CHEST RADIOGRAPH PATTERN IN NEONATES WITH RESPIRATORY DISTRESS AT KENYATTA NATIONAL HOSPITAL

BY

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DECLARATION

I, **Dr. GACHUIRI THOMAS THIGA** declare that this dissertation is my original work and has not been presented at any other place to the best of my knowledge.

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Finally to all my classmates who became a pillar of strength when things were tough.

DEDICATIONS

This dissertation is dedicated to

1 My late grandfather Thiga Gichinga who laid the foundation of education in the family by educating my father .God rest his soul in eternal peace
2 My parents who through a lot of sacrifice took my siblings and i to school and ensured we attained the best .May God grant them good health and long life.
3 My brothers and sisters who encouraged me and took care of things at home when I was not available. May GOD grant their families good health and happiness.
4 MY loving wife who handled the domestic front ably in my absence. May GOD grant you happiness and long life
5 Angel my daughter whose smile and laughter gave me strength to push on. May you grow to conquer the world

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ABBREVIATIONS AND DEFINITIONS

AP	Antero posterior
BPD	Bronchopulmonary Dysplasia
CNS	Central nervous system
CT	Computerized tomography
CVS	Cardiovascular system
CXR	Chest Radiograph
GBS	Group B Streptococcus
GIT	Gastro intestinal tract
GUS	Genital urinary system
KES	Kenya Shillings
KVP	Peak Kilo voltage
KNH	Kenyatta National Hospital
MAS	Meconium aspiration syndrome
mS	milliseconds
MBChB	Bachelor's Degree in Medicine and Surgery
MMED	Masters Degree in Medicine
MRI	Magnetic Resonance Imaging
MSS	Musculoskeletal system
NBU	New Born Unit
RDS	Respiratory distress syndrome
RNI	Radionuclide imaging
RS	Respiratory system
SSPS	Statistical package for social sciences
TOF	Tracheo-oesophageal fistula
TTN	Transient Tachypnoea of the Newborn
UON	University of Nairobi
USA	United States of America
U/S	Ultrasound

ABSTRACT

Most of the global neonatal deaths occur in developing nations, are from pulmonary related causes for which a plain chest radiograph is the radiological investigation of choice in the initial diagnosis and subsequent follow up [4,6,8]

There being no local published studies available , my study will act as a baseline upon which future studies can improve on to inform policy. Such information is critical in planning evidence based interventions.

Objectives

The main objective of this study was to describe the chest radiographic pattern in neonates with signs and symptoms of respiratory distress admitted to the new born unit of Kenyatta National Hospital .

Methods

A cross-sectional descriptive study was carried out over a period of 4 months between September and December 2010. All patients who met the selection criteria during the study period were included in the study after obtaining an informed consent from their guardians/parents .

The study was performed using a portable Philips PRACTIX 160 X-ray machine manufactured in October 2006.

Each chest radiograph was reviewed by the researcher and a consultant radiologist. The findings were recorded in the data collection form of each participant. The data was analyzed using a computer programme; SPSS 15 and the results presented in form of tables, graphs and charts.

Results

A total of 100 neonates were recruited during the study period. 23% of the study population were prematures. The study participants comprised 51 males (51%) and 49 females (49%) representing a Male-Female ratio of 1.04:1.

The mean age of neonates studied was 5.3 days with a range from 1 to 30 days.

The mean weight of the 100 neonates at birth was 2.1 kilograms (SD=0.9) and the range 0.8 to 4.6 kilograms. An Apgar score was available for most neonates at birth (87%) and at 5 minutes (68%). However only 22% of the neonates has a score recorded 10 minutes after birth.

The neonates presented with respiratory symptoms with tachpnoea highest at 54%, chest wall indrawing at 45% and grunting and nasal flaring in that order .

The most common causes of respiratory distress among neonates were respiratory distress syndrome (41.1%), transient tachpnoea of the newborn (16.8%) and Pneumonia (15.8%) .Neonatal septicemia was the primary cause of respiratory distress in 4.2% neonates.

Non-pulmonary causes of respiratory distress were diagnosed in six neonates presenting with cardiac problems and metabolic disorders. Among the five children with cardiac problems congenital heart disease was the most common diagnosis (n = 3).Upper airway obstruction as a result of choanal atresia also seen as one case of respiratory distress.

Most of the chest radiographs had ground glass opacification 32%, reticulonodular 10% and nodular opacity at 3%. The type of opacification showed a statistically significant association with the neonate's diagnosis.

48% of premature neonates had abnormal chest radiographic which was not statistically significant p=0.34

68% of the neonates had some form of indwelling tube, catheter or line. Nasal gastric tube was found in majority followed by endotracheal tubes and chest ECG leads.

The endotracheal tubes were the most affected in misplacement at 20% followed by nasogastric tubes at 13.7%

Conclusion

Respiratory Distress in neonates is a clinical entity that requires proper ante and intrapartum history, however for accurate separation of entities chest radiography plays a very pivotal role. Chest radiographs in this study were able to differentiate between the surgical and the medical causes as well as characterize the medical causes. This correlated well with previous studies. (9)

LITERATURE REVIEW

Background

The Kenyatta National Hospital is a tertiary referral hospital and teaching hospital with a bed capacity of 1882.The New Born Unit has 60 beds which includes a Neonatal Intensive Care Unit of 4 beds and a high dependence unit of 10 beds.

There were 2150 admissions in 2010, of which 1214 were discharged home. 913 deaths were reported giving a mortality rate of 42.5% which was significantly high as the national infant mortality rate is 52/1000 live births .The high mortality rates have been attributed to various reasons including very low nurse: patient ratio at 1:10 against accepted level of 1:5, late referrals, poor infection control/prevention and inadequate support services like lack of intra departmental side laboratory and radiology reports during ward rounds and patient reviews [7,10]

Plain chest radiography remains the basis for evaluation of the chest in the neonatal period and the modality of choice for screening neonates with respiratory distress [1-6].

It is estimated that in the United States 68 million chest radiographs are performed each year. [11]

Omwenga A O in his desertation on use of chest radiography in Intensive care units reported 33748 done at Kenyatta National Hospital in 1998 [12]

Radiographs of the chest and the abdomen are the most commonly requested diagnostic X-ray examinations in neonatal intensive care units. Frequently, for a single child, both radiographs are requested simultaneously. These images can be obtained either as two separate exposures (one for the chest and one for the abdomen), or as a single exposure to include both anatomical regions on one film [13]

Satisfactory films can be obtained in incubators using modern mobile X-ray apparatus. The radiographs are taken to confirm or exclude a diagnosis, confirm the position of tubes and catheters used in NBU and to monitor treatment especially where ventilation is being used to look out for complications like barotrauma and air leaks [1] Pulmonary disease is the most important cause of morbidity in preterm neonates, whose lungs are often physiologically and morphologically immature. (9)

Epidemiology

Respiratory distress is a symptom, not a disease. Respiratory distress occurs in about 7% of all infants .The neonate presents with apnoea, cyanosis, grunting, inspiratory stridor, nasal flaring, poor feeding, tachpnoea (>60 breaths per min) and chest wall retraction [15,16].

Approximately 487,000 infants were delivered before completing 37 weeks gestation in the United States in 2002, a population that represents 12.1% of all live births and a 14% increase since 1990.(5) The increase in the preterm birth rate is related in part to the steep rise in the number of multiple births over the past 2 decades. Many premature newborns require treatment in a neonatal intensive care unit at an annual national cost that exceeds $4 billion. [16]

Pediatric respiratory illness is a major cause of morbidity and mortality, with marked global variation in the epidemiology of such diseases. The highest burden of disease occurs in children in developing countries, where relatively poor resources limit the ability to effectively prevent and treat pediatric respiratory illness. These differences highlight the global inequities in healthcare and the urgent need for further research and global measures to prevent and treat the substantial burden of pediatric respiratory disease [17]

Chest Radiography; Technique and interpretation

Chest radiography is one of the most challenging examinations to perform because of the wide range of tissue densities present in the thorax (especially considering the wide variety of thoracic sizes in pediatric patients), the inherently low-contrast structures of soft tissues structures in children, and the need to minimize exposure to ionizing radiation.

These difficulties of imaging neonates are further complicated by the requirement that images should be acquired at peak inspiration and with minimum patient motion, a daunting task when imaging young or uncooperative children [2,18]

Key points to remember when taking Chest X-rays on children include; Selecting a kilovoltage that will allow adequate penetration and gray scale . lowest time possible to minimize motion , minimize magnification ,use a grid on older, larger patients . always remember to collimate and provide shielding when applicable [19]

The technique and interpretation of CXR often poses serious challenges and a systemic approach to it is the best way. Myto et al proposed a systemic approach using the alphabet that covers all areas and structures within and adjacent to the chest, this was for junior doctors and medical students in his medical school. [18] This borrowed heavily from the standard and universal approach adopted by Tally et al and Corne et al [20,21]

A------------------ Airway

B--------------------Bone

C---------------------Cardiac shadow

D------------------ Diaphragm

E and F-------------Equal lung fields

G-------------------Gastric air bubble

H----------------- Hilar region

AIRWAY

These are the trachea and its branches: check the site, size, shape, and shadows, patency, areas of narrowing indicating stenosis or edema..

In children it should be straight but in adults it can deviate to the right due the aortic arch [18, 20, 21]

Bone

Attention should be given to site, size, shape, shadows and borders of the clavicles, ribs, scapulae, thoracic vertebrae, and humeri.

Bony lesions like fractures, sclerotic or lytic areas deformed bones or missing bones should be noted [18,20,21]

Cardiac shadow

The site, size, shape, shadows and borders, most of the pediatric chest is done in anterior posterior projection and the cardiothoracic ratio upto 0.60 is accepted [18,19,20]

Diaphragm

Diaphragmatic outlinet should be clear and smooth; the right hemi diaphragm should be 2-3 centimeters above the left. The costophrenic angles should be clear [18,20,21]

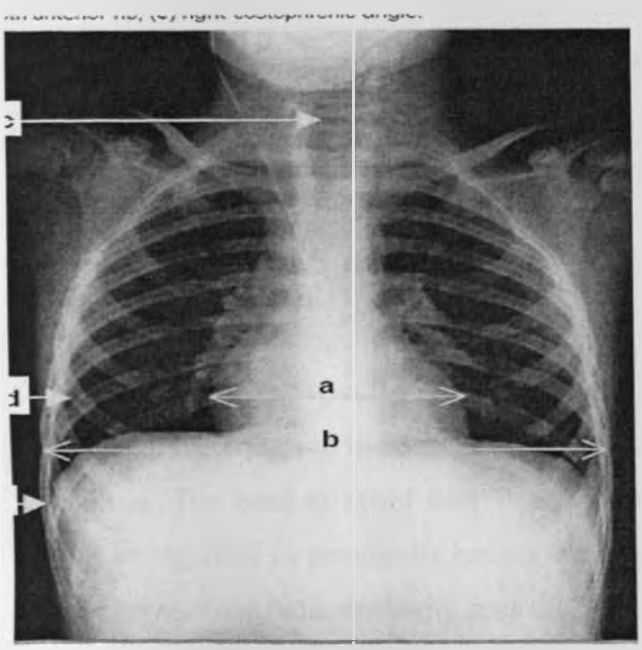
Gastric air bubble

Should be under the left hemi diaphragm in an erect chest radiograph

Hilar area

The left should be higher than the right by about 1 .5 centimeters, the densities and shapes should be similar

Figure 1: A normal chest x-ray [18]



A	-	Cardiac diameter.
B	-	Thoracic diameter
C	-	Trachea
D	-	5^{th} anterior rib
E	-	Right costophrenic angle.

LIMITATIONS

Plain chest radiographs are not without limitations. Felson reported that 20%-30% of significant information on a chest film may be overlooked by a trained radiologist. Some disease processes may fail to appear on a plain film, examples include miliary shadowing, metastasis, tuberculosis, histoplasmosis *Pneumocystis, bronchiectasis* and small pleural effusions.

Shadow patterns are rarely specific to a single disease pattern process; for example consolidation due to infection or following infarction may have identical appearances.

Some of these lesions can be demonstrated using other imaging modalities for example High resolution CT ,U/S . U/S for pleural effusion and High resolution CT for interstitial lung disease (2)

The appearance of portable chest radiographs (CXRs) may be affected by changes in ventilation, particularly when patients are mechanically ventilated. Synchronization of the CXR with the ventilator cycle and limit the influence of respiratory variation on the appearance of the CXR. [(22)]

Recognizing subtle signs of air in abnormal anatomic spaces and using special views like lateral decubitus , lordotic and oblique views and serial imaging to resolve equivocal findings can save an infant's life . Conversely, patient outcomes can change drastically when abnormalities are overlooked [(14)]

Close co-operation between the radiographer and other care givers with mutual understanding of the needs of the baby and the demand for high quality radiographs can overcome many of these difficulties. The need to avoid film rejects calls for very close cooperation (1,6). Neonates should be regarded as potentially having the greatest remaining lifespan of any patient, which together with their radiosensitivity and the potentially large number of radiographs performed should demand for dose optimization. [(6,23)]

Consultation between clinicians in the NICU or newborn nursery and radiologists is also imperative, because radiographs may provide more specific evidence of a problem than clinical or laboratory findings. Other imaging techniques are ancillary for example CT chest for diagnosing air in the wrong places, and may be used to answer specific questions [(24)]

Linda et al in a 3 phase study developed inclusive criteria for X-ray requisition and these were: Legibility, clear history provided and signed requisition with a Printed name.

They also developed a criteria for a quality chest X-ray image which included. Correct position, none/minimum artifacts, proper collimation, minimal rotation, proper centering and proper shielding

After 3 reviews done at 1 week, 1 month and 1year intervals with continuous encouragement of medical workers they demonstrated significant overall improvement in the quality of CXRs [6]

ARTIFACTS

Artifacts in neonatal chest imaging pose peculiar challenges and their recognition allows for timely intervention and minimizes the need for repeat exposures. Some artifacts include; Skin folds which may be interpreted as a pneumothorax. These artifacts should be followed to see whether they pass beyond the confines of the thoracic cage. The radiolucency is usually lateral whereas small pneumothoraces are more typically seen adjacent to the heart shadow medially in the lung fields in the supine neonate.

Other causes of artifacts includes incubators,patient positioning and immobilization devices. Radiographs taken through the plastic roof of the incubator can cast a radiolucency which may give rise to a pseudo cystic appearance due to the holes therein for infusion tubing, etc. Obliquity in the radiographic projection may resultin the sternal centres being projected over the lung fields thereby causing confusing appearances. Immobilization devices used during positioning may mimic or obliterate an abnormal area in the anatomy whereas a prominent thymus could enlarge the cardio-mediastinal silhouette making lung boundaries difficult to trace. Artifacts occur more frequently in chest malformations, dwarfism, andr restrictive lung disease [19 26,27]

Evaluation of tubes and lines

Critically sick newborn babies usually require central lines for prolonged intravenous treatment or for nutritional purposes, administration of fluids and monitoring patients hemodynamically. The most common catheters used are the central venous catheters (CVC) and Swan –ganz catheters (SGC) [12,22]

All tubes, catheters and lines should be evaluated on each radiograph carried out on an infant as they are often the major reason for taking the radiograph. Optimal positioning for an endotracheal tube (ETT) is approximately 1–1.5 cm above the carina. Radiographic clues of malposition of the ETT (in the esophagus, for example) are: low position, a tracheal column distinct from the ETT. pulmonary under aeration. air in the distal esophagus, and gaseous distension of the gastrointestinal tract [28]

Umbilical arterial and venous lines should be differentiated from each other. This is normally possible on an antero-posterior (AP) view of the chest and abdomen but occasionally a lateral view may be required. The umbilical arterial line initially courses caudally through the internal and common iliac arteries to enter the aorta, and is seen just lateral to the left side of the spine. The tip should ideally lie between T6 and T10 to avoid the spinal arteries or at L3–L5 below the level of the bowel and renal arteries. [25,28,29] The umbilical vein catheter courses directly cephalad on the right side of the abdomen and enters the left portal vein, at which point it may enter the ductus venosus and then the inferior vena cava. Radiographs should confirm that the tip lies above the liver and has not passed into a tributary vein [26]. Central lines and peripheral vascular lines extending from the periphery also need to be evaluated. These are often small and the position of the tip may be difficult to determine. In this situation a radiograph following introduction of contrast medium into the line may be helpful [6, 25]

Omwenga in his Mmed dissertation reported malpositioned central venous catheters in 58.47%, malpositioned ETT in19.46%, and 3.38% of the nasogastric tubes were malpositioned . This was comparable to other previous studies [12]

Sirit et al in a review of chest radiographs in a critical care unit reported 35% malposition of endotracheal tubes and 41% malposition of central venous catheters [29]

A comparison study done in adult population by Kun-Eng Lim et al showed CT to be more accurate in picking malpositioned tubes than chest radiographs [29])

Role of chest radiography is to confirm that the tips are in the correct positions and whether any associated complications [12,29]

Radiation Protection

As children are more radiosensitive than adults and have longer life expectancy, this gives greater opportunity for the radiation detriment to be expressed. In this regard, it is imperative that special care is taken to ensure that any radiation doses to children are justified. In addition, very young children may be uncooperative and need some form of sedation or immobilization. The assistance of a parent will usually help to keep the child still, but the parent should be provided with protective clothing. The possibility of the mother being pregnant must also be considered (30).

To minimize the potential risks of radiation exposure, ICRP has consistently issued guidelines that can be summarized into principals of Justification and Optimization. This framework can be simplified as follows;

- Justification implies that an exposure does more good than harm.
- Optimization implies that the margin of good over harm is maximized.
- Application of dose limits implies an adequate standard of protection has been applied (30,31)

N.F Jones et al calculated the overall risk of chest radiography in inducing a fatal childhood cancer to be between 4.6 and 4.8 per million exposures (13)

In pediatric radiography, fast imaging systems should be used so that exposure times are as short as possible; additional tube filtration will reduce skin dose (although excessive filtration will harden the beam and reduce image quality). The use of a grid is often unnecessary, particularly with smaller children and removing it can reduce the dose by as much as 50% (6) The X-ray beam should be well collimated and appropriately sized gonad shielding used to minimize the dose to organs outside the area of interest (6,26)

PATHOLOGY

The causes of respiratory distress include Transient Tachypnoea of the New born (TTN) (42.7%), respiratory distress syndrome (RDS) (9.3%), meconium aspiration syndrome (MAS) (10.7%), infections (17%), birth asphyxia (3.3%) anemia, congenital anomalies, and neurological/metabolic disorders (15,17,32)

The causes can be broadly divided into 2 categories; Medical and surgical

Medical causes

These are medically treatable cause with no need for surgical intervention these includeTransient Tachypnoea of the Newborn .Respiratory Distress syndrome.Meconium Aspiration syndrome. Delayed transition .Infections, upper airway obstruction, Pneumothorax and non pulmonary causes include anemia. cardiac, metabolic, neurological, medication.

Surgical causes of respiratory distress

A surgical intervention will be undertaken to restore the neonates normal physiological state .these include: Diaphragmatic hernias. Congenital cystic adenomatoid malformation, esophageal atresia /fistula and gastric and intestinal obstructions. [15]

Transient Tachypnoea of the Newborn

Transient Tachypnoea of the Newborn (TTN) or wet lung disease is the commonest cause of respiratory distress accounting for about 40% of respiratory distress in the USA [24] The causes include Caesarian section delivery, breech delivery, maternal diabetes, rapid delivery. male sex, and maternal asthma [1,2,24] There is delayed fluid clearance from the lungs and CXR taken within 6 hours shows a wet silhouette.

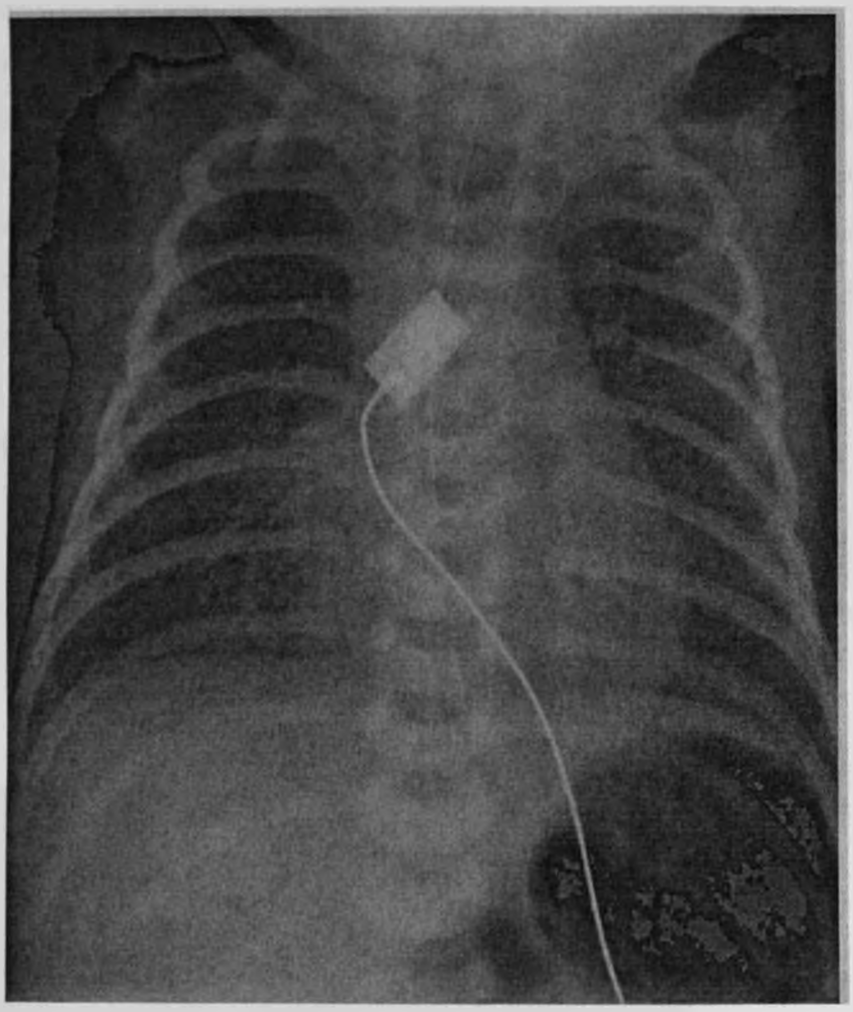
Kitar et al in a historical cohort analysis were able to establish a direct causal-effect between maternal asthma and Transient Tachypnoea of the Newborn and male sex in term neonates [33]

Morrison et al in a retrospective cohort study demonstrated a significant reduction in neonatal respiratory morbidity is obtained if elective caesarean section was performed in the week 39+0 to 39+6 of pregnancy. Caesarean sections done after 37 weeks but before onset of labour had statistically significant pulmonary morbidity [34]

Clinical signs of TTN are Term infant with mild to moderate signs of respiratory distress ,with normal oxygenation in an infant at risk . The symptoms usually clear in 48 to 72 hours.

Radiological findings of TTN include increased lung volume, strand like opacities throughout the lungs emanating from the hilum. fluid in the fissures and pleural effusion [15]

Figure 2 Chest radiograph of an infant with transient tachypnoea of the newborn showing increased lung volume (splaying of ribs) and strand opacities radiating from the hilum[24]



Respiratory Distress Syndrome

RDS, also known as Hyaline Membrane Disease is a sign of pulmonary immaturity, an expression of surfactant deficiency in neonates. In 2002, the overall rate of RDS was 6.1 cases per 1,000 neonates, or approximately 24,000 newborns in the USA. This represented a decrease since the highest levels were reported for 1994–1995. [16] It is most common in infants born at less than 28 weeks' gestation and affects one third of infants born at 28 to 34 weeks' gestation, it occurs in less than 5 percent of those born after 34 weeks' gestation. The condition is more common in boys .The incidence is approximately six times higher in infants whose mothers have diabetes. because of delayed pulmonary maturity despite macrosomia. [24]

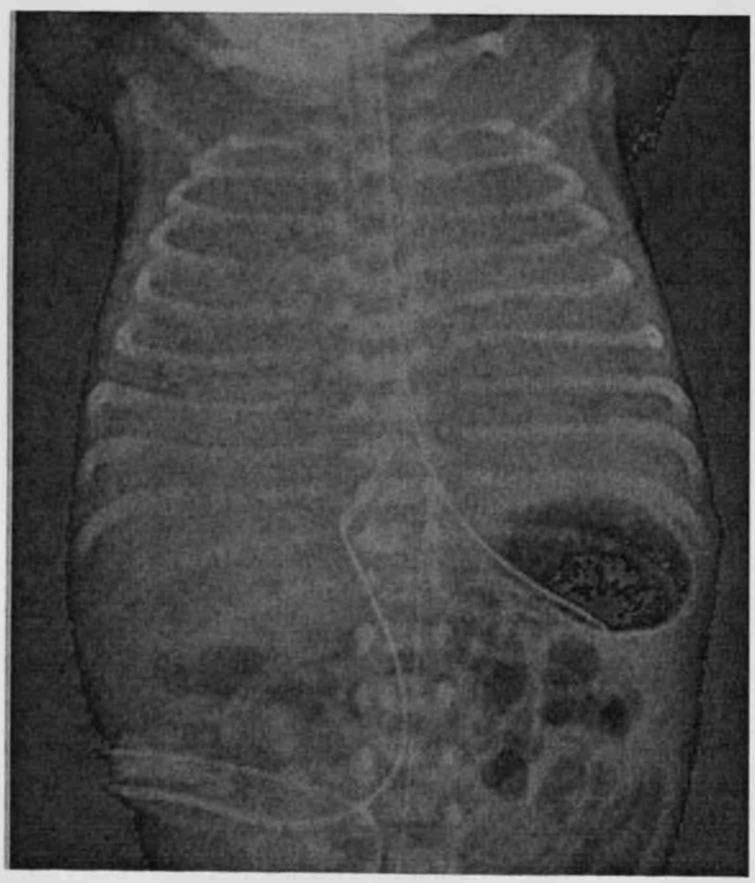
Crowley et al in randomized controlled studies showed that corticosteroid administration to preterms before delivery reduced the overall occurrence of respiratory distress syndrome, intraventricular hemorrhage. necrotizing enterocolitis and neonatal death [35].

Clinical signs are seen commonly in preterms born between 28-34 weeks who develop signs of respiratory distress within the first 6 hours of age and progress with peak symptoms between 24 to 48 hours. [13] The diagnosis of respiratory distress syndrome should be suspected when grunting. retractions. or other typical distress symptoms occur in a premature infant immediately after birth. Hypoxia and cyanosis often occur.

Radiological signs seen include low volume lungs. homogeneous opacification (ground glass) with air bronchograms

Figure 3

Chest radiograph of an infant with respiratory distress syndrome of the newborn showing homogenous opacification bilateral lung fields with air bronchograms [24]



Meconium aspiration syndrome

Meconium-stained amniotic fluid occurs in approximately 15 percent of deliveries, causing Meconium aspiration syndrome in the infant in 10 to 15 percent of those cases, typically in term and post-term infants. [24] Meconium is composed of desquamated cells, secretions, lanugo, water, bile pigments, pancreatic enzymes, and amniotic fluid. Although sterile, meconium is locally irritative, obstructive, and a medium for bacterial culture. Meconium passage may represent hypoxia or fetal distress in utero. Similar symptoms can occur after aspiration of blood or non stained amniotic fluid.

Meconium aspiration syndrome causes significant respiratory distress immediately after delivery. Hypoxia occurs because aspiration takes place in utero.

Patients are small for age or post mature infants born through meconium stained liquor who develops signs of respiratory distress.

Radiologically they present with increased lung volume, heterogeneous opacities in central two thirds of lung and frequently present with air leaks (pneumomediastinum and Pneumothorax)

Figure 4. Chest radiograph of an infant with Meconium aspiration syndrome showing increased lung volume and reticulonodular opacification in both lung fields in a neonate with MAS [24].

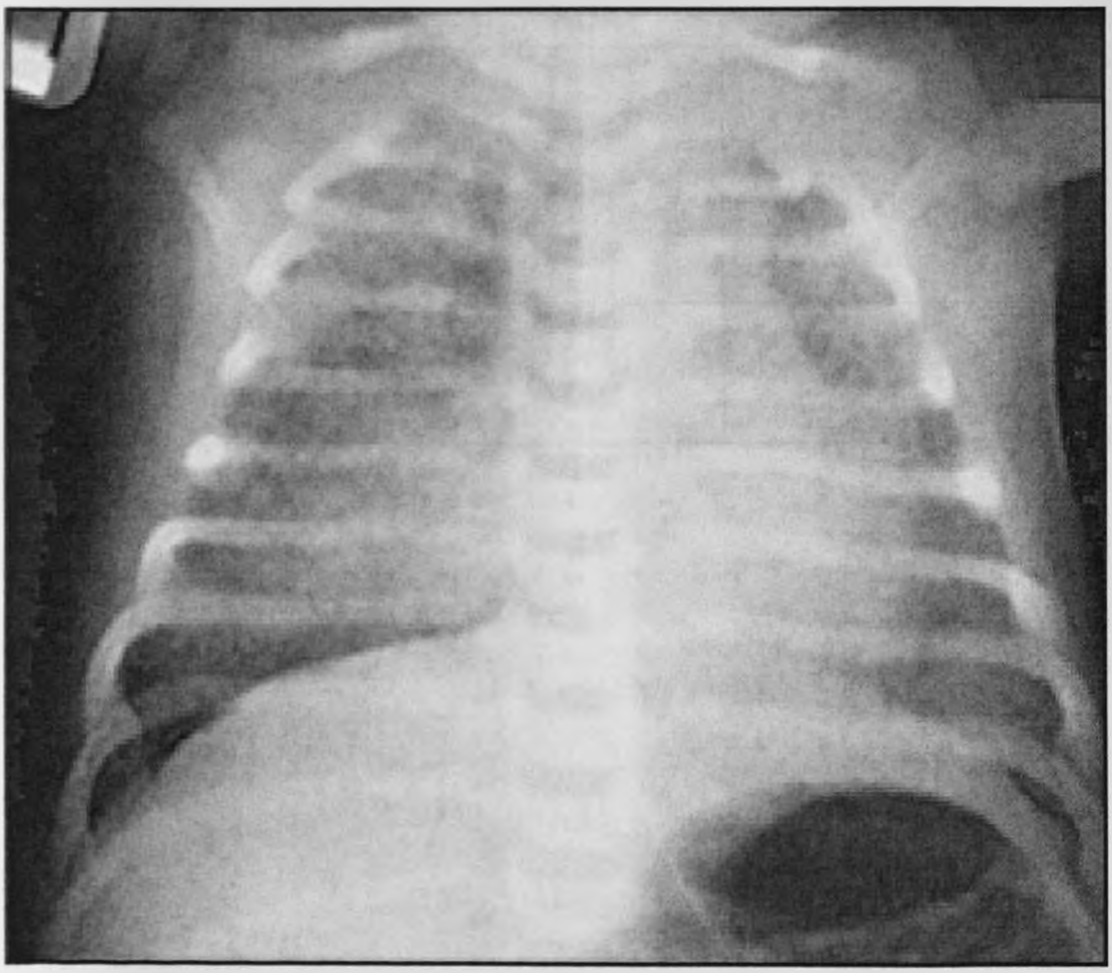


Table 1 - Distinguishing Features of TTN, RDS, and MAS

Cause	Etiology	Timing of delivery	Risk factors	Clinical features	Chest radiography findings
TTN	Persistent lung fluid	Any	Cesarean delivery Macrosomia Male sex Maternal asthma Maternal diabetes	Tachypnoea Often no hypoxia or cyanosis	Parenchymal infiltrates "Wet silhouette" around the heart Intralobar fluid accumulation
RDS	Surfactant deficiency Lung underdevelopment	Preterm	Male sex Maternal diabetes Preterm delivery	Tachypnoea Hypoxia Cyanosis	Homogenous infiltrates Air bronchograms Decreased lung volumes
MAS	Lung irritation and obstruction	Term or post-term	Meconium-stained amniotic fluid Post-term delivery	Tachypnoea Hypoxia	Patchy atelectasis Consolidation

BPD – Bronchopulmonary Dysplasia

This is a complication of prolonged ventilation with oxygen

Northway and Rosin in 1967 described 4 stages of BPD based on radiological appearance and chronological progression on follow up chest radiography.

Radiological findings include spongy bubbly coarse linear densities in hyperaeted lungs, lower lobe emphysema.This may clear over months or years or may retain linear densities in upper lobe emphysema [36]

Sequential CXR shows persistent over inflation during infancy [2,16]

Figure5) "Classic" severe BPD in a 3-month-old premature infant. Frontal radiograph shows heterogeneous aeration, coarse strand like areas of opacity, and intervening cystic lucencies [24]

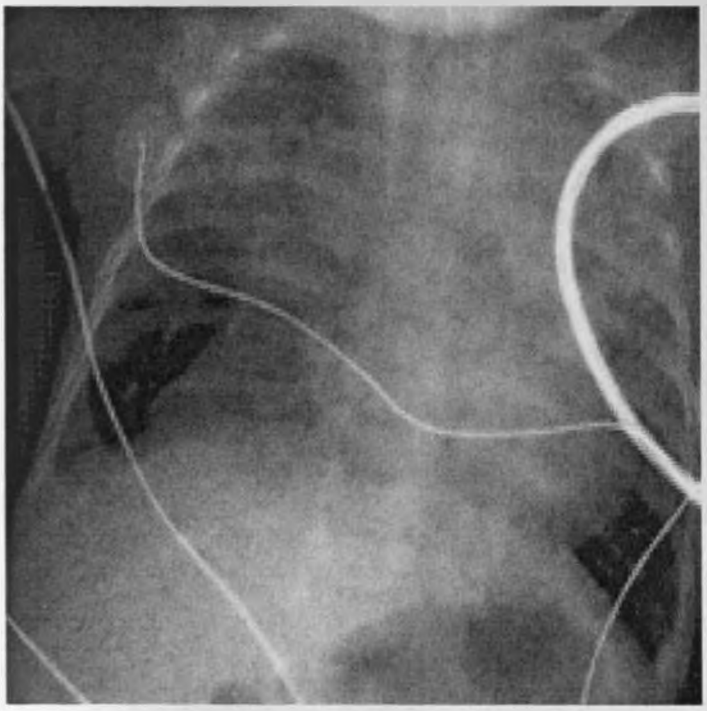
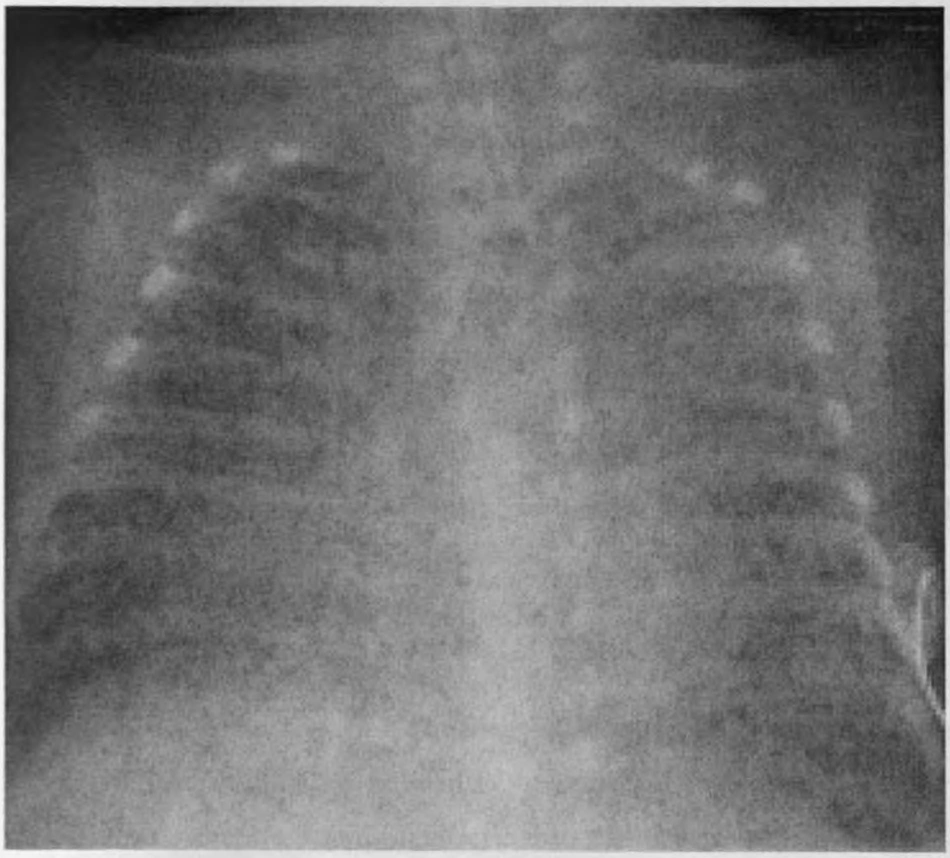


Figure 6) . BPD in a 33-day-old preterm infant. Frontal chest radiograph demonstrates uniform distribution of reticular opacities and small cystic lucencies [24]



Infection

Bacterial infection is another possible cause of neonatal respiratory distress. Common pathogens include group B streptococci (GBS), *Staphylococcus aureus, Streptococcus pneumonia*, and gram-negative enteric rods. Pneumonia and sepsis have various manifestations, including the typical signs of distress as well as temperature instability. Unlike transient tachypnoea of the newborn, respiratory distress syndrome, and Meconium aspiration syndrome, bacterial infection takes time to develop, with respiratory consequences occurring hours to days after birth [2, 16,17].

Risk factors for pneumonia include prolonged rupture of membranes, prematurity, and maternal fever. Prevention of GBS infection through universal screening and ante partum treatment reduces rates of early-onset disease, including pneumonia and sepsis by 80 percent. [24]

Chest radiography helps in the diagnosis, with bilateral infiltrates suggesting in utero infection. Pleural effusions are present in two thirds of cases. Serial blood cultures may be obtained to later identify an infecting organism.

Govedi in her Mmed dissertation showed the importance of CXR in the diagnosis of late neonatal pneumonia at KNH. CXR had a positive predictive value of 0.73 with a sensitivity of 80% and specifity of 50%. [36]

Grafakou et al concluded that the extent of lung consolidation in the chest X-ray and the location of pneumonia should be taken into consideration for the assessment of severity of the disease, as children with leftsided pneumonia are at increased risk for developing parapneumonic effusion [39]

Less Common Causes

Pneumothorax, defined as air in the pleural space, can be a cause of neonatal respiratory distress when pressure within the pulmonary space exceeds extra- pleural pressure. It can occur spontaneously or as a result of infection, meconium aspiration, lung deformity, or ventilation barotrauma. The incidence of spontaneous pneumothorax is 1 to 2 percent in term births, but it increases to about 6 percent in premature births [39]

Persistent pulmonary hypertension of the newborn occurs when pulmonary vascular resistance fails to decrease soon after birth as with normal transition. The etiology may be idiopathic or secondary to meconium aspiration syndrome, pneumonia, sepsis, respiratory distress syndrome, or transient tachypnoea of the newborn. Maternal use of selective serotonin reuptake inhibitors in the third trimester also has been implicated [39].

Certain congenital malformations can lead to respiratory distress. These include pulmonary hypoplasia, congenital emphysema, congental cystic adenomatoid disease (CCAM), Bronchogenic cyst, pulmonary sequestration, esophageal atresia, and diaphragmatic hernia. Upper airway obstruction from choanal atresia or vascular rings may cause similar results. Other obstructive lesions include macroglossia, Pierre Robin syndrome (airway obstruction due to micrognathia) lymphangioma, teratoma, mediastinal masses, cysts, subglottic stenosis and laryngotracheomalacia. Congenital heart disease also may be implicated. Cyanotic heart disease includes transposition of the great arteries and tetralogy of Fallot. Noncyanotic heart lesions may cause a pulmonary overflow state leading to congestive heart failure. These lesions include large septal defects, patent ductus arteriosus, and coarctation of the aorta. Malformations can sometimes be found on antepartum imaging [39,40]

Neurological disorders such as hydrocephalus and intracranial hemorrhage can cause respiratory distress. Central respiratory depression can occur after maternal exposure to medications, including labor analgesia and illicit drugs. [26,36,39]

Metabolic and hematological derangements (e.g., hypoglycemia, hypocalcaemia, polycythemia and anemia) can also cause respiratory symptoms. Inborn errors of metabolism should also be considered [4]

Finally, a small but significant number of infants do not fit previously described patterns. Delayed transition is diagnosed retrospectively when symptoms resolve within the first few hours of life instead of progressing as respiratory distress syndrome, transient tachypnoea of the newborn, or meconium aspiration syndrome. The etiology is most likely a combination of retained fluid and incompletely expanded alveoli. Treatment is supportive until the distress resolves in a few hours as the transition completes [4]

Other imaging modalities in neonatal imaging

Fluoroscopy ,Barium swallows, Computed Tomography, Bronchography and Angiography are other imaging modalities of the neonatal chest,but are all associated with high radiation doses to the neonate and their use must be justified [2]

Most of these procedures require use of a contrast medium.this is associated with various complications like anaphylactic reactions .

In conventional CT unccoperative neonates may require some sedation to minimize motion blurring, this again introduces the risk of adverse drug reactions. Image quality may again suffer motion blurring from cardiac and respiratory movement [2,]

MRI is a non- ionizing imaging modality with multiplaner capability is especially good in congenital cardiac lesions, anomalies of the great vessels, however sedation is required. Prolonged time taken in acquisition exposes the neonate to hypothermia and motion artifacts.

U/S is particularly important as it obviates the need for ionizing radiation. It is useful in evaluating pleural fluids and pleural masses.

RNI is helpful in delineating cardiac function, right to left shunts, pulmonary inflammatory conditions. It's use have been replaced by newer methods especially CT and MRI. [2]

Lung Funtion Tests

Yuksel et concluded that lung function can be assessed by measuring of thoracic gas volume (TGV) and airway resistance (Raw) plethysmographically, and of functional residual capacity (FRC) but suggested further research to standardize results [41]

Godfrey et al. concluded that lung function testing in infants is used overwhelmingly for research at the present time, and its role in clinical management has not been established [42]

Fumey et al. in a comparative study between lung function test and plain chest radiographs concluded that the radiographic method presents many advantages. The skill of the technique is quite easily and rapidly acquired. It can be performed in a very short time (< 2minutes) with good intra- and inter-observer reproducibility.

Furthermore, this study confirmed that lung volume could be estimated in infants using the AP chest film alone, without the previously reported need for a lateral view [27]

OBJECTIVES

Broad Objective

To describe the pattern of radiological findings on plain chest radiographs in neonates admitted with Respiratory distress to NBU of Kenyatta National Hospital.

Specific Objectives

1. Determine the frequency and distribution of radiological findings in respiratory distress

2. Determine age and sex distribution of neonates with various causes of respiratory distress.

3. Determine the presenting complaints of patients with respiratory distress.

4. Determine positions of any indwelling lines, catheters and tubes.

DESIGN AND METHODOLOGY

Study Area

The study was done at the New born unit of Kenyatta National Hospital.

Study Population

This included all neonates admitted with a diagnosis of respiratory distress with a CXR taken on admission or during follow up in the unit.

Study design

It is a descriptive cross sectional study that was undertaken from the time approval was received from the Ethics Committee for a period of at 4 months.

Study methodology

Patient's clinical summary (age, gender, serial number, and other radiological investigations done) was obtained from the request form and filled into the data collection form The CXR findings were reviewed by the researcher and a consultant Radiologist using standard text books diagnostic criteria and the World Health Organization standard guidelines [43]. Only after consensus was reached were the findings recorded in the data collection forms According to new recommendations from the WHO, each CXR should have been assessed by two independent readers and the consensual findings used in the analysis. Nonetheless, the CXR evaluation was standardized through use of a simple form that specified the radiographic features to search for. (Appendix A).

Equipment

This cross sectional study was conducted at KNH (Nairobi), which is the main Referral Hospital in Kenya. The radiographs for the study were performed on a portable Philips PRACTIX 160 X-ray machine manufactured in October 2006. The machine has a tube potential of 40-125 Kvp, exposure time of 1mS-5.3mS and source to floor distance of 70cm to 200cm.The system uses a single film screen combination..

Inclusion criteria

This included all neonates admitted to the NBU with respiratory distress, with an initial CXR taken at admission or during treatment in the unit.

Exclusion criteria

Neonate without clinical signs and symptoms of respiratory distress or poor quality radiographies.

Sample Size Determination

The sample size was determined by the following formula by Fisher et al (1998). [29] The prevalence level of 7% [32]

$$n = \frac{z^2 p (1-p)}{d^2}$$

Where n = desired sample size

z = standard normal distribution

p = known prevalence rate for the factor of interest under study

d = the level of significance desired

When this formula is applied at d = 0.05, z = 1.96, and p = 7 %

$$N = \frac{1.96^2 \times 0.07\,(1-0.07)}{0.05^2}$$

N =100

The expected sample size was be 100 for the period of 4 months

Currently KNH performs an average of at least 10 CXR on neonates with respiratory distress per week and therefore the researcher easily obtained the required sample size in the study period of 4 months.

Standardization of Radiological Results

The researcher reviewed the CXR and formed an opinion. The images were then presented to a qualified consultant radiologist for her opinion. The consensus opinion was then taken as the radiological diagnosis. This is what was entered as the diagnosis in the data collection forms. This process provided for both standardization and reproducibility of the radiological results

Data Management

Data analysis was done using statistical package for social science research (SPSS) and Microsoft computer software. Results were presented in form of frequency distributions and descriptive statistics. Sample images were selected and presented in the illustrations.

Ethical Considerations

1. The patients names did not appear anywhere in the data collections forms in order to maintain confidentiality. Instead the patients were coded with serial numbers. For referral purposes only the patients IP/ OP number were recorded. Consent from the parent/guardian was obtained
2. No additional examination was done on a patient other than the one requested by the primary physician

3. The ALARA principle that is keeping the radiation exposure As Low As Reasonably Achievable was maintained for all the patients. Only the standard radiological procedure for CXR was applied to all patients..

4. Permission to carry out the study was sought from the Ethical and Research Committee of Kenyatta National Hospital. The study commenced as soon as the study was approved by the committee. The results of the study will be published for future reference and to facilitate any possible improvements in patient management.

CHAPTER FOUR: RESULTS

Epidemiology

This study recruited 100 neonates admitted in KNH newborn unit with respiratory distress and investigated using chest radiography from September 2010 to December 2010. Out of the 100 neonates in the study, 4 births did not occur in a health facility (Born before arrival) and 2 deliveries were referrals from peripheral health facilities, leaving a total of 94 neonates admitted with respiratory distress and delivered within KNH.

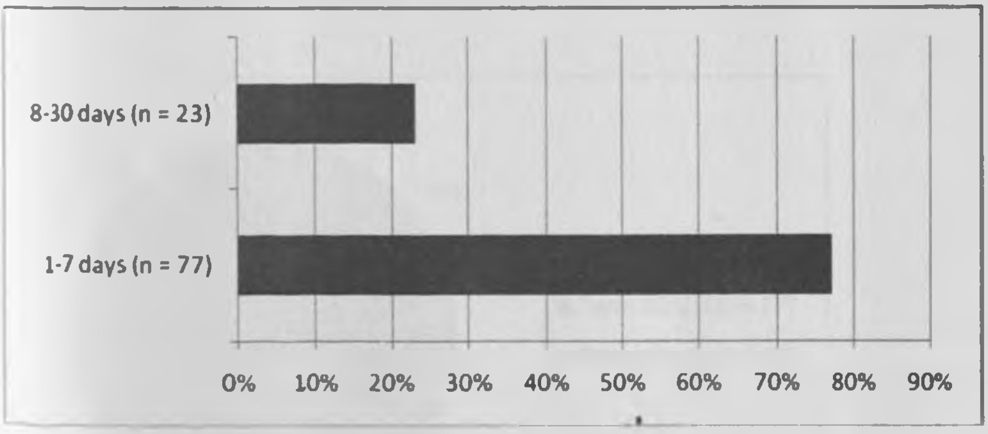
Gender of neonates with respiratory distress

An approximately equal number of male and females were enrolled in the study. The participants comprised 51 males (51%) and 49 females (49%) representing a Male-Female ratio of 1: 1.

Age of neonates with respiratory distress

The mean age of neonates studied was 5.3 days with a range from 1 to 30 days. Figure 1 presents the age of neonates categorized into first week of life and neonates older than one week. Most (77%) of the neonates, were less than 7 days of age, and the remaining 23% were between 8 and 30 days of age.

Figure 1: Age distribution of neonates with respiratory distress at KNH newborn unit



Birth weight

The mean weight of the 100 neonates at birth was 2.1 kilograms (SD=0.9) and the range 0.8 to 4.6 kilograms. Twenty-four babies weighed under 1.5 kilograms at birth, 15 weighed between 1.5 - 2 kilograms, 17 weighed between 2 - 2.5 kilograms and the remaining babies weighed at least 2.5 kilograms (Table 1).

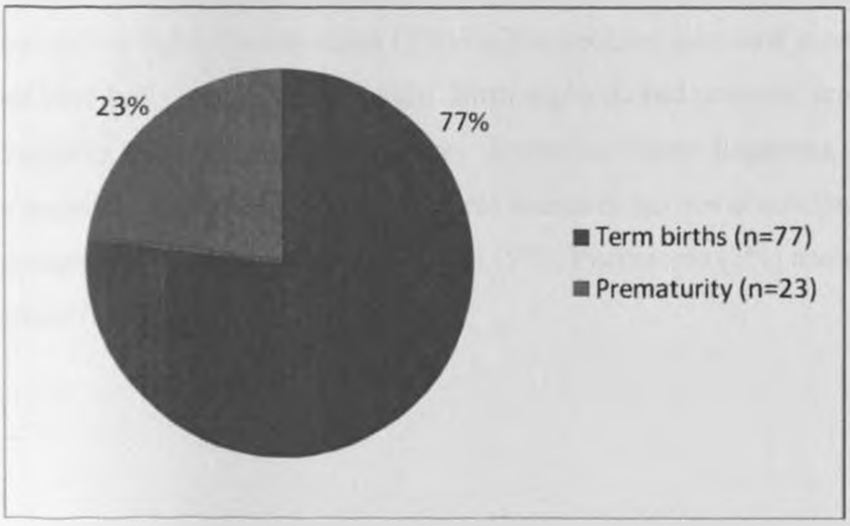
Table 1: Birth weights of infants admitted to KNH newborn unit with respiratory distress

Birth weight	Preterms	Term infants	Chi square
Below 1.5 kg	13	12	$\chi^2(4) = 25.7$
1.5- <2.0 kg	6	9	P<0.0001
2.0- <2.5 kg	4	13	
2.5- <3.0 kg	0	12	
3.0 kg and above	0	28	

Prematurity

Seventy seven percent of the neonates in the study were born at term and the remaining 23 infants were born before term. As shown in Table 1 above all the preterm infants weighed less than 2.5 kg and 13 (56.5%) preterms weighed less than 1.5 kg. Prematurity showed a significant association with low birth weight, p < 0.0001. Figure 2 shows the proportion of neonates with a diagnosis of prematurity and respiratory distress and term infants with respiratory distress in the newborn unit at KNH.

Figure 2: Prevalence of prematurity among newborns with respiratory distress admitted at KNH newborn unit



APGAR scores

APGAR scores were available for most neonates at birth (87%) and 5 minutes (68%). As shown in Table 2. most neonates had an Apgar score of 7-10 (59.8%) with the rest scoring 4-6 (31%) at one minute. Among the 87 neonates with a documented Apgar score at one minute, 8 (9.2%) neonates scored poorly (Apgar score=0-3). However, very few (22%) of the neonates has a score recorded 10 minutes after birth. The researcher liaised with the ward matron who promised to impress upon her members of staff on the importance of proper scoring and recording.

Table 2: APGAR scores of neonates admitted to KNH NBU with respiratory distress

APGAR score	Time of scoring after birth:		
	1 minute	5 minutes	10 minutes
0-3	8(9.2)	3(4.4)	1(3.1)
4-6	27(31)	17(25)	9(28.1)
7-10	52(59.8)	48(70.6)	22(68.8)

Provisional diagnoses

The admission diagnoses for the patients in this study are listed in Table 3 below. Neonatal respiratory distress was commonly associated with admission diagnoses of prematurity and very low birth weight. Twenty-three (23%) of the neonates admitted to newborn unit were premature and 20% had very low birth weight. Birth asphyxia and neonatal sepsis were also frequent diagnoses in neonates with respiratory distress and these diagnoses were present in 13% and 9% of neonates, respectively. The other provisional diagnoses at admission included: meconium aspiration (5%), GIT atresia and fistula (5%), Pneumonia (3%) and one neonate with acute renal failure (1%).

Table 3: Admission diagnoses among neonates in KNH newborn unit

	Number of neonates	Percent
Prematurity	23	23
Very low birth weight	20	20
Respiratory distress syndrome	21	21
Asphyxia	13	13
Neonatal sepsis	9	9
Meconium aspiration syndrome	5	5
Gastro intestinal atresia/ fistula	5	5
Pneumonia	3	3
Acute renal failure	1	1

Clinical presentation

The presenting complaints of the patients with respiratory distress recorded in the study are summarized in Table 4 below for premature and term infants. Overall, infants commonly presented with multiple complaints with only 14 (14%) neonates presenting with a single complaint.

Table 4: Clinical presentation of 100 neonates admitted in KNH newborn unit with respiratory distress

	Prematurity (n=23)	Term infants (n=77)	Overall
Tachypnoea	10(43)	44(57)	54(54)
Lower chest wall indrawing	10(43)	35(45)	45(45)
Grunting	8(35)	22(29)	30(30)
Nasal flaring	8(35)	15(19)	23(23)
Apnoea	1(4)	9(12)	10(10)
Convulsions	1(4)	9(12)	10(10)
Difficulty in breathing	0	5(6.5)	5(5)
Refusal to breastfeed/ feed	1(4)	3(4)	4(4)
Cyanosis	1(4)	2(3)	3(3)
Abdominal distention	2(9)	1(1.3)	3(3)
Fever	0	2(3)	2(2)
Vomiting	0	2(3)	2(2)
Sternal retraction	0	2(3)	2(2)
Jaundice	2(9)	0	2(2)
Perinatal Asphyxia	0	1(1.3)	1(1)

As shown in Table 4 above, respiratory signs were the most common presenting complaints in respiratory distress among both the term and premature infants. Overall, tachypnoea was the most common sign reported in 54% of all neonates including 43% of preterms and 57% of term neonates. The documented respiratory rates among tachypnoeic patients ranged from 64 breaths per minute to 102 breaths per minute. Lower chest wall indrawing, grunting and nasal flaring was present in 45%, 30% and 23% of neonates, respectively. Ten (10%) patients had apnoeic attacks and nine of these patients were term infants and the remaining patient was premature.

Among the non-respiratory signs associated with respiratory distress, convulsions including twitching were the most frequent signs occurring in 10% of neonates; 9 out of the 10 neonates with convulsion were term infants (Table 4). The other non-respiratory signs that were reported in the sample although they occurred quite infrequently included: refusal to breast feed (5%), abdominal distention (3%), fever (2%), vomiting (2%) and jaundice (2%).

Radiographic finding

Figure 3 presents the findings on chest radiography films of all the neonates in the study. Thirty-nine percent of with respiratory distress had normal chest x-ray findings. Most (61%) of the patients in respiratory distress also had abnormal chest x-ray findings.

Figure 3: Chest radiography findings among neonates with RDS in KNH

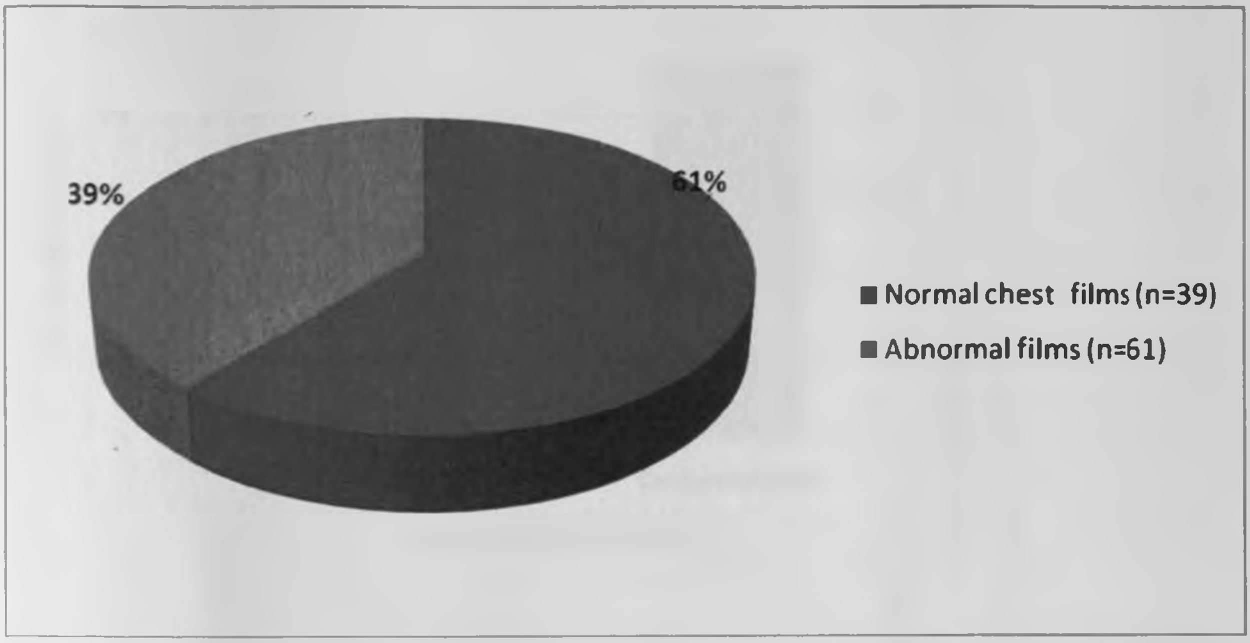


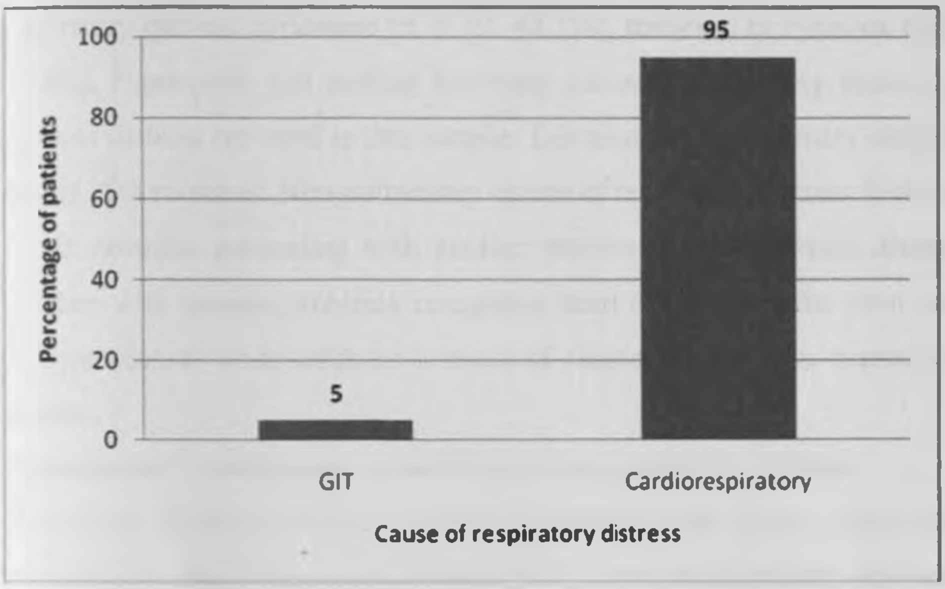
Table 5 compares the chest radiograph findings of preterm and term infants with respiratory distress at KNH. Although abnormal chest x-rays were more common among premature (48%) compared to term infants (36%) prematurity was not significantly associated with abnormal chest x-ray findings, χ^2 (1) = 0.98; p = 0.34.

Table 5: Comparison of chest radigraph findings for preterm and term infants with respiratory distress

	Prematurity	Term infant	Chi square
Chest x ray finding			
Normal chest film	12(52)	49(64)	χ^2 (1) =0.98
Abnormal film	11(48)	28(36)	p = 0.34
Total	23(100)	77(100)	

Figure 4 shows the causes of respiratory distress among the neonates based on radiographic confirmation of cardiorespiratory conditions. The primary cause of respiratory distress in majority of patients (95/ 100, 95%) was cardiorespiratory; only 5 (5%) patients had a GIT related cause to the diagnosis of respiratory distress. All the five children with a GIT diagnosis also had normal chest radiographs.

Figure 4: Causes of respiratory distress among neonates admitted at KNH newborn unit



All the five GIT causes of respiratory distress involved atresia or fistula occuring at different levels of the alimentary canal. These conditions were as follows: tracheo-oesophangeal fistula (n=1), esophangeal atresia (n=1), duodenal atresia (n=1) and anorectal malformation (n=2). Findings of the cardiorespiratory causes of respiratory distress are presented in Table 5 below.

Table 5: Cardiorespiratory causes of respiratory distress among 95 neonates at KNH NBU

Cause	Number of neonates	Percent (%)
Respiratory Distress Syndrome (RDS)	39	41.1
Transient Tachypnoea of the Newborn (TTN)	16	16.8
Pneumonia	15	15.8
Congenital Heart diseases	5	5.4
Asphyxia	5	5.3
Neonatal sepsis	4	4.2
Meconium Aspiration Syndrome (MAS)	3	3.2
Hyperbilirubinemia	3	3.2
Necrotizing enterocolitis	1	1.1
Metabolic (renal failure)	1	1.1
Pneumothorax	1	1.1
Choanal atresia	1	1.1
Twin transfusion	1	1.1

As shown in Table 5 above the most common cause of respiratory distress among neonates was respiratory distress syndrome (n = 39, 41.1%), transient tachypnoea of the newborn (n = 16, 16.8%). Pneumonia was another important cause of respiratory distress causing 15.8% of the cases of distress reported in this sample. Infection was the primary cause of respiratory distress in 4 (4.2%) neonates. Non-pulmonary causes of respiratory distress in this study were diagnosed in six neonates presenting with cardiac problems and metabolic disorders. Among the five children with cardiac problems congenital heart disease was the most common diagnosis (n = 3).Upper airway obstruction as a result of choanal atresia also caused one case of respiratory distress.

Radiographic visualization of indwelling lines, catheters and tubes

None of the neonates in this study had an indwelling line. Figure 5 shows that among the 100 neonates recruited in this study, 68% (n = 68) either had a catheters or a tube inserted. For all these 68 neonates the tubes and catheters were visualized using radiography and evaluated to confirm their positioning.

Figure 5: Percentage of neonates with indwelling lines, catheters and tubes

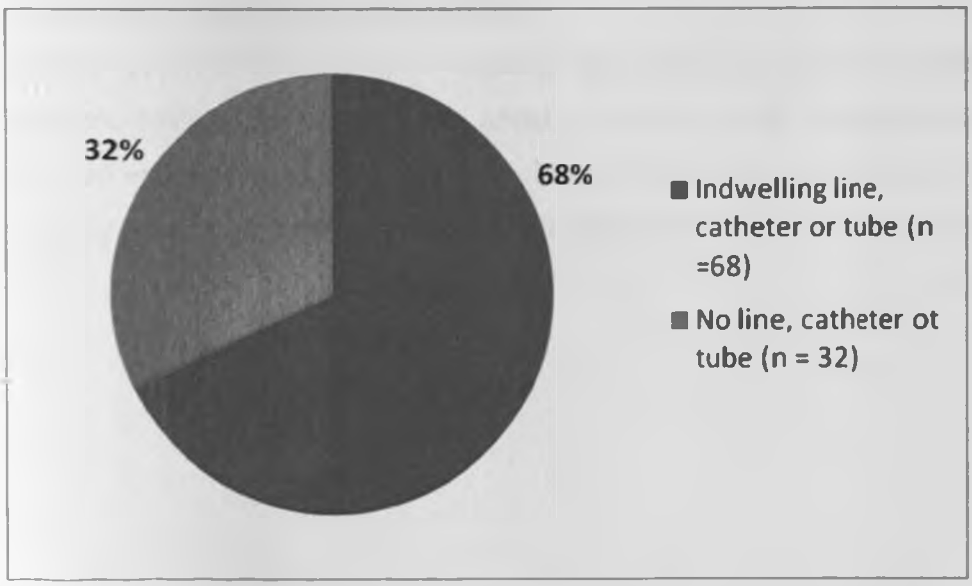
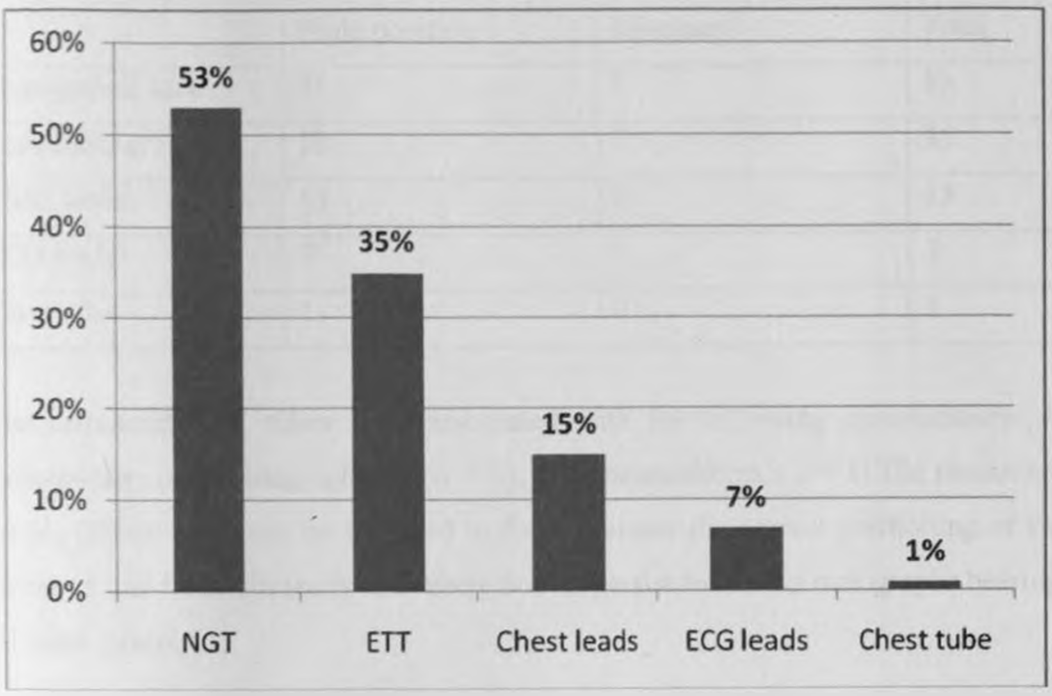


Figure 6 shows the specific type of tubes and catheters that were used for the neonates. The most commonly inserted tube was a nasogastric tube used in 53% of all neonates in the study. Thirty five percent of neonates had undergone endotracheal intubation, 15% had chest leads, 7% ECG leads and only one (1%).neonate had a chest tube.

Figure 6: Type of indwelling lines, tubes and catheters among neonates at KNH newborn unit



Positioning of lines, tubes and catheters

Table 6 presents findings on evaluating radiographs to confirm positioning of tubes and catheters. Malposition of tubes was noted for neonates with nasogastric tubes (2%) and those who had endotracheal tubes (7%). The chest tube inserted in one neonate was confirmed to be correctly positioned. Similarly, all the ECG leads and chest leads were correctly positioned.

Table 6: Evaluation of indwelling lines, tubes and catheter positions among neonates at KNH newborn unit

	Right position	Misplaced	Total
Naso-gastric tube	51	7	53
Endotracheal tube	28	7	35
Chest leads	15	0	15
ECG leads	7	0	7
Chest tube	1	0	1

The displaced ETT tubes were associated with the following complications visualised on radiography: partial lung collapse (n = 1), and pneumothorax (n = 1).The researcher impressesd on his fellow collegues on the need to fully evaluate the correct positioning of the indwelling catheters and tubes clinically and where doubts persist follow up radiographs bearing in mind the ALARA principle .

Radio clinical correlation

The frequencies of chest radiography findings are summarized in Table 7 for all the neonates and for neonates with each of the three leading causes of respiratory distress. Overall, parenchyma opacification (47%) and homogenous consolidation (14%) were the common findings in chest radiographs.

Table 7: Frequency of radiography findings for each of the 3 main clinical diagnoses

CXR finding	RDS (n = 39)	TTN (n = 16)	Pneumonia (n = 15)	Others (n = 30)	Overall (n=100)
Lung parenchyma opacification	29(74)	3(19)	10(67)	5(17)	47(47)
Ground glass	9(32)	1(6)	0	0	10(10)
Reticulonodular	4(10)	0	0	0	4(4)
Nodular	1(3)	1(6)	2(13)	2(7)	6(6)
Homogenous consolidation	10(27)	0	3(20)	1(3)	14(14)
Air bronchogram	4(10)	0	1(7)	0	5(5)
Pneumothorax	0	0	0	1(3)	1(1)
Cardiomegaly	0	0	0	2(6)	2(2)
Pleural effusion	0	0	0	1(3)	1(1)
Hyperinflated lung	1(3)	1(6)	1(6)	2(7)	5(5)
Collapsed lung	1(3)	0	0	0	1(1)

As shown in Table 7, a significantly higher percentage of neonates with RDS (74%) and pneumonia (67%) had visible opacities in their chest radiographs compared to neonates with TTN (19%) or other diagnoses (17%). Twenty (42.5%) of the 47 opacities visible on chest radiographs were classified as either ground glass opacities (10%), nodular (6%) or reticulonodular (4%) opacities. The type of opacities seen on chest radiographs also showed a statistically significant association with the neonate's diagnosis (Fischer's exact test, P= 0.01). Ground glass and reticulonodular opacities were visualized on the chest radiographs of 32% and 10%, respectively, of all neonates with RDS. These two patterns were not seen on the radiographs of any of the neonates diagnosed with either pneumonia or other diagnoses.

Similarly, radiography findings of homogenous infiltrates, airbronchogram, consolidation, hyperinflation, cardiomegaly and lung collapse were statistically significantly associated with the diagnosis (Fischer's exact test, P= 0.008). There were ten films with homogenous infiltrates (Table 7). Nine out of these 10 homogenous infiltrates occurred in neonates with RDS. The single case of pneumothorax (1%) identified on chest radiography was in a neonate with a clinical diagnosis of pneumothorax. Twenty percent of neonates with pneumonia had consolidation compared to less than 5% or 0% of children with RDS and TTN, respectively. Both of the children with a diagnosis of MAS had hyperinflated lungs on inspection of their chest radiographs.

Other findings seen on chest radiographs and presented in Table 3 were as follows: air bronchogram (n = 5 neonates), pleural effusion (n =2 neonates) and cardiomegaly (n = 2 neonates) and a single case each of lung collapse and pneumothorax.

Chest radiograph findings among premature and term infants

The comparison of the main chest radiograph patterns seen in the chest films of preterms are compared to the findings on films of term infants in Table 8. The pattern of findings for the main radiographic findings were similar among the premature and term infants. The proportion of premature infants with lung parenchyma opacification was 48% compared to 47% in term infants (χ^2=0.01, p=0.56). The percentages of preterm infants with homogenous consolidations (χ^2=0.29, p=0.41) and ground glass patterns (χ^2=0.06. p=0.59) were also similar to those of term infants as presented in Table 8 below.

Table 8: Comparison of Chest radiography patterns among premature and term infants

	Prematurity	Term infants	Chi square p value
Lung parenchyma opacification			
Yes	11(48)	36(47)	0.56
No	12(52)	41(53)	
Homogeneous consolidation			
Yes	4(17)	10(13)	0.41
No	19(83)	67(87)	
Ground glass pattern			
Yes	2(9)	8(10)	0.59
No	21(91)	69(90)	
Total	23(100)	77(100)	

Correlation between clinical signs and radiological diagnosis

Table 9 presents the clinical signs in neonates who had respiratory distress for each of the main causes of respiratory distress confirmed by radiography. Respiratory signs were commonly present in neonates in respiratory distress. Tacyhypnoea was the most prominent sign of respiratory distress across all the diagnoses. It was present in 54% of patients with RDS, 69% of TTN, 47% of pneumonia and 50% of neonates with other diagnosis. Lower chest wall indrawing was present in TTN (50%) and RDS (44%). However, this sign was seen in only 27% of the neonates who were diagnosed with pneumonia (Table 9).

Table 9: Clinical presentation for neonates with each of the main causes of respiratory distress admitted in KNH newborn unit

CXR finding	RDS (n = 39)	TTN (n = 16)	Pneumonia (n = 15)	Others (n = 30)
Tachypnoea	21(54)	11(69)	7(47)	15(50)
Lower chest wall indrawing	17(44)	8(50)	5(33)	15(50)
Grunting	11(28)	5(31)	8(53)	6(20)
Nasal flaring	8(20)	6(38)	3(20)	6(20)
Apnoea	5(13)	2(13)	1(7)	2(7)
Convulsions	2(5)	0	5(33)	3(10)
Difficulty in breathing	2(5)	2(13)	1(7)	0
Refusal to breastfeed/ feed	2(5)	0	1(7)	1(3)
Cyanosis	1(3)	0	0	2(7)
Abdominal distention	0	1(6)	0	2(7)

Grunting was seen more commonly among 53% of neonates with pneumonia compared to 31% of neonates with TTN, 28% of neonates with RDS and 20% of other cases. Convulsions did not occur in neonates with TTN and occurred in 33%, 10% and 5% of neonates with pneumonia, other diagnosis and RDS respectively. Cyanosis, abdominal distention and refusal to breastfeed were rare with each of these signs affecting only less than 5 neonates. As shown in Table 9, two out of the five neonates who refused to breastfeed had RDS.

Table 10: Chi square tests of association between chest radiograph findings and clinical diagnoses

	RDS	TTN	Pneumonia	Others	Chi square
Number of neonates (N)	39	16	15	30	
Patterns					
Ground glass	32%	6%	0	0	
Reticulonodular	10%	0	0	0	p = 0.04
Nodular	3%	6%	13%	6%	
Clinical signs					
Tachypnoea	55%	69%	47%	50%	p = 0.2
Lower chest wall indrawing	44%	50%	33%	50%	
Grunting	28%	31%	53%	20%	
Nasal flaring	20%	38%	20%	20%	
Apnoea	13%	13%	7%	7%	
Convulsions	5%	0%	33%	10%	

Findings of the Fisher's exact chi square test presented above showed that the six most common signs namely: tachypnoea, lower chest wall in drawing, grunting, nasal flaring, apnoea and convulsions were not discriminative enough to predict the specific cause of respiratory distress (Fischer's exact P = 0.2).

As shown in the table clinical diagnosis was significant in predicting opacities and infiltrates on the chest radiographs of neonates (Fischer's exact test, P= 0.04).

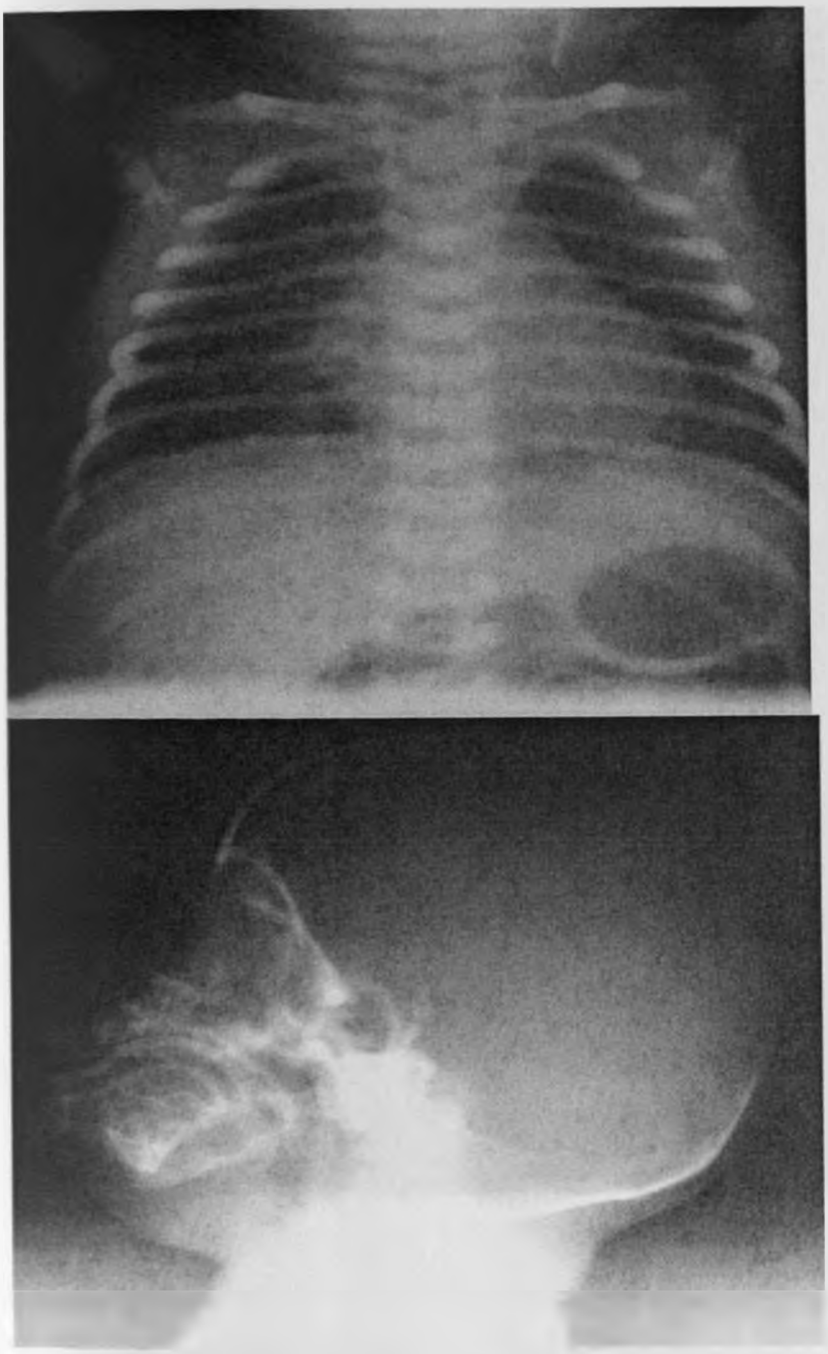


Plate 1: PNS and CXR radiographs showing obstruction of posterior nasal airways. A laryngeal airway is seen in the mouth in the post nasal space radiograph.

The tip of a nasogastric tube is demonstrated in the upper airway after attempts of intubation failed.(choanal atresia)

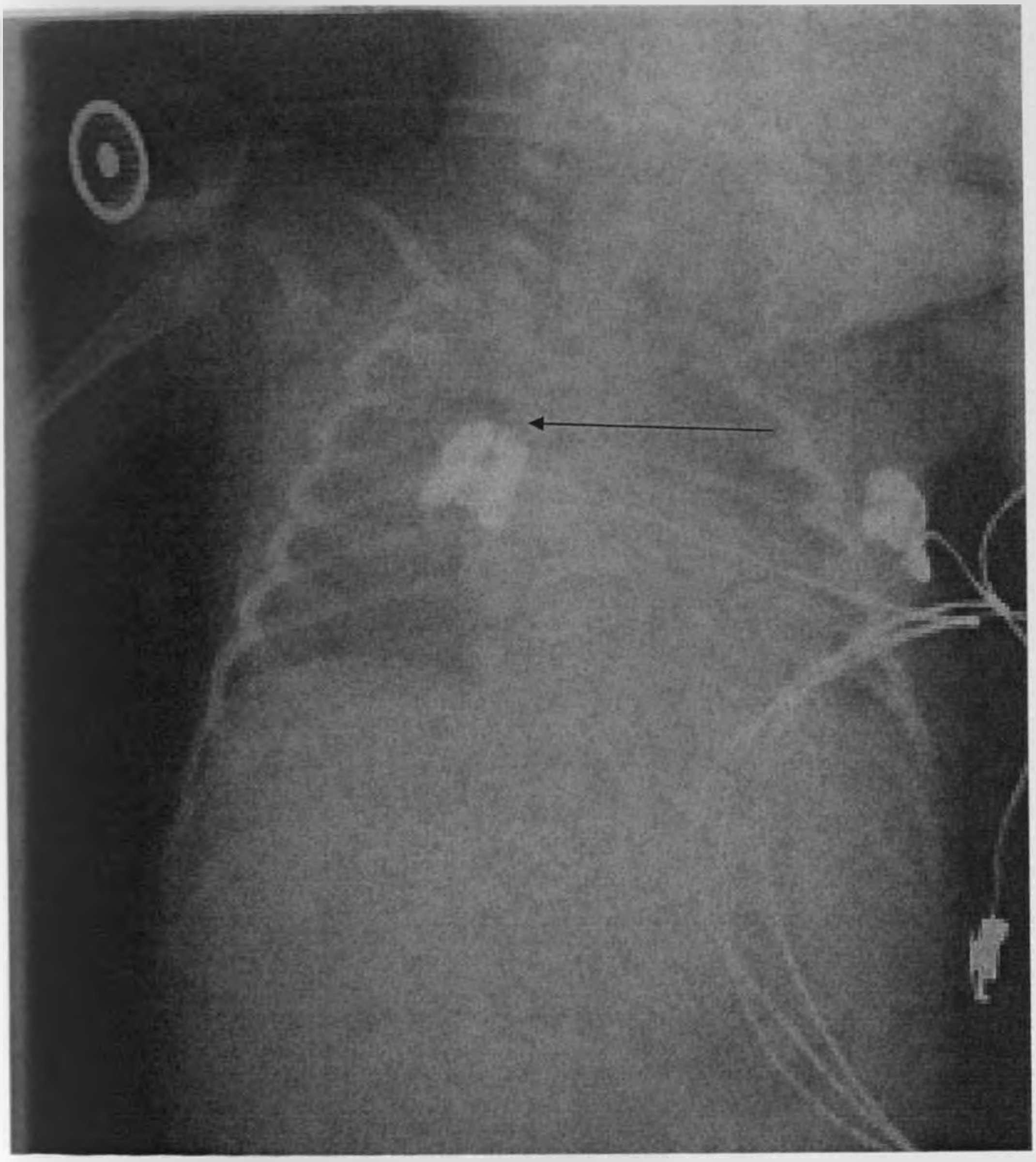


Plate 2: CXR showing a normally placed endotracheal tube in a neonate admitted with severe respiratory distress. Note the bilateral ground glass homogeneous opacification consistent with RDS

ECG leads are seen.

Plate 3: CXR Showing total opacification of the left hemithorax,low lung volume and ground glass opacification of the right upper zone. This was treated as respiratory distress syndrome.

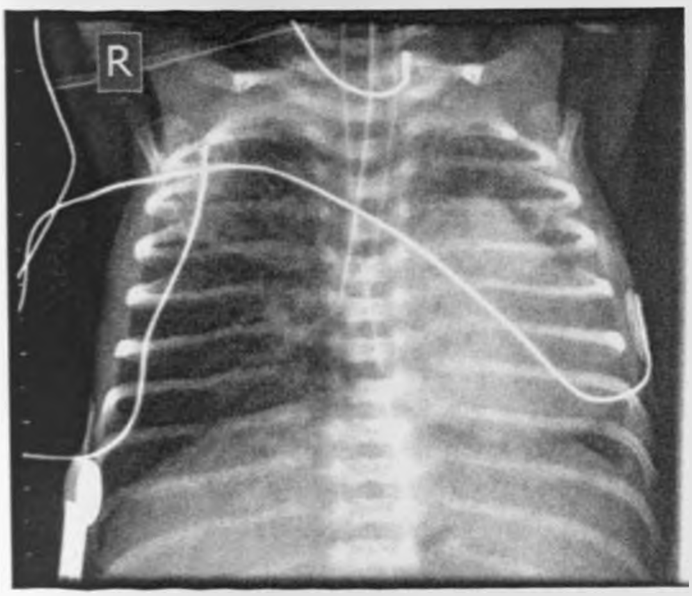


Plate 4: CXR – showing an endotracheal tube with a tip at the T5 level with hyperinflated right hemithorax with medistanial shift to the left. This was a case of malpositioned ETT, patient died two days later

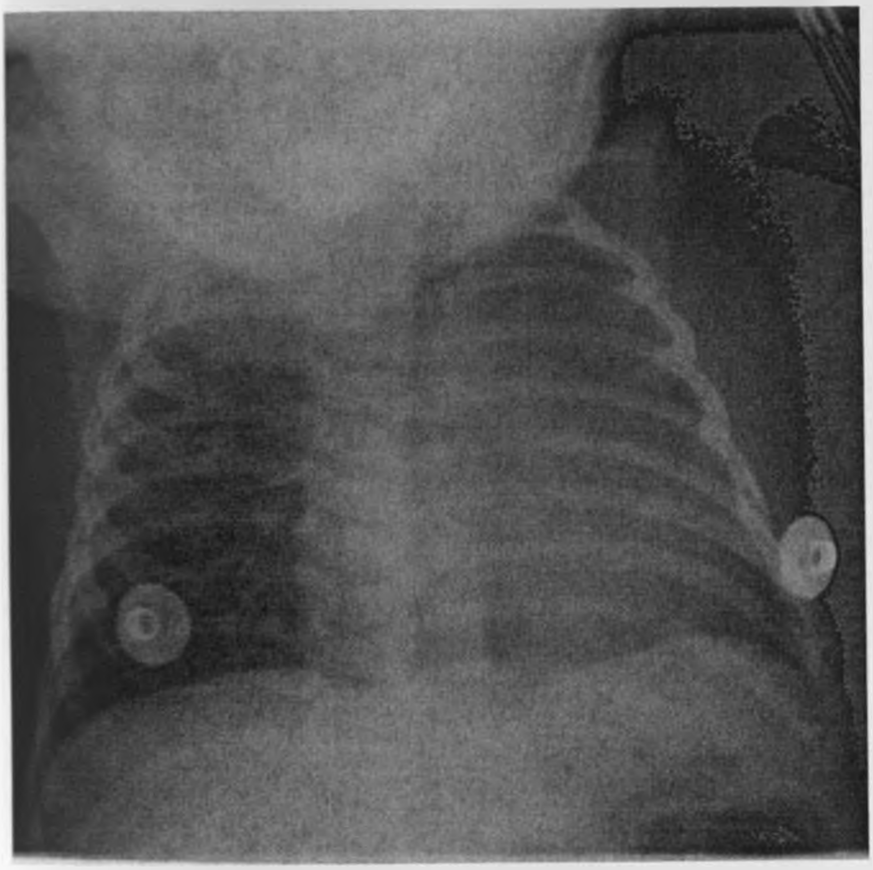


Plate 5: CXR showing a nasogastric tube coiling in the upper esophagus in a case of esophageal atresia with a distal tracheo esophageal fistula.Confirmed at surgery

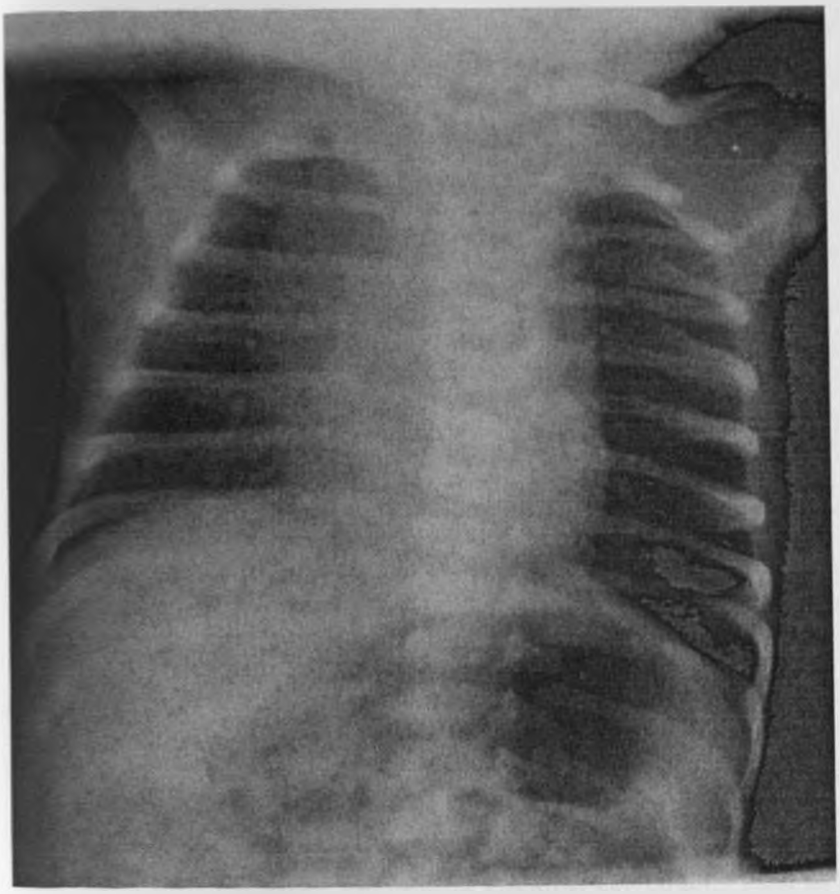
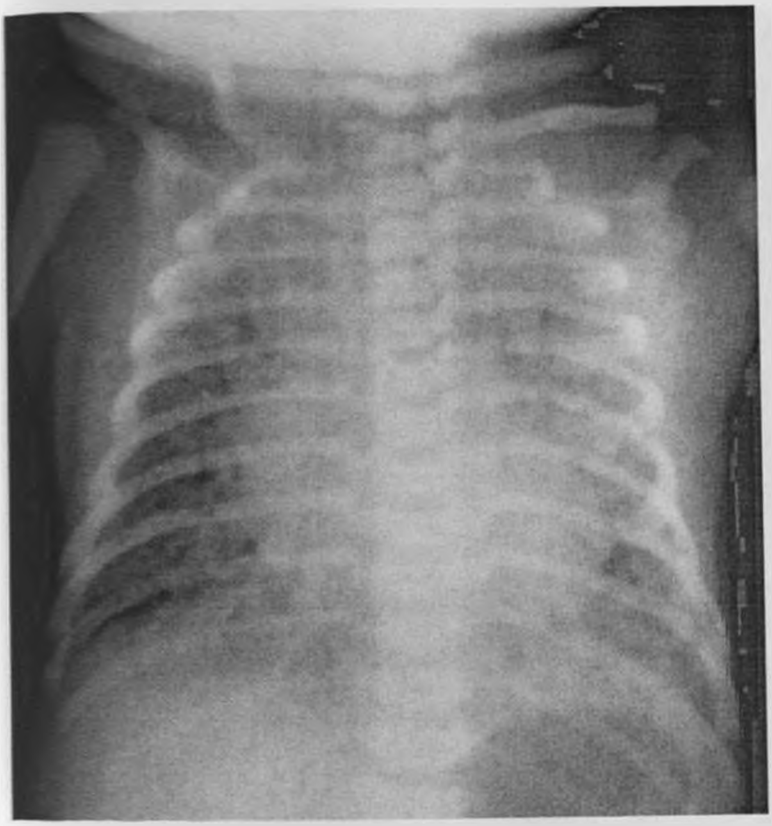


Plate 6: CXR Showing widened superior mediastinum. in a case of a normal thymus.The lung fields were normal.

CXR showing an incorrectly position nasograstic tube in the duodenal cap.



- Plate 8: CXR ; Coarse rounded opacities scattered throughout the lung fields with hyperinflation in a term infant with MAS.

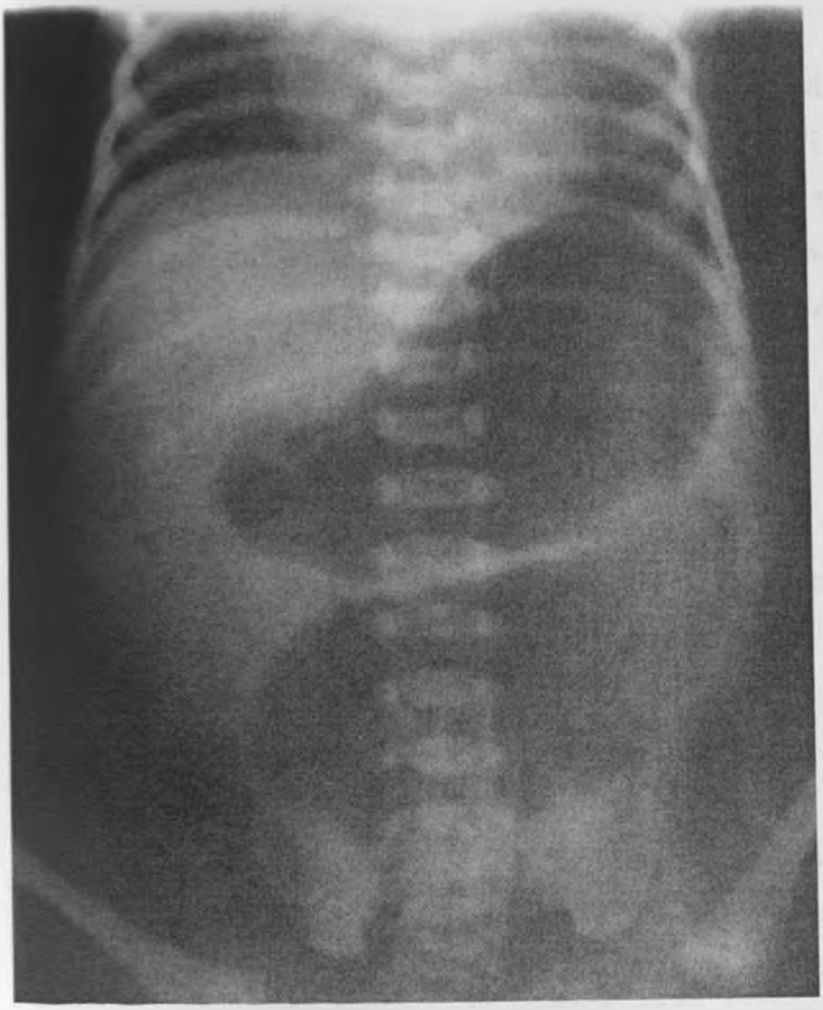


Plate 9: abdominal x-ray showing the characteristic double bubble sign, in a case of Duodenal atresia.

DISCUSSION

The aim of this study was to describe the chest radiograph findings among neonates admitted with respiratory distress at KNH- a tertiary level hospital in a developing country. The radiographic findings in respiratory distress were examined in relation to factors such as age, gender, clinical presentations and provisional admission diagnosis. In addition the aim was to investigate the radioclinical correlates in neonates with respiratory distress. The main findings are summarized and discussed in the following section.

Epidemiology of infants with respiratory distress

Infant's age

Based on the results of this study, it can be concluded that respiratory distress during the neonatal period occurred more commonly within the first week of life with 77% of infants being in their first seven days of life. Higher prevalence of respiratory distress in the first week of life have similarly been reported in a Kenyan District hospital by Mwaniki and colleagues and Kasirye-Bainda also reported similar results within the KNH newborn unit. [45,46]

Birth weight

Very low birth weight babies accounted for one-quarter of all children with respiratory distress, contributing disproportionately to admissions with respiratory distress. Possible explanations for high number of children with very low birth weight and respiratory distress include prematurity with the possibility of lung immaturity. Prematurity was significantly associated with low birth weight, $p < 0.0001$ [52]

Prematurity

Prematurity, a well established risk factor for respiratory distress, was diagnosed in 23% of all children with RDS in this study. As indicated in previous studies, respiratory distress among the preterm newborns was commonly related to diffuse pulmonary disease with approximately one-half of all the preterm infants having abnormal chest x rays. The commonly seen patterns in these preterm infants were fine granular opacities [32,52]

APGAR Scores

Most children in distress had high APGAR scores (≥ 7) at 1 minute and 5 minutes after birth, an expected finding, this is because signs and symptoms of respiratory distress develop gradually over 48-72 hrs after delivery [49,52]

Clinical presentation and provisional diagnosis

Neonates with respiratory distress in this study presented to the newborn unit with well established and documented signs commonly including: tachypnoea, lower chest wall indrawing, grunting and nasal flaring confirming the utility of these signs in diagnosing respiratory distress. Further, the findings show that most (95%) cases of respiratory distress in neonates presenting at this facility had a medical cause. Among medical causes of respiratory distress, the study demonstrated that pneumonia; RDS and TTN were likely to be the major causes of respiratory distress in the neonatal period. This finding is in broad agreement with published studies in KNH [46] and similar facility types both in Kenya (Moi Teaching and Referral) and other developing countries [47].

Radiographic findings

This study reviewed 100 neonates in respiratory distress. Chest radiographs revealed abnormalities in 61% of the patients, representing most of the patients with RDS (74%) and pneumonia (67%) and only 19% of the TTN cases. Despite the presence of few comparable radiological studies among neonates with respiratory distress in Kenya the patterns reported in this study are consistent with the previous reports. Out of the 15 neonates with respiratory distress caused by pneumonia 67% had consolidation on chest radiography and 74% of the 39 cases of RDS had infiltrates. This compares with findings of radiological evidence consistent with TTN/ RDS spectrum among all 8 young infant admissions with respiratory distress and consolidation on chest x-rays of 33% (44/133) of admissions at a rural Kenyan district hospital [48]. A prospective study set in a teaching hospital in Nigeria among 108 infants with respiratory distress reported that 24 (34.3%) out of the 70 children with negative cultures had radiologic evidence of pulmonary infiltration consistent with pneumonia [47]

In addition, the chest radiograph patterns reported in this study were also similar to that of studies from other low- and middle- income countries. In a study of 308 neonates presenting with respiratory distress at a university hospital in Brazil 38.7% of neonates had indicators of bacterial infection and 19.7% had radiographic changes suggestive of pneumonia (foci of patchy infiltrates in one or both lungs or reticulogranularity or haziness in both lungs [49].

Radioclinical correlations

In this study, clinical signs were not found to show any significant correlation with chest radiograph findings implying that although respiratory signs are adequate for identifying respiratory distress they were poor at discriminating specific features or causes of respiratory distress. However, both the clinical diagnosis and radiological diagnosis were found to be highly and significantly correlated with chest radiograph findings. The importance of chest radiograph findings as a predictor of clinical diagnosis was an important finding with implications for clinicians and radiologists practicing in facilities in which radiography services are available. Although it may not be appropriate to recommend routine radiography for all neonates presenting with respiratory distress, this study demonstrates the potential benefit that can be derived from performing chest radiographs among neonates with respiratory distress when there is a difficulty in establishing a clinical diagnosis.

Study limitations

The study limitations are listed in this section. First, interobserver variations in interpretation of chest radiographs have been reported previously and misclassification errors are possible in such studies. However, attempts made to minimise these errors in this study included independent interpretation of chest radiographs by the researcher and a senior consultant radiologist. The radiologist then confirmed the researcher's radiographic findings and where differences occurred they were resolved by reexamination of the films by both the researcher and consultant.

Second, not all patients admitted in KNH in respiratory distress with a chest radiograph were included in the study because the study was limited to neonates with xrays taken in KNH. This could have introduced selection bias in the study if neonates with xrays done outside KNH differed systematically from those whose xrays were done within the study hospital.

Generalisability of study findings

In considering generalisability of the study findings it is important to note that the population of neonates admitted to KNH newborn unit could potentially differ from most neonates admitted in lower level facilities in the country. These findings are however, applicable to admissions to similar newborn units in developing countries and in the absence of radiological studies on newborn respiratory distress in low-income setting these data contribute significantly to the existing body of knowledge in the developing countries.

Conclusion and recommendations

This study has established that radiological abnormalities commonly occur in neonates presenting with respiaratory distress at tertiary level hospital in Kenya. Among these neonates with abnormal chest radiographs, specific patterns were shown to be more prevalent among particular commonly occuring diagnoses including pneumonia and RDS.

On the basis of these findings, the study provides evidence for use of chest radiography in establishing abnormalities associated with common clinical diagnosis in respiratory distress, especially in cases where either neonates do not respond to emperical therapy or clinical features do not provide adequate information to allow clinicians make a definitive diagnosis on the cause of respiratory distress.

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APPENDIX A: QUESTIONNAIRE

1. PATIENT'S BIODATA

Serial No --------------------

IP/OP No---------------------

Age in days-------------------

Gender Male………………… Female…………………

Birth Weight…………

APGAR score…………….

2. PRESENTING COMPLAINNTS

- Cyanosis--
- Chest wall retraction---------------------------------------
- Tachypnoea---
- Grunting--
- Inspiratory stridor--
- Nasal flaring---
- Poor feeding--
- Unstable temperatures--------------------------------------
- Others ………………………………. Specify

3. CXR findings

- Pleural effusion
- Pneumothorax
- Lung collapse
- Cardiomegaly
- Hyperinflated lung
- Hypo inflated lung
- Lung parenchyma opacification
- Increased lung markings

- Malpositioned tube..........specify

Other findings...........................

4 **FOLLOW UP CXRS FINDINGS**

- Worsening
- Improving

Newer findings.........

5 **OTHER IMAGING STUDIES (if available)**

- Echocardiographs
- Ultrasound
- Chest CT
- MRI Scans
- None

6 **ASSOCIATED MORBIDITY**

- M S S
- CNS
- GIT
- GUS
- CVS
- Birth Trauma

APPENDIX B: ESTIMATED BUDGET

ALLOCATION	BREAKDOWN	AMOUNT IN KES.
Stationary	4 reams printing papers @ 500/-	2,000
	Biro pens (1 box) @ 1,000/-	1,000
	10 Folders @ 200	2,000
Ethics board	Ethics Fee	1,000
Secretarial services	Typist fees	5,000
	Photocopy	3,000
Computer and printer	Laptop Computer	60,000
	Computer software's	6,000
	Printer and cartridges	8,000
	SSPS software	2,000
	Flash disk	1,000
Internet hours	50 hours @ 60	3,000
Data collection and analysis	Statistician services	20,000
	Data collection assistant	10,000
Selected images	Scanning of images	5,000
	Digital transfer of images	3,000
Printing and binding	Proposal	4,000
	Final report	12,000
Contingencies	Contingencies	10,000
Total		**158,000**

The above expenses will be met by the researcher.

APPENDIX C: PATIENT CONSENT FORM

My name is Dr Thomas Thiga Gachuiri, a master of medicine student in the department of Diagnostic imaging and Radiation Medicine at the University of Nairobi. I am carrying out a study on CXR findings on neonates with respiratory distress.

I would like to recruit your baby in this study. Information obtained from you will be treated with confidentiality. Only the hospital number will be used. Results of the study will be used to inquire on clinical management of patients with respiratory distress.

The researcher will only review radiographs ordered by the attending clinicians and any procedure arising from such review will be for the benefit of the patient and not the researcher.

Please note that your participation is voluntary and you have a right to decline or withdraw from the study.

The researcher will have no financial or material gain.

Signature ____________________

Date ____________________

I certify that the patient has understood and consented participation in the study.

Dr. Thomas Thiga Gachuiri

Signature ____________________

Date ____________________

APPENDIX D: KIBALI CHA MGONJWA

Jina langu ni Daktari Thomas Thiga Gachuiri , mwanafunzi wa masomo ya upigaji picha za mwili katika chuo kikuu cha Nairobi. Nafanya uchunguzi wa watoto wachanga ambao wana shida za kupumua. Naomba ruhusa kwako ili nitumie majibu yako kwa uchunguzi ninaofanya. Majibu yatashungulikiwa kisiri. Nitatumia nambari ya hospitali tu ili kukutambulisha. Mwishowe maoni ya uchunguzi wangu yatasaidia kwenye utibabu wa watoto wenye shida za kupumua.

Nitakagua zile picha zimeagiswa na daktari anayekutibu tu.na ikiwa kuna haja ya matibabu ya siada itakuwa kwa manufaa ya mgonjwa na sio ya mkaguzi

Hauwajibiki kukubali hila hakuna uchuguzi mwingine utakaotekekelezwa juu ya mtoto wako.

Mchunguzi hafaidiki kwa fedha ama rasilimali zozote

Kama umekubali, tafadhali weka sahihi hapa chini

Sahihi ________________

Tarehe ________________

Nadhibitisha kwamba nimemueleza mgonjwa juu ya uchunguzi na amenipatia kibali.

Daktari Thomas Thiga Gachuiri

Sahihi ________________

Tarehe ________________