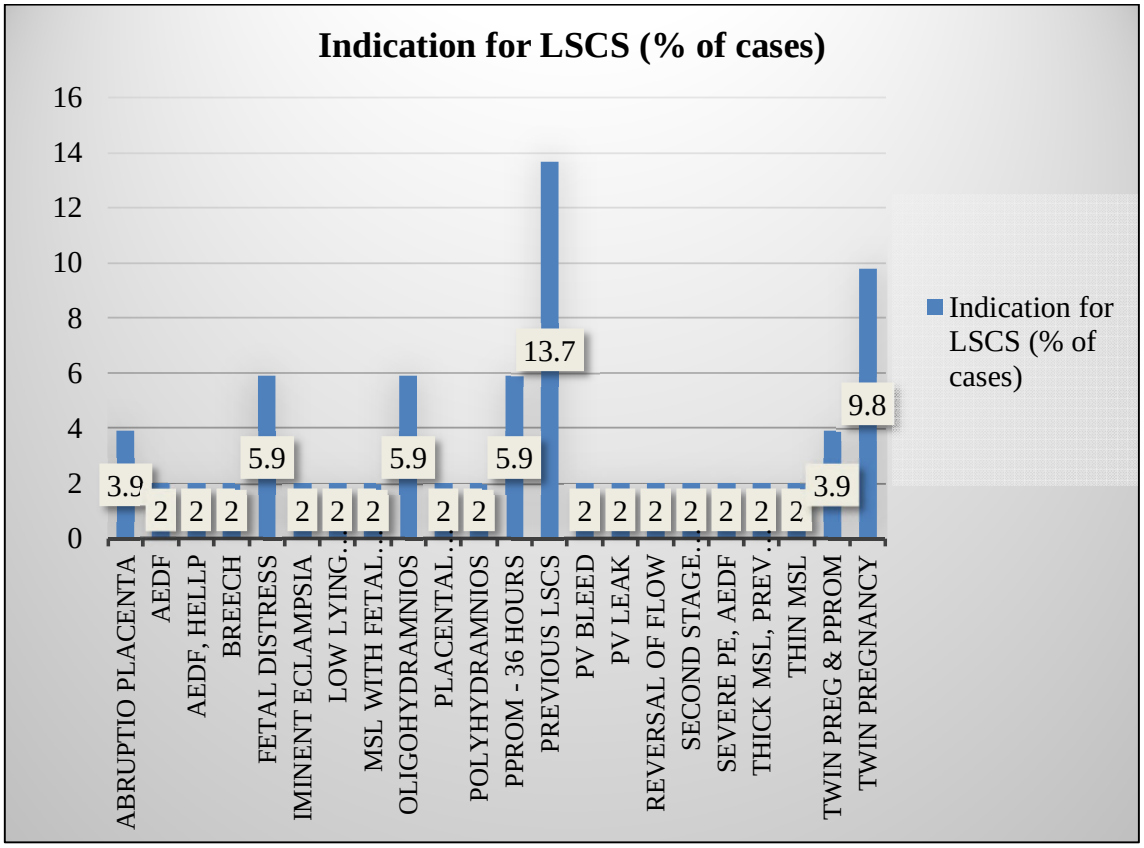


Table 16: Description of temperature distribution at birth in subjects

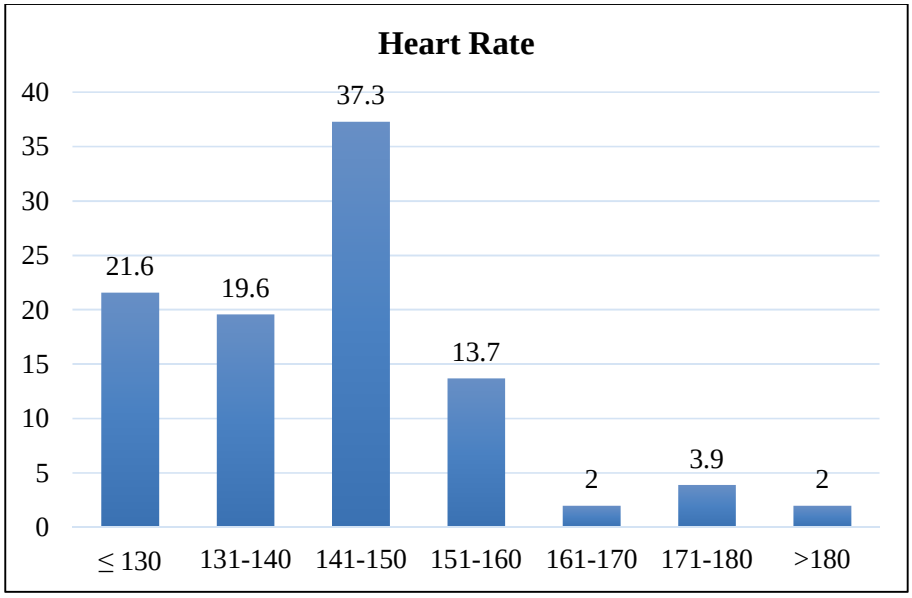
Temperature	N	%
EUTHERMIC	51	100.0

Temperature was euthermic for all the study subjects

Table 17: Distribution of Heart rate and Respiratory rate in subjects

		Frequency	Percent
Heart Rate	≤ 130	11	21.6
	131-140	10	19.6
	141-150	19	37.3
	151-160	7	13.7
	161-170	1	2.0
	171-180	2	3.9
	>180	1	2.0
Respiratory rate	≤50	1	2.0
	51-55	3	5.9
	56-60	11	21.6
	61-65	28	54.9
	>66	8	15.7

Graph 16: Bar graph showing distribution of heart rate in subjects



Graph 17: Bar graph showing distribution of respiratory rate in subjects

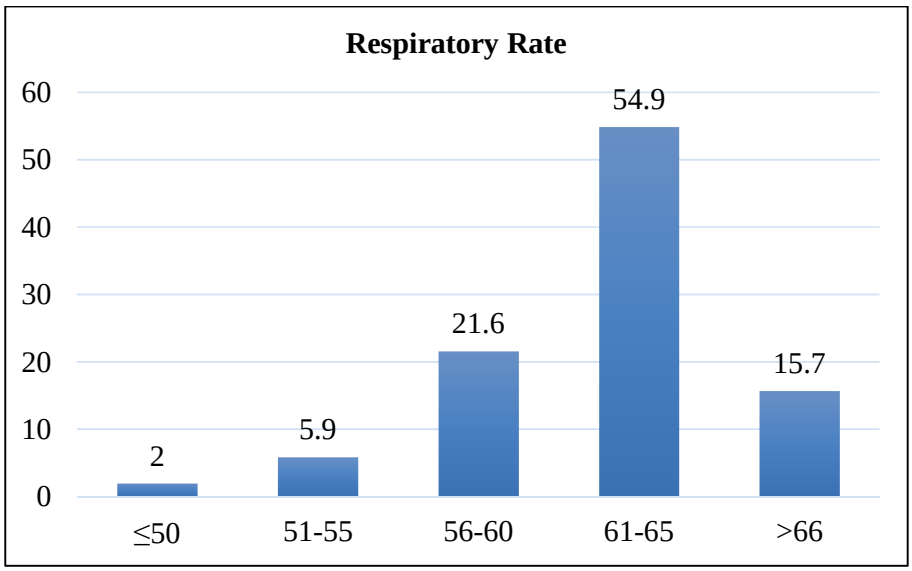


Table 18: Frequency distribution of APGAR score in subjects

APGAR Score	APGAR-1		APGAR-5	
	Frequency	Percent	Frequency	Percent
1	0	0	0	0
2	2	3.9	0	0
3	0	0	0	0
4	10	19.6	0	0
5	3	5.9	2	3.9
6	15	29.4	0	0
7	17	33.3	13	25.5
8	4	7.8	16	31.4
9	0	0	17	33.3
10	0	0	3	5.9

Graph 18: Two column chart depicting distribution of APGAR score in subjects

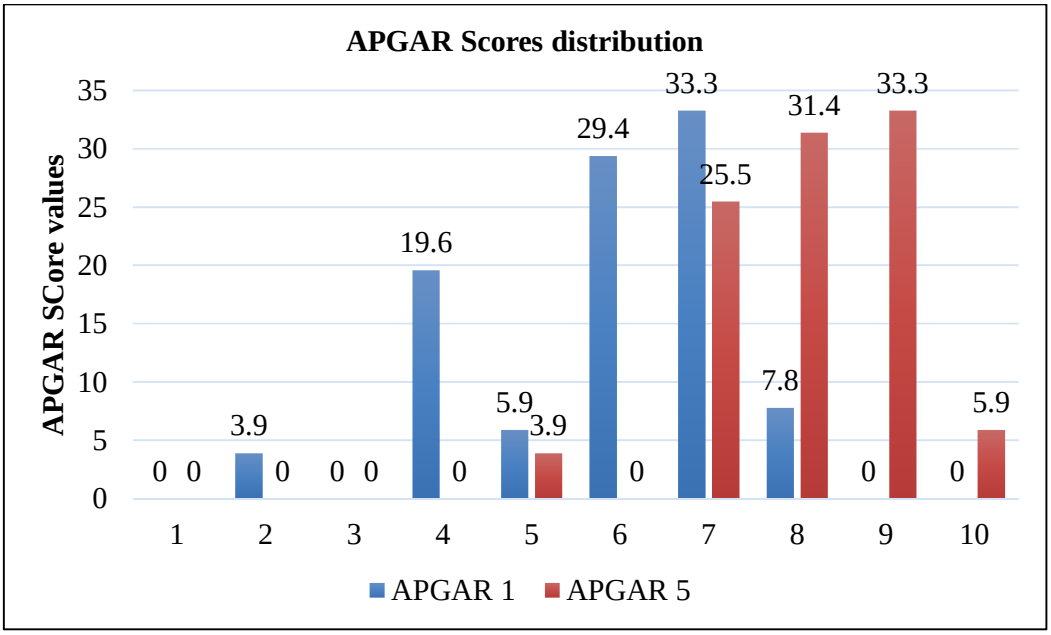


Table 19: Distribution of organisms causing sepsis among cases

	N	%
ACINETOBACTER	1	2.0
CANDIDA	2	3.9
CANDIDA, CITROBACTER	1	2.0
S.HEMOLYTICUS	1	2.0
ENTEROCOCCUS	1	2.0
KLEBSIELLA	5	9.8
KLEBSIELLA, ACINETO	1	2.0
NEGATIVE	39	76.5

Majority of the subjects i.e. almost 76.5 % of the study population had no sepsis.

Graph 19: Bar graph showing distribution of causative organism for sepsis in subjects

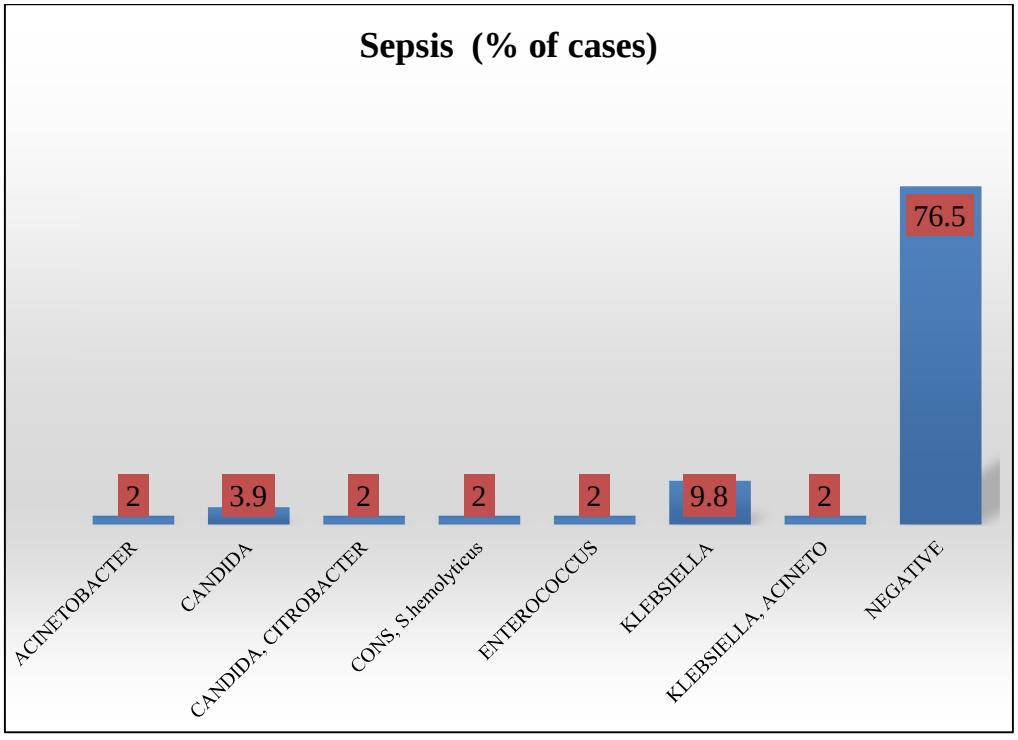


Table 20: Table of A-line distribution in subjects

	N	%
NO	45	88.2
YES	6	11.8

A-lines i.e the normal pleural line was present in 11.8 % of the patients and absent in 88.2 % of the patients. Partial or complete absence of A-lines is suggestive of underlying lung pathology.

Graph 20: Bar chart depicting distribution of A-line and B-line among cases

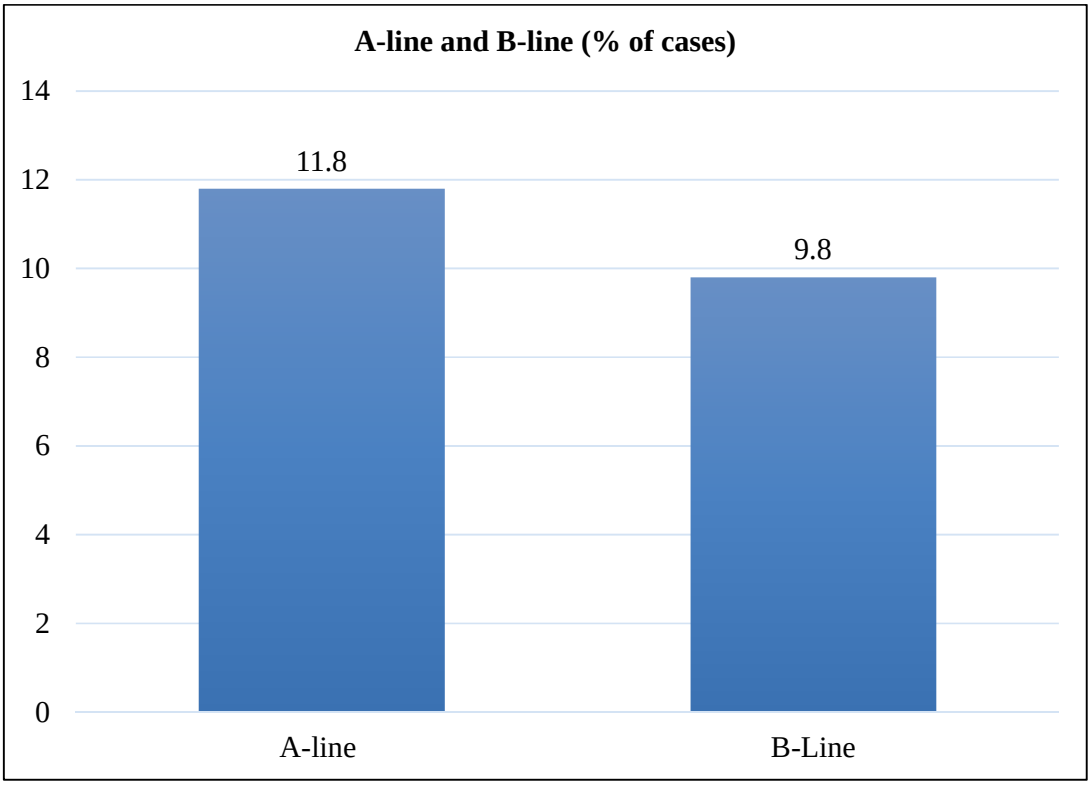


Table 21: Table of % of Lung sliding among cases

	N	%
NO	35	68.6
YES	16	31.4

Lung sliding is a normal ultrasonography finding, which suggests normal lung movement during respiration. Lung Sliding in our study was present only in 31.4 % of the patients and absent in 68.6 % patients.

Table 22: Air bronchogram finding among subjects

	N	%
ABSENT	48	94.1
PRESENT	3	5.9

Air bronchograms which are indicative of lung consolidation were present only in 5.9 % of the study population.

Table 23: B- line finding among cases

	N	%
NO	18	35.3
YES	33	64.7

B-line is a comet-tail artifact which are well-defined, vertical, hyperechoic, dynamic lines originating from the pleural line and spreading like a laser ray up to the edge of the screen. When present, B-lines suggest underlying lung pathology. They are most commonly seen in Respiratory distress syndrome and very few cases of MAS. In our study, B-lines was observed in 64.7 % subjects

Table 24: Description of Pleural abnormality among cases

	N	%
NO	6	11.8
YES	45	88.2

Pleural abnormalities like pleural thickening & irregularity are suggestive of underlying pathology. They are most commonly seen in RDS and MAS. Pleural abnormalities result in reduced movement of parietal pleura over visceral pleura.

Table 25: Description of pleural effusion among cases

	N	%
NO	41	80.4
YES	10	19.6

Pleural effusion refers to the collection of fluid between the parietal and visceral pleura. Pleural effusion was present in 19.6 % of the study cases. 80.4 % of the study subjects had no pleural effusion.

Graph 21: Bar chart depicting distribution of lung ultrasonography findings among cases

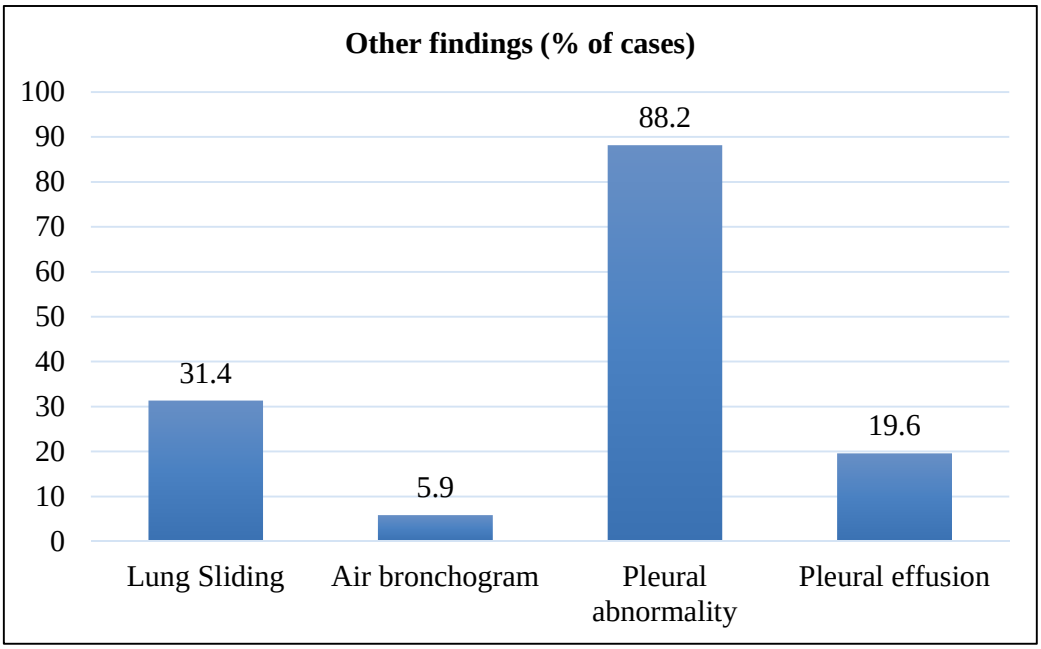


Table 26: Summary of distribution of clinical diagnoses among cases

	N	%
BIRTH ASPHYXIA	2	3.9
MAS	5	9.8
PNEUMONIA	2	3.9
PNEUMOTHORAX	1	2.0
RDS	31	60.8
RDS, AOP	1	2.0
RDS, LT PNEUMO	1	2.0
RDS, RT PNEUMO	1	2.0
TTNB	7	13.7

The most common clinical diagnosis for the study subjects was RDS which was diagnosed in 31 babies, followed by TTNB which was diagnosed in 7 babies. The third common clinical diagnosis was MAS which was diagnosed in 5 babies.

Graph 22: Bar graph showing distribution of clinical diagnoses among cases

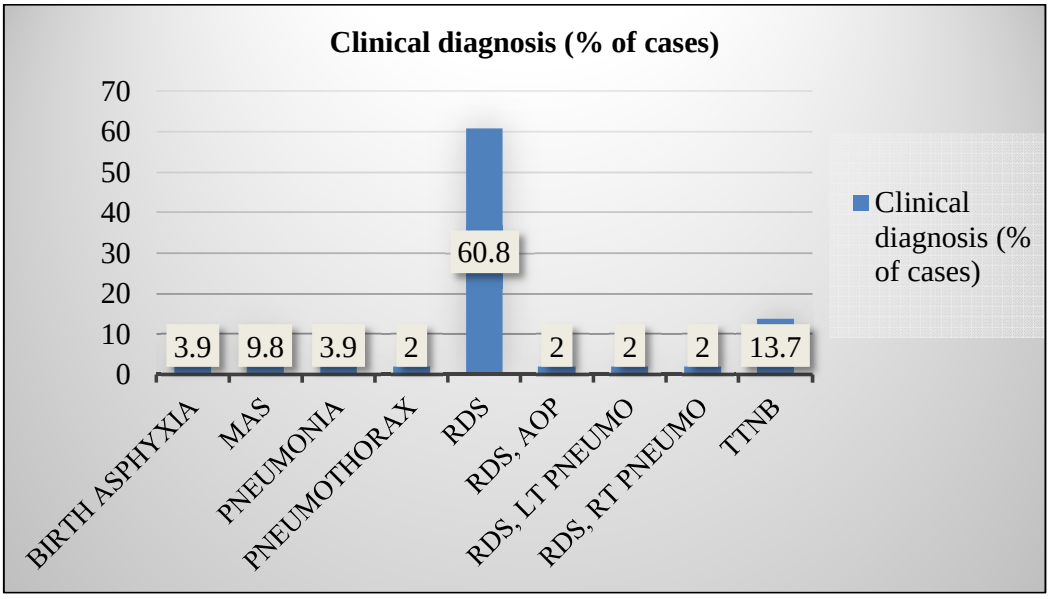


Table 27: Summary of distribution of radiographic diagnosis among cases

	N	%
PNEUMONIA	3	5.9
PNEUMOTHORAX	2	3.9
MAS	3	5.9
NORMAL	9	17.6
RDS	24	47.1
TTNB	9	17.6

All the study subjects were subjected to Chest radiography and were diagnosed on the basis of findings in chest X-ray. The most common radiographic diagnosis was RDS followed by TTNB. About 9 neonates had a normal chest radiograph.

Graph 23: Bar graph showing distribution of radiographic diagnoses

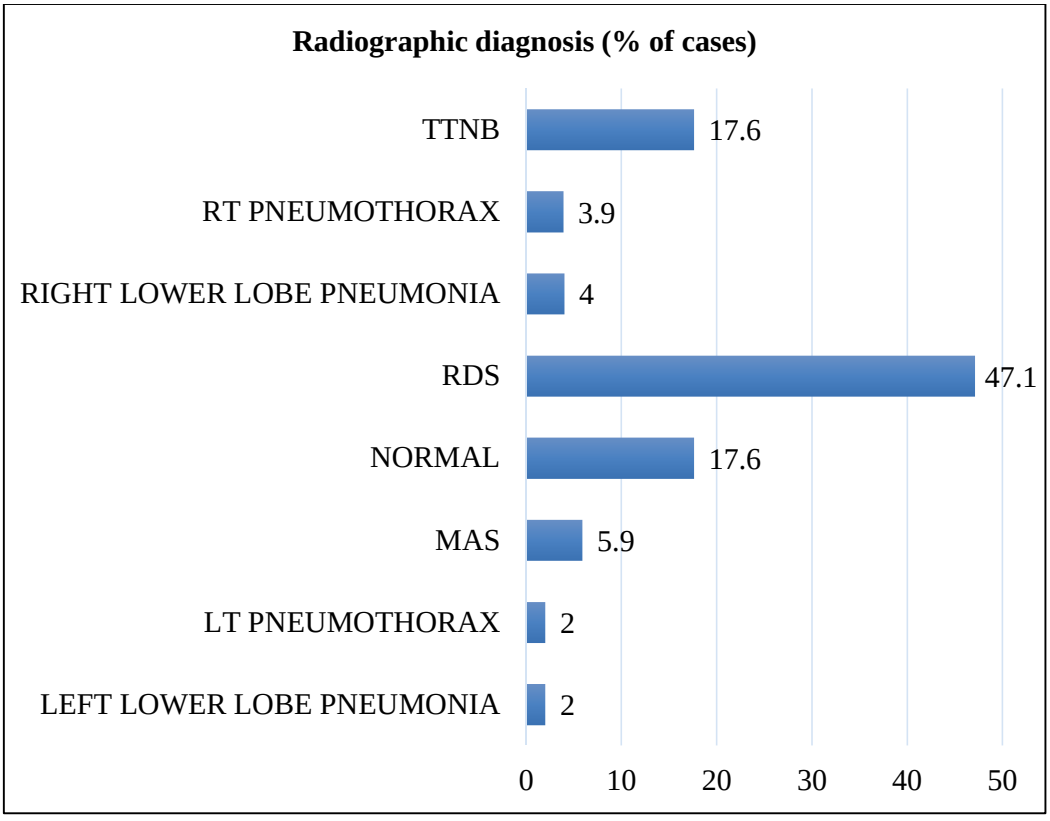


Table 28: Summary of USG diagnoses among cases

	N	%
PNEUMONIA	3	5.9
PNEUMOTHORAX	2	3.9
MAS	5	9.8
NORMAL	6	11.8
RDS	23	45.1
TTNB	11	21.6

Out of 51 neonates enrolled in the study, 23 neonates were diagnosed with respiratory distress syndrome, 11 neonates were diagnosed with transient tachypnea of the newborn, 5 neonates were diagnosed with meconium aspiration syndrome, 3 neonates were diagnosed with pneumonia and 2 neonates with pneumothorax. 6 neonates comprising 11.8 % of the total neonates enrolled in the study were diagnosed as normal according to lung ultrasonography. The most common USG diagnosis was RDS, followed by TTNB and is similar to clinical and radiographic diagnosis

Graph 24: Bar chart depicting summary of ultrasonographic diagnoses

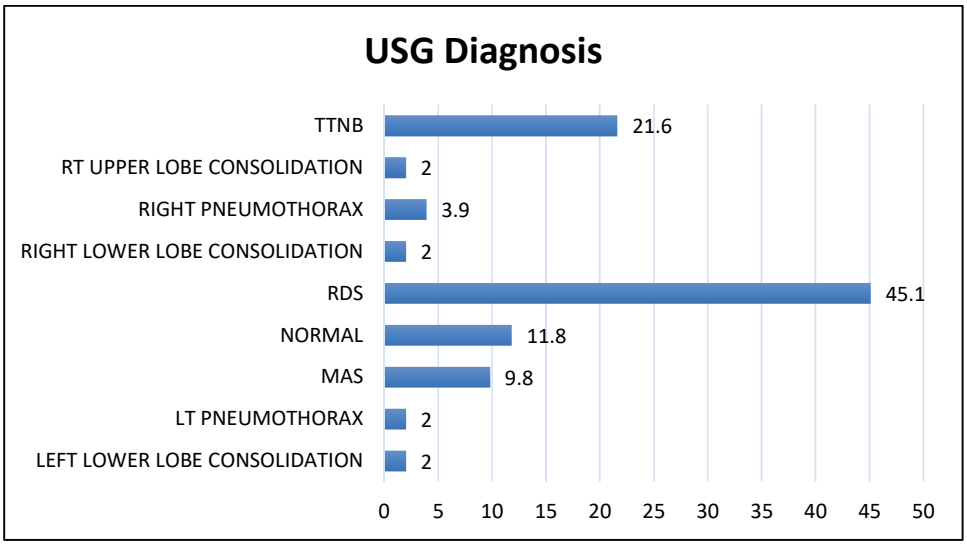


Table 29: Descriptive statistics of diagnostic accuracy of lung USG

Comparator group	Sensitivity	Specificity	PPV	NPV
USG	92.7%	87.21%	90.14%	79.2%

The diagnostic accuracy of ultrasound in our study with sensitivity was 92.7 %, specificity was 87.21 %, positive predictive value was 90.14 % and negative predictive value was 79.2 %.

Graph 25: Bar chart indicating diagnostic accuracy of USG of cases

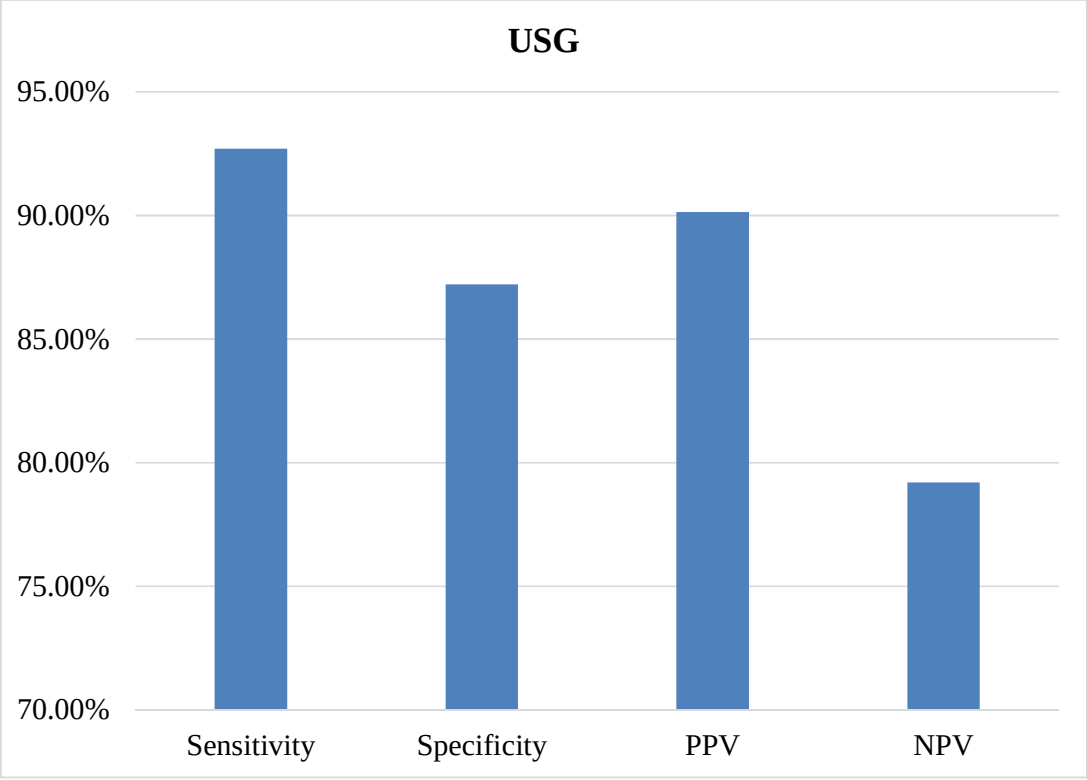


Table 30: Description of outcome among cases

	N	%
DEATH	6	11.8
DISCHARGE	45	88.2

Majority of the cases i.e. 88.2 % were discharged after hospitalization. Around 11.8 % of the study subjects succumbed to the complications arising from their pathological condition.

Graph 26: Bar graph showing the distribution of outcome in cases.

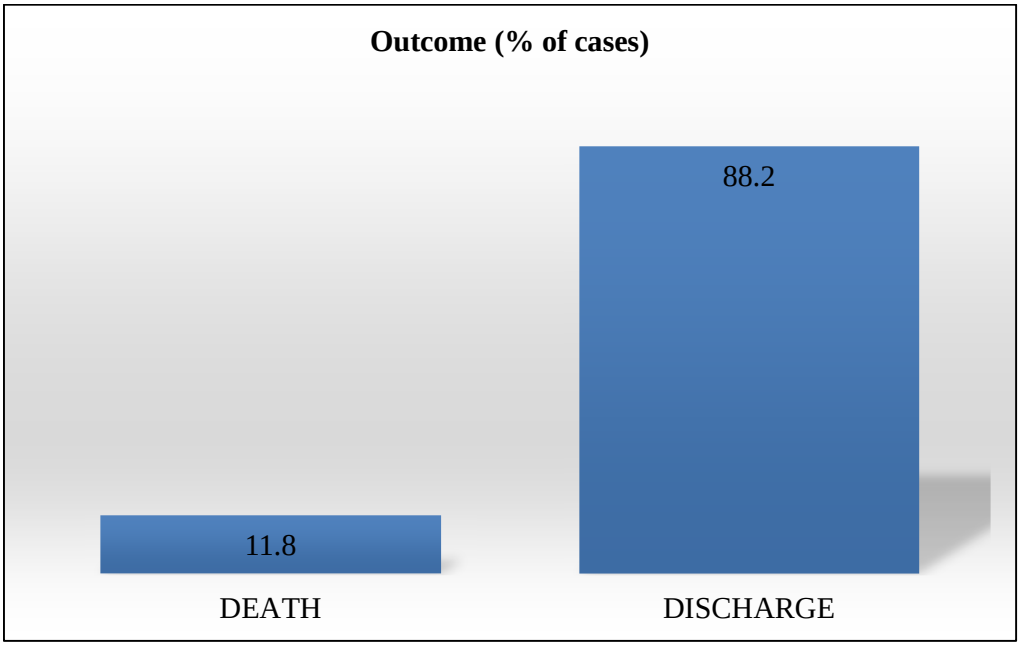


Table 31: Table of descriptive statistics for quantitative data among cases

	N	Mean	Std. Deviation
Age	51	2.12	.993
Gestational Age (weeks)	51	34.53	3.743
APGAR- 1	51	5.8824	1.46488
APGAR-5	51	8.0784	1.09258
Heart rate	51	143.3922	14.20574
Respiratory rate	51	61.4902	3.92108
TLC	51	11.9373	4.26084
Birth Weight	51	1878.63	784.581

DISCUSSION

Neonatal pulmonary diseases are the most common reason in a newborn for admission to the neonatal intensive care unit. Lung ultrasonography is a non-invasive and cost-effective imaging modality that has a vital function in diagnosing pulmonary diseases in babies.

Age & Sex distribution:

In the current study, which included 51 neonates, the number of male patients was more, 32 cases (62.7 %) as compared to the female patients who were 19 (37.3 %).

In a study conducted by Anandkat et al, Male sex independently increases risk for RDS regardless of gestational age which was consistent with our study[50].

A maximum number of cases in this study were from the age group of 1- 3 days - 17 cases (33.3%) were 1 day old, followed by the 15 neonates who were 2 days old and lastly 16 neonates were of 3 days.

1 day was the minimum age of the patient in our study and the maximum age was 3 days. The mean age was 1.98 days.

Distribution of blood group in neonates

In the current research, the percentage of babies with blood group A (35.3 %) are more than any other group. In a study conducted by McMahon et al, AB blood group was significantly associated with a 14-89% increased risk of sepsis and RDS[51]. However, no such correlation was found in our study.

Distribution of birth weight in neonates:

In the current research, most of the neonates belonged to the Low birth-weight (LBW) category and compromised of 19 (37.3%)

This was in consistency with a research conducted by Fehlman et al which concluded that RDS had a high incidence in very low birth weight infants, despite the frequent use of antenatal steroids. VLBW Infants with RDS had a higher mortality and an increase risk of relevant morbidity.

Distribution of gestational age group among cases:

In this study out of 51 patients, most of the children belonged to the Late preterm gestational age category which comprised of 19 (39.2%)

Institute of Medicine Committee consensus on Understanding premature birth and outcomes, concluded that Infants born prematurely are more likely to suffer major morbidity such as respiratory distress, and experience higher mortality than infants born at term.

Another study conducted by McMahon et al concluded that the incidence of respiratory distress syndrome (RDS) and chronic lung disease (CLD) is higher in infants born prematurely.

Distribution of mode of delivery among cases:

The majority of the babies (more than 2/3rd) were born via LSCS comprising 40 babies i.e 78.4 %. 9 babies (17.6 %) were born via normal vaginal delivery and 2 babies (3.9 %) via vaginal delivery with vacuum.

This finding is consistent with several previous studies which have documented the high incidence of respiratory distress and NICU admissions in infants born by cesarean delivery prominent among them being Alderdice et al and Donaldson et al[52]

Distribution of indication for LSCS among cases:

The most common indication for LSCS in our study was Previous LSCS followed by twin pregnancy. 13.7 % had previous LSCS as the indication while 7.9 % had twin pregnancy as the indication for current cesarean section

In a prospective cohort study conducted by Hansen et al on term infants found that the odds of respiratory morbidity and serious respiratory morbidity were higher when delivered by elective section as compared to those delivered vaginally[53]. Skokić, et al conducted a study which concluded that risk of respiratory distress is higher in premature twins.

Distribution of antenatal steroid therapy among cases:

56.9 % of the mothers of the subjects had received antenatal steroid therapy in our study and 43.1 % had not received any steroid therapy.

Exposure to antenatal corticosteroids does not significantly affect respiratory outcomes among those with a subsequent late-preterm birth.

But many randomized trials have confirmed that a course of antenatal corticosteroid therapy (ACS) administered to women at risk for preterm delivery reduced the incidence and severity of respiratory distress syndrome (RDS) in offspring[54].

Distribution of maternal gravidity and parity among cases :

In our study, majority of the mothers of the study subjects had single gravidity and single parity and comprised 52.9 & 31.4 % respectively.

In a study conducted by Ashwin Ramachandrappa and Lucky jain , it was mentioned that Higher gravidity and parity were associated with a significant risk of RDS[55].

Lung Ultrasonography as a diagnostic modality:

In this study, Lung ultrasonography in the diagnosis of neonatal pulmonary diseases had a sensitivity of 92.7 %, specificity of 87.21 %, positive predictive value of 90.14 % and negative predictive value of 79.2 %

Our data indicate that lung US can be adopted as a simple and noninvasive method for evaluating children with pneumonia. It is easy to perform at the patient's bedside, allows close follow-up and avoids the use of ionizing radiation. We believe that lung US may be used extensively in cases of suspected pneumonia and that a clear clinical picture of pneumonia associated with positive lung US findings excludes the need to perform CXR.

LIMITATIONS.

The examination technique and small sample size are the limitations of the study. Since the ultrasound technique depends on the examiner's skill, there are many intra and inter-observer variations in diagnosing neonatal pulmonary diseases.

Another limitation of the study is that lung ultrasonography cannot diagnose all neonatal pulmonary diseases. Lesions distant to the pleura, such as congenital pulmonary airway malformation (CPAM), and interlobar pulmonary sequestration, are missed by lung ultrasound. Conditions such as pulmonary bullae and pulmonary interstitial emphysema cannot be detected by lung ultrasound.

Although lung ultrasound is sensitive for the diagnosis of pneumothorax, it is unable to measure the volume of the pneumothorax. A distinction between infected and non-infected consolidation cannot be made on lung ultrasound. The diagnosis of pneumonia by lung ultrasound should therefore be combined with the medical history

CONCLUSION

- Neonatal lung ultrasonography is the safest and first-line investigation for the evaluation of neonatal pulmonary disorders since it is non-invasive, economical, and radiation-free.
- Our study showed that LUS is a sensitive (sensitivity-92.7%) and specific (specificity - 87.2%) diagnostic tool in neonates with respiratory distress. As a result, we speculate that LUS might be used as the first imaging test in neonates with respiratory distress.
- According to this study, preterm babies and men are more likely to have newborn pulmonary disorders.
- This study establishes evidence of the prevalence of RDS according to lung ultrasonography in the given study group was found to be 45.16%.
- This study establishes that there's no significant correlation between neonatal pulmonary diseases and temperature and the baby's & maternal blood group
- A significant association between respiratory distress and babies born via LSCS was found in the study.
- In the differential diagnosis of neonates with increased work of breathing, our study found good agreement between lung ultrasound and chest radiographs, and that lung ultrasound shortened the time to diagnosis. However, the diagnostic performance of LUS is noticeably superior to that of radiographic diagnosis in several conditions in neonates presenting with respiratory distress. Rapid testing is one of the additional advantages of lung ultrasonography.

- Lung ultrasonography may be used in addition to other diagnostic methods for the detection of newborn pneumonia. It may also be used to track the progress of pneumonia recovery.
- In conclusion, lung ultrasonography seems to be an accurate, dependable, and non-invasive bedside tool for the diagnosis of MAS, pneumonia, and RDS.
- Lung ultrasonography is also appropriate for dynamic monitoring and can quickly provide useful information when clinicians need to identify the reason for of acute respiratory distress. It can also provide e rapid diagnosis in response to changes in the patient's state.
- In particular, lung ultrasonography uses no radiation, protecting the patient and the medical staff from radiation-related harm.
- To conclude, lung ultrasonography may eventually replace X-rays for the diagnosis and differential diagnosis of common lung disorders in newborns.

SUMMARY

- Neonatal pulmonary disorders are one of the most common conditions for admission to a neonatal intensive care unit after congenital conditions. This study was aimed to determine the accuracy and effectiveness of lung ultrasonography as a diagnostic tool in neonates with pulmonary diseases.
- Due to the lack of sufficient research on ultrasonography in Indian neonates with pulmonary diseases, hence this study wasncarried out.
- The study was a hospital-based cross-sectional study, conducted from January 2021 – December 2021 on 51 neonates admitted with respiratory distress in the neonatal intensive care unit of KLE'S Dr. Prabhakar Kore Hospital Belagavi. The exclusion criteria were babies with congenital conditions.
- The study was conducted for the detection of abnormal lung ultrasound findings and for subsequent comparison with chest radiograph findings. The age of the neonates enrolled in the study ranged from 1 to 3 days and belonged to varied gestational age groups such as early preterm, late preterm, and term.
- After obtaining informed consent baseline data was recorded on a self-designed proforma. Lung ultrasonography was performed on all the participants using MINDRAY M7 Premium scanner 7.5 – 12 MHz equipped with a high-frequency linear transducer.
- Detailed examination in supine and both lateral decubitus positions of the anterior lung area, lateral lung area, and posterior lung area was done in the caudo-cranial direction.
- Chest radiographs of neonates were obtained in the AP view. Lung ultrasound images were evaluated for specific ultrasound findings like presence/absence of

A and B lines, pleural effusion, pleural abnormalities, air bronchograms and lung sliding.

- It was found that males were affected more as compared to females.
- Upon evaluation of lung ultrasound images 45(88.2%) neonates were having an absence of A-lines, 35(68.6%) neonates were having an absence of lung sliding, in 3(5.9%) neonates air bronchograms were present, in 33(64.7 %) neonates B lines were present, in 45(88.2%) neonates pleural abnormalities were present and in 10 (19.6%) neonates pleural effusion was positive.
- On basis of the above findings 5 (9.8%) neonates were given the diagnosis of MAS, 3 (5.9%) neonates were given the diagnosis of pneumonia, 3 (5.9 %) neonates were diagnosed with pneumothorax, 11 neonates(21.6%) were diagnosed with transient tachypnea of newborn and 23(45.1%) neonates were given the diagnosis of respiratory distress syndrome.
- On chest radiograph examination, 9 (17.6 %) radiographs were normal , 3 (5.9 %) neonates were given the diagnosis of MAS, 3 (5.9 %) neonates were given the diagnosis of pneumonia, 3 (5.9 %) neonates were given the diagnosis of pneumothorax, 9 (17.6%) neonates were given the diagnosis of TTNB and 24 (43.5 %) neonates were given the diagnosis of respiratory distress syndrome.
- In this study, Lung ultrasonography in the diagnosis of neonatal pulmonary diseases had a sensitivity of 92.7 %, specificity of 87.21 %, positive predictive value of 90.14 % and negative predictive value of 79.2 %
- On comparison of lung ultrasound and chest radiograph findings it was found that LUS sensitivity is comparable with routine CXR and in few cases it surpasses it.
- This study fulfills both the objectives of our study.

- Ultrasound based analysis of neonatal lungs is an effective method to diagnose the cause of neonatal respiratory diseases. Ultrasound based analysis can play an effective role in reducing radiation exposure in neonates with respiratory diseases. With its added advantages lung ultrasound can become part of routine neonatal care and all time available facility in NICU setup.
- Limitations of the present study include:
  - Cross-sectional assessment.
  - Small sample size with intra & inter-observer variation in the technique.
  - Limitations of lung ultrasound in the detection of pulmonary interstitial syndromes and pleural based lesions
  - Limitations of lung ultrasound in quantification of pneumothorax
  - Limitation of lung ultrasound in identification of consolidation as infective/ non-infective
- Recommendations for future study include:
  - Longitudinal assessment with larger sample size & control groups.

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ANNEXURE I –

INFORMED CONSENT

TITLE OF THE STUDY: "EFFECTIVENESS OF LUNG ULTRASONOGRAPHY IN THE EVALUATION OF NEONATAL PULMONARY DISEASES: A ONE YEAR TERTIARY HOSPITAL BASED OBSERVATIONAL STUDY

PRINCIPAL INVESTIGATOR:

GUIDE:

CO-GUIDE:

INTRODUCTION AND PURPOSE: Respiratory conditions are the most common reason for admission to a neonatal unit in both term and preterm infants. This study is being done to determine the role of ultrasonography as a diagnostic utility in neonates with pulmonary diseases in the Neonatal Intensive Care Unit of a tertiary hospital.

PROCEDURE: "EFFECTIVENESS OF LUNG ULTRASONOGRAPHY IN THE EVALUATION OF NEONATAL PULMONARY DISEASES: A ONE YEAR HOSPITAL BASED OBSERVATIONAL STUDY" at Dr. Prabhakar Kore Hospital and Medical Research Centre, Belagavi is being conducted by **Dr. _____,** Post graduate in Radio-diagnosis at J. N. Medical College Belagavi, Karnataka, under the guidance and supervision of **Dr. _____,** Professor, Dept. of Radio -diagnosis, J. N. Medical College, Belagavi and **Dr. _____** Associate Professor, Department of Paediatrics, J. N. Medical College, Belagavi.

We request you to allow the participation of your baby in this study as he/she is eligible to be included. During the study, you will be asked questions regarding your present and past medical and obstetric history and your baby's medical history and you will be required to answer to the best of your knowledge. Your baby will also have to undergo an ultrasound of the lungs. If you agree for the participation of your baby in the study, please furnish the details pertaining to the study.

RISKS & BENEFITS: Non-invasive modality of Investigation of Respiratory Distress

COMPLICATIONS: No risk to the patient has been documented from ultrasound imaging of the abdomen earlier.

ALTERNATIVES: If the parents are not willing for their baby to take part in the study, the child's treatment or any other further investigations the he/she wants to undergo, in future, in KLE Hospital will not be affected by their decision.

VOLUNTARY PARTICIPATION/WITHDRAWAL: Taking part in this study is voluntary. You may choose for your child to not take part in this study, or if you decide for him/her to take part, you can later change your mind and withdraw your child from the study. Your decision will not change the present or future health care or other services that your child receives. The study doctor or the sponsor may stop your child's participation in this study. You will tell of any important new findings that may change your willingness to continue to take

part. If you choose for your child to not to take part in the study, you will receive the standard treatment for patients with your child's condition.

COSTS: NIL

PAYMENT FOR PARTICIPATION: No incentive will be paid to you for allowing your child to participate in this study.

COMPENSATION: In the event that your child becomes injured as a result of taking part in this study, treatment whatever available at KLE charitable hospital, Belagavi, will be offered to him/her. No reimbursement, compensation or free medical care is given.

CONFIDENTIALITY: All information collected about your child during the course of the study will be kept confidential to the extent permitted by the law. The code numbers will identify him/her in this research record. Information from this study may be published, but his/her personal identity will be confidential in any publication/presentation.

QUESTION: If any enquiries in the future or in case of research related injury/ illness, you may contact following person.

Dr. Harsha Hegde
Chairperson, J.N. Medical College, IEC & Scientist D, ICMR, National Institute of Traditional Medicine, KAHER, Belgavi-590010
Ph. No: 0831-2473777, Ext. 1529

KAHER

JAWAHARLAL NEHRU MEDICAL COLLEGE, BELAGAVI

DEPARTMENT OF RADIO-DIAGNOSIS

CONSENT TO PARTICIPATE IN RESEARCH STUDY

TOPIC: "EFFECTIVENESS OF LUNG ULTRASONOGRAPHY IN THEEVALUATION OF NEONATAL PULMONARY DISEASES: A ONE YEAR TERTIARY HOSPITAL BASED OBSERVATIONAL STUDY"

PRINCIPAL INVESTIGATOR: DR

GUIDE: **CO-GUIDE:**

1. I understand that my child will be participating in the study, which includes ultrasound of the lungs.

2. I confirm that I have read and understood the information in the patient information sheet. Procedure is explained to me in detail along with information about the advantages and disadvantages of my child taking part in the study. I have been given the opportunity to discuss all aspects of the trial, to ask questions and hereby consent my child to participate in the trial outlined above.

3. I understand that the decision to take part in this study is completely voluntary and I am aware that I can choose to withdraw my child from the study at any point of time.

4. I consent to the photographing or recording of the procedure to be performed including appropriate portions of my child's body, for medical,

scientific or educational purposes provided his/her identity is not revealed in the pictures or by the descriptive texts accompanying them.

5. I understand that there is no significant risk involved in the test that would be done in this study.

6. No guarantee or assurance has given by anyone as to the results that may be obtained.

7. My signature on this form signifies that I have willingly decided for my child's participation after understanding the above information.

Participant's Name/ legally authorized representative _____

Signature _____

Name and signature of witness _____

Name and signature of interviewer _____

Date _____ Place: _____

ANNEXURE II-PROFORMA

PROFORMA FOR DATA COLLECTION

TOPIC: "EFFECTIVENESS OF LUNG ULTRASONOGRAPHY IN THE EVALUATION OF NEONATAL PULMONARY DISEASES: A ONE YEAR TERTIARY HOSPITAL-BASED OBSERVATIONAL STUDY"

PRINCIPAL INVESTIGATOR:

GUIDE: DR.

CO-GUIDE: DR.

FORM NO.:

DATE OF INTERVIEW:

NAME OF THE PATIENT: _____

SEX: M / F

DATE OF BIRTH: _____

AGE (IN DAYS) _____

IP NO _____

PARENT'S MOBILE NUMBER: _____

ADDRESS: _____

WARD/VILLAGE: _____

DISTRICT: _____

USG NUMBER: _____

CHIEF COMPLAINTS: 1._____

2. _____

3. _____

HISTORY OF PRESENTING ILLNESS: _____

OBSTETRIC HISTORY OF MOTHER:

BIRTH HISTORY:

CLINICAL EXAMINATION:

VITALS:

TEMP - C **HR - beats/ min**

RR – cycles/ min **SPO2 – %**

SYSTEMIC EXAMINATION:

- **CVS -**
- **RS -**
- **P/A -**
- **CNS -**

CLINICAL DIAGNOSIS: _____

CHEST RADIOGRAPH FINDINGS: _____

USG FINDINGS:

ANNEXURE III: FIGURES

Fig 15: MINDRAY M-7 machine used for the study

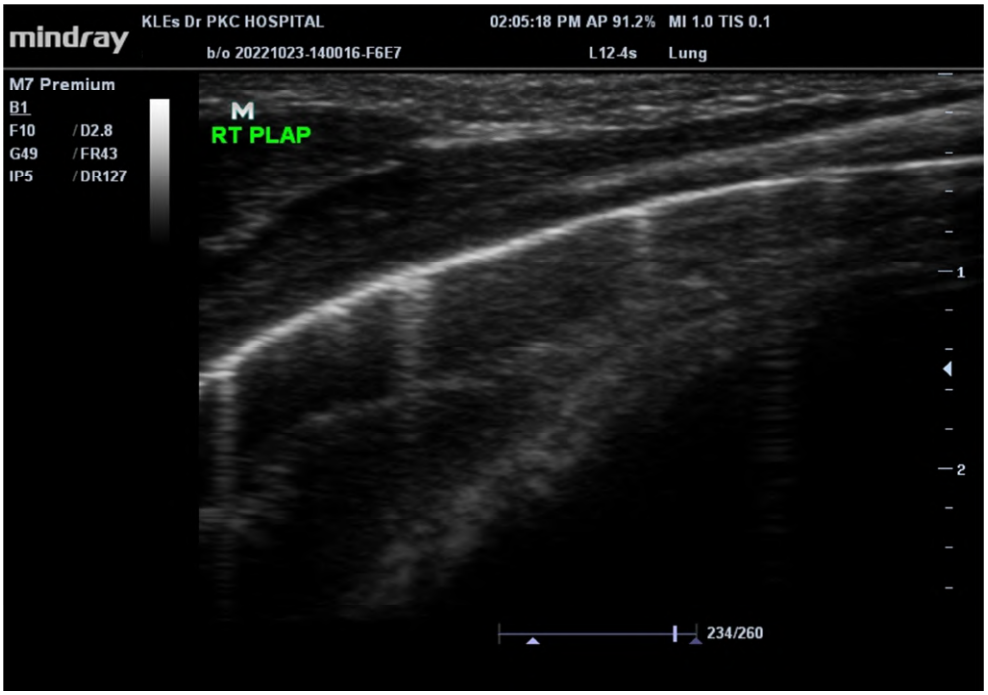
Fig 16: High frequency linear array transducer used for the study

Fig 17: Performing lung ultrasonography on a neonate in the neonatal Intensive Care unit

PHOTOGRAPHS OF CASES

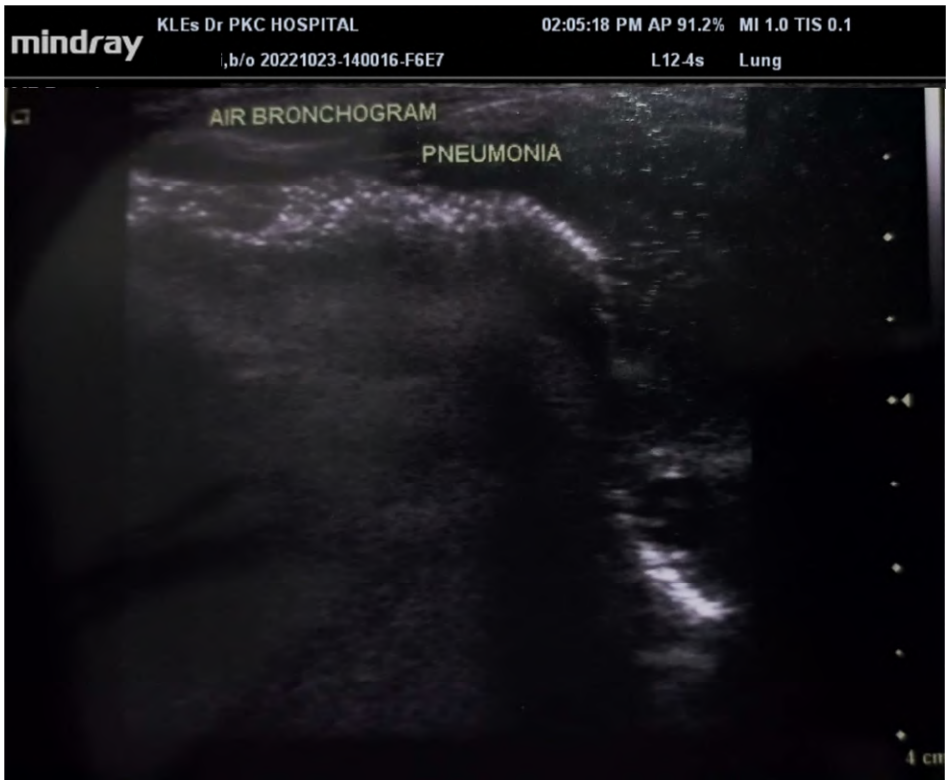
Case 1

1 day old neonate was admitted to NICU with complaints of tachypnea, and grunting respiration. On Lung ultrasonography from both the lungs , thickened pleural line with multiple coalescent B lines. This patient was diagnosed as RDS.



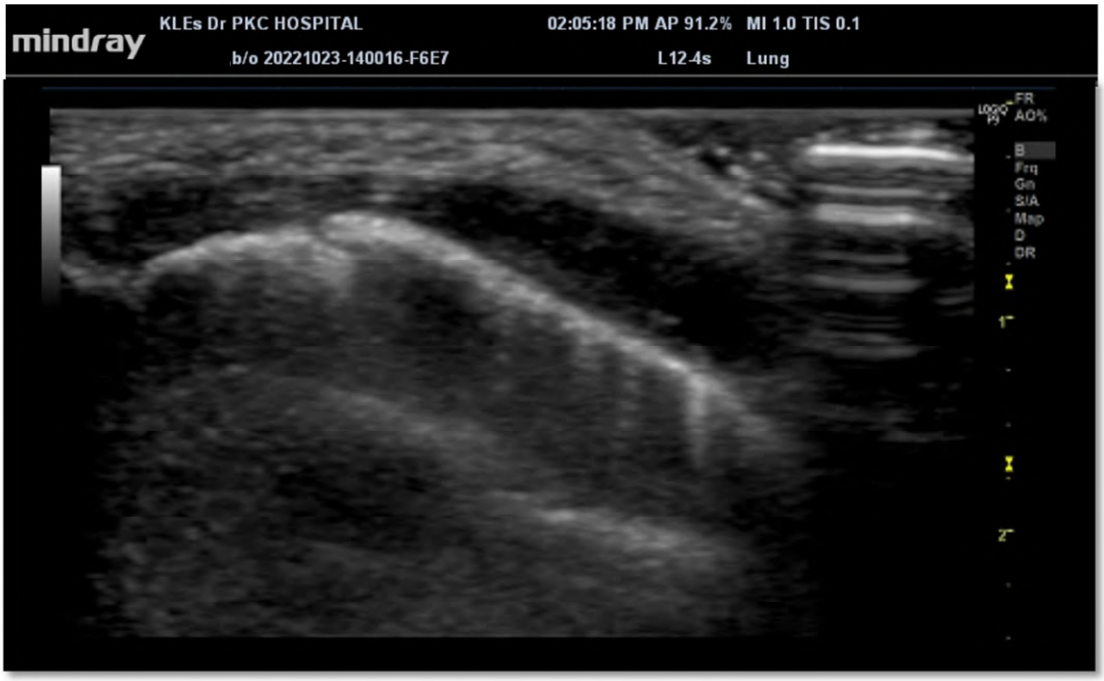
Case 2

A neonate was admitted to NICU with complaints of fever and Tachypnea, On Lung ultrasonography, multiple echogenic foci suggestive of Air bronchograms were seen in branching pattern few of the lung segments.There was decresed lung sliding seen and pleural line was less echogenic. The neonate was diagnosed with pneumonia.



Case 3

A neonate was admitted to NICU with history of thick meconium stained liquor and was clinically diagnosed as MAS. On Lung ultrasonography, multiple B lines were seen causing comet-tail artifact, arising from the pleural line, spreadinout without fading to the edge of the sereen. The child was diagnosed as Meconium aspiration syndrome .



ANNEXURE – IV

KEY TO MASTER CHART

IP	Inpatient
M	Male
F	Female
Rh	Rhesus
BG	Blood Group
Oligo	Oligohydramnios
PPROM	Preterm Premature Rupture Of Membranes
AEDF	Absent End-Diastolic Flow
IUD	Intra-Uterine Death
HELLP	Hemolysis, Elevated Liver Enzymes And Low Platelets
IUGR	Intra-Uterine Growth Retardation
PIH	Pregnancy Induced Hypertension
MSL	Meconium Stained Liquor
CPD	Cephalopelvic Disproportion
USG	Ultrasonography

PE	Pre-Eclampsia
PV	Per-Vaginum
LBW	Low-Birth Weight
ELBW	Extremely Low Birth Weight
VLBW	Very Low Birth Weight
AGA	Appropriate For Gestation Age
SGA	Small For Gestation Age
LGA	Large For Gestation Age
CXR	Chest X-Ray
RDS	Respiratory Distress Syndrome
MAS	Meconium Aspiration Syndrome
TTNB	Transient Tachypnea Of Newborn
LSCS	Lower Segment Cesarean Section
CPAP	Continuous Positive Airway Pressure
NP	Nasal Prongs

Sl no.	IP no.	Gender	Age	BABY'S BG	Mother's age	MOTHERS BG	Gravida	Parity	Complications during pregnancy	Complication category	Steroid Therapy	Mode of delivery	Indication for LSCS	Birth Weight	Birth weight group	Gestational Age	Gestational age group	APGAR-1	APGAR-5	O2 Support/Advice	Heart rate	Temperature	Respiratory rate	Clinical Diagnosis	Radiograph diagnosis	Sepsis	TLC	USG diagnosis	A -line	Lung Sliding	Air bronchogram	B-line	Pleural abnormality	Pleural effusion	OUTCOME
1	1131534	M	DAY 3	O	26Y	O	2	1	BREECH, OLIGO, CORD PROLAPSE	OLIGOHYDRAMNIOS, CORD ABNORMALITY	YES	VAGINAL		1100 g	VLBW	29W 3D	EARLY PRETERM	5	7	CPAP	146	EUTHERMIC	61	RDS	RDS	NEGATIVE	7	RDS	NO	NO	ABSENT	YES	YES	NO	DISCHARGE
2	1132380	M	DAY 1	A	35Y	AB	4	1	NIL	NIL	YES	LSCS	PREVIOUS LSCS	1360 g	VLBW	34W	LATE PRETERM	6	9	CPAP	124	EUTHERMIC	66	RDS	RDS	NEGATIVE	8.9	RDS	NO	NO	ABSENT	YES	YES	NO	DISCHARGE
3	1133673	M	DAY 3	A	26 Y	A	4	1	NIL	NIL	YES	LSCS	PREVIOUS LSCS	2250 g	LBW	35W 5 DAYS	LATE PRETERM	5	7	CPAP	136	EUTHERMIC	62	RDS	RDS	NEGATIVE	18.6	RDS	NO	NO	ABSENT	YES	YES	NO	DISCHARGE
4	1134985	M	DAY 1	A	30 Y	A	3	2	NIL	NIL	NO	LSCS	REVERSAL OF FLOW	1060 g	VLBW	32W 2 D	LATE PRETERM	4	8	CPAP	144	EUTHERMIC	61	RDS	RDS	NEGATIVE	13.5	RDS	NO	NO	ABSENT	YES	YES	NO	DISCHARGE
5	1137030	M	DAY 1	O	31 Y	A	1		NIL	NIL	YES	VAGINAL		1100 g	ELBW	30 W 5 DAYS	EARLY PRETERM	6	8	NIL	146	EUTHERMIC	61	RDS	RDS	KLEBSIELLA	8.8	RDS	NO	NO	ABSENT	YES	YES	NO	DISCHARGE
6	1134957	F	DAY 1	B	30 Y	O	1		PRE-ECLAMPSIA, HYPOTHYROIDISM	PIH	YES	LSCS	TWIN PREGNANCY	1100 g	ELBW	29 W 4	EARLY PRETERM	7	9	CPAP	150	EUTHERMIC	62	RDS	RDS	KLEBSIELLA	6.5	RDS	NO	NO	ABSENT	YES	YES	NO	DEATH
7	1138998	M	DAY 2	O	28 Y	O	3	1	PPROM	ABNORMAL LABOUR	NO	LSCS	PREVIOUS LSCS	1080 g	ELBW	27 W 5D	EXTREME PRETERM	6	8	CPAP	155	EUTHERMIC	64	RDS	RDS	NEGATIVE	11.1	RDS	NO	NO	ABSENT	YES	YES	NO	DEATH
8	1138986	F	DAY 3	B	26 Y	B	1		SEVERE PRE-ECLAMPSIA, AEDF, HYPOTHYROIDISM	PIH	YES	LSCS	AEDF	930 g	ELBW	32 W	LATE PRETERM	4	7	NIL	152	EUTHERMIC	62	RDS	RDS	NEGATIVE	5.4	RDS	NO	NO	ABSENT	YES	YES	NO	DISCHARGE
9	1139453	F	DAY 2	AB	23 Y	A	2	1	PPROM	ABNORMAL LABOUR	YES	LSCS	PREVIOUS LSCS	2000 g	LBW	33 W 6D	LATE PRETERM	7	9	CPAP	144	EUTHERMIC	62	RDS	NORMAL	NEGATIVE	13.4	NORMAL	YES	YES	ABSENT	NO	NO	NO	DISCHARGE
10	1136672	F	DAY 1	O	23 Y	O	3	1	ABRUPTIO PLACENTA	PLACENTAL DISORDERS	NO	LSCS	ABRUPTIO PLACENTA	1960 g	LBW	36 W 4D	LATE PRETERM	7	9	NP	130	EUTHERMIC	68	RDS	RDS	KLEBSIELLA	9.9	RDS	NO	NO	ABSENT	YES	YES	NO	DISCHARGE
11	1142481	F	DAY 1	A	33 Y	B	1		POLYHDRAMNIOS	POLYHYDRAMNIOS	NO	LSCS	POLYHYDRAMNIOS	2800 g	AGA	37 W 2 D	TERM	6	8	NIL	130	EUTHERMIC	60	TTNB	TTNB	NEGATIVE	14.2	TTNB	NO	YES	ABSENT	NO	YES	YES	DISCHARGE
12	1143339	M	DAY 2	A	28 Y	O	4	3	NIL	NIL	NO	LSCS	PV BLEED	3600 g	AGA	39 W 1 D	TERM	6	7	NP	132	EUTHERMIC	60	TTNB	TTNB	NEGATIVE	5.1	TTNB	NO	YES	ABSENT	NO	YES	YES	DISCHARGE
13	1128518	M	DAY 2	B	20 Y	B	2	1	SHORT STATURE	CPPD	NO	VENTOUSE		3040 g	AGA	39 W 2 D	TERM	5	7	NIL	134	EUTHERMIC	61	MAS	MAS	NEGATIVE	14.7	MAS	NO	NO	ABSENT	NO	YES	YES	DISCHARGE
14	1128764	F	DAY 2	A	22 Y	A	1		NIL	NIL	NO	VAGINAL		2300 g	LBW	39 W 3 D	TERM	6	8	CPAP	124	EUTHERMIC	55	MAS	TTNB	NEGATIVE	17	TTNB	NO	YES	ABSENT	NO	YES	YES	DISCHARGE
15	1136789	M	DAY 3	O	22 Y	A	1		GESTATIONAL HYPERTENSION	PIH	NO	LSCS	FETAL DISTRESS	2230 g	LBW	38 W 4 D	TERM	2	5	CPAP	130	EUTHERMIC	62	MAS	MAS	CONS, S.hemolyticus	15.2	MAS	NO	NO	ABSENT	YES	YES	NO	DISCHARGE
16	1121175	M	DAY 2	B	22 Y	A	1		PPROM, POLYHYDRAMNIOS	ABNORMAL LABOUR, POLYHYDRAMNIOS	NO	VAGINAL		750 g	ELBW	27 W 5D	EXTREME PRETERM	4	7	CPAP	132	EUTHERMIC	68	RDS, AOP	RDS	NEGATIVE	17.7	RDS	NO	NO	ABSENT	YES	YES	NO	DISCHARGE
17	1125670	M	DAY 3	A	31 Y	A	1		PPROM	ABNORMAL LABOUR	YES	LSCS	PPROM - 36 HOURS	1960 g	VLBW	33 W	LATE PRETERM	7	8	CPAP	121	EUTHERMIC	61	RDS	RDS	NEGATIVE	15.3	RDS	NO	NO	ABSENT	YES	YES	NO	DISCHARGE
18	1128721	M	DAY 3	O	24 Y	A	1		PPROM	ABNORMAL LABOUR	YES	LSCS	PPROM - 36 HOURS	2200 g	LBW	33 W 6 D	LATE PRETERM	6	8	CPAP	145	EUTHERMIC	67	RDS	NORMAL	NEGATIVE	6.3	RDS	NO	NO	ABSENT	YES	YES	NO	DISCHARGE
19	1139594	F	DAY 3	AB	23 Y	B	2	1	BREECH , CORD AROUND NECK	CORD ABNORMALITY	NO	LSCS	BREECH	2830 g	AGA	37 W 4 D	TERM	7	9	NIL	134	EUTHERMIC	62	TTNB	NORMAL	KLEBSIELLA	2.3	NORMAL	YES	YES	ABSENT	NO	NO	NO	DISCHARGE
20	1136468	M	DAY 3	A	37 Y	O	1		TWIN II - IUD	TWIN PREGNANCY	YES	LSCS	TWIN PREGNANCY	700 g	ELBW	32W 4 D	LATE PRETERM	4	7	CPAP	140	EUTHERMIC	55	RDS	RIGHT LOWER LOBE PNEUMONIA	NEGATIVE	15.5	RT UPPER LOBE CONSOLIDATION	NO	NO	PRESENT	YES	YES	NO	DEATH
21	1135560	M	DAY 2	AB	35 Y	A	3	1	SEVERE OLIGOHYDRAMNIOS	OLIGOHYDRAMNIOS	YES	LSCS	OLIGOHYDRAMNIOS	2250 g	LBW	36 W	LATE PRETERM	6	8	CPAP	140	EUTHERMIC	46	RDS	RDS	KLEBSIELLA	12.3	RDS	NO	NO	ABSENT	YES	YES	NO	DISCHARGE
22	1145526	F	DAY 1	A	22 Y	A	1		OLIGOHYDRAMNIOS	PIH	YES	LSCS	OLIGOHYDRAMNIOS	2000G	LBW	34W 4D	LATE PRETERM	7	8	O2	142	EUTHERMIC	59	TTNB	TTNB	KLEBSIELLA, ACINETO	18.3	TTNB	NO	YES	ABSENT	NO	YES	YES	DISCHARGE
23	1145650	M	DAY 1	O	29 Y	O	2	1	CHRONIC HYPERTENSION	PIH	YES	LSCS	ABRUPTIO PLACENTA	1600 G	LBW	32W 5D	LATE PRETERM	8	10	NIL	125	EUTHERMIC	61	RDS	RDS	NEGATIVE	12.2	RDS	NO	NO	ABSENT	YES	YES	NO	DISCHARGE
24	1145509	M	DAY 3	B	22 Y	B neg	1		SEVERE PRE-ECLAMPSIA, IUGR, HELLP	PIH,	YES	LSCS	AEDF, HELLP	940 g	ELBW	30 W 3 D	EARLY PRETERM	4	7	CPAP	140	EUTHERMIC	62	RDS	RDS	NEGATIVE	22.1	RDS	NO	NO	ABSENT	YES	YES	NO	DISCHARGE
25	1142160	M	DAY2	O	23 Y	B	1		TWIN PREGNANCY	TWIN PREGNANCY	YES	LSCS	TWIN PREGNANCY	960 G	ELBW	28 W 6D	EXTREME PRETERM	4	7	CPAP	160	EUTHERMIC	64	RDS, LT PNEUMO	LT PNEUMOTHORAX	NEGATIVE	12.9	LT PNEUMOTHORAX	NO	NO	ABSENT	YES	YES	NO	DEATH
26	1142161	M	DAY2	O	23 Y	B	1		TWIN PREGNANCY	TWIN PREGNANCY	YES	LSCS	TWIN PREGNANCY	780 G	ELBW	28 W 6D	EXTREME PRETERM	4	7	CPAP	158	EUTHERMIC	61	RDS	RDS	NEGATIVE	10.8	RDS	NO	NO	ABSENT	YES	YES	NO	DEATH
27	1147603	M	DAY3	B	27 Y	B	2		NIL	NIL	NO	LSCS	PREVIOUS LSCS	2500 G	LBW	37 W 1D	TERM	7	9	CPAP	148	EUTHERMIC	66	RDS	TTNB	NEGATIVE	14.8	TTNB	NO	YES	ABSENT	NO	YES	NO	DISCHARGE
28	1150251	M	DAY1	A	22 Y	A	3	2	TWIN PREGNANCY, GESTATIONAL HYPERTENSION	TWIN PREGNANCY, PIH	YES	LSCS	TWIN PREGNANCY	1300 g	VLBW	33W 6D	LATE PRETERM	7	9	NIL	156	EUTHERMIC	63	RDS	NORMAL	NEGATIVE	10.2	NORMAL	YES	YES	ABSENT	YES	NO	NO	DISCHARGE
29	1137263	M	DAY 3	A	20 Y	A	1		FETAL DISTRESS, PV LEAK	FEATL DISTRESS	NO	LSCS	FETAL DISTRESS	1970 g	LBW	37 W	TERM	6	8	NIL	134	EUTHERMIC	63	RDS	RDS	NEGATIVE	7	TTNB	NO	YES	ABSENT	NO	YES	NO	DISCHARGE
30	1143567	F	DAY 1	O	22 Y	B	1		SEVERE PRE-ECLAMPSIA, BREECH, ABRUPTION	PIH, PLACENTAL DISORDERS	NO	LSCS	PLACENTAL DISORDERS	1730 g	LBW	36 W 4 D	LATE PRETERM	4	7	NIL	150	EUTHERMIC	66	RDS	RDS	NEGATIVE	9.6	RDS	NO	NO	ABSENT	YES	YES	NO	DEATH
31	1146321	F	DAY 2	O	19 Y	O	1		IMINENT ECLAMPSIA	PIH	YES	LSCS	IMINENT ECLAMPSIA	900 g	ELBW	28 W 5D	EXTREME PRETERM	2	5	CPAP	143	EUTHERMIC	61	RDS	RDS	ACINETOBACTER	15.2	RDS	NO	NO	ABSENT	YES	YES	NO	DISCHARGE
32	1147247	M	DAY 2	B	23 Y	B	1		PRETERM LABOUR, PPROM	ABNORMAL LABOUR	YES	VAGINAL		1250 g	VLBW	30 W 5 D	EARLY PRTERM	6	8	NP	140	EUTHERMIC	60	RDS	RDS	NEGATIVE	15.4	RDS	NO	NO	ABSENT	YES	YES	NO	DISCHARGE
33	1146401	F	DAY 3	O	26 Y	O	3	2	NIL	NIL	NO	LSCS	PREVIOUS LSCS	3400 g	AGA	38 W 6 D	TERM	7	10	CPAP	142	EUTHERMIC	60	RDS	TTNB	NEGATIVE	12	TTNB	NO	YES	ABSENT	NO	YES	YES	DISCHARGE
34	1132050	M	DAY 1	A	20 Y	A	1		PIH, AEDF	PIH	NO	LSCS	SEVERE PE, AEDF	2200 g	LBW	40 W 2 D	TERM	8	10	NIL	144	EUTHERMIC	61	BIRTH ASPHYXIA	NORMAL	NEGATIVE	11	NORMAL	YES	YES	ABSENT	YES	NO	NO	DISCHARGE
35	1132567	M	DAY 1	A	23 Y	A	2	1	GESTATIONAL HYPERTENSION	PIH	NO	LSCS	FETAL DISTRESS	2600 g	AGA	37 W 1 D	TERM	6	8	CPAP	121	EUTHERMIC	67	PNEUMONIA	RT LOWER LOBE PNEUMONIA	NEGATIVE	11.2	RIGHT LOWER LOBE CONSOLIDATION	NO	NO	PRESENT	YES	YES	NO	DISCHARGE
36	1145678	F	DAY 2	B	21 Y	B	1		PPROM	ABNORMAL LABOUR	YES	LSCS	PPROM - 36 HOURS	2070 g	LBW	33 W 4 D	LATE PRETERM	4	7	CPAP	123	EUTHERMIC	63	PNEUMONIA	LEFT LOWER LOBE PNEUMONIA	NEGATIVE	12	LEFT LOWER LOBE CONSOLIDATION	NO	NO	PRESENT	YES	YES	NO	DISCHARGE
37	1120780	M	DAY 3	O	26 Y	B	2		LOW LYING PLACENTA	PLACENTAL ABNORMALITIES	NO	LSCS	LOW LYING PLACENTA	1960 g	LBW	32W 6D	EARLY PRETERM	4	7	CPAP	145	EUTHERMIC	64	RDS	RDS	NEGATIVE	5	RDS	NO	NO	ABSENT	YES	YES	NO	DISCHARGE
38	1184416	M	DAY 1	B	26 Y	B	3	2	OLIGOHYDRAMNIOS	OLIGOHYDRAMNIOS	YES	LSCS	THICK MSL, PREV LSCS	2050 g	LBW	39 W	TERM	8	9	NIL	156	EUTHERMIC	56	MAS	NORMAL	NEGATIVE	7	MAS	NO	NO	ABSENT	NO	YES	YES	DISCHARGE
39	1185416	M	DAY 2	A	31 Y	A	2	1	TRANSVERSE LIE	ABNORMAL PRESENTATION	YES	LSCS	PV LEAK	2600 g	AGA	36 W 3 D	LATE PRETERM	7	9	NIL	122	EUTHERMIC	64	RDS	NORMAL	NEGATIVE	11	NORMAL	YES	YES	ABSENT	YES	NO	NO	DISCHARGE
40	1089468	M	DAY 3	B	29 Y	O NEG	3	2	RH NEGATIVE	RH INCOMPATIBILITY	NO	LSCS	THIN MSL	3300 g	AGA	39 W 3 D	TERM	7	9	NP	150	EUTHERMIC	61	TTNB	TTNB	CANDIDA, CITROBACTER	15.8	TTNB	NO	NO	ABSENT	NO	YES	NO	DISCHARGE
41	1080284	F	DAY 1	O	34 Y	O NEG	2	1	RH NEGATIVE PREGNANCY, OLIGOHYDRAMNIOS	RH INCOMPATIBILITY, OLIGOHYDRAMNIOS	YES	LSCS	OLIGOHYDRAMNIOS	1110 g	LBW	33W 6D	LATE PRETERM	7	9	CPAP	168	EUTHERMIC	68	RDS	RDS	NEGATIVE	12	RDS	NO	NO	ABSENT	YES	YES	NO	DISCHARGE
42	1091246	F	DAY 3	O	21 Y	B	1		NIL	NIL	YES	VAGINAL		1300 g	VLBW, SGA	30 W	EARLY PRETERM	6	8	CPAP	148	EUTHERMIC	60	RDS	RDS	CANDIDA	18.6	RDS	NO	NO	ABSENT	YES	YES	NO	DISCHARGE
43	1091229	M	DAY 3	B	22 Y	B	1		NIL	NIL	YES	VAGINAL		1250 g	VLBW, SGA	35 W	LATE PRETERM	7	9	CPAP	160	EUTHERMIC	61	PNEUMOTHORAX	RT PNEUMOTHORAX	CANDIDA	8.9	RIGHT PNEUMOTHORAX	NO	NO	ABSENT	YES	YES	NO	DISCHARGE
44	1143756	M	DAY 3	A	21 y	O	1		MSL WITH FETAL DISTRESS	FETAL DISTRESS	NO	LSCS	MSL WITH FETAL DISTRESS	3200 g	AGA	40 W 3 D	TERM	7	9	NIL	142	EUTHERMIC	60	BIRTH ASPHYXIA	NORMAL	NEGATIVE	8.9	MAS	NO	NO	ABSENT	NO	YES	YES	DISCHARGE
45	1132467	F	DAY 1	O	25 Y	O	2	1	NIL	NIL	NO	LSCS	PREVIOUS LSCS	2600 g	AGA	37 W 2 D	TERM	7	9	NIL	126	EUTHERMIC	60	TTNB	TTNB	NEGATIVE	10.2	TTNB	NO	YES	ABSENT	NO	YES	NO	DISCHARGE
46	1085215	F	DAY 2	A	22 Y	O	2	1	NIL	NIL	YES	VAGINAL		1700 g	LBW	34 W 5 D	LATE PRETERM	7	9	CPAP	150	EUTHERMIC	61	RDS	RDS	ENTEROCOCCUS	15.5	RDS	NO	NO	ABSENT	YES	YES	NO	DISCHARGE
47	1092722	M	DAY 1	O	22Y	O	1		NIL	NIL	NO	VACUUM		3000 g	AGA	40W 1D	TERM	8	9	NIL	150	EUTHERMIC	61	TTNB	TTNB	NEGATIVE	20.2	TTNB	NO	YES	ABSENT	NO	YES	NO	DISCHARGE
48	1149910	F	DAY 1	A	23 Y	B	1		TWIN PREGNANCY, PPROM	TWIN PREGNANCY	YES	LSCS	TWIN PREG & PPROM	1300 g	VLBW	31W	EARLY PRETERM	6	8	CPAP	173	EUTHERMIC	60	RDS	RDS	NEGATIVE	10.7	TTNB	NO	YES	ABSENT	NO	YES	NO	DISCHARGE
49	1149911	F	DAY 1	A	23 Y	B	1		TWIN PREGNANCY, PPROM	TWIN PREGNANCY	YES	LSCS	TWIN PREG & PPROM	1200 g	VLBW	31W	EARLY PRETERM	6	8	CPAP	176	EUTHERMIC	65	RDS, RT PNEUMO	RT PNEUMOTHORAX	NEGATIVE	12.5	RIGHT PNEUMOTHORAX	NO	NO	ABSENT	YES	YES	NO	DISCHARGE
50	1150115	F	DAY 2	O	26 Y	A neg	1		Rh NEGATIVE PREGNANCY	RH INCOMPATABILITY	NO	LSCS	SECOND STAGE ARREST	2700 g	AGA	39 W 5 D	TERM	6	8	NIL	182	EUTHERMIC	60	MAS	MAS	NEGATIVE	8.9	MAS	NO	NO	ABSENT	NO	YES	YES	DISCHARGE
51	1150629	M	DAY 2	O	27 Y	O	2	1	THREATENED PRETERM	ABNORMAL LABOUR	YES	VAGINAL		1740 g	LBW	32 W 5 D	LATE PRETERM	7	9	NIL	150	EUTHERMIC	52	RDS	NORMAL	NEGATIVE	10.2	NORMAL	YES	YES	ABSENT	NO	NO	NO	DISCHARGE

B/o Aruna
B/o Nikhat
B/o Jyothi Manjunath
B/o Kalyani - I
B/o Kalyani - II
B/o Ashwini
B/o Jyothi - Twin II
B/o Heena
B/o Laxmi
B/o Mufiza
B/o Chaitra
B/o padma
B/o Meenaz
B/o Savitha