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Review article

The Role of Chest X-Ray in Intensive Care Unit

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Abstract

Purpose: Chest X-rays (CXRs) are the most common radiological tests performed in the intensive care unit (ICU). The purpose of the current study was to investigate the relationship between the performance CRX in ICU and the patient's confirmed pathologic finding. ***Methods:*** This retrospective study was evaluated 50 ICU chest X-rays were retrieved from the Picture Archiving and Communication System (PACS) of the different Saudi Hospitals in Al-Medina (February - April 2017). Frequency Distribution, Ratio and Linear Regression were used for statistical analysis. ***Result:*** This study demonstrated that based on analyzing the data, 92% of chest X-ray requests were used among 50 ICU patients to confirm the diagnosis, and a significant relationship was found between the use of chest X-rays between the ICU patients and the patient's confirmed pathologic finding which may mean that chest X-ray had a great role in confirming the disease or its complications. There has been a recommendation to perform daily CRX for patients with severe cardiopulmonary disease or receiving mechanical ventilation, as well as immediate CXR imaging for all patients who have had endotracheal tubes, feeding tubes, vascular catheters, and chest tubes. The most effective principle of radiation protection is distance, when performing an X-ray, the technologist must be at least six feet (1.5 to 2 m) from the radiation source. If the technician needs to be close to the radiation source, wearable lead shields and thyroid collars can protect the radiation-sensitive areas of the body. ***Conclusion:*** The chest X-ray of ICU patients was an important diagnostic tool that would affect patient management; however, it may also be a tool that can lead to serious complications for patient. A small sample size was used in this investigation that results in unconfirmed information, the future research using a large sample size is needed to carry out a more reliable and valid information.

Keywords: ***X-ray, chest, intensive care unit, radiology, pathology.***

Introduction

Background: Radiology is a specialty that uses medical imaging to diagnose and treat diseases seen within the body. Diagnostic radiography involves the use of both ionizing radiation and non-ionizing radiation to create images for medical diagnoses. A variety of imaging techniques such as X-ray radiography, ultrasound, computed tomography (CT), nuclear medicine including positron emission tomography (PET), and magnetic resonance imaging (MRI) are used to diagnose and/or treat diseases.

Mobility in Medical Imaging has become a focal point for healthcare as technology continues to improve the quality of patient care and drive down costs. The use of mobile x-ray equipment in the study of trauma and mobile radiography requires an understanding of the functions and operations of the equipment being used. Trauma radiography may be performed with a conventional overhead tube and x-ray table or with mobile (portable) units that are brought to the Emergency Department (ED), the patient's bedside, or the Operating Room (OR) for surgical procedures.

The ability to utilize diagnostic radiography and receive instant results has left imaging specialists wanting more. Technology offered Battery-Driven, Battery-Operated, Mobile X-Ray Units which are powered by 10 to 16 rechargeable, sealed, lead acid–type 12-volt batteries connected in series. The self-propelled systems of these units are also battery-powered and have variable travel speeds up to an average walking speed of 2.5 to 3 mph with a maximum incline of 7°. They have a driving range of up to 10 miles on a level surface after a full charge. These units are driven and maneuvered by dual-drive motors that operate the two drive wheels. They also have a lower speed forward and reverse for maneuvering in close quarters. Parking brakes are automatically engaged when the control levers are not in use; this is known as dead man's control. If the technologist releases the control levers, the mobile unit will come to an abrupt halt. The unit can be plugged in for recharging when it is not being used and can be recharged at 110 or 220 V. The parking brakes are also used during charging. With 110-V, 5-amp outlets, the charging time is about 8 hours when fully discharged.

The acquisition of medical images is usually carried out by the Radiographer or Radiologic Technologist. Depending on location, the Diagnostic Radiologist, or Reporting Radiographer, then interprets or "reads" the images and produces a report of their findings and impression or diagnosis. This report is then transmitted to the Clinician who requested the imaging, either routinely or emergently. Imaging exams are stored digitally in the picture archiving and communication system (PACS) where they can be viewed by all members of the healthcare team within the same health system and compared later on with future imaging exams.

One of the most extensive users of radiologic services in a healthcare facility is the intensive care unit (ICU). An ICU also known as an intensive therapy unit or intensive treatment unit (ITU) or critical care unit (CCU) is a special department of a hospital or health care facility that provides intensive treatment medicine.

The use of radiation in intensive care requires special attention because Intensive care units cater to patients with severe and life-threatening illnesses and injuries, which require constant, close monitoring and support from specialist equipment and medications in order to ensure normal bodily functions. They are staffed by highly trained doctors and nurses who specialize in caring for critically ill patients. ICUs are also distinguished from normal hospital wards by a higher staff-to-patient ratio and access to advanced medical resources and equipment that is not routinely available elsewhere. Common conditions that are treated within ICUs include ARDS, trauma, multiple organ failure and sepsis.

As chest x-ray is the most frequent radiological tests performed in ICU, this study aimed to evaluate the performance of this method as a diagnostic tool for chest pathologies. Moreover, it determined the exposure factors of the mobile machine and figure out the best way for radiographic imaging. Procedures and ways to protect the patients and staff accompanying radiation dose employed by the hospital was also determined.

Objective

General objective: This study aimed to describe the use of chest X-ray among patients in Intensive Care Units to impact patient care.

Specific objective

More specifically, it sought to answer the following:

a. Describe the demographic profile of the subjects as to gender and age.
b. Evaluate the common indication of chest x-ray need in ICU.
c. Determine significant association between the use of chest X-ray and confirmed diagnosis of patient’s condition.
d. Define technical considerations and exposure factor to get quality radiographic imaging.
e. Describe the practices employed by the hospital to protect patients and staff in the ICU department from the excess dosage of radiation.

Importance of the Study: Intensive care department is one of the most important sections in the hospital and require special care because patients are often in a dangerous situation and need a special attention. As radiographic image plays an important and effective role in helping doctors and consultants in the care of ICU patients, the result of this research will provide data on the utility of chest x-ray examinations required in the intensive care unit by using mobile machine, so the photographer can get a complete knowledge of radiation requirements in this section and the best imaging performance.

Literature Review

Anatomy and physiology of chest and lungs

The chest, or thorax, is a cage of bone, cartilage, and muscle capable of movement as the lungs expand. It consists anteriorly of the sternum, manubrium, xiphoid process, and costal cartilages; laterally, of the 12 pairs of ribs; and posteriorly, of the 12 thoracic vertebrae.

All the ribs are connected to the thoracic vertebrae; the upper seven are attached anteriorly to the sternum by the costal cartilages, and ribs 8, 9, and 10 joins with the costal cartilages just above them. Ribs 11 and 12, sometimes referred to as floating ribs, attach posteriorly but not anteriorly. The lateral diameter of the chest generally exceeds the AP diameter in adults.

The primary muscles of respiration are the diaphragm and the intercostal muscles. The diaphragm, the dominant muscle, contracts and moves downward during inspiration, lowering the abdominal contents to increase the intrathoracic space. The external intercostal muscles increase the AP chest diameter during inspiration, and the internal intercostals decrease the lateral diameter during expiration. The sternocleidomastoid and trapezius muscles may also contribute to respiratory movements. These “accessory” muscles are used during exercise or when there is pulmonary compromise.

The interior of the chest is divided into three major spaces: the right and left pleural cavities and the mediastinum. The mediastinum, situated between the lungs, contains all of the thoracic viscera except the lungs. The pleural cavities are lined with the parietal and visceral pleurae, serous membranes that enclose the lungs. The spongy and highly elastic lungs are paired but not symmetric, the right having three lobes and the left having two.

The left upper lobe has an inferior tongue like projection, the lingula, which is a counterpart of the right middle lobe. Each lung has a major fissure the oblique that divides the upper and lower portions. In addition, a lesser horizontal fissure divides the upper portion of the right lung into the upper and middle lobes at the level of the fifth rib in the axilla and the fourth rib anteriorly. Each lobe consists of blood vessels, lymphatics, nerves, and an alveolar duct connecting with the alveoli (as many as 300 million in an adult).

The entire lung parenchyma is shaped by an elastic subpleural tissue that limits its expansion. Each lung is conical; the apex is rounded and extends anteriorly about 4 cm above the first rib into the base of the neck in adults. Posteriorly, the apexes of the lungs rise to about the level of T1. The lower borders descend on deep inspiration to about T12 and rise on forced expiration to about T9. The base of each lung is broad and concave, resting on the convex surface of the diaphragm. The medial surfaces of the lung are to some extent concave, providing a cradle for the heart.

The tracheobronchial tree is a tubular system that provides a pathway along which air is filtered, humidified, and warmed as it moves from the upper airway to the alveoli. The trachea is 10 to 11 cm long and about 2 cm in diameter. It lies anterior to the esophagus and posterior to the isthmus of the thyroid. The trachea divides into the right and left main bronchi at about the level of T4 or T5 and just below the manubriosternal joint. The right bronchus is wider, shorter, and more vertically placed than the left bronchus (and therefore more susceptible to aspiration of foreign bodies).

The main bronchi are divided into three branches on the right and two on the left, each branch supplying one lobe of the lungs. The branches then begin to subdivide into terminal bronchioles and ultimately into respiratory bronchioles. The bronchial arteries branch from the anterior thoracic aorta and the intercostal arteries, supplying blood to the lung parenchyma and stroma.

Mobile X-Ray Equipment

A study of trauma and mobile radiography requires an understanding of the functions and operations of the equipment being used. Trauma radiography may be performed with a conventional overhead tube and x-ray table or with mobile (portable) units that are brought to the ED, the patient's bedside, or the OR for surgical procedures.

Types of Mobile X-Ray Systems: Major advances have been made in mobile radiographic and fluoroscopic equipment. Examples of general types commonly used are:

Battery-Driven, Battery-Operated, Mobile X-Ray Units

These systems are powered by 10 to 16 rechargeable, sealed, lead acid–type 12-volt batteries connected in series. The self-propelled systems of these units are also battery-powered and have variable travel speeds up to an average walking speed of 2.5 to 3 mph with a maximum incline of 7°. They have a driving range of up to 10 miles on a level surface after a full charge. These units are driven and maneuvered by dual-drive motors that operate the two drive wheels. They also have a lower speed forward and reverse for maneuvering in close quarters. Parking brakes are automatically engaged when the control levers are not in use; this is known as dead man's control. If the technologist releases the control levers, the mobile unit will come to an abrupt halt. The unit can be plugged in for recharging when it is not being used and can be recharged at 110 or 220 V. The parking brakes are also used during charging. With 110-V, 5-amp outlets, the charging time is about 8 hours when fully discharged.

Standard Power Source, Capacitor-Discharge, Non-Motor-Driven Units

A second type of mobile x-ray unit without battery power is now available. These models are much lighter in weight and usually are not motor-driven. They operate with a 110-V, 15-amp power source or a 220-V, 10-amp power source. These units generally incorporate a capacitor discharge system, which stores electrical charges when plugged in and then discharges this electrical energy across the x-ray tube when exposure is initiated. This increases the electrical power (voltage) from the standard 110- or 220-V power source. Other systems offer a dual power source with both battery power and plug-in electrical power for increased output. These generally also have a battery-assisted motor drive for easier transporting. The controls on these units may include some type of optional programmed memory system that is based on anatomic parts, or they may have operator-selected kV and mas technique controls.

Note: These are only two examples of available mobile systems. Other manufacturers offer various modifications, features, and options.

Mobile C-Arm Digital Fluoroscopy Systems

Another type of mobile imaging equipment is the C-arm mobile fluoroscopy system. The term C-arm is descriptive of a basic design of a mobile fluoroscopy unit, which forms a large C shape with the x-ray tube located at one end of the C-arm and the image intensifier tower at the other. Familiarity with the C-arm, monitor, and image controls is essential for the technologist who is performing ER or OR procedures, during which these systems are most commonly used. One also must become familiar with the various types of special beds or carts used with the C-arm. For example, a surgical bed used for operative cholangiography may not accommodate the C-arm x-ray tube under the table in the abdominal area because of the base supports unless the patient's head is placed at the correct end of the bed or cart.

Related Studies

1.1 Accuracy and Efficacy of Chest Radiography in the Intensive Care Unit

Cardiopulmonary Abnormalities

Atelectasis: Atelectasis is often associated with general anesthesia and is most often seen after thoracic or upper abdominal surgery, particularly in patients with preexisting lung disease, in smokers, and in obese and elderly patients, although it can be observed in any patient in the ICU.

Pneumonia: The diagnosis of pneumonia is often made on the basis of findings such as fever and leukocytosis as well as presence of new or progressive pulmonary opacification on chest films. These radiographic findings may not be reliable in the ICU, particularly in patients who are immunocompromised or who are receiving anti-inflammatory medication

Pulmonary Edema: The usual indicators of CHF-pulmonary venous engorgement, signs of interstitial or air-space edema, and enlargement of the cardiac silhouette-may be unreliable on a portable chest radiography. Pulmonary vascular redistribution to the upper zones is a normal finding in the supine patient. Pulmonary edema may also have an atypical distribution, because of the effects of gravity in the bedridden patient and because edema does not accumulate in the under perfused areas that are found in patients with COPD or pulmonary embolism.

Pulmonary Embolic Disease: Pulmonary embolism (PE) is usually a complication of surgery or prolonged bedrest and is a difficult clinical and radiologic diagnosis to make. Findings may include peripheral, wedge-shaped pleural based opacities, atelectasis, elevation of the diaphragm, pleural effusion, and focal oligemia.

Pleural Effusions: Pleural effusions, like atelectasis, are common in the postsurgical patient. Pleural effusions have been found in 60% of patients after upper abdominal surgery and in 34% after lower abdominal surgery. Patients who have undergone thoracotomy or median sternotomy also frequently develop pleural effusions

Abnormal Air Collections: Most patients in the ICU are intubated with either an endotracheal or tracheostomy tube. Many receive positive end-expiratory pressure ventilation (PEEP). Five percent to 15% of patients receiving PEEP develop complications pneumothorax, pneumomediastinum, subcutaneous emphysema, or other extra-alveolar air collections

1.2 Monitoring and Therapeutic Devices

Endotracheal Tubes: Treatment for respiratory failure includes establishing an airway, administering oxygen, and maintaining adequate alveolar ventilation, usually with volume-cycled positive-pressure mechanical ventilators. Mechanical ventilation requires placement of a cuffed endotracheal tube (ETT) or tracheostomy tube of appropriate size to ensure an adequate airway.

Tracheostomy Tubes: If long-term intubation is required, tracheostomy tubes need to be placed to avoid the long-term complications of the ETT. An advantage of the tracheostomy tube is that neck flexion and extension will not affect its position.

Central Venous Pressure Monitors: In addition to ventilatory assistance, many ICU patients require ongoing monitoring of the circulatory blood volume using central venous pressure (CVP) monitoring.

Thoracostomy Tubes: Closed-thoracostomy tubes are used to evacuate pneumothoraxes and to drain pleural effusions, empyema's, and hydrothoraxes or mesothoraces. After insertion or manipulation of tubes, chest films should be taken to verify their position

Nasogastric Tubes: Nasogastric (NG) tubes usually are inserted for gastric decompression. The most distal side hole (usually within 10 cm of the tip) should be in the stomach so that applied suction will not cause obstruction of the esophagus.

In summary, the chest radiograph has only moderate accuracy in visualizing opacification caused by cardiopulmonary abnormalities and may be quite nonspecific as to etiology, whereas it has high diagnostic accuracy for detecting malpositioning of tubes and lines. While focal parenchymal abnormalities are usually Visualized on chest radiographs, identification of concomitant abnormalities when ARDS or PE already exist is more difficult. Atelectasis, aspiration, pneumonia, pulmonary hemorrhage, pulmonary thromboembolism, atypical cardiogenic edema, asymmetric ARDS, and neoplasms may be indistinguishable. Repeat chest radiographs and different Views may be helpful, as the progression and time course of various etiologies can be quite different. On the other hand, Winer-Muram et al48 found that. review of prior radiographs and clinical data did not improve the diagnostic accuracy for either ARDS or pneumonia. Pleural effusions may even be difficult to distinguish from parenchymal processes, particularly when the patient is in the supine position. Additional views with the patient in a different position-semi-erect, decubitus, or cross-table lateral-may are of assistance. In most cases, pneumothorax is readily detected. Additional studies such as the decubitus View occasionally may be necessary for further evaluation when there is uncertainty about the findings. Subcutaneous air is readily visualized radiographically. Pneumomediastinum and interstitial pulmonary emphysema may be more difficult to see. It is well known that CT allows visualization of much smaller abnormal air collections than radiography.

Materials used to collect data: Chest X-ray information of the ICU patients were retrieved from the Picture Archiving and Communication System (PACS) of the select hospitals in Al-Medina, KSA. These information were then transferred to the questionnaire (instrument) designed by the researchers which contain data needed to achieve the objectives of the study. Only ICU patients who underwent chest X-ray using Analog mobile radiography unit (Ares MB Ergonomic Mobile X-ray Unit) and Digital mobile radiography unit (Digital Mobile Radiography unit Aero DR X30) were retrieved by the researchers.

Study Design: Retrospective research design was utilized in the study to retrieved data of patients subjected for chest X-ray using Analog mobile radiography unit (Ares MB Ergonomic Mobile X-ray Unit) and Digital mobile radiography unit (Digital Mobile Radiography unit Aero DR X30) while admitted in the ICU. This is the most appropriate research design to establish how chest X-ray helped in confirming diagnosis to patients who need special care and attention and how the information impact to patient management.

Study Population: ICU patients requested to undergo chest X-ray using either Analog or Digital mobile radiography unit to confirm diagnosis were the subjects of this study.

Sampling Design and Sample Size: This study utilized purposive sampling design specifically critical case sampling where the researchers collected cases sharing the same characteristics, that is, being an ICU patient who underwent chest X-ray to provide the needful information in achieving the objectives of the study. A total of 50 ICU cases were retrieved from the Picture Archiving and Communication System (PACS) of the select hospitals.

Place and Duration of the Study: Select ICU patients were from the different Saudi Hospitals in Al-Medina admitted in months of February to April 2017.

Variables of the study: This study investigated if there is a significant association between the use of chest X-ray (independent variable) among ICU patients and confirmed diagnosis of patients' condition (dependent variable). Other variables (nominal) described include: gender, age, condition of the patient, technical consideration and exposure factor in using radiographic unit, patient position, projection, and radiation protection for the patient and hospital staff.

Methods of Data Analysis

Frequency Distribution was used to describe the number of instances in which a variable takes each of its possible values in the distribution. Data is needed to calculate the ratio (proportion) of the variable against the whole population.

Ratio was used to determine the value of the occurrences of each variable to the whole population. It is reported as percent (%) in this study.

Linear Regression Analysis was used to determine the significant association between the use of chest x-ray and confirmed diagnosis among ICU patients.

Results

Table 1 shows that the subjects purposively chosen to be part of this study are distributed across all age brackets with patients belonging to 61-70 years old constituting 26%. Of the study population, 40 (80%) are males while 10 (20%) are females.

Table 1: Demographic profile of subjects admitted in ICU, February – April 2017 (n=50)

Age Bracket Years old	Male	Female	Total / (%)
>40	5	2	7 (14)
41-50	6	4	10 (20)
51-60	8	-	8 (16)
61-70	11	2	13 (26)
71-80	4	1	5 (10)
81-90	5	1	6 (12)
91-100	1	-	1 (2)
Total	**40 (80%)**	**10 (20%)**	**50** (100)

Use of Chest X-ray in ICU

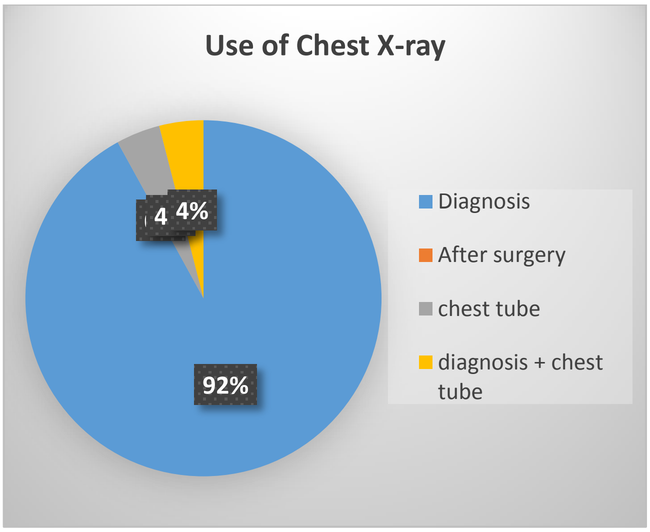

Figure 1: Purpose of Chest X-ray Request in ICU

Figure 1 show that 92% of the request for chest X-ray among the 50 ICU patients was used to confirm diagnosis, while 4% is equally shared for the placement of chest tube and diagnosis plus chest tube placement.

Chest X-ray Technical Consideration

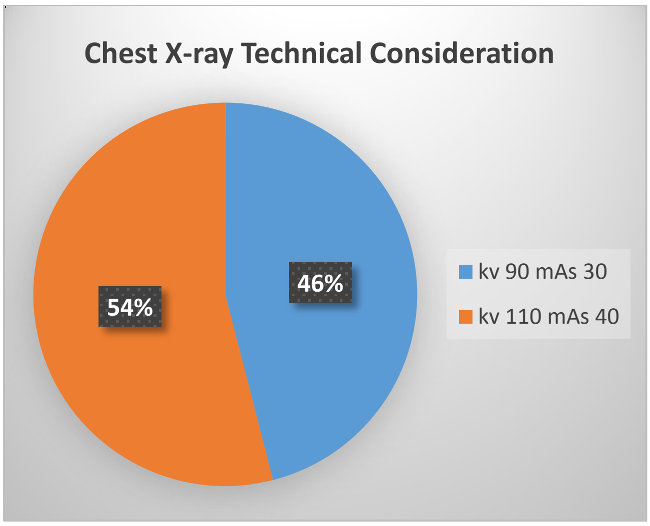

Figure 2: Chest X-ray Technical Consideration

Figure 2 shows that 54% of the requested chest X-rays among the ICU patients was set at 110 kilovolt which may mean that the machine was set at a lower contrast to have better radiographic image of the patient's condition. Meanwhile, 46% of the patients was set at 90 kilovolts.

Patient Position and Projection

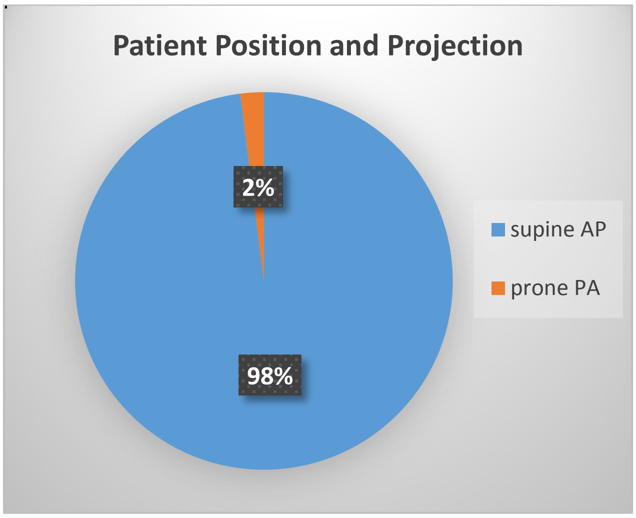

Figure 3: Patient Position and Projection

Figure 3 presents that 98% of the chest X-ray of the ICU subjects were taken in supine anteroposterior (AP) position and only 2% was taken in prone posteroanterior (PA) position. Whenever possible the patient should be imaged in an upright PA position to prevent the magnification of the heart and widening of mediastinum. ICU patients are very ill and thus explains why most of radiographic image was taken in supine AP position in this study.

Radiation Protection of the patient and staff

Table 2 depicts that hospitals from which the ICU subjects where selected employed time to protect the patients from radiation. This means that there should be a short exposure of the patient to high dosage of ionizing radiation, hence, mastery is required of the radiographer. Meanwhile, distance from the machine of up to 1.5 to 2 m, shielding, and the use thermo luminescent dosimeter (TLD) are ways employed to protect their staff from ionizing radiation.

Table 2: Radiation protection for Patient and Staff

Protection Method	Patient	Staff (F / %)
Distance		
1.5 m	-	25 (50)
2.0 m	-	25 (50)
Shielding	-	50 (100)
Time	50 (100)	-
Thermo luminescent dosimeter (TLD)		50 (100)

Table 3 depicts that from among the 50 ICU select cases, 14 (28%) were confirmed to have cardiomegaly or heart enlargement diagnosed by chest X-ray. Lung pathologies follow to include pleural effusion, pneumonia and pulmonary edema with an occurrence rate of 14%, 14%, and 10% respectively.

The table further shows that there is a significant correlation or association between the request or use of chest x-ray in ICU among the patients with that of the occurrence of pathologic finding with a p value $< .05$ level of significance ($p= .0027$) using Linear Regression Analysis. This may mean that chest X-ray can be a vital diagnostic tool to support the clinician's primary diagnosis which would consequently impact patient management.

Table 3: Linear Regression Analysis between the use of Chest X-ray and Patient Pathology Finding

Pathologic Finding	Frequency/Percent (%) Occurrence in Chest X-ray Request	Coefficients	Standard Error	t (df=48)	p-value
heart enlargement	14 (28)	*7.1667*	*2.2691*	*3.158*	*.0027*
effusion	7 (14)				
pneumonia	7 (14)				
collapsed lung	5 (10)				
pulmonary edema	7 (10)				
chest tube placement	3 (6)				
metastasis	2 (4)				
lung CA	1 (2)				
trauma	1 (2)				
tuberculosis	1 (2)				
pulmonary embolism	1 (2)				
bronchiectasis	1 (2)				

Discussion

The result of this study showed a significant correlation between the use of chest X-ray among ICU patients and the patient's confirmed pathologic finding which may mean that chest X-ray can be a very helpful tool in confirming disease or disease complication. This result affirms the American College of Radiology recommendation of daily chest radiography for critically ill patients who have acute cardiopulmonary disease or are receiving mechanical ventilation, as well as immediate imaging for all patients who have undergone placement of endotracheal tubes (ETTs), feeding tubes, vascular catheters, and chest tubes (Amorosa *et al., 2008*). These recommendations are made because the malpositioning of these devices and the serious complications that may ensue are often not clinically apparent (Baik *et al.*, 2010; Stawicki, Sarani & Braslow, 2008; Amorosa *et al., 2008;* Jaillard *et al.*, 2002).

Interpreting chest radiographs of the critically ill patients who are in intensive care units (ICUs) poses a challenge not only for the intensive care physicians but also for the radiologist. In this retrospective study, 98% of ICU patients were taken radiograph in supine anteroposterior position (AP) which is reasonable due to their condition, however, the standard posteroanterior (PA) position could offer a better image that would help diagnosis and better patient management (Graat *et al., 2007;* Brainsky *et al.*, 1997). Therefore, it is imperative that future studies be directed on the radiographic findings of cardiopulmonary disorders common in ICU patient to offer guidelines for interpretation based not only on the chest radiograph but also on the pathophysiology and clinical grounds of the patient.

Over the years, health risk associated with exposure to ionizing radiation remains a controversial issue prompting healthcare facilities to impose precautionary measures to protect patients and workers alike from excess dosage of ionizing radiation. In this study, hospitals protect patients by doing the procedure in a short time, thus, lessened exposure to radiation. As the length of time a patient is exposed to radiation increases, the dose received increases in direct proportion (Chen *et al.*, 2010; Fazel *et al*, 2009; Einstein *et al.*, 2007;).

While medical professionals specifically the radiologist and radiology technician should make sure that they can safely operate x-ray equipment, they also have to protect their health. In this investigation, distance from the radiograph unit of up to 2 meters, shielding, and the use of thermoluminescent dosimeter (TLD) are ways by which workers involved in radiograph task are protected. During fluoroscopic exams a technologist should only be in the room when needed to assist. Otherwise, they should be behind the lead wall, dressed in lead apron and thyroid collar in case their assistance is needed. Another way to reduce the time exposed is to avoid holding patients during exams if possible (Cardis *et al.*, 2007).

Perhaps the most effective of the principles of protecting oneself is distance. The further a person is from the source the less intense the radiation source is. When the distance from the source is doubled the intensity at the new distance is only 1/4 the original intensity. When performing portable x-ray exams, a tech should be at least six feet from the source of the radiation (Murhead *et al.*, 2010; Cardis *et al.*, 2007).

When the use of the time and distance principles are not possible shielding should always be used. Wearing protective lead shielding and thyroid collars can protect the radiosensitive areas of the body when it is required for the technologist to be near the source of radiation. Protective aprons, gloves and thyroid collars are usually made of lead impregnated vinyl. The most widely used and recommended is a 0.5 mm lead equivalent for protective apparel (Einstein *et al.*, 2007).

Whenever a worker is likely to receive 10 percent or more of the annual occupational dose of 5 rem (50 mSv) in a years' time, radiation exposure monitoring is required. Monitoring of these exposure levels is achieved by issuing personal dosimeters to the worker to wear during their shift. A dosimeter detects and measures the amount of radiation a worker has been exposed to over a set amount of time. In this investigation, TLD is must for the radiograph technicians. TLDs contain a crystal form of lithium fluoride which when exposed to ionizing radiation causes the crystals to undergo changes in their physical properties. An advantage to TLDs is their ability to interact with radiation in a similar way to human tissue which allows the monitor to provide a more accurate dose. TLDs can be worn for up to 3 months and after the monitor is read it can be reused.

This study has so far established the significant use of chest X-ray among ICU patients for diagnostic purposes thus impact their management. Technical considerations and exposure factor have also been described to get better radiograph images as well as the ways of protecting patients and staff from excess dosage of ionizing radiation.

Conclusion

Chest X-ray for ICU patients can be a vital diagnostic tool that would impact patient care and management; however, it may also be a tool that would lead to serious complications that may endanger more a critically-ill patient's life. Given a small overall sample size of this investigation, the total usefulness of the radiograph procedure remains uncertain which warrants future investigations.

Summary of Findings

Based on the data gathered, the following information are drawn:

1. 80% of the ICU cases are males and only 20% are female's majority belonging to age bracket 61-70 years old.
2. 92% of the request for chest X-ray among the 50 ICU patients was used to confirm diagnosis
3. 54% of the requested chest X-rays among the ICU patients was set at 110 kilovolts at 40 mAs while 46% was set at 90 kvp at 30 mAs.
4. 98% of the chest X-ray of the ICU subjects were taken in supine anteroposterior (AP).
5. Time of exposure was employed time to protect the patients from radiation while distance from the machine of up to 1.5 to 2 m, shielding, and the use thermoluminescent dosimeter (TLD) are ways employed to protect their staff from ionizing radiation.
6. Cardiomegaly or heart enlargement diagnosed by chest X-ray and other Lung pathologies such as pleural effusion, pneumonia and pulmonary edema were conditions to which chest X-ray was requested among the 50 ICU select cases.
7. There is a significant correlation or association between the request or use of chest x-ray in ICU among the patients with that of the occurrence of pathologic finding with a p value < .05 level of significance (*p= .0027*) using Linear Regression Analysis.

Recommendations

1. Future researches should be directed on using larger sample size to carry out a more comprehensive and reliable information.
2. Future studies should be directed on the radiographic findings of cardiopulmonary disorders common in ICU patient to offer guidelines for interpretation based not only on the chest radiograph but also on the pathophysiology and clinical grounds of the patient.
3. The study be carried out Kingdom wide to describe the safety practices employed by the healthcare facilities to protect both the patient and the healthcare worker.

Ethics approval and consent to participate

Ethical consideration was made for patient information and responses to safeguard against the risk of unintended exposure of their responses and possible fear of victimization by health care workers. Confidentiality and anonymity was maintained at all times during the process of data collection. For both quantitative and qualitative data collection, there were no patient identifiers and the sessions were conducted in a room for privacy where only the study participant and the research assistant were.

Ethical approval was sought from: Alghad International College for Applied Medical Science in Al Madinah Al Munawara

List of abbreviations

ARDS: Acute Respiratory Distress Syndrome
AP: Anteroposterior
CCU: Critical Care Unit
CHF: Congestive Heart Failure
COPD: Chronic Obstructive Pulmonary Disease
CT: Computed Tomography
CVP: Central Venous Pressure
ED: Emergency Department
ETT: Endotracheal Tube
ICU: Intensive Care Unit
ITU: Intensive Treatment Unit
MRI: Megnetic Resonance Imaging
NG: Nasogastric Tube
OR: Operation Room
PACS: Picture Archeiving and Communication System
PA: PosteroAnterior
PEEP: Positive End-Expiratory Pressure ventilation
PE: Pulmonary Embolism
PET: Positron Emission Tomography
TLD: Thermoluminescent Dosimeter

Conflicts of Interest

Authors have no interest to declare

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Authors' contributions

Shouq: collect and diagnosed of patient x-ray examination by help of Radiologist at each hospital of Almadinah And analyze data according to age.
Yousra: writing results and recommendation and was major contributor of writing manuscript.
Malak: Analyzed data according to patient positions and projections.
Mashaeel: collect information of portable x ray unit and chest anatomy.
Ahlam: analyzed data according to purpose of chest x-ray request.
Dr.mayson: checking information of all manuscript.

All of authors read and approved final manuscript.

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