Journal of Health, Medicine and Nursing
ISSN 2422-8419 An International Peer-reviewed Journal
Vol.42, 2017 www.iiste.org

Diagnostic Imaging and Radiation Therapy in the Arab World: A New Model of Advanced Practice

Dr. Ayman Jehad Abed Abutaima
Dr. Maryam Khalid Aledrisi
Dr. ALFAIFI ABDULLATIF AHMED M
Dr. ASIRI KHALID ALI M
Dr. ALANAZI ADEL SALEH
Dr. ALHAZMI, ALMOTASEM BLLAH ALI Y
Dr. ALQAHTANI, SAIF ABDULLAH A

Abstract
This study aimed at suggesting a new model for advanced practice in the diagnostic imaging and radiation therapy in the Arab World by presenting a comparative study between the different medical imaging techniques, the concepts, benefits, risks and medical applications of these techniques has been presented with details. Attempting For building a new model of advanced practice for the diagnostic role of imaging and radiation therapy in the Arab World; by analyzing the current status of the imaging and radiation therapy in the Arab World, and then surveying the different medical imaging techniques. Then to suggest a model of best practices upon the outcomes of the study.

Acknowledgement
This research has been prepared through cooperation and concerted efforts of the researchers in collecting and compiling the necessary data; each researcher with a certain role. Hence, this research was conducted with the joint efforts of the researchers; Dr. Ayman Jehad Abed Abutaima and Dr. Maryam Khalid Aledrisi as main authors, and Dr. ALFAIFI ABDULLATIF AHMED M, Dr. ASIRI KHALID ALI M, Dr. ALANAZI ADEL SALEH, Dr. ALHAZMI, ALMOTASEM BLLAH ALI Y and Dr. ALQAHTANI, SAIF ABDULLAH A as co-authors.

The researchers thank everyone who contributed to providing the data and information that helped to accomplish this research.

1.1 Introduction

To begin an investigation into the role development for Medical Radiation Technologists (MRTs) through this research project that aimed to investigate the need for advanced practice roles in both medical imaging and radiation therapy, and to recommend a possible structure for career progression; the investigation will predicate on the growing body of knowledge, arising particularly from the Arab World, that demonstrates the capability of MRTs to extend their role into non-traditional areas, performing these to high levels of expertise when they have undertaken appropriate postgraduate education and experience (Yielder, Sinclair, Murphy & Dunedin, 2008).

It confirmed the perception that the Arab World MRTs wish to obtain clinical advancement through an extended career progression framework, as opposed to advancement through management roles, and believe that this would increase job satisfaction, recruitment and retention for the profession. Several studies were performed within this project that demonstrated that the Arab World MRTs are capable of performing extended roles. The study added local evidence to two decades of research evidence and supported role development as an important part of the evolution of the profession (Young, 2008).

There is an opportunity to establish new models of clinical care in medical imaging and radiation, ensuring that quality of service and patient safety are prioritized above all else. Formal mechanisms for negotiation of practice boundaries must be put in place to ensure that advanced radiographic and radiation therapy practice are performed within an appropriate legal, ethical, moral, social and economic framework. This can only be achieved by inter professional consultation, negotiation and teamwork (Advanced Practice Working Group, 2009).

Providing radiographers and radiation therapists with professional development opportunities, such as extended clinical roles, will increase the likelihood of them staying in the medical radiation workforce for longer periods. It will also provide the opportunity for radiologists to focus their extensive knowledge, skills and ability on complex cases (Field & Snaith, 2013).

Advanced diagnostic imaging can benefit patients when used appropriately; it detects diseases and conditions early and accurately, allows health care practitioners to direct patients to the health care services they need, and improves patient outcomes. But, when used inappropriately, advanced diagnostic imaging provides practitioners and patients with minimal clinical benefits, wastes scarce health care resources and can even jeopardize patient safety (Smith-Bindman, Miglioretti, Johnson, Lee, Feigelson, Flynn & Solberg, 2012).

The practice of radiography is performed by health care professionals responsible for the administration of ionizing radiation for diagnostic, therapeutic or research purposes. A radiographer performs radiographic procedures at the request of and for interpretation by a licensed practitioner. The complex nature of disease processes involves multiple imaging modalities. Although an interdisciplinary team of clinicians, radiographers and support staff plays a critical role in the delivery of health services, it is the radiographer who performs the radiographic procedure that creates the images needed for diagnosis (Hafslund, Clare, Graverholt & Nortvedt, 2008).

Radiography integrates scientific knowledge, technical competence and patient interaction skills to provide safe and accurate procedures with the highest regard to all aspects of patient care. A radiographer recognizes patient conditions essential for the successful completion of the procedure.

Radiation therapy is a field of oncology in which ionizing radiation is used to treat malignant conditions. After the radiation oncologist (physician specializing in the treatment of cancer) has determined the best course of therapy, the radiation therapist is the medical professional who carries out the treatment plan by delivering targeted radiation to a very precise location. Radiation therapists are responsible for the operation of radiation-producing equipment, simulation of a patient's treatment plan, and administration of treatment as prescribed by the radiation oncologist. Radiation therapists are educated in physics, radiation safety, cancer management, patient anatomy, and patient care (Bruner, Moore-Higgs & Haas, 2001).

1.2 Problem statement

For building a new model of advanced practice for the diagnostic role of imaging and radiation therapy in the Arab World; came this research to analyze the current status of the imaging and radiation therapy in the Arab World, and then surveying the different medical imaging techniques; with the concepts, benefits, risks and applications of these techniques. Therefore, the problem of this study lies in its attempt to explore the used techniques of the imaging and radiation therapy in the Arab World, and to suggest a model of best practices upon the outcomes of the study.

1.3 Radiography Clinical Performance Standards

1.3.1 Standard One: Assessment

The radiographer collects pertinent data about the patient and the procedure. Rationale: Information about the patient's health status is essential in providing appropriate imaging and therapeutic services (American Society of Radiologic Technologists, 2017).

General Stipulation: The individual must be educationally prepared and clinically competent as a prerequisite to professional practice.

General Criteria; The radiographer:

1. Obtains relevant information from all available resources and the release of information as needed.
2. Verifies patient identification and the procedure requested or prescribed.
3. Verifies that the patient has consented to the procedure.
4. Reviews all available patient medical record information to verify the appropriateness of the procedure requested or prescribed.
5. Verifies the patient's pregnancy status.
6. Assesses factors that may negatively affect the procedure, such as medications, patient history, insufficient patient preparation or artifact producing objects.
7. Recognizes signs and symptoms of an emergency.

Specific Criteria The radiographer:

1. Assesses patient risk for allergic reaction(s) to medication prior to administration.
2. Locates and reviews previous examinations for comparison.
3. Identifies and removes artifact-producing objects.

1.3.2 Standard Two: Analysis (Determination)

The radiographer analyzes the information obtained during the assessment phase and develops an action plan for completing the procedure.

Rationale: Determining the most appropriate action plan enhances patient safety and comfort, optimizes diagnostic and therapeutic quality and improves efficiency.

General Criteria; The radiographer:

1. Selects the most appropriate and efficient action plan after reviewing all pertinent data and assessing the patient's abilities and condition.
2. Employs professional judgment to adapt imaging and therapeutic procedures to improve diagnostic quality and therapeutic outcomes.
3. Consults appropriate medical personnel to determine a modified action plan.
4. Determines the need for and selects supplies, accessory equipment, shielding, positioning and

immobilization devices.
5. Determines the course of action for an emergent situation.
6. Determines that all procedural requirements are in place to achieve a quality diagnostic or therapeutic procedure.

Specific Criteria; The radiographer:
1. Reviews lab values prior to administering medication and initiating specialized radiologic procedures.
2. Determines type and dose of contrast agent to be administered, based on the patient's age, weight and medical/physical status.
3. Verifies that exposure indicator data for digital radiographic systems has not been altered or modified and is included in the Digital Imaging Communications in Medicine (DICOM) header and on images exported to media.
4. Analyzes images to determine the use of appropriate imaging parameters.

1.3.3 Standard Three: Education
The radiographer provides information about the procedure and related health issues according to protocol.

Rationale Communication and education are necessary to establish a positive relationship.

General Criteria; The radiographer:
1. Provides an accurate explanation and instructions at an appropriate time and at a level the patient and their care providers can understand. Addresses questions and concerns regarding the procedure.
2. Refers questions about diagnosis, treatment or prognosis to a licensed practitioner.
3. Provides patient education.
4. Explains effects and potential side effects of medications.

Specific Criteria; The radiographer:
1. Provides pre and post-procedure education.
2. Educates the patient about the risks and benefits of radiation.

1.3.4 Standard Four: Performance
The radiographer performs the action plan.

Rationale: Quality patient services are provided through the safe and accurate performance of a deliberate plan of action.

General Criteria; The radiographer:
1. Performs procedural timeout.
2. Implements an action plan.
3. Explains to the patient each step of the action plan as it occurs and elicits the cooperation of the patient.
4. Uses an integrated team approach.
5. Modifies the action plan according to changes in the clinical situation.
6. Administers first aid or provides life support.
7. Uses accessory equipment.
8. Assesses and monitors the patient's physical, emotional and mental status.
9. Applies principles of sterile technique.
10. Positions patient for anatomic area of interest, respecting patient ability and comfort.
11. Immobilizes patient for procedure.
12. Monitors the patient for reactions to medications.

Specific Criteria; The radiographer:
1. Employs proper radiation safety practices.
2. Optimizes technical factors according to equipment specifications to meet the ALARA principle.
3. Uses pre-exposure collimation and proper field-of-view selection.
4. Uses appropriate uniquely identifiable pre-exposure radiopaque markers for anatomical and procedural purposes.
5. Selects the best position for the demonstration of anatomy.
6. Injects medication into peripherally inserted central catheter lines or ports.
7. Coordinates and manages the collection and labeling of tissue and fluid specimens.
8. Performs appropriate post-processing on digital images in preparation for interpretation.

1.3.5 Standard Five: Evaluation
The radiographer determines whether the goals of the action plan have been achieved.

Rationale: Careful examination of the procedure is important to determine that expected outcomes have been met.

General Criteria; The radiographer:
1. Evaluates the patient and the procedure to identify variances that might affect the expected outcome.
2. Completes the evaluation process in a timely, accurate and comprehensive manner.
3. Measures the procedure against established policies, protocols and benchmarks.

4. Identifies exceptions to the expected outcome.
5. Develops a revised action plan to achieve the intended outcome.
6. Communicates the revised action plan to appropriate team members.

Specific Criteria; The radiographer:

1. Evaluates images for positioning to demonstrate the anatomy of interest.
2. Evaluates images for optimal technical exposure factors.
3. Reviews images to determine if additional images will enhance the diagnostic value of the procedure

1.3.6 Standard Six: Implementation

The radiographer implements the revised action plan.

Rationale: It may be necessary to make changes to the action plan to achieve the expected outcome.

General Criteria; The radiographer:

1. Bases the revised plan on the patient's condition and the most appropriate means of achieving the expected outcome.
2. Takes action based on patient and procedural variances.
3. Measures and evaluates the results of the revised action plan.
4. Notifies the appropriate health care provider when immediate clinical response is necessary, based on procedural findings and patient condition.

Specific Criteria; The radiographer:

1. Performs additional images that will produce the expected outcomes based upon patient condition and procedural variances.

1.4 Radiography Quality Performance Standards

1.4.1 Standard One: Assessment

The radiographer collects pertinent information regarding equipment, procedures and the work environment.

Rationale: The planning and provision of safe and effective medical services relies on the collection of pertinent information about equipment, procedures and the work environment.

General Criteria; The radiographer:

1- Determines that services are performed in a safe environment, minimizing potential hazards.
2- Confirms that equipment performance, maintenance and operation comply with the manufacturer's specifications.
3- Verifies that protocol and procedure manuals include recommended criteria and are reviewed and revised.

Specific Criteria; The radiographer:

1- Controls access to restricted areas during radiation exposure.
2- Follows federal and state guidelines to minimize occupational and patient radiation exposure levels.
3- Maintains and performs quality control on radiation safety equipment.
4- Develops and maintains standardized exposure technique guidelines for all equipment.
5- Participates in radiation protection, patient safety, risk management and quality management activities.
6- Reviews digital images for the purpose of monitoring radiation exposure.

1.4.2 Standard Two: Analysis (Determination)

The radiographer analyzes information collected during the assessment phase to determine the need for changes to equipment, procedures or the work environment.

Rationale: Determination of acceptable performance is necessary to provide safe and effective services.

General Criteria; The radiographer:

1- Evaluates services, procedures and the environment to determine if they meet or exceed established guidelines, and revises the action plan.
2- Monitors equipment to meet or exceed established standards and revises the action plan.
3- Assesses and maintains the integrity of medical supplies.

1.4.3 Standard Three: Education

The radiographer informs the patient, public and other health care providers about procedures, equipment and facilities.

Rationale Open communication promotes safe practices.

General Criteria; The radiographer:

1- Elicits confidence and cooperation from the patient, the public and other health care providers by providing timely communication and effective instruction.
2- Presents explanations and instructions at the learner's level of understanding.
3- Educates the patient, public and other health care providers about procedures and the associated biological effects.
4- Provides information to patients, health care providers, students and the public concerning the role and

responsibilities of individuals in the profession.

1.4.4 Standard Four: Performance

The radiographer performs quality assurance activities.

Rationale Quality assurance activities provide valid and reliable information regarding the performance of equipment, materials and processes.

General Criteria; The radiographer:

1- Maintains current information on equipment, materials and processes.
2- Performs ongoing quality assurance activities.
3- Performs quality control testing of equipment.
4- Participates in safety and risk management activities.
5- When appropriate, wears one or more personal radiation monitoring devices at the location indicated on the personal radiation monitoring device or as indicated by the radiation safety officer or designee.

Specific Criteria; The radiographer:

1- Consults with the medical physicist when performing the quality assurance tests.
2- Monitors image production to determine technical acceptability.
3- Verifies archival storage of image data as appropriate. 4. Routinely reviews patient exposure records and reject analyses as part of the quality assurance program.

1.4.5 Standard Five: Evaluation

The radiographer evaluates quality assurance results and establishes an appropriate action plan.

Rationale Equipment, materials and processes depend on ongoing quality assurance activities that evaluate performance based on established guidelines.

General Criteria; The radiographer:

1- Validates quality assurance testing conditions and results.
2- Evaluates quality assurance results.
3- Formulates an action plan.

1.4.6 Standard Six: Implementation

The radiographer implements the quality assurance action plan for equipment, materials and processes.

Rationale Implementation of a quality assurance action plan promotes safe and effective services.

General Criteria; The radiographer:

1- Obtains assistance to support the quality assurance action plan.
2- Implements the quality assurance action plan.

1.5 Competence Standards

Competence standards are a description of the ability of a medical imaging/radiation therapy practitioner to practice safely and effectively in a variety of contexts and environments.

Competence is influenced by many factors including, but not limited to, the practitioner's qualifications, clinical experience, professional development and his/her ability to integrate knowledge, skills, attitudes, values and judgements within a practice setting.

A critical value of competence standards is their capacity to support and facilitate professional practice and growth. The standards to be adopted are expressed as entry-level competencies and behaviors. However it is expected that all practitioners will successively build on these competence standards to levels expected of experienced practitioners.

The competence standards identify the minimum knowledge, skills and professional attributes necessary for practice. During any one procedure it is expected practitioners will demonstrate elements of practice across a number of broadly-defined domains of competence. This recognizes that competent professional practice is more than a sum of each discrete part. It requires an ability to draw on and integrate the breadth of competencies to support overall performance (Medical Radiation Technologists Board, 2017).

1.5.1 Context of the Competence Standards

The competence standards for the practice of medical imaging and radiation therapy are directly linked to each of the scopes of practice. And only individuals who must hold current registration with the Medical Radiation Technologists Board are permitted to use any of the following professional titles:

- Medical Imaging Technologist
- Radiation Therapist
- Nuclear Medical Imaging Technologist
- Sonographer
- Magnetic Resonance Imaging Technologist
- Trainee Nuclear Medical Imaging Technologist
- Trainee Sonographer
- Trainee Magnetic Resonance Imaging Technologist

1.6 Diagnostic Radiology

The choice of imaging modality/modalities depends on the clinical indication, resource availability and access, expertise, cost, patient acceptance and patient convenience. Some imaging modalities may be employed as problem solving tools rather than as routinely recommended diagnostic investigations. It is important to recognize and understand the strengths and limitations of each modality in order to utilize resources optimally. For response assessment, imaging is undertaken to establish response to definitive treatment, to plan further treatment (e.g. neo-adjuvant radiation therapy for rectal cancer), or to provide prognostic information. Where pre-treatment imaging is optimal, imaging techniques for response assessment should be identical to those used for initial staging, as reproducibility is important in accurate assessment of response.

1.6.1 Radiology in Radiation Treatment Workflow Beyond Diagnosis

There has been rapid technological growth in diagnostic and therapeutic radiology in recent times. This has enabled effective translation of sophisticated cross sectional and physiological imaging into highly conformal and targeted planning and treatment. Imaging for treatment planning should be undertaken in the treatment position. Careful attention to patient immobilization and recording patient position for reproduction at daily set up is critical to accurate delivery of treatment. Use of oral and/ or intravenous contrast agents aids in target/normal tissue localization. Where appropriate, markers placed either on skin (e.g. anal verge markers) or within organs (e.g. fiducials in prostate cancer) prior to imaging, further assist in target localization and improve accuracy and precision in treatment delivery. Diagnostic imaging is often undertaken in a different position from that for planning purposes making accurate image registration difficult. Where appropriate, repeating the diagnostic imaging in treatment position aids in accurate delineation of the target (Pitman, Jones, Stuart, Lloydhope, Mallitt & O'rourke, 2009).

1.6.2 X-Ray Radiography

Radiography is a diagnostic technique that used the ionizing electromagnet radiation, such as X-ray to view objects. X-ray is a high energy electromagnetic radiation that can penetrate solids and ionize gas; it has a wavelength between 0.01 and 10 manometers. For medical imaging], X-ray passes through the body, they are absorbed or attenuated at differing levels, according to the density and atomic number of the different tissues, creating a profile.

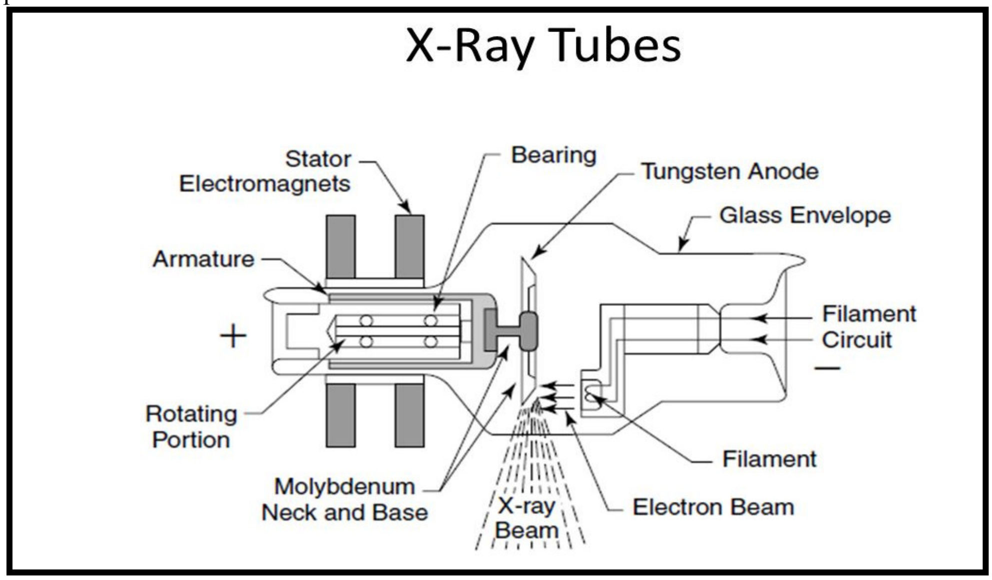

Figure (1): Rotating X-ray tube

The X-ray profile is registered on a detector creating an image. The construction of the X-ray tube that used for medical imaging is shown in figure 1. Electrons are emitted by the filament wire when it is heated by an electric current. A rotating metal anode attracted the electrons providing an alternating current in the filament wire. The area of the anode from which X-ray are emitted is referred to as the focal spot. The used photon energies range from 17- 150 KeV, the choice for a particular application or tissue probed being a trade-off between acceptable radiation dose and achievable image contrast. Figure 2 shows some examples of X-ray images.

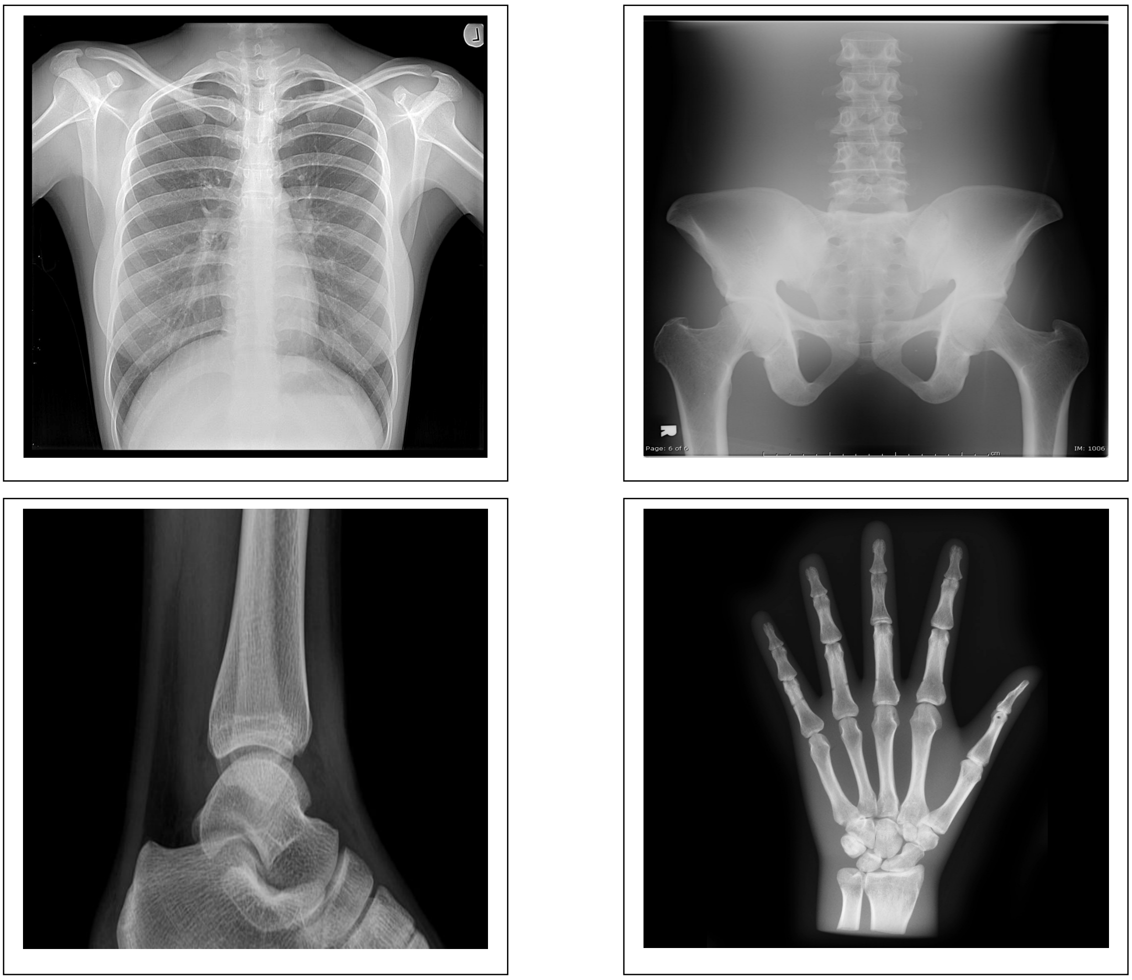

Figure (2): Examples of X-ray images

Table (1): Benefits, risks and medical applications of X-Ray Radiography

Benefits	Noninvasive, quick, and painless.
	Support medical and surgical treatment planning.
	Guide medical personnel as they insert catheters or stents inside the body to treat tumors, or remove blood clots.
Risks	Exposure to ionizing radiation, this increase the possibility of developing cancer later in life.
	Tissue effects such as cataracts, skin reddening, and hair loss, which occur at relatively high levels of radiation exposure.
Medical Applications	X-ray radiography is used in many types of examinations such as; chiropractic, dental.
	Fluoroscopy radiographs used for showing the movement of organs, such as the stomach, intestine, and colon, in the body, also can be used for studding the blood vessels of the heart and the brain.
	Projectional radiographs used for determining the type and extent of a fracture, also used for detecting pathological changes in the lungs, and used for visualizing the structure of the stomach and intestines.
	Mammography used for diagnosing and screening of the breast tissue.
	Bone Densitometry used for measures bone mineral content and density.
	Arthrography used for seeing inside the joint.
	Hysterosalpingogram used for examining of the uterus and Fallopian tubes.

1.6.3 X-Ray Computed Tomography

Computed Tomography (CT) (Kasban, El-Bendary & Salama, 2015), is a diagnostic technology that combines X-ray equipment with a computer and a cathode ray tube display to produce images of cross sections of the human body. The Radiographic film is replaced by a detector which measures the X-ray profile. Inside the CT scanner, there is a rotating frame that has an X-ray tube mounted on one side and the detector mounted on the opposite side. A beam of X-ray is generated as a rotating frame spins the X-ray tube and detector around the patient as shown in figure (3).

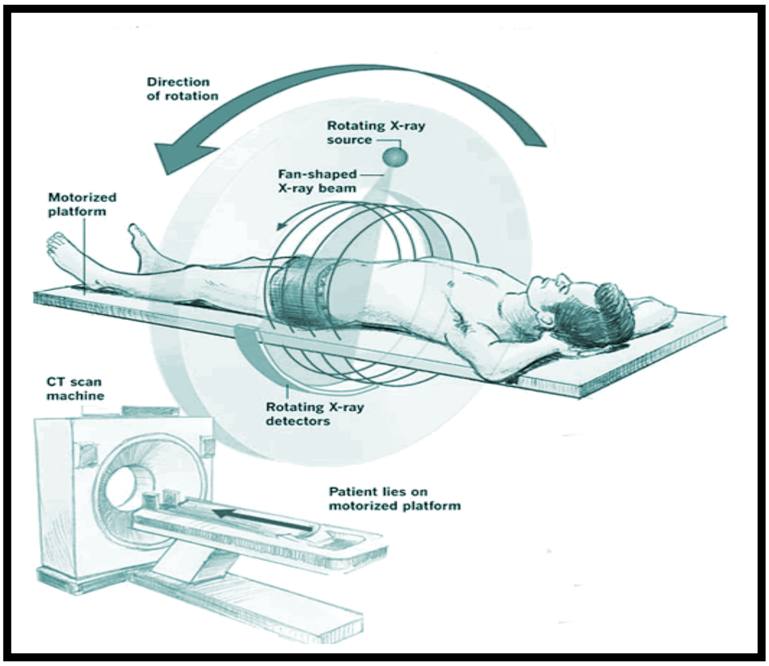

Figure (3): CT Scanner

Each time the X-ray tube and detector make one complete rotation, an image or slice is acquired. As the X-ray tube and detector make this rotation, the detector takes numerous profiles of the attenuated X-ray beam. Each profile is reconstructed by the computer into a 2D image of the slice that was scanned. 3D CT can be obtained using spiral CT, spiral CT acquires a volume of data with the patient anatomy all in one position. This volume data set can then be computer reconstructed to provide three dimensional (3D) images of complex structures. The resulting 3D CT images help in visualization of the tumor masses in three dimensions. Recently, four dimensional (4D) CT has been introduced to overcome problems imposed by respiratory movements. 4D CT generates both spatial and temporal information on organ mobility. Some examples of CT scans are shown in figure (4).

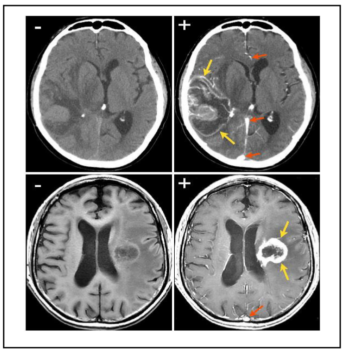

Figure (4): Examples of CT scans

Table (2): Benefits, risks and medical applications of X-Ray Computed Tomography

Benefits	Noninvasive, quick, and painless.
	Good spatial resolution.
	Global view of veins.
	Distinguished by small differences in physical density.
	Avoids invasive insertion of an arterial catheter and guidewire.
Risks	Exposure to ionizing radiation, this increase the possibility of developing cancer later in life.
	No real time information.
	Cannot detect intra-luminal abnormalities.
	Cannot be performed without contrast (allergy, toxicity).
	Less contrast resolution where soft tissue contrast is low.
Medical Applications	Examining many parts of human body such as; brain, sinus, facial bones, dental, spines, cervical, hands, wrist, elbow, shoulder, hip, knee, ankle foot, renal tract.
	Diagnosing disease, trauma and abnormality.
	Planning and guiding the interventional or therapeutic procedures.
	Monitoring the effectiveness of therapy (cancer treatment).

1.6.4 Magnetic Resonance Imaging (MRI)

MRI is a diagnostic technology that uses magnetic and radio frequency fields to image the body tissues and monitor body chemistry (Mehmood, Ejaz, Sajjad & Baik, 2013).

The MRI used for visualizing morphological alterations rests on its ability to detect changes in proton density and magnetic spin relaxation times, which are characteristic of the environment presented by the diseased tissue. The MR scanner consists of three main components; a main magnet, a magnetic field gradient system, and a Radio Frequency (RF) system as shown in figure (5).

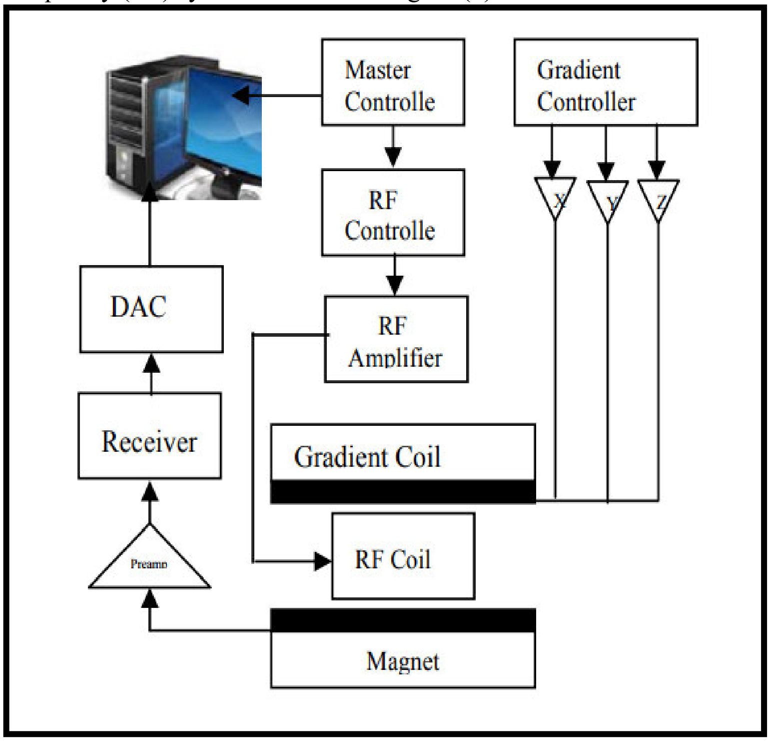

Figure (5): MR scanner drawing

The main magnet is a permanent magnet generates a magnetic field. The magnetic field gradient system normally consists of three orthogonal gradient coils, essential for signal localization. The RF system consists of a transmitter coil that is capable of generating a rotating magnetic field, for exciting a spin system, and a receiver coil that converts a processing magnetization into an electrical signals as shown in figure 6-b.

The signals are measured by the MR scanner and digital computer reconstructs these signals into images. Examples of MRI images are shown in figures 7- a, b. Recently, a new procedure that uses MRI to measure the tiny metabolic changes that take place in an active part of the brain called functional magnetic resonance imaging (fMRI) is designed (Abugharbieh, Huang & McKeown, 2009).

Example of MRI image is shown in figure (6).

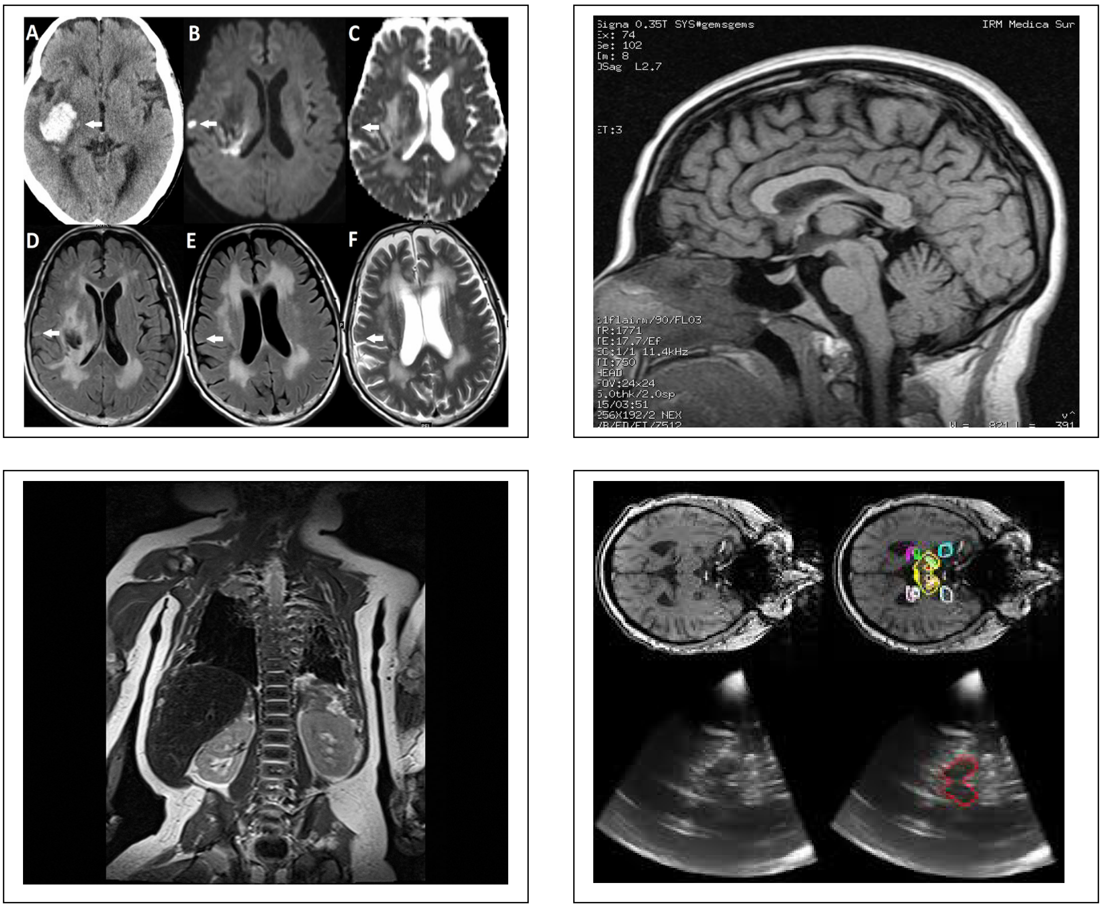

Figure (6): Examples of MRI image

Table (3): Benefits, risks and medical applications of Magnetic Resonance Imaging (MRI)

Benefits	Noninvasive and painless.
	Without ionizing radiation.
	High spatial resolution.
	Operator independent.
	Easy to blind and ability to measure flow and velocity with advanced technique.
	Can be performed without contrast (pregnancy allergy).
	Good soft tissue contrast.
Risks	Relatively low sensitivity.
	Long scan and post processing time.
	Mass quantity of the probe may be needed.
	No real time information.
	Cannot detect intra-luminal abnormalities.
	Can make some people feel claustrophobic.
	Sedation may be required for young children who can’t remain still.
	Relatively expensive.
Medical Applications	Examining the abnormalities of the brain and spinal cord.
	Examining the injuries or abnormalities of the joints.
	Examining the diseases of the liver and other abdominal organs.
	Knowing causes of pelvic pain in women.
	Finding the unhealthy tissue in the body.
	Planning the surgery.
	Providing a global view of collateral veins.
	Providing a global view of intra and extra cranial.

1.6.5 Ultrasonography

Ultrasonography is a diagnostic technology that uses high frequency broadband sound waves in the megahertz range that are reflected by tissue to varying degrees to produce medical images (Sahuquillo, Tembl, Parkhutik, Vázquez, Sastre & Lago, 2013).

The ultrasound transducer is placed against the skin of the patient near the region of interest. The transducer produces a stream of high frequency sound waves that penetrate into the body and reflect from the organs inside. The transducer detects sound waves as they echo back from the internal structures of the organs. Different tissues reflect these sound waves differently resulting a signature that can be measured and transformed into an image. These waves are received by the ultrasound machine and turned into live pictures. The real time moving image obtained can be used to guide drainage and biopsy procedures. Doppler capabilities of the recent scanners allow the blood flow in arteries and veins to be assessed. Figure 7 shows some examples of ultrasound images.

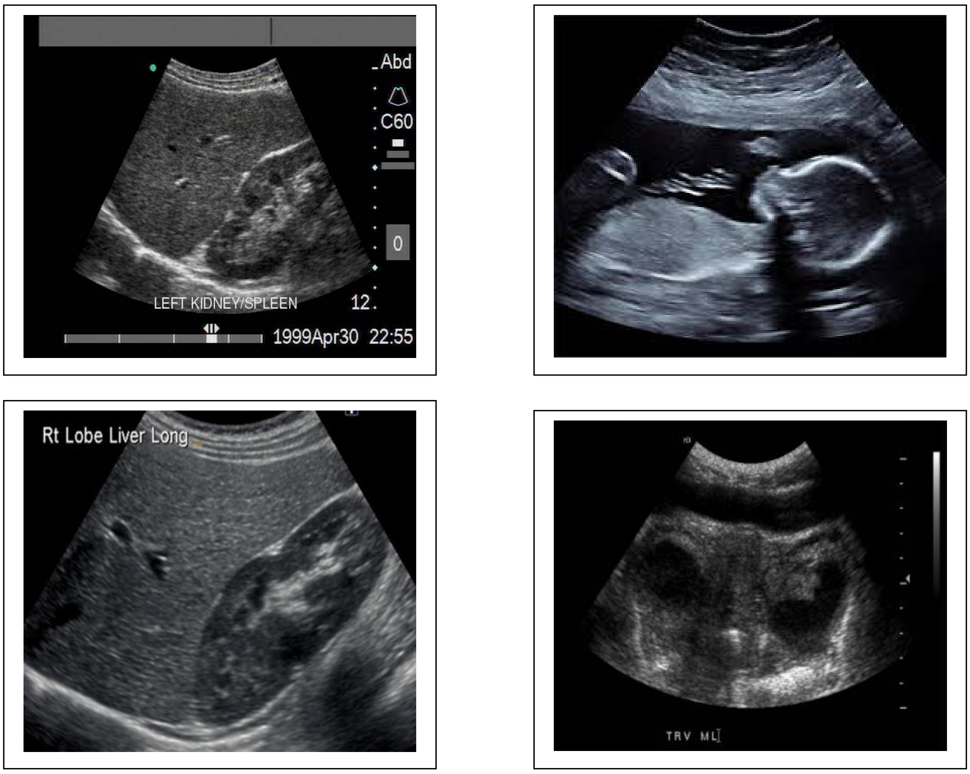

Figure (7) Examples of ultrasound images

Table (4): Benefits, risks and medical applications of Ultrasonography

Benefits	Noninvasive and painless.
	Without using ionizing radiation.
	High resolution.
	Real time information.
	Sensitive to detect flow changes, intra and extra luminal abnormalities.
	Ability to measure velocity.
	Possible control of respiratory phases.
Risks	No standardized guidelines.
	Operator dependent.
	Time consuming.
	Blinding procedures are challenging.
	Cannot perform global view of the veins.
	Influenced by hydration status.
Medical Applications	Checking the development of the fetus during pregnancy.
	Imaging most structures of the head and neck, including the thyroid and parathyroid glands, lymph nodes, and salivary glands.
	Imaging the solid organs of the abdomen such as; the pancreas, aorta, inferior vena cava, liver, gall bladder, bile ducts, kidneys, and spleen.
	Guiding the injecting of needles when placing local anesthetic solutions near nerves.
	Echocardiography used for diagnosing the heart and function of heart ventricles and valves.

1.7 Conclusion

The paper presented a comparative study between the different medical imaging techniques, the concepts, benefits, risks and medical applications of these techniques has been presented with details. Attempting For building a new model of advanced practice for the diagnostic role of imaging and radiation therapy in the Arab World; by analyzing the current status of the imaging and radiation therapy in the Arab World, and then surveying the different medical imaging techniques. Then to suggest a model of best practices upon the outcomes of the study.

References

Abugharbieh, X. Huang and M. J. McKeown, "Spatial Characterization of fMRI Activation Maps Using Invariant 3-D Moment Descriptors", IEEE Transactions On Medical Imaging, vol. 28, no. 2, pp. 261-268, 2009.

Advanced Practice Working Group (APWG), 2009, Advanced practice in diagnostic imaging and radiation therapy, Australian Institute of Radiography (AIR).

American Society of Radiologic Technologists, 2017, The Practice Standards for Medical Imaging and Radiation Therapy, ASRT Communications Department.

Bruner, D. W., Moore-Higgs, G., & Haas, M. (2001). *Outcomes in radiation therapy: multidisciplinary management*. Jones & Bartlett Learning.

Field, L. J., & Snaith, B. A. (2013). Developing radiographer roles in the context of advanced and consultant practice. *Journal of medical radiation sciences*, *60*(1), 11-15.

Hafslund, B., Clare, J., Graverholt, B., & Nortvedt, M. W. (2008). Evidence-based radiography. *Radiography*, *14*(4), 343-348.

Kasban, H., El-Bendary, M. A. M., & Salama, D. H. A, 2015, Comparative Study of Medical Imaging Techniques.

Medical Radiation Technologists Board, 2017, Competence Standards for Medical Imaging and Radiation Therapy Practice in New Zealand, New Zealand.

Mehmood, Ejaz, Sajjad & Baik, 2013, "Prioritization of Brain MRI Volumes Using Medical Image Perception Model And Tumor Region Segmentation", Computers in Biology and Medicine, vol. 43, no. 10, pp. 1471-1483, 2013.

Pitman, A., Jones, D. N., Stuart, D., Lloydhope, K., Mallitt, K., & O'rourke, P. (2009). The Royal Australian and New Zealand College of Radiologists (RANZCR) relative value unit workload model, its limitations and the evolution to a safety, quality and performance framework. *Journal of medical imaging and radiation oncology*, *53*(5), 450-458.

Sahuquillo, J. I. Tembl, V. Parkhutik, J. F. Vázquez, I. Sastre and A. Lago, "The Study of Deep Brain Structures by Transcranial Duplex Sonography and Imaging Resonance Correlation", Ultrasound in Medicine & Biology, vol. 39, no. 2, pp. 226-232, 2013.

Smith-Bindman, R., Miglioretti, D. L., Johnson, E., Lee, C., Feigelson, H. S., Flynn, M., ... & Solberg, L. I. (2012). Use of diagnostic imaging studies and associated radiation exposure for patients enrolled in large integrated health care systems, 1996-2010. *Jama*, *307*(22), 2400-2409.

Yielder J, Sinclair T, Murphy F. Dunedin: Taieri Print; 2008. Role development and career progression for New Zealand medical radiation technology: A research report Report for the New Zealand Institute of Medical Radiation Technology.

Young, A. (2008). An investigation into formal role extension opportunities for MRI technologists in New Zealand.