THE ROLE OF THE CHEST RADIOGRAPH IN THE MANAGEMENT OF PATIENTS ADMITTED TO THE INTENSIVE CARE UNIT AT KENYATTA NATIONAL HOSPITAL AND NAIROBI HOSPITAL

A dissertation submitted in part-fulfillment for the degree of master of medicine in diagnostic Radiology, University of Nairobi.

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By
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DECLARATION

CANDIDATE.

This dissertation is my original work and has not been presented for a degree in any other university.

Signed _____

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SUPERVISOR

This dissertation has been submitted for examination with my approval as a University supervisor.

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Quotation

"I did not think, I investigated".

Professor Wilhelm Rontgen to Sir James Mackenzie-Davidson during his only recorded interview, when asked what he thought when he discovered X-rays.

DEDICATION

My brains were in this study but my heart was with my wife and friend Roselyne Bonareri and my daughter Gloria Bwari.

Contents

STUDY JUSTIFICATION

There were 33,748 chest radiographs done in the whole of Kenyatta National Hospital (KNH) in 1998 out of which 831 were done in the intensive care unit (ICU) (1). This high figure is consistent with earlier findings which showed that the chest X-ray examination is the second commonest performed radiological examination with a frequency of 28.9% (2). Patients in the intensive care unit have various cardiopulmonary disorders and are frequently monitored and supported by various mechanical devices that make physical and radiological examinations difficult. The later is due to difficulties encountered in positioning and setting out exposure factors in an ICU set up. These two factors were also found to be the leading contributors to the rejection of chest films which stood at 28.5% of the films rejected in KNH and 18.5% of the films rejected at Aga Khan Hospitals in Nairobi (3).

The patients in an ICU are often unable to communicate verbally (5) to their physicians and are bed ridden for long hours, a factor which predisposes them to chest infections e.g. pneumonia which can be endogenous in origin or from contaminated catheters and tubes (11). The chest radiograph has been found to be effective in diagnosing various chest pathologies and in some occasions the first indicator of change in patients status. (6,9,11). Indeed the exact position of tubes, lines and pacemakers cannot be determined by any other method (5). There are no studies which have been done in out set up to evaluate the value of the chest film in the management of the critically ill and to document our experience in the use of this imaging modality. This study is aimed at filling this gap in knowledge.

TERMINOLOGIES (ABREVIATIONS)

KNH	-	Kenyatta National Hospital
ICU	-	Intensive Care Unit
COAD	-	Chronic obstructive airway disease
HDU	-	High dependence unit
CUC	-	Central venous catheter
SGC	-	Swan -ganz catheter
PCWP	-	Pulmonary Capillary Wedge Pressure
ARDS	-	Adult respiratory distress syndrome
CPE	-	Cardiogenic pulmonary edema
NCPE	-	Non cardiogenic pulmonary edema
PEEP	-	Positive end expiratory pressure
TNH	-	The Nairobi Hospital.
CT-SCAN	-	Computerised Tomography.

LITERATURE REVIEW

3.1 Introduction & technical factors

The Kenyatta National Hospital is a referral hospital and teaching hospital with a bed capacity of 1503. It has 8 beds in its high dependence unit and 10 beds in its intensive care unit. This gives a ration of 18:1503.
The Nairobi Hospital is a privately owned non-profit making referral hospital with a catchment area spanning the eastern parts of Africa. It has 7 beds in its high dependence unit and 7 beds in its ICU. Its overall bed capacity is 200, giving an ICU bed capacity to whole hospital bed capacity ration of 14: 200 (3). This ratio is supposed to be about 1:100 (12). In the USA there are about 55,000 Intensive Care Unit beds comprising 5% of the hospital beds (5).

There were 740 admissions to the Kenyatta Hospital ICU. In 1998 from the records available 831 chest X-ray examinations were done on this patients in the same period compared to 33,748 chest X-ray examinations done in the whole hospital. (1). The level of ICU chest examinations is lower in KNH compared to other hospitals where for example the ratio of chest radiograph per patient per day is 0.7 (5).

The KNH and Nairobi ICU admits patients with either a medical or a surgical condition. There are no separate ICU as to the practice elsewhere (5,6,7). Therefore the ICU admission diagnosis in our setup includes such entities like accidents (Trauma or burns), Renal failure, cardiac disease, respiratory failure, adult respiratory distress syndrome and post surgery (thoracic, abdominal and maxilofacial)(1,4). Indeed this is the case in other hospitals reported in the literature (5). The age distribution and male: female ratio are important parameters to be noted in this study. It has been observed that many older patients in ICU have chronic obstructive airway disease (COPD) and air trapping making the incidence of expiratory films low (9). Also more chest radiographic abnormalities are present in-patients above 40 years of age than those below (6).

Furthermore women run a greater risk than men for malpositioning of the endotracheal tube after emergency intubation (14). Endotracheal malposition is a known complication and occurs in 10% - 15% of cases (6,15).

The percentage of chest X-ray films which was rejected in ICU and reason for rejection in our setup is not available. Chest film rejection rates contributed to 28.5% of all films rejected in KNH and 18.5% of all films rejected in Aga Khan (3). The reasons for rejection or non-usefulness should be known and improvements done to reduce costs and maximize utilization of available scarce resources. Elsewhere the non-useful chest films in ICU consisted of 9% of the examinations done (6). From the 831 films done last year, it is not clear which ones were done as: -

i) a routine examination for the purpose of admission to ICU,
ii) to monitor a known cardiopulmonary lesion ,
iii) To monitor various chest devises used in the management of the critical ill,
iv) Done as routine daily examinations.

The register available is used for keeping records of all the portable examinations done in the whole hospital including ICU examinations. ICU chest films require special labels and registration (9).

Studies to evaluate the role or value of the chest X-ray examination have been done and show that the chest radiograph is useful in the management of the critically ill. (5,6,7,8,9,10,11). Suggestions for improvement of this examination have been given by other workers (6,7,8,9). This include, timely delivery of films for use during ICU morning rounds, use of qualified personnel to perform X-ray work (9), review by ICU radiologist (9) and use of labels to indicate exposure factors and state position of patient at time of exposure (i.e. on mechanical ventilation or not on PEEP or supine or semi erect) and even training of referring physicians (8).

The chest radiograph despite its generalized acceptance in imaging the chest in ICU has its shortcomings and limitations. Under exposed films show lung parenchyma more prominently and this might be mistaken for lung disease (10). Over exposed radiograph appears dark and lung disease can easily be overlooked (10).

The ends (or business ends) (10) of faint catheters are not often seen until contrast media has been injected into them (10, 11). Wrong exposure factor, have led to poor quality films which are not supposed to be reported or used (11,22).

This adds to the cost of health-care, which has little funds and many commitments. The cost of one chest x-ray examinations in KNH now stands at Kshs. 700.00 at a time when one USA dollar attracts Kshs. 75.00 (1).

In our set-up the films once ready in the X-ray Department are sent to ICU to be read by the attending physician. On rare occasions these films are send back to be reported by the radiologist on duty or a senior registrar in radiology. The literature reveals that the practice elsewhere is for an ICU radiologist to review most of these films (5,9).

The chest X-ray examination is of value in identifying position of various chest devices frequently used to monitor critically ill patients. The chest radiograph is also used in the diagnosing of cardiopulmonary disorders and to monitor these disorders to see if they are improving, worsening or new ones are developing.

In a study designed to evaluate efficacy of the chest radiograph in the management of the critically ill, Hall et al (16) compared the clinical findings of attending physicians and the chest radiograph findings, and they found that in 13% of patients new findings were discovered only by the chest radiograph. Indeed Milne ENC in his article " physiological approach to reading critical care unit films" concludes that the critical care unit chest film is the single most sophisticated and valuable, non-intervention data gathering technique that can be used in the case of critically ill patients (9). He predicts that its value both to the patient and the referring physician will grow. Increased use is expected especially with improvements in digital imaging of the chest (17).

3.2 Catheters, tubes, Cannulas and drainage devices.

Catheters are used to monitor the patients hemodynamically, central venous pressure, administration of fluids and drugs and for total parental nutrition.(12).The most common catheters used are the central venous catheters (CVC) and the swan-ganz catheters (SGC).

Vascular catheters are more commonly inserted through a jugular or a subclavian approach; they get to the superior venacava through the innominate veins. However these catheters can be malpositioned or misplaced by entering into the internal mammary, pericardiophrenic, azygos or superior intercostal veins (11). Malposition of chest devices as been observed by other radiologists (5,6,7,8,16,19,20,21,22,23).

Swan-Ganz catheters are two or three lumen catheters, the smallest of which is situated close to the tip and connected with an inflatable balloon, making the catheter flowing downstream towards the superior venacava (SVC), the right heart, the main pulmonary branches, where it remains at rest. They are used to measure several cardiovascular parameters including the pressure in the left atrium, then its further advanced into a small basal artery and the balloon infiltrated to temporarily obstruct its lumen. The pressure measured at the catheter tip is called pulmonary wedge pressure (PCWP) and appropriately expresses the pressure of the left atrium. The normal radiological position of the tip of this catheter should be within the main pulmonary artery or right or left pulmonary branch (19).

The Central Venous Catheters (CVC) have more than one line and are commonly used. They normally live in and parallel the walls of the SVC and not supposed to enter the right atrium, otherwise arrthymias, endocardial damage and perforation might occur (20,21).

The central venous catheters can be misplaced or malpositioned when they enter contralateral or collateral vessel. When it enters the internal mammary a lateral chest X-ray projection film will show its tip pointing towards the sternum (19). A

left sided catheter with the tip impinging perpendicularly or angled against the right lateral wall of the SVC might lead to perforation and ectopic infusion (20,24).

These misplacements apart form giving misleading pressure measurements can lead to chemical phlebitis and thrombosis from the irritating substances infused through the catheters. (19,20,23).

Coiled catheters with the tip directed upstream are considered misplaced or malpositioned because they create turbulence and favour thrombosis. (22)

Such patients with thrombosis may develop sepsis, superior vena-cava syndrome or loss of central venous accesses, even in the presence of a normal radiograph. (25)

Other less common complications of use of catheters include knotted catheters and detached fragments. The knotting can be loosened and detached fragment removed by interventional radiological techniques. (26)

The incidence of malposition depends on the site of insertion and is more when a left approach is used than the right.

On the right the safer approach is through the jugular (27). When occurring, usually the pneumothorax is a complication of a subclavian catheter. (27)

3.3 Tracheal tubes and Cannulas

Tracheal tubes serve three main functions namely,

(1 to allow for mechanical ventilation of the airways
(2 suction of bronchial secretions and
(3 prevent aspiration in unconscious patient.

Radiologically the tracheal tip should project not less than 2cm to and not more than 7cm above the carina on an Antero-posterior film. This corresponds to T3 - T4 vertebral spine level. Neck flexion causes a descent of the tube by 2 cm while neck extension causes the tube to ascend

A tracheal tube placed proximally is at a risk of damaging the laryngeal structures and increasing the chances of accidental extubation, while a distally placed tube is at a risk of entering the right main bronchus or intermediate bronchus leading to a left lung atelectasis in most cases (14,19). These misplacements have been seen to occur in about 10 - 15% of cases (6,15).

Other rear complications include Endotracheal tubes in the esophagus and tracheal tear with subsequent complications such as cervical abscess; mediastinitis, soft tissue emphysema and pneumo-thorax. (29,30).

3.4 Esophageal feeding tubes

Feeding of the critically ill patient is done by a nasogastric tube or by intravenous alimentation. The nasogastric tube can be misplaced and enter the tracheo-bronchial system such an occurrence has a high likelihood of causing tracheal damage and chemical pneumonia (31).

The nasogastric tube can also perforate the esophagus leading to pleural effusion, pneumo-mediastinum, extra-esophageal tube portions, mediastinal widening or mediastinal air - fluid level (31,32).

3.5 Pleural drainage

Chest tubes are used to drain air or fluid in the pleural cavity. They are inserted anteriorly when they have to drain air and posteriorly when they have to drain fluid. In the presence of a pneumnothorax both inner and outer edge of the tube should be recognizable because of the presence of air internally and externally to it. This does not happen when the tube is draining fluid or when it's misplaced in the consolidated lung or the soft tissues of the chest especially in the obese people. when misplacement occurs, computerized tomography has been found to be a useful alternative imaging modality or oblique views to show the tube in a fissure or lung or soft tissue of the chest. Misplacement is suspected when the drained fluid is small or pneumothorax persists.

3.6 Atelectasis and pleural disorders

Atelectalsis is a common finding in postoperative patients especially thoracic and upper abdominal surgery (9,10,11) or in smokers, obese and elderly patients, particularly if a previous disease exists at the lung level (34) and in those patients with diminished mental status (9). The collapse of the lining is associated with several factors including:

(a) depression of the muco-cilliary clearance and the
(b) impairment of the cough reflex resulting in retention of secretions in the airways and subsequent bronchial obstruction from mucous imparction
(c) and reduction of lung surfactants.

Atelectasis may also occur in the presence of pleural effusion, pneumothorax and diaphragm paresis also called passive atelectasis (35). The lung becomes heavier and collapses on itself. This is more in the lower lobes, particularly to the left and occasionally on the right upper lobe (9,10,11).

The radiological landmark of collapse is an increased opacity of the left cardiac region and concomitant disappearance of the diaphragm.

Some air bronchograms can be seen within the opacity. Subsequent atelectasis appears like band-like opacities in the lungs. This will disappear when the patient begins to breathe and becomes ambulatory (10). Other features of atelectasis include shift of mediastinal structures or displacement of interlobar fissure (10). Reported cases of atelectasis usually lead to urgent bronchoscopy to be done to remove bronchial secretions and this leads to reduction of the previously observed opacities in the lung (11).

Air bronchograms are present in patients having pulmonary consolidation unlike in pleural effusion. Small effusions and consolidation are frequently missed on the radiography in supine subjects (9,10,35,36). Larger amounts of fluid are responsible for unilateral densities, reduced visibility of the lower lobe vessels and a missing diaphragm that mimics basal atelectasis (26,27). Large fluids enough to spill from behind the lung presents with an apical cup blunted costophrenic angle, an extra pulmonary pleural band and absence of air bronchograms. (11).

Dense and homogeneous pulmonary consolidations occurring after pulmonary trauma (pulmonary contusions) may not show an air bronchogram and thus mimic effusions. In such a case, chest computerized tomography and ultrasound examinations have been recommended to quantify the amount of effusion (13,38). Pulmonary trauma occurs in about 50% of RTA involving the chest and such patients especially those presenting with a flail chest require ICU care (39).

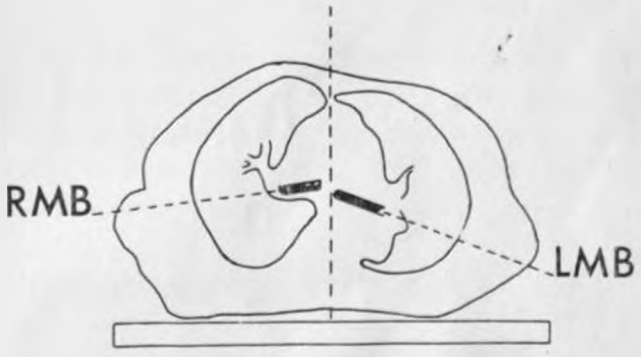


Diagram showing the mean angulation of the right and left main bronchus in the supine patient (9). Aspiration will pass preferentially in the supine position to the left lower lobe (9,40).

3.7 Pneumonia

Pneumonia is a major problem affecting the critically ill as it is a source of sepsis particularly in the mechanically ventilated (41). The radiological feature of pneumonia i.e. chest infiltrates are often confusing with those of adult respiratory syndrome (ARDS) where atelectasis, aspiration, hemorrhage, lung Infarct, contusion, pleural effusion and edema may coexist (42,43). Where else the opacities due to pneumonia clear with time and use of antibiotics, those of ARDS become progressively worse and do not change for several days or longer (10). In a patient on mechanical ventilation pneumonia can be confused with pulmonary edema. The airspace opacities in pneumonia tend to be scattered, patchy or focal and sometimes lobar. Different opacities are seen in both conditions (10)

3.8 Edema

Depending on the cause, there are various types of pulmonary edema that can be found in the critically ill. Hydrostatic pulmonary edema also called cardiogenic pulmonary edema (CPE) as it is best seen in cardiac failure, occurs when the hydrostatic pressure (the PCWP) measured through the swan gang catheter at the arteriolar level exceeds the oncotic pressure at the venular level. The end result is flooding of the alveoli (44,45).

Injury to this membrane at the alveoli capillary level makes it to be more permeable to fluids that move from the vascular compartment directly into the alveoli and produce an edema called injury edema or permeability or non-cardiogenic edema (NCPE). NCPE is the edema of ARDS, a condition in which the lung is damaged by different pathological Noxae coming to it either through the bronchi or from vessels or because of injury e.g. trauma (34, 46)

Air-borne ARDS is a combination following the inhalation of toxic fumes, gases, near drowning or aspiration of gastric juice (mendelson syndrome). Vessel - borne ARDS follows fat embolism, the dissemination of endogenous toxin or products of necrosis as in acute pancreatitis and in septic conditions or after massive blood transfusions (9,10,11).

The pattern of pulmonary infiltrates is different Radiologically in the three types of edema. This is because hydrostatic edema is made of water at low viscosity and this freely flows throughout the interstitium as a continuum according to the law of gravity, hence the basal lung is preferred almost in the half sitting position. The osmotic gradient in hydrostatic edema increases from the periphery to the center of the lung hence helping to explain the vascular blurring, hillar haziness and bronchial cuffing seen. When the fluid fills the bronchi, the bronchi will not be recognized within the opacities (absence of air bronchogram) (9,10,11).

Injury edema on the contrary is a high-viscosity fluid that contains proteins, fibrin, and other material that does not allow the fluid to move easily throughout the interstitium and into the bronchi. This accounts for the presence of an air bronchogram, which stands within a pattern of patchy opacities, scattered more or less homogeneously throughout the lungs. (44,47,48).

The evolution of the opacities overtime is also different and the chest radiograph is effective in monitoring the effect of the therapy. Cardiogenic pulmonary edema responds very fast to cardiac drugs and diuretics while injury edema sets in rapidly but persists overtime. (47,48,49). No matter the cause of ARDS the sequence of clinical and radiological events is similar but the severity of the disease and timing of there evolution is different (11,49).

The patient initially develops a sudden respiratory failure with no lung opacities but with a decreased lung volume (50). Histopathological findings of this early phase show alveoli filled with fluid and others are collapse (Microatelectasis). Later patchy opacities occur with presence of air bronchograms. Follow-up films show fully developed opacities and even change of pattern; a situation, which indicates, superimposed aspiration, pneumonia, fluid overload or cardiogenic pulmonary edema. The most devastating forms of injury edema are those following sepsis (51). Histopathologically this appears as epithelial degeneration, vascular occlusion with scattered areas of infarction and extensive fibrosis (49).

Radiographic differentiation of causes of pulmonary edema Milne ENC (9) as quoted by Sanford A. Rubin (10).

	Edema caused by CHF, RF OR FLUID OVERLOAD	CAPILLARY PERMEABILITY PULMONARY EDEMA
1. Vascular pedicle width	Normal or widened	Normal or narrowed
2. Distribution of edema Horizontal axis	Even or central	Peripheral
3. Heart size	Enlarged	Normal
4. Septal lines	Common	uncommon
5. Peribronchial cuffing	Common	uncommon
6. Air bronchogram	Infrequent	very frequent
7. Pleural effusion	Common	uncommon
8.		

Recognition of enlargement of the azygus vein and superior vena-cava (both forming the distensible venous side of the mediastinum) is analogous to recognizing neck vein distension on physical examination. This finding plus an enlarged cardiac indicate that the patient's intravascular volume is greater than normal or that venous return to the right atrium is impeded. This observation helps to differentiate capillary permeability edema from other causes of pulmonary edema. (9).

3.9 Fluid overload pattern

The critically ill are often in a state of fluid overload following introduction of liquids to sustain blood pressure in trauma, shock, and burned and dehydrated patient or as a consequence of fluid retention in renal failure. Fluid will move from the intra-vascular space to extra-vascular space and eventually to the third space i.e. pleural cavity and subcutaneous soft tissue which will subsequently increase in thickness.

Radiographically this will be seen as:

1 the increase in the extra-vascular lung water through the signs of pulmonary edema,
2 the increase in the pulmonary blood volume through the increase in diameter of the pulmonary vessels,
3 the increase in the systemic intra-vascular blood volume through the enlargement of the vascular pedicle (the width of the mediastinum at the level of the great vessels the superior vena cava and aorta. According to Milne ENC, 1 cm of change in the vascular pedicle width in two subsequent films corresponds to a change in intra-vascular volume of 2 litres(9),
4 the accumulation of fluids in the third space through the increase in thickness of the soft tissues of the Lateral chest, according to Milne ENC, 1 cm of variation in the soft tissue width may correspond to a variation of 1 litre of fluids in the third space (9).

3.10 Assisted ventilation

Assisted ventilation is done by connecting a mechanical ventilator through a tracheal or tracheotomy tube in order to support the respiratory function in a patient having respiratory insufficiency. When this is done, the volumes of air that a spontaneously breathing patient is able to get through very small changes in his pulmonary pressures are obtained artificially by raising the intrabronchial pressures through the ventilator. To further expand stiff lungs, the whole volume can be increased by raising the base level of these pressures i.e. making their base level positive (positive end expiratory pressure PEEP). PEEP increases oxygenation of blood by, recruiting alveoli not initially ventilated, reduction of shunt and over inflation of the already ventilated ones (11). The chest radiograph of a patient on PEEP can look normal despite the patients worse clinical picture (54,55,56).

Mechanical ventilation causes complications due to rupture of the interstitial septa or of the pleural boundaries due to increased volumes (volotrauma) or increased pressures (Barotrauma) (9, 10, 57, 58). Barotrauma results in interstitial emphysema, pneumomediastinum, subcutaneous emphysema and pneumothorax

(9, 28, and 59). Indeed a single pneumothorax can be made worse (tension pneumothorax) by mechanical ventilation (55). A tension pneumothorax has the following radiological signs, massive pleural air collection, flattening of the cardiac border, contra-lateral shift in the mediastinum and depression of the diaphragm (60).

Other important signs of pneumothorax include increased sharpness of the mediastinal lines, better seen on follow-up films. Very tiny collections of air within the pleural space can be detected by performing a cross-table lateral x-ray or an anteroposterior view with the patient lying on the contralateral side (11).

4. Rationale

The critically ill patients in ICU are often unable to talk about their sickness, they lie supine for long hours and have various chest devices in site to assist in hemodynamic monitoring, giving of drugs and parental alimentation.
They hence stand a high risk of developing chest infections, other cardiopulmonary disorders, misplacement and complications of the chest devices (4, 5, 6, 7, 8, 9, 10, 11).

The chest radiograph is the single most sophisticated radiological imaging modality, which has been able to provide useful information on the above conditions in the ICU set up (9). However in our setup a study to evaluate the role of the chest radiograph in the diagnosis of chest disorders and to monitor progress of treatment in ICU has not been done. There is therefore no base-line data on its role in our set up.

At the conclusion of this study it's hoped that knowledge gained will be used in improvement of the management of patients admitted in Intensive care units in this country.

5. OBJECTIVES

5.1 AIM

To assess the value of the chest radiograph in the management of patients admitted in Kenyatta National Hospital and Nairobi Hospital intensive care.

Units. This information will be useful in:

1 Suggesting ways of improving the quality of chest radiograph examination in ICU.
(2 Suggesting ways of improving the radiological assessment of patients admitted to ICU.

(d) Form a database for value of chest radiograph exam in ICU.

5.2 SPECIFIC OBJECTIVES

(a) To find out the reasons of rejection and non-use of ICU chest films.
(b) To find out the reasons of requesting chest x-ray examination.
(c) To document the radiological findings shown by the chest radiographs.
(d) To find out the level of malposition (misplacement) of the chest devices.
(e) To find out the complications of the chest devices.
(f) To find out whether the chest x-ray findings, assisted in diagnosis or change of treatment given to the patient while in ICU.
(g) To correlate chest clinical presentation and radiological findings.

6. HYPOTHESIS

The chest radiograph has a role in the management of patients admitted in ICU in KHN and Nairobi Hospital

7.0 Materials and methods

7.1 Study design

This will be a prospective cross sectional study over a period of 3 months covering September 1999 to December 1999. Chest radiograph films done in the intensive care unit of Nairobi Hospital and Kenyatta National Hospital will be reviewed on a daily basis for 3 months.

7.2. STUDY POPULATION

The chest radiographs taken in anteposterior, lateral posterio- anterior and others projections of all patients admitted two ICU will be analyzed for their role in management of the admitted patients.

7.3. Sample size

Sample size estimation was based on film rejection (non-useful films) which was taken as 10% based on earlier studies (6). The minimum sample size at 95% confidence level and a 5% level of significance is: -

$$n > \frac{(1.96)^2 \times (0.1)(0.90)}{(0.05)^2}$$

$$= 138$$ Approximately 140 films should be analyzed.

Where 1.96 is the value correspondence to the 95% confidence level and 0.05 is the allowable error.

It is hoped that by the end of this study, over 300 films will be analyzed.

7.4 Study Methodology

The study will be conducted by the principal investigator under guidance of his supervisor from the University of Nairobi, Department of Diagnostic Radiology. While in Nairobi Hospital the investigator will be guided by Dr. Talwar V.K. Consultant Radiologist and former lecturer Department of Diagnostic Radiology, University of Nairobi.
For each film analysed the following information will be recorded (A and B see appendix 1).

1 Demographic data :- i.e. patients No. , Sex, and date & time of examination.

2 Technical data i.e. exposure factors, patient positioning, x-ray projection Who did the examination (years of experience) Level of positive end expiratory pressure if applicable, was film used in the morning round if not what was reason ?.

3 for the radiological findings the following information will be looked for

1. What is the reason for ordering the chest X-ray examination 6 reasons will be given as choices see appendix A.
2. What is the position of the various chest devises see appendix B?
3. What complications are associated with the above devices are present.
4. What radiological findings are present i.e. pathological findings see Appendix B.
5. Is the above abnormality a new finding, a known lesion worsening or improving or not changing?
6. Did the above radiological finding elicit a diagnostic response or a therapeutic response see Appendix B.
7. If diagnostic response which? See Appendix B

8. If therapeutic response which? See Appendix B.

7.5. Eligibility criteria

1 Inclusions

All those chest X-ray films of patients admitted to the two ICU will be analyzed.

2 Exclusions

Chest radiographs done elsewhere e.g.X- Ray Department or done using different portable X-ray machine other than the one chosen for the study.

7.6 The hospitals and the ICU Departments

KNH is a national referral hospital and teaching hospital of the University of Nairobi Medical School. It has an ICU and HDU bed capacity of eighteen.

The Nairobi Hospital is a privately owned non-profit making hospital with an ICU bed capacity of 7 and HDU bed capacity of 7. The Nairobi hospital X-ray Department is an external training centre for radiologists in conjunction with the Department of Diagnostic Radiology University of Nairobi.

7.7 The X-ray Equipment

The X-ray machine to be used in Kenyatta will be Mobile MCD 105 with maximum exposures of kV - 125 and 100 MAS.

The X-ray machine to be used in Nairobi Hospital will be Mobile 300 CP with exposure factors of kV - 150 and MAS 100.

Both machines are of comparable exposure factors.

The processing of the films will be done using the following automatic machines;

Nairobi Hospital Fuji - FPM 6000
KNH Compact 2 - protect processor technology.

7.8 The data collection and analysis will be done by using computer packages and results would be presented in form of graphs and tables.

8. Ethical considerations

Ethics and research are as old as the world and as far back as 104 BC Greek philosophers tried to give a definition of ethics. Anassimander suggested its hypothetical elements "balance, harmony, moderation", while Socrates talked about universal ethics, saying that "all men are alike in good works". Later Spinioza in his masterpiece "Ethics" spoke about the Universality of ethics and said, "it is fundamental in order to know the truth." (61)

In 1340 Geoffrey Chaucer applied ethics in a professional environment and wrote the "Knight Ethical Code." emphasizing the fact that the right laws and rules must guide men towards justice. However the first internationally registered code relating to medical experiments is the Nuremberg code of 1949 whose fundamental principle is the respect for the physical integrity and autonomy of individuals. Through the Helsinki declaration of 1964, the World Medical Association (WMA) adopted the Nuremberg code (62). Subsequently the WMA has revised its recommendation in 1975, 1983 and 1989.

This study recognizes the role of medical ethics in radiological research and will adopt the following ethical considerations.

1 Permission to carry out the study will be sought from the ethical committees of KNH and Nairobi Hospital.

2 All information obtained from the study will be treated with utmost confidentiality and used only for the intended purpose.

3 All questionnaire and entry tables will bear no patient's name or ethnicity; they will be identified by their hospital or unit numbers.

4 the chest X-ray examination will be done only on those patients the attending physician in ICU has requested for.

5 Necessary information found would be communicated to the ICU physician.

LIMITATION OF THE STUDY

1. The patient in ICU has many gadgets attached to his chest and body and sometimes he is in coma. The radiographer finds it difficult to position the patient and to take the film in full inspiration. This will result in a poor quality radiograph.

2. The chest X-ray examination requires a highly trained and committed radiographer to conduct these examinations. It will not be always that such skilled manpower will be available.

3. It will be difficult to get data e.g. Age from patients and in such cases close relatives will be interviewed by the investigator.

4. X-ray machine or developer may breakdown.

10. Budget (Kshs.)

Source of financing

Funds for this study will come from my sponsor.

Cost of the project

1.	Human resource e.g. Assistants	-	30,000.00
2.	Secretarial services and typing proposal	-	30,000.00
3.	Supplies and equipment		
	Films and development	-	14,000.00
	Questionnaires	-	8,000.00
	Computer diskettes	-	2,000.00
	Computer paper	-	6,000.00
4.	Data analysis and computing	-	30,000.00
5.	Binding of final project	-	30,000.00
			150,000.00

RESULTS

A total of 380 films were studied of these, 150 (or 39.5%) were from Kenyatta National Hospital while the remaining 230 (or 60.5%) were from Nairobi Hospital.

Q6 AGES

Fifty - one (20 from KNH and 31 from Nairobi Hospital) had no age recorded. For the remaining the ages were as given in the table below;

TABLE 3: AGE DISTRIBUTION

Age group (Years)	KNH		NAIROBI HOSPITAL		BOTH	
	No.	%	No.	%	No.	%
Under 18	52	40.0	58	29.1	110	33.4
18 and above	78	60.0	141	70.9	219	66.6
Total	130	100.0	199	100	329	100.0

TABLE 1: PRESENTS WHETHER THE TIME WAS RECORDED (Q3)

Reported	KNH		NAIROBI HOSPITAL		ALL	
	No.	%	No.	%	No.	%
Indicated	77	51.3	35	15.2	112	29.5
Not indicated	73	48.7	195	84.8	268	70.5
Total	150	100.0	230	100.0	380	100.0

TABLE 2: SEX DISTRIBUTION (Q4)

SEX	KNH		NAIROBI HOSPITAL		ALL	
	No.	%	No.	%	No.	%
Males	101	71.1	123	56.4	224	62.2
Females	41	28.9	95	43.6	136	37.8
Total	142	100.0	218	100.0	360	100.0

Sex for 20, 8 from KNH and 12 from Nairobi Hospital was not specified.

TABLE 4: PATIENT POSITIONING (Q7)

POSITION	KNH		NAIROBI HOSPITAL		ALL	
Erect	1	0.7	-	-	1	0.3
Semi-erect	-	-	7	3.0	7	1.8
Supine	42	28.0	172	74.8	214	56.3
Lateral	-	-	1	0.4	1	0.3
Others	-	-	35	15.2	35	9.2
Not indicated	107	71.3	15	6.6	122	32.1
Total	150	100.0	230	100.0	380	100.0

TABLE 5: RADIOGRAPHIC PROJECTION (Q8)

PROJECTION	KNH		NAIROBI HOSPITAL		ALL	
	No.	%	No.	%	No.	%
Antero-posterior	44	29.3	95	41.3	139	36.6
Lateral	-	-	1	0.4	1	0.3
Postero-anterior	1	0.7	0	-	1	0.3
Oblique	-	-	-	-	-	-
Others	-	-	7	3.0	7	1.8
Not indicated	105	70.0	127	55.3	232	61.0
Total	150	100.0	230	100.0	380	100.0

TABLE 6: EXPOSURE FACTORS USED (Q9)

EXPOSURE FACTOR	KNH		NAIROBI HOSPITAL		ALL	
	No.	%	No.	%	No.	%
Tube-Output (KVp)						
Indicated	56	37.3	210	91.3	266	70.0
Not indicated	94	62.7	20	8.7	114	30.0
Total	150	100.0	230	100.0	380	100.0
Film Tube Distance						
Indicated	1	0.7	2	0.9	3	0.8
Not Indicated	149	99.3	228	99.1	377	99.2
Total	150	100.0	230	100.0	380	100.0
MAS						
Indicated	56	37.3	210	91.3	266	70.0
Not indicated	94	62.7	20	8.7	114	30.0
Total	150	100.0	230	100.0	380	100.0

MEAN TUBE OUTPUTS AND MAS

	KNH	NAIROBI HOSPITAL
Tube Output (kV)	67	54
MAS	8	5

TABLE 7: PRESENTS AS TO WHO DID THE EXAMINATION (YEARS OF EXPERIENCE) Q10.

YEARS OF EXPERIENCE	KNH		NAIROBI HOSPITAL		ALL	
	No.	%	No.	%	No.	%
0	6	4.1	-	-	6	1.6
1 – 5	24	16.6	10	4.4	34	9.2
Over 5	115	79.3	215	95.6	330	89.2
Total	145	100.0	225	100.0	370	100.0

TABLE 8: PRESENTS WHETHER THE FILM WAS USED IN THE MORNING OR NOT (Q11)

USED	KNH		NAIROBI HOSPITAL		ALL	
	No.	%	No.	%	No.	%
Yes	94	62.7	222	96.9	316	83.4
No	56	37.3	7	3.1	63	16.6
Total	150	100.0	229	100.0	379	100.0

- 1 not specified for Nairobi Hospital.

	KNH		NAIROBI HOSPITAL		BOTH	
	No.	% (n=56)	No.	% (n=7)	No.	% (n=63)
Not done by technician	-	-	-	-	-	-
Not delivered on time	32	57.1	1	14.3	3.3	52.4
Available but not seen on rounds	-	-	-	-	-	-
Technically unacceptable film	28	50.0	7	100.0	35	55.6

Table 8 and 9

Presents whether the film was used in the morning Round or not and what was the reason it was not used.

TABLE 10: TECHNICAL FAULT IN THE FILM (Q13)

FAULT	KNH		NAIROBI HOSPITAL		BOTH	
	No.	% (n=24)	No.	% (n=7)	No.	% (n=31)
Poor Quality	2	8.3	-	-	2	6.5
Poor position	4	16.7	3	42.9	7	22.6
Under-penetrated	2	8.3	2	28.6	4	12.9
Others e.g film, over-penetrated.	16	66.7	2	28.6	18	58.1

TABLE 11: REASONS FOR ORDERING THE EXAMINATION (O14)

	KNH		NAIROBI HOSP.		BOTH	
	No.	% (n=145)	No.	% (n= 226)	No.	% (n=371)
Daily routine as a policy of the ICU	-	-	-	-	-	-
Admission radiograph for initial evaluation of patient as a policy of ICU	4	2.8	20	8.8	24	6.5
Post procedure evaluation	38	26.2	49	21.7	87	6.5
Examination as a result of change of clinical condition of patient	107	73.8	5	2.2	112	23.5
Evaluation of previously known or suspected/routine abnormality	-	-	168	74.3	168	30.2
Routine follow-up examination done other than as a morning routine examination	-	-	2	0.9	2	0.5

TABLE 12(a): POSITION OF CHEST DEVICE (Q15)

CHEST DEVICE	KNH			NAIROBI HOSP.			COMBINED		
	Norn.	Abn.	Total	Norm.	Abn.	Total	Norm.	Abn.	Total
Pulmonary artery caterers	-	-	-	0	0	2	-	-	-
Central Venous Catheters	25	56	81	88	89	177	103	145	146
Thoracostomy tubes	15	12	27	26	4	30	41	16	57
Endotracheal tubes	82	23	165	100	21	121	182	44	226
Nasogastric tubes	83	5	88	124	2	126	107	7	214
Others	34	-	34	69	16	85	103	16	119

TABLE 12(b): SPECIFICATION UNDER 'OTHER' IN TABLE 12 (a)

NORMAL	ABNORMAL (NONE)
Mediastianal Drains (24)	
Mitral Value (7)	
Sternal Sutures (8)	
Cardiac Pacing wires (11)	
Trachestomy (6)	
Stenostomy (4)	
Pacemaker & Catheter (3)	
Right thoracostomy (1)	
Respirator tubules (1)	
Vertriculo-peritoneal shunt (1)	
Oxygen tubules (1)	
Aortic Repair (1)	

( ) Absolute numbers

TABLE 12C: MISPLACEMENT OF DEVICE & SITE

DEVICE	Abnormality/Site	Frequency
Central Venous Catheters	Right artrium	50
	Rt. Auxiliary vein	3
	Inferior Vena Cava	9
	Left Innominate Vein	1
	Left Subclavian	3
	Cup coiled into Junglar	7
	Right Subclavian	2
	Angle in superior venacava	8
	Bronchio- cephalic vein	2
	In lungs	1
Thoracostomy Tubes	Mediastinum	4
	Near the Diaphram	4
	Lungs / Fissure	2
Endotracheal tubes	Bronchus	13
	Near Carina	8
	At the Neck	2
	At Carina	10
Nasogastric Tubes	Left Lung bronchus	1
	Oesophagus	1
	Right lower bronchus	2

ASSOCIATED COMPLICATIONS (Q16)

- In total 343 (133 - KNH, 210 Nairobi Hospital) had no complications.
- Complications associated with 37 films are presented in Tables 13.

TABLE 13:

DEVICE	COMPLICATIONS (ABSOLUTE NUMBERS)
Pulmonary artery Catheters	-
Central Venons Catheters	- Pneumothorax - 8 - Subcutaneous - 2
Thoracostomy Tubes	- Non Drainage -1 - Pneumothorax - 5 - Others (not specified) - 3
Endotracheal tubes	- Pneumothorax - 7 - Lung collapse - 8 - Pneumomedia Stinum - 1
Nasogastric Tubes	- Lung Infection - 2

TABLE 14: RADIOLOGICAL PATHOLOGICAL FINDINGS

	KNH		NAIROBI HOSP.		BOTH	
	No.	% (n=129)	No.	% (n=206)	No.	% (n=335)
Pleural Effusion	19	14.7	44	21.4	63	18.8
Pneumothorax	11	8.5	21	10.2	32	9.6
Pneumonia or lung infection	51	39.5	71	34.5	122	36.4
Atelectasis or reduced lung volume	9	7.0	5	2.4	14	4.2
Cardiomegally	28	21.7	33	16.0	61	18.2
Pulmonary Edema	25	19.4	75	36.4	100	29.9
RDS	3	2.3	24	11.7	27	8.1
Rib Fracture	21	16.3	5	2.4	26	7.8
Mediastinal Shift or enlargement	4	3.1	5	2.4	9	2.7
Others	20	15.5	24	11.7	44	13.1

TABLE 15: PRESENTS WHAT THE ABNORMALITY WAS (Q18).

ABNORMALITY	KNH		NAIROBI HOSP.		BOTH	
	No.	% (n=129)	No.	% (n=206)	No.	% (n=355)
A new finding	57	44.2	62	30.1	119	33.5
A known lesion (increasing)	22	17.1	64	31.1	86	24.2
A known lesion (decreasing)	14	10.9	43	20.9	57	16.1
A known lesion (not changing)	37	28.7	56	27.2	93	26.2
Others	1	0.8	1	0.5	2	0.6

TABLE 16 (a): WHETHER THE FINDINGS ELICITED A DIAGNOSTIC RESPONSE OR NOT AND TYPE OF DIAGNOSTIC RESPONSE.

	KNH		NAIROBI HOSP.		BOTH	
	No.	%	No.	%	No.	%
Diagnostic Response?						
Yes	125	83.3	194	85.5	319	84.6
No	25	16.7	33	14.5	58	15.4
Total	150	100.0	227	100.0	377	100.0
Type of Diagnostic Response	**No.**	**% (n=125)**	**No**	**% (n=194)**	**No.**	**% (n=319)**
Institution of hemodynamic monitoring	3	2.4	6	3.1	9	2.8
Thoracocentesis	-	-	3	1.5	3	0.9
Bronchoscopy	-	-	-	-	-	-
Collection of cultures	15	12.0	18	9.3	33	10.3
Special radiographs	5	4.0	7	3.6	12	3.8
Others	117	94.4	193	99.5	311	97.5

TABLE 16 (b): WHETHER THE FINDINGS ELICITED A THERAPEUTIC RESPONSE.

Therapeutic Response	KNH		NAIROBI HOSP.		BOTH	
	No.	%	No.	%	No.	%
Yes	72	52.0	122	53.7	200	53.1
No	72	48.0	105	46.3	177	46.9
Total	150	100.0	227	100.0	377	100.0

TABLE 17: TYPE OF THERAPEUTIC RESPONSE (Q21)

Therapeutic Response	KNH		NAIROBI HOSP.		BOTH	
	No.	% (n=78)	No.	% (n=122)	No.	% (=200)
Changes in Medication	45	57.7	92	75.4	137	68.5
Changes in respiratory therapy	1	1.3	25	20.5	26	13.0
Changes in Ventilation setting	8	10.3	30	24.6	38	19.0
Placement of thoracostomy tubes	15	19.2	12	9.8	27	13.5
Tracheal inhibation or exhibation	10	12.8	7	5.7	17	8.5
Other therapy changes	27	34.6	43	35.2	70	35.0

Note: Other therapy changes are presented in Table 17 (a).

TABLE 17 (b): OTHER THERAPY CHANGES

Other Changes	Number
Chest physiotherapy	39
Dialysis	11
Ultrafiltration	4
Thoracostomy Tube	4
Hernial Repair	2
Reduce Fluid Intake	2
Oral Suction	2
Discharge from ICU	2
Removal of Cardiac Drains	1
Drainage	1
Diuretics	1
Removal of NG Tube	1
Paralysis or Sedetation	1

- Five (5) were not specified.

Figure1 .Shows malposition of both the endotracheal tube and the right subclavian catheter.The catheter crosses from the right side of the chest andits tip is seen in the left subclavian vein.The endotracheal tube tip is in the neck and stands a high chance of extubation.This was an antero-posterior supine film.

Figure 2.Right subclavian catheter tip lving parallel to the walls of the superior vena cava and a left sided pleural effusion.

Figure 3.Shows right sided hyper-inflation of the lungs,pleural effusion,endotracheal tube in the collect position,catheter is visible in the right auxillary vein and its tip is in the right atrium.

Figure 4.Shows left subclavian venous catheter whose tip is in the right atrium.ECG leads are visible.The details of the upper chest are not clear.This was an AP view. Nolabel or marks are in place to show exposure factors used,position of patient and the time when the examination was done.

Figure 5.Shows aleft subclavian catheter whose tip is in the left bronchocephalic vein projecting in the direction of the superior vena cava.There is a left sided pleural effusion. No labels are in place to show exposure factors,time and patient position.

Figure 6.Shows an AP supine film with the tip of the endotracheal tube in the right main bronchus.There incollapse of the left lung fields with compensatory inflation of the right lung fields.The patient is rotated.

Figure 7.Shows an AP supine film of a child with tetralogy of fallot and severe pneumonia.The exposure factors are indicated.

Figure 8.Shows the endotracheal tube tip at the carina.The right subc is also malpositioned with its tip in the right atrium.

Figure 9.Shows an AP supine chest film,showing a right sided upper lobe pneumonia,ECG leads,endotracheal tube and thepatient is rotated.

Figure 10.Shows an AP supine chest film showing multiple radiodense opacities in the lung, irregular cardiac margin ,pleural effusion and rotationof the patient.The patienthad Ca oesophagus which was resected.This film illustrates the complexity of the chest film in ICU and the need of agood clinical history of the patient.

Table 1 presents whether the time when the portable x-rav examination was done, was recorded.

The time when the examination was done was indicated on 51% of films done in KNH and 15.2% of the films done in the Nairobi Hospital. Time indication allows for proper evaluation of films done in the same day. Progression or regression of disease can therefore be properly documented Milne ENC (9) and Rubin S(10) advocate for such. This is especially so when following up a patient with pulmonary edema.

Table 2

Sex Distribution.

In both centres men were the majority of the patients admitted in ICU, comprising of an overall 62.2% while the females contributed 37.8%. This concurs with work done by Henschke et al (5) who found a male to female ratio of 55.7% to 44.3%.

Table 3: Age Distribution

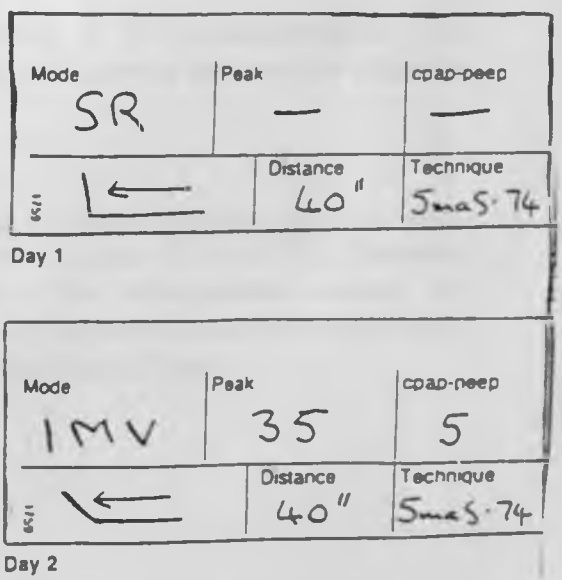
Majority of the patients admitted in KNH ICU, 60% and the Nairobi Hospital ICU, 70% were above 40 years of age. Other worker (5) found a similar pattern with their average age being 61 years. Patients above 40 years with suspected chest disease have been found to have serious radiographic abnormalities in over 50% (6).

As many more elderly people continue to live, many more of them will be admitted in ICU because of organ failure, infections, malignancies or replacement surgeries. Most of the young people seen in this study had under gone cardiac surgery. Two young people stayed in ICU in the entire period of study due to Gullen-Barre Syndrome. This is because they required respiratory support.

Table 4: Patient Positioning

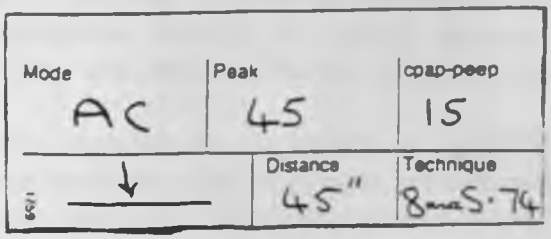
On a large number of films done in KNH 70%, the position of the patient was not indicated. In TNH only 6.6% of the films was the position of the patient not indicated. The importance of this has been discussed and film labelling examples have been suggested by other workers (Milne et al) and Ruben S. et al).

Adhesive labels (3 × 1 in; 7.5 × 2.5 cm) fastened to all CCU films. Top line: Mode, type of ventilation; PEAK, maximum pressure on inspiration; CPAP, continuous positive airways pressure, PEEP, positive end-expiratory pressure. The bottom row: 3 spaces for patient's position (represented by stick figure) and angle of x-ray beam (represented by arrow), distance, and technique. Three labels are shown from one patient on successive days. *Day 1:* SR (spontaneous respiration)—patient is sitting up with horizontal x-ray beam, AFD 40 ft (108 m) and technique 5 maS at 74 kV. *Day 2:* IMV (patient has been put on intermittent mandatory ventilation) at a peak of 35 and PEEP of 5, is now only partially erect; condition is obviously worsening. *Day 3:* AC (assist control ventilation) has been instituted. The PEAK of 45 and PEEP of 15 indicate diminishing lung compliance. Patient now supine with vertical x-ray beam. Slight increase in AFD and maS.



EXAMPLE 1. MILNE ENC.

Examples 1 follow the suggestions given by Milne et al. Adhesive labels 3 x 1 in, 7.5 x 2.5cm are fastened to the cassette in ICU and filled. Later the label is fastened to the ICU films.



Day 3

Example 2 follow the suggestion by Rubin SA et al(64), who suggest use of a bedside sticker with important information to guide the technologist on the exposure factors to use and other information. The same exposure factors and other information should be used in subsequent examinations.

The sticker has the following information:-

Name
Date .....Time ..... a.m. .....p.m.
Mas ..... KUP ..... Distance .....
Supine ..... Semi-upright .....upright .....
Respirator ..... Yes ..... No.....
PEEP ..... Peak Inspiratory Pressure .....
Cassette Type and Screens
Lanex ..... Grid / lanet ..... Regular .....

Milne et al (9) in particular recommends the training of ICU radiographers to give improved quality films and on basic functioning of ventilators so that they can examine patients at peak inspiratory pressures.

Table 5: Radiographic Projection

When data was given on which projection was used, the antero-posterior projection was the commonest. This projection was used in 29.3% in KNH and 41.3% in TNH. However this percentages are expected to increase greatly if the radiographers indicate the projection they have used. When considering the x-ray projection, incomplete data entry was seen in 70% of KNH films and 55.3 of the Nairobi Hospital films.

Bekemeyer et al (6) found the frequency of antero-posterior projection to be 82% of the films done in their study. Lack of information about the projection used did not stop the usage of the film in ICU. However it denies the interpreting radiologist and the ICU physician important information required to correctly evaluate lung volume, flow distribution within the lung, size and configuration of the mediastinum and the heart (9,11,65).
The lateral projection is important in localization of malpositioned catheters and endotracheal tubes. It was rarely done and when done, presents with difficulties because less powerful machines are used in ICU. Thick structures are not well penetrated(65).

Mean Tube Output and MAS

The average KVp used in KNH was 67 and 54 in the Nairobi Hospital. The average MAS used in KNH was 8 while in the Nairobi hospital it was 5. The most minimum of the above parameters should be used to produce a quality film and to avoid unnecessary radiation to the patient, other patients, the ICU staff and the radiographer doing the examination.

The amount of radiation to the patients undergoing chest roentegenography is relatively small compared to other radiographic examination and is relatively benign when the exposure that would cause tissue damage is considered.

For example, a portable chest x-ray examination results in about 44 mR of skin exposure, whereas a barium enema would yield approximately 1,320 mR of skin exposure. Considering that the maximum permissible dose of radiation to the general population per year is 500 mR, the average adult would have to receive 11 Chest examinations to exceed this limit (65). It is very possible to exceed this limit in an ICU set up especially where a policy for a daily routine is actively followed.

Herman et al (66) have stated that the average exposure for non-occupational staff in a four bed ICU was 0.05 mR per week. This translates to an exposure of 2.6 mR per year which is well below the 500 mR limit imposed by National Council of Radiation Protection for the general population.

The radiation to the patient and staff especially the technologist is expected to rise greatly if portable computerised tomography is going to be used in ICU. The technologists will receive 25% of the "as low as reasonably achievable" standard (67) while the patient undergoing chest CT might receive a dose equivalent to 400 chest radiographs (68). Clearly, there is need to vet this investigation by a radiologist before it is done.

Table 8, Table 9 & 10.
Presents whether the film was used in the morning round and if not what was the reason?

A high percentage of films done were used in the morning ICU round in the Nairobi Hospital 96.9% as compared to 62.7% in KNH, providing an overall usage of 83.4%.

A high percentage of films done were not used in the immediate ICU morning rounds in KNH 37.3% as compared to a small percentage 3.1% in the Nairobi Hospital. Overall 16.6% of films done were not used in the immediate morning round.

There were two main reasons for this, first, 52.4% of films not used in the morning ICU round were not delivered on time for the morning round. Secondly, 55.6% of films not used were found to be of technically unacceptable quality.

The following were the main causes of the technical faults observed. 58.1% were over-penetrated, 22.6% were due to poor positioning, 12.9% were under penetrated and 6.5% were poor quality mainly due to motion blur.

These results concur with those of Bekemeyer et al (6) who found a rejection rate of 9% in the films done in their study and the reasons for non-use were; motion blur, improper exposure and inadequate patient positioning.

Greenbaum et al(7) found that out of the 200 film done in a medical ICU 37% were not immediately used on patient management. 14% of their films were not delivered on time to ICU, 6% were of poor quality, 4% were available, but not seen on the rounds and 14% were not done by technician as ordered. They found their system to be 63% efficient in providing the service required.

Table 11: Reasons for Ordering the Examination

Examination as a result of change of clinical condition of the patient accounted for 73.8% of examinations done in KNH compared to 2.2% in TNH. Evaluation of previously known or suspected abnormality accounted for the majority of examinations done, 74.3% in TNH compared to none in KNH. Henschke et al(5) found a routine daily morning chest x-ray examination to be the most common reason for ordering the examination.

Post procedure evaluation accounted for 26.2% of reasons for ordering examinations in KNH and 21.7% in the TNH. Admission radiograph for initial evaluation of patient as a policy of ICU accounted for 2.8% and 8.8% in KNH and the Nairobi Hospital respectively. A daily routine has a policy of the ICU did not cause an examination to be done. This is mainly because both hospitals don't have a rigid policy on this issue. Instead, in an attempt to reduce the costs to the patient in ICU KNH prefers to evaluate

the patients depending on the patient's clinical condition while a form of routine is adopted in the Nairobi Hospital.

However other studies suggest that a daily routine morning examination is the commonest reason for ordering ICU portable chest x-ray examination (5,6,7,9). For example the table below shows the findings of Henschke et al(5).

NUMBER OF ICU RADIOGRAPHIC EXAMINATION BY CATEGORY		
CATEGORY	**NUMBER**	**%**
Admission	48	3.6%
Routine Morning	716	52.8%
Routine follow-up	18	1.3%
Post Procedure	305	22.5%
Change in Clinical Condition	124	9.2%
Evaluate an existing abnormality	145	10.6%
Total	1354	100%

TABLE 12 a,b,c AND TABLE 13 POSITION OF CHEST DEVISE AND ASSOCIATED ABNORMALITIES.

A total of 248 films showed central venous catheters in use. One hundred and forty five (58.47%) of them were misplaced. The commonest site of misplacement was the right atrium seen 20.16% of case, inferior Vena Cava 3.68%, angled in superior vena cava 3.23% and coiled up into the jugular in 2.82%. A rare, but potentially dangerous position of the CVC was seen with the tip in the lung.

Central Venous catheters were associated with the following complications; pneumothorax and subcutaneous emphysema in which portable chest radiographs were used to diagnose and monitor progress of management of the patient.

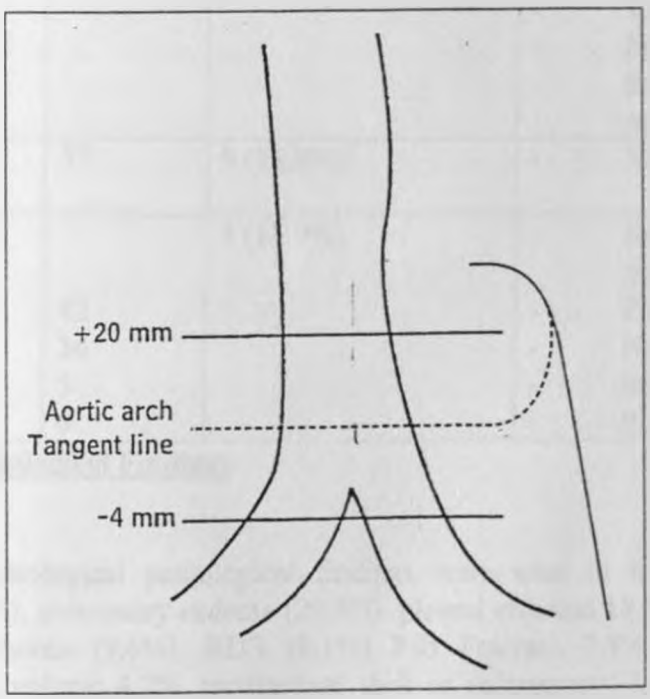
A total of 57 films showed thoracostomy tubes and sixteen of them (28.07%) were abnormally placed. The abnormal positions observed include, tubes close to the mediastinum, close to the diaphragm and in the fissure. The complications that arose with usage of chest tubes include pnuemothorax, emphysema and non-drainage.

A total of 226 films showed endotracheal tubes in place out of which forty four (19.46%) were in abnormal position. 13 were in the main bronchus, 8 were near the carina, 10 were at the carina and two were at the neck. The complications associated with usage of endotracheal tubes were lung collapse (8 cases), pnumothorax (7 cases), pneumomediatrinum (one case).

Nasogastric tubes were seen in 214 films and revealed abnormal positions in 3.38% of the times. The noted abnormal positions include 2 cases when the nasogastric tube was in

the bronchus. Twice the tubes were coiled up in the stomach. Stuart A. Groskin (69) lists intracranial perforation as a complication of NG tubes.

The proper position of an endotracheal tube is 3.0 - 7.0 cm above the carina when the head and neck are in neutral position Goodman et al (70). Other studies have shown comparable rates of Endotracheal tube malposition. Approximately 10% of all routine intubations and as many as 28% of emergence intubations result in malposition, which can often be detected on chest radiographs(71,72).
Poor visualisation of the carina in under exposed patients hinders accurate assessment of the endotracheal tube position(73).These workers have described the target line of the aortic arch on a portable chest radiograph by localising the aortic knob, traced a convex line in a clockwise direction around its left lateral contour and extended a tangential line across the mediastinum . Using the tangent of the aortic arch as a point of reference, any endotracheal positioned 3.4 - 5.0 cm above this line will be in a safe and proper position 95% of the times.



-Diagram shows that 95% of all drawn tangent lines of aortic arch fall between 20 mm above and 4 mm below carina. Any endotracheal tube 3.4–5.0 cm above drawn tangent line falls within acceptable range of proper endotracheal tube placement (5.0 ± 2.0 cm from carina).

Henschke et al(5) found a lower incidence of misplacement of chest devices and their complications. The table below summarises their findings.

Radiographically Evident Complications of Procedures.

Procedure	Number	Number (%) with Abnormal tube or Catheter Placement	Other Complications (number).
Pulmonary Artery Catheter	101	24 (23.8%)	- Vascular abnormality (1) - Pleural Effusion (1) - Mediastinal abnormality (1) - Pneumothorax (3)
Tube thoracostomy	60	4(6.7%)	- Mediastinal abnormality (1) - Volume Loss (1) - Infiltrate (1) - Substaneous emphysima (3)
Endotracheal Incubation	57	9 (15.8%)	- None
Central Venous		5 (11.9%)	- Extrathoracic abnormality (1)
Catheterisation	42		- Pneumothorax (2)
Thoracocentesis	36		- None
Bronchoscopy	5		- Infiltrate
Surgery / others	4		- Pleural effusion

Radiological Pathological Findings
Table 14

The following radiological pathological findings were seen in the films analysed. Pneumonia (36.4%), pulmonary oedema (29.9%), pleural effusion 18.8%, Cardiomegally (18.2%) pneumothorax (9.6%), RDS (8.1%) Rib Fracture 7.8%, atelectoasis and reduction of lung volume 4.2%, mediastinal shift or enlargement in 2.7% and others 13.1%. Comparable cardiopulmonary findings, some of which increased during stay in ICU by 55- 70 % were found by Henschke et al (5) whose findings are summarised in a table form below.

Cardiopulmonary findings at admission (Henskche et al).

Finding	Percentage	No.
Congestive heart failure	30.7%	43
Pleural effusion	24.3%	34
Collapse – partial or total	19.2%	27
Focal Infiltrate	11.4%	16
Diffuse Infiltrate	10.7%	15
Pneumothorax	1.4%	2
At least one abnormal finding	40.7%	57

The use of the chest radiograph has been shown to be less accurate in detecting some of the above pathologies. It has been shown that its 52% accurate in detecting pneumonia in the ICU set-up Winer-Muram et al (74). Earlier studies using fixed computerised tomography of the chest have shown improvement in diagnosis of the above pathologies. (75). Recently Charles S. White et al (75) have shown that portable computerised tomography by using Tomoscan; Philips Medical Systems, Shelton CT, provided additional information to that available on chest radiography, particularly in regard to disease of the pleural space and chest wall. They further found out that the greater sensitivity of CT for delineating intrathoracic disease revealed findings that changed treatment decisions in 25% of patients. However caution should be taken against unvetted use of CT for it gives excess radiation to the patient, technologist and ICU staff (68,79).

Table 15: Presents Whatever the Abnormality Detected was New, Worsening, Regressing or not Changing.

Overall 57.7% of the films showed a new lesion or an old lesion which was worsening. Only 16% of the films showed a lesion improving and 26.2 % showed a lesion which was not changing status. These information helped the attending physician to make appropriate adjustments and serve to defend the need for a daily routine portable x-ray examination in our set up. A study done by Henschke et al (5) found that a new abnormal cardiopulmonary finding or worsening of existing condition varied between 30 - 60%.

Table 16 (a) Presents whether the findings elicited a diagnostic repsonse and what type of diagnostic response.

The radiographic findings elicited a diagnostic response in an overall 85%. The clinicians wanted to know about the clinical state of the patient or the cause of the lesion e.g. Cardio-pulmonary abnormality. Most other investigations were requested for as a result of clinical findings. The most requested form of investigation as a result of an abnormal radiographic finding was another chest x-ray examination. Other investigations requested for include, specimen collection for culture and sensitivity, Echocardiography and CT Scans.

Table 16 (b): Whether the Findings Elicited a Therapeutic Response and Table 17 a&b what types of responses.

About 53.1% of films showed the need to alter or improve the treatment options to the patient. Overall changes in medication were done as a result of 68.5% of the 200 films analysed. Other therapeutic responses include chest physiotherapy, changes in respiratory settings, changes in ventilatory settings, placement of thoracostomy tubes, tracheal incubation or extubation and other therapy changes e.g. Utrafiltration and Dialysis.

CONCLUSION

1. Important information about the patient age, sex, position during examination, x-ray projection used, KVp and MAS and time of examination should be attached to the film and the patients bed. This will help the ICU technologist to use know exposures which will give a quality examination. The information stuck on the film, will help the radiologist interpreting the film to give a better evaluation especially on the mediastinum, heart size and lung volume.
2. The following observation on the technical aspects of ICU radiography were made:-
   a) A higher percentage of examination were done by less experienced radiographers.
   b) A significant percentage of films were not used in the morning round.
   c) The main reasons for non-use were, delay in delivery of films and technical faults e.g exposure and under exposure.

The following recommendations are made to counter above effects:-

a) Create a special unit of radiographers to be called respiratory technologists to provide service in ICU, neonatal Unit and other portables. This will ease the work load of the casualty radiographer and hence improve quality of service.
b) In service courses to be done in two parts, part 1 to be conducted by ICU radiologist and aimed at convincing the technologists of their personal importance in contributing to the diagnosis of the critically ill and hence saving life.
   Part II should be conducted by a senior respiratory technologist who will teach other radiographers how positive pressure ventilators work and where to look for data they need to fill the film label and take their films at maximum inspiratory pressures. This format has been found to work well by other workers (Milne et al).
c) Encourage use of digital radiography which has less incidence of under or over exposed films.
d). A porter should deliver films to KNH ICU. This is the case in The Nairobi Hospital.

3. **Observation & Recommendation on Table 11**

Observation; A policy guideline on daily portable chest x-ray examination especially in the mornings before the ICU Round is lacking in our hospitals. A policy guideline should be discussed and introduced. This is supported by the findings from the work done by Bekemeyer et al (6) and Janower et al (8) who showed that a daily routine morning radiographic examination, demonstrated at least one clinically unsuspected new finding, worsening or a chest devise malposition in 45% of the examinations. In this study a higher percentage was found.

4. Observation and Recommendation.

Concerning chest devices, it was observed that the attending physician did not adjust catheter position in the atrium or those pointing at the lateral wall of the superior vena cava. This was despite the radiologist report. Its recommended that a communication be made to the attending physician that catheters in this positions will not only cause arrthymias but also cause perforation of the walls of the heart during contraction and perforation of superior vena cava during injection of drugs.

Endotracheal tube positions near the carina and at the carina should be immediately adjusted to avoid selective main bronchus intubation and lead to lung collapse. The right position of this devise is 3.0 - 7 cm above the carina. And in case of under exposed films as was observed in this study, the endotracheal tube position, should be assessed by use of the tangent line of the arch of the aorta. This will avoid unnecessary repeat examinations, limit patient expenses and reduce radiation exposure to the patient.

The finding of the Nasogastric tube in the lower bronchus and the associated complications of the thoracostomy tubes, emphasise once again the need for a post procedure portable X-ray examination and a daily routine examination.

5. Accuracy of portable chest x-ray examination has been found to be 52% in diagnosis of pneumonia. Other imaging modalities especially fixed CT and portable CT give a higher yield in the diagnosis of pneumonia and pleural disorders and are recommended. However measures to protect against excess radiation to the patient, ICU staff and technologists should be incorporated.

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APPENDIX A

QUESTIONNAIRE

PART A: TO BE FILLED BY TECHNICIAN

1. HOSPITAL
2. DATE .....
3. TIME.....
4. PATIENT NO.
5. SEX.....
6. AGE.....
7. PATIENT POSITIONING

1) Erect 2) Semi-erect 3) Supine 4) Lateral 5) Others

8. X-ray projection
   1) Antero posterior 2) Lateral 3) Postero-anterior 4) Oblique
   5) Others

9. Exposure factors used.
   1) Tube output (KV).....
   2) Film tube distance.....
   3) MAS.....

10. Who did the exam (years of experience after training)
    1) 0 (Student radiographer)
    2) 1 - 5year
    3) Above 5 years

11. Was the film used in the morning round for patient management
    1 Yes 2) No go to to (12).

12. If not what was the reason given
    1 Not done by technician
    2) No delivered on time to KU
    3) Available but not seen on rounds
    4) Technically unacceptable film - if so go to (13).

13. What was the technical fault in the film?
    1 poor quality (motion blur)
    2 Poor position
    3 Under penetrated
    4 Others eg.over-penetration.

14. What was the reason for ordering this examination?

1 Daily routine as a policy of the ICU
2 Admission radiograph for initial evaluation of patient as a policy of the unit.
3 Post procedure evaluation (All invasive procedure to the central vasculature, airway, thoracic cavity)
4 Examination as a result of change of clinical condition of patient as supported by symptoms, physical examination or laboratory findings.
5 Evaluation of previously known or suspected abnormality.
6 Routine follow up examination done other than as a morning routine examination.

PART B

APPENDIX

		NORMAL	ABNORMAL
1	**Pulmonary artery catheters**		
2	Central venous catheters		
3	Thoracostomy tubes		
4	Endotracheal tubes		
5	Nasogastric tubes		
6	Others		

16. For each of the devices indicate the associated complications if present.

1	Pulmonary artery catheters	(1)	(2)		(3)	
2	Central venous catheters	(1)		(2)		(3)
3	Thoracostomy tubes	(1)	(2)		(3)	
4	Endotracheal tubes	(1)	(2)		(3)	
5	Nasogastric tubes	(1)	(2)		(3)	
6	Others					

17. From the chest radiograph what radiological pathological findings are present?

1 Plural effusion
2 Pneumothorax
3 Pneumonia or long infection
4 Atelectasis or reduced lung volume
5. Cardiomegally
6 Pulmonary edema
7 ARDS

8) Rib fracture
9) Midiastinal shift or enlargement

18. Was the above abnormality?

1 A new finding (not present in the last two previous films)
2 A known lesion which is increasing
3 A known lesion which is decreasing
4 A known lesion not changing
5 Others.

19. Did the above finding elicit ?

1) a diagnostic response Yes/No _____
If yes go to 20.
2) a therapeutic response Yes/No _____
If yes go to 21.

20. If so what diagnostic response?

1 Institution of hemodynamic monitoring
2 Thoracocentesis
3 Bronchoscopy
4 Collection of cultures
5 Special radiographs
6 Others eg.Another chest x-ray.

21. If so what therapeautic response?

1 Changes in medication
2 Changes in respiratory therapy
3 Changes in ventilation setting
4 Placement of thoracostomy tubes
5 Tracheal intubation or extubation
6 Other therapy changes

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