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A Retrospective Study to Measure the Justification for CT scans of the Abdomen and pelvis in Palestinian Public Hospitals

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A Retrospective Study to Measure the Justification for CT Scans of the Abdomen and pelvis in Palestinian Public Hospitals

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Thesis Approval

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Declaration:

I certify and confirm that the master's thesis I have submitted is the product of my own study, and no other university or organization has received it in exchange for a higher degree.

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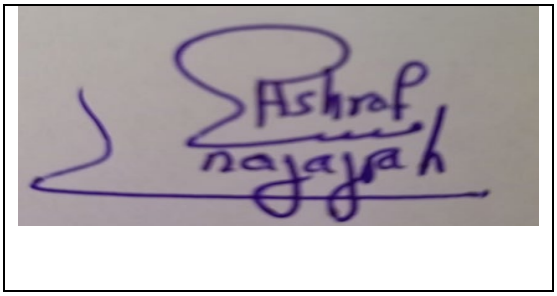

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Abstract

Computed axial tomography it is a noninvasive diagnostic imaging procedure that uses a combination of computer technologies and X-ray radiation to produce axial images (often called slices) of the organs of human body. CT scan is a powerful device and highly flexible diagnostic tool enable of making radical changes to the patient clinical management. The most appropriate use of CT scan depends on a lot of factors which must be considered every time a CT scan is justified. CT scan as a diagnostic modality, it delivers higher radiation doses compared to other imaging modalities, if the patient effective dose increase the risk of cancer increase. The researcher aims from this retrospective study to determine whether the abdomen and pelvis CT scan examination in the Palestinian public hospitals were justified or not. In this retrospective study, the sample size 892 referrals were included,458 female and 434 male from seven public hospitals in Palestine. Three radiologists participated in this study. Two of them separately participated to judge if the examination justified or unjustified according to five groups criteria's of justification, and the role of third participated radiologist only to reach the consensus if there are any discrepancies between the main two separate radiologists. Chi square test, excel software and SPSS used for any analysis.

There is significant difference between justified and unjustified CT examinations in public hospitals in Palestine with p value 0.00. 58.6% of the referrals were unjustified. Also, there is significant difference in the number of justified and unjustified between with contrast and without contrast with p value 0.02. Otherwise, the rest of parameters showed no significant difference. In conclusion, our present study showed high number of unjustified examinations in the Palestinian public hospitals. And the number of pediatric patients (8%) in acceptable range in compared to the number of adults patients (92%) included in the study.

There is significant difference in the number of justified and unjustified between CT examinations with contrast and without contrast with p value 0.02. It's important to introduce Palestinian indications or guidelines for CT scans attach it to the HIS. As well as increase the awareness of patient's and his/ hers family about the radiation risks on the other hand, introduce continuous training and learning about the CT justification and risks for medical team especially physicians who responsible for referring patients to CT scan.

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Abbreviations:

Abbreviation	Definition
CT or CAT	Computed Tomography or Computed Axial Tomography
FOV	Field Of View
MDCT	Multi detectors Computed Tomography
DNA	Deoxyribonucleic acid
GP	General Physicians
ALARA	As Low as Reasonably Achievable
ACR	American College of Radiology
mSv	millisievert
ER	Emergency Room
JUN	June
DEC	December
FEB	February
AUG	August

BSS	Basic Safety Standards
ICRP	International Commission on Radiological Protection
PACS	Picture Archiving and Communication System
HIS	Hospital Information System
RIS	Radiology Information System
SPSS	Statistical Package for Social Science

Chapter One

1. Introduction

This chapter provides the historical background, problem statement, justification of study, study goals and objectives, hypothesis, research questions and feasibility of the study.

1.1. Historical background

X-rays a form of intense electromagnetic radiation. In 1895 William Rontgen was invented it. It consists of ionizing X-ray photons, which can pass through human being body organs to produce images and are frequently used in the treatment of tumors as an alternative to surgery, similar to (radiotherapy), which was previously used for medical diagnosis. X-ray machines are used widely and have been developing continuously up to this point.

The probability of Cancer risk will increase with even a minor increase in the effective dose (>50 mSv). These days, public health is a concern on a global scale. Every day, a sizable portion of the population had CT scans. This encourages additional epidemiological research and study in this area (Almasri & Inayyem, 2021).

Justification of radiation medical exposures is one of the key tenets of medical radiation protection, which aims to confirm that the benefits from medical radiological exposures always exceed any associated potential risks(Foley et al., 2022). This is particularly necessary in the modality of computed tomography (CT) which is progressively being utilized and continues to be the highest contributor to population dose from medical exposures across many states and countries (Foley et al., 2022).

Appropriate imaging referrals not only reduce the radiation exposure of the population, but importantly also save valuable healthcare resources (Foley et al., 2022).

1.1.1. Computed tomography

Computed tomography (CT scan or CAT scan) it is a noninvasive diagnostic imaging procedure that uses a combination of computer technologies and X-ray radiation to produce axial or horizontal images (often called slices) of the organs of human body. A CT scan shows clear and detailed images of any part of the body, including the blood vessels, nerves, bones, muscles, fat, and organs. CT scans are more accurate and detailed than plain radiography (Muhogora et al., 2009).

The intervention of computed tomography was in the 1970. Its technology depends on X-Ray tubes which rotate in a closed circle integrated with detectors, connected to a computer to process and produce an image of all body tissues. It produces images with high-quality better than X-ray in contrast resolution, spatial resolution, and has the ability to cover a large area or field of view (FOV) of the patient's body (Tsalafoutas, 2010).

The invention of multi-detectors computed tomography (MDCT) scanners lead to an increase in the number of clinical examinations of CTs for the diagnosis. However, MDCT, if not used correctly, this may deliver high unjustified doses (15.7 mSv from contrast CT exam and 7.7 mSv from non-contrast CT exam) to the patients without benefits and, consequently, the hazard of radiation will be significant. So, optimization of technical parameters or clinical justification are necessary to maintain the highest benefits and lowest risk ratio (Aprile et al., 2012).

1.1.2. Reasons to do abdomen and pelvis CT scan

Computed tomography (CT) of the abdomen and pelvis is a diagnostic medical imaging exam. Referral physicians were used the CT scan to evaluate and detect diseases of the blood vessels, small and large bowels, gallbladder, liver, adrenal gland, kidneys, pancreas, spleen and other internal organs. It is often used to determine the cause of unexplained abdominal pain after routine abdominal and pelvis ultrasound. On the other hand, the CT scanning is very quick, painless, noninvasive procedure with high accuracy. In urgent or emergency cases, the CT scan can reveal quickly enough if there is an organs injury or not. As well as if there is bleeding to help rescue lives.

1.1.3. Risks of using CT scan

The number of CT scanners is increasing dramatically with high and continuous improvements in the image quality, high image resolution, high image accuracy, decrease scan time and increase speed. So the number of CT scan procedures has been increased with much of patients being exposed to hazard of ionizing radiation (Almasri & Inayyem, 2021).

In recent years the availability of computed tomography (CT) systems increased and most of Palestinian public hospitals had CT scans and because of CT scan high capabilities in diagnosis, this lead to increase in the number of examinations requested and performed. Consequently, this lead to increase true negative examinations and therefore an increase of patients absorbed dose (Aprile et al., 2012).

CT scan considered the biggest contributor to the total population dose, in the United States more than 60 million CT scans examinations done yearly (Almasri & Inayyem, 2021). Also, in 2006 in the United State, CT scan was responsible for about70% of medical radiation

exposure, the effective dose of CT scan has probability future or lifetime cancer risks for the patients. Ionizing radiation of X-ray beams can result in DNA damage and mutations of cells in the tissue, which then may grow to form different types of tumors (Almasri & Inayyem, 2021). So, the effective dose from CT examinations has become a global issue in public health (Almasri & Inayyem, 2021).

According to the above described detailed about the ionizing radiation risks, It's important to develop appropriate polices and strategies to minimize the dose of radiation for medical use while preserving the quality of imaging for a diagnostic standard to limit the radiation risk in patients within an ALARA level (as low as reasonably achievable) (Aprile et al., 2012).

This study aimed to assess whether previous abdominal and pelvic CT scans conducted in Palestinian governmental hospitals were justified.

1.2. Problem statement

In Palestinian public sector hospitals, the number of patients who underwent CT scans of the abdomen and pelvis increased unreasonably, with no evidence as to whether CT scans of the abdomen and pelvis were justified or unjustified. According to the Palestinian Ministry of health census in 2022, there are 182,305 CT scan examinations were done(Palestinian Hospitals 2022, n.d.).

Unjustified use of CT will result in an increase in operating expenses by increasing numbers of medical staffs such as radiologists, medical imaging technologist and consuming a lot of medical disposable materials like contrast media and any related materials.

According to a study published in 2021 that concluded the average effective dose for adult patients who underwent abdominal and pelvic CT scans in West Bank hospitals was 11.8 ± 5.3

millisieverts (mSv) (Almasri & Inayyem, 2021). This effective dose increases the probability of cancer risk for the patient who exposed to ionizing radiation from CT scan.

1.3. Justifications of study

Limited studies about the abdomen and pelvis justifications in Palestine. The referring physicians should follow principle of ALARA (as low as reasonable achievable) which state that to justify the radiation uses the benefits from radiation must be more than radiation risks.

According to study published by Malone and et al in 2016 which stated that the use of CT is a major contributor to the increased incidence of cancer (Malone et al., 2016).

Most of previous studies aim to minimize ionizing radiation through technical optimizations, emphasizing the importance of clinical justifications for reducing the number of requesting CT scan. On other hand, in economic and quality aspect the unjustified CT examinations lead to increase operating expenses and reduce patient satisfaction.

1.4. Study Objectives

1.4.1. Main objective:

- The study aimed to assess whether previous abdominal and pelvic CT scans conducted in Palestinian governmental hospitals were justified.
- To introduce a local guidance for referral of CT scan procedures

1.4.2. Specific objective:

- A study of the percentage of reports written on CT scans of the abdomen and pelvis in Palestinian public hospitals.

- To examine variation in the number of unjustified referred CT scans as a function of contrast status (the exam done with intravenous contrast or without intravenous contrast).
- Studying the percentage of paediatric patients who underwent abdomen and pelvis CT scan.

1.5. Study hypothesis:

The percentage of unjustified examinations of the abdomen and pelvis CT scan in the Palestinian governmental hospital is high.

1.6. Study research questions:

- Is there any difference in the number of justified and unjustified abdomen pelvis CT scan in the Palestinian governmental hospitals?
- Is there any difference in the number of justified patients who underwent abdomen and pelvis CT according to contrast status?
- What is the percentage of pediatric patients who underwent abdomen and pelvis CT from the total sample size?
- What is the percentage of radiological reports written by radiologist on CT scans of the abdomen and pelvis in Palestinian public hospitals?

1.7. Feasibility of the study:

The researcher work in the primary health care of the Palestinian ministry of health. And he has close contact with hospitals managers which will help to facilitate the collection of data and to obtain the ethical approval.

1.8. Summary:

This chapter presented the problem statement, the study objectives, research questions and feasibility of the study

The next chapter will discuss the literature reviews of this study

Chapter Two

Literatures review

Introduction:

This chapter demonstrates some literatures reviews, published studies and researches that illustrate the hazard of ionizing radiation toward the patients and the importance of clinical justification to reduce the patient's dose and public dose.

2.1. Principle of justification and optimization:

According to the justification principle, any decision that alters or change the radiation exposure scenario must be more advantageous than harmful. This means that any positive effects on the individual or society should outweigh any bad effects from adding a new radiation source, reducing existing exposure, or reducing the danger of potential exposure (Do, 2016). The principle of optimization of protection: The maximization of protection concept states that, while taking social and economic considerations into account, the likelihood of exposures, the number of people exposed, and the volume of each individual dosage should all be maintained as low as reasonably practicable. This suggests that the protection level should be as high as possible given the current situation, maximizing the margin of benefit over danger. There should be limitations on the doses or hazards to individuals from a certain source in order to prevent significantly unequal results from this optimization approach (Do, 2016).

2.2. Literature review

2.2.1. Regional and local studies.

There are limited studies in the world and especially in Palestine about the CTguidelines justifications for abdomen and pelvis.

it is important to develop a justification process and Regular updating of referral indications or guidelines with the computer system used at the hospital to increase justification.(Al-Tell, 2019) (Justification For The Urgent CT Scan Examinations In The Palestinian Health System : A Study To Control The Quality, 2021) Continuous and simple communication system between referrers, radiologist and radiographer will improve the unjustifiable CT exam by feedback for each request. HIS and PACS system make these communications easier. (Al-Tell, 2019)

2.2.2. International studies.

The international Atomic Energy Agency illustrated in Vienna 2014 that the radiation safety and protection demands guidelines and policies that recognize its many health benefits while minimizing the related risks of radiation. The requirements of safety for medical radiation exposure are clearly communicate in the new International and European Basic Safety Standards (BSS) and supporting documents. They include, among other requirements, clinical justification of procedures and technical optimization of radiation protection and safety, also including requirements for imaging asymptomatic individuals (international atomic energy agency, n.d.-b).

An article published by Shairlkar and et al in 2003 illustrated that An area of particular concern is the random and unnecessary use of ionizing radiation when clinical evaluating or other medical imaging modalities may be provides very accurate diagnosis (justification of examination). In addition to the scientific evidence, justification of CT procedure or an examination must be depends on professional evaluation of all patient information, such as patient clinical history, previous medical imaging examinations, laboratory examinations and previous treatment. Once the examination has been justified, methods for dose reduction should be applied to decrease and manage the radiation dose equal with the medical purpose (optimization of protection). Medical radiation protection is relies on these two basic principles: clinical justification and technical optimization. However, some health professionals are not deals with these two principles and have a very low level of awareness about the effect of radiation at the patient cells, tissue and potential cancer risks (Shiralkar et al., 2003).

An article published in 2015 by Del Rosario Pérez, showed that the regulatory body or government, as appropriate, must be ensure that provision is made for the justification of any kind of clinical practice and for review of the justification, as necessary, and must ensure that only justified practices are authorized. It is confirmed that radiation exposures must be justified by weighing the expected medical diagnosis or therapeutic benefits against the potential radiation hazard, with the risks and the benefits of available alternative medical imaging techniques that do not include exposure to radiation taken into account. While the health authority and appropriate professional bodies are responsible for assigned of generic justification (Del Rosario Pe´rezpe´rez, n.d.).

The personal justification should be performed through consultation between the referring medical practitioner and radiological medical practitioner, as appropriate, with consideration of appropriateness, health patient conditions. Urgency, type of medical exposure, and relevant previous information, with relevant referral indications or guidelines taken into account. Justification of medical radiation examinations or procedures in asymptomatic populations as part of a health screening program must be undertaken by the appropriate professional bodies in conjunction with health authority (Del Rosario Pe´rezpe´rez, n.d.).

Study published in 2012 by Merzenich and et al showed that the diagnostic medical imaging modalities are used more frequently in health care to determine the illness and various diseases (Merzenich et al., 2012).

Other study published in 2018 by Squillaro showed that the Using various imaging modalities that use ionizing radiation, such as fluoroscopy, conventional radiology and computed tomography, can still enhance and improve the quality of diagnosis and treatment for a variety of medical disorders in both pediatric and adult patients. According to scientific research, radiation has biological impacts on an organism that depend on the amount and length of exposure (Squillaro et al., 2018).

An International Commission on Radiological Protection in 2012 illustrated that in Compared to other ionizing radiation modalities, the CT has comparatively high radiation doses. So, protecting against the radiation risk is a crucial concern. Justification, protection optimization, and application of dose limits are the three principles of radiation protection according to the International Commission on Radiological Protection (ICRP) for ionizing radiation (international atomic energy agency, n.d.-a).

Previous study published by Malone and et al in 2016 showed that the risk against benefit trade-off is the foundation of the justifying process. This foundation is used in a variety of methods, including ionizing and non-ionizing radiation (Malone et al., 2016).

Utilizing the whole medical staff, including radiologists, radiologic technologist, and referring doctors, is part of the justification (Malone et al., 2016).

An article published by Remedios in 2011 illustrated that all diagnostic radiological exams must be justified to prevent subjecting patients to unneeded radiation (Remedios, 2011).

Further study was performed by Brenner and et al showed that every year, more CT procedures are performed (Brenner et al., 2007)

Moreover, published study by Keijzers and Britton in 2010 showed that in a time-constrained setting, referring doctors in the emergency department (ER) and in the other departments who ordered radiological exams need to understand when diagnostic imaging is necessary as well as the requirement to have proper awareness of the hazards involve (Keijzers & Britton, 2010).

In recent years the consensus of Several studies published showed that By definition, medical exposure is justified when the advantages of the test or exam outweigh the disadvantages.

According to prior studies, hundreds of examinations are requested each year, the majority of which are unjustified or unnecessary, including CT exams.(Hobbs et al., 2018), (Teferi et al., 2018).

Additionally, some of these research studies demonstrate that doctors frequently overlook radiation doses. (Heyer et al., 2010), (Thomas et al., 2006).

Muhogora and et al in their studied published in 2009 illustrated that the referring physicians can play an important role to convince the patients and their families about the benefits and hazard of radiations. There have been some studies on the radiation protection awareness of medical personnel who deal with ionizing radiation (Muhogora et al., 2009).

However, a few studies have been used as a reference for a doctor's understanding of the justification for the procedures (Moifo et al., 2014).

In the next chapter the researcher will explain the materials and methods of study.

Chapter Three

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3. Materials and methods

3.1. Introduction

This chapter outlines the conceptual framework of the study, study population, study sample and sampling technique as well as the process of data collections.

3.1.1. Definition of framework

A conceptual framework is a framework the researcher believes can explain the logical development of the thing being examined(Camp, 2000).

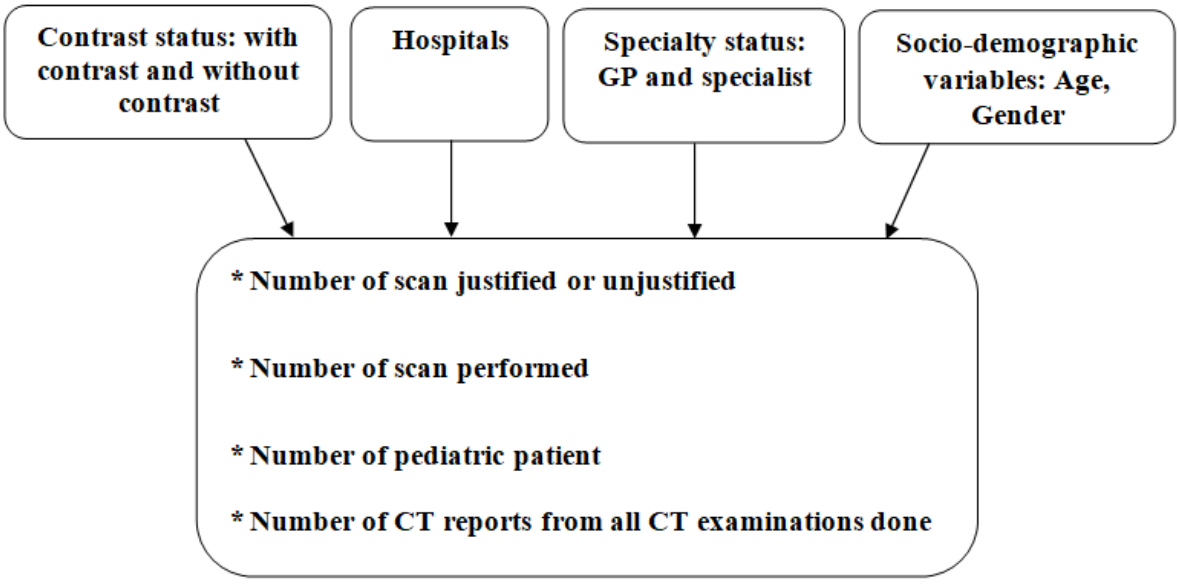

Figure 3.1: conceptual framework of this study (dependent and independentvariables).

3.2. Dependent and independent variable:

3.2.1. Dependent variable:

Dependent Variables of this study consist of:

- Number of scan justified and unjustified in the sample.
- Number of scan justified and unjustified performed either contrast or without contrast.
- The number of CT images on which reports were written by the radiologist.
- Number of justified and unjustified pediatric examinations who had CT scans of the abdomen and pelvis.

3.2.2. Independent variable:

Independent Variables of this study consist of:

1- **Socio-demographic variables:**

- Age: All patients ages
- Gender: (male and female)

2- **Hospitals:** seven public hospitals participated in this retrospective study as describe later in table 3.1.

3- **Contrast status:** (either with contrast or without contrast)

4- **Specialty status:** (either Specialist or GP physicians)

3.3. Setting:

This study was conducted in seven governmental hospitals in Palestine which included: Hebron (or Princess Alia Hospital), ALHussein, Palestine Medical Complex (Ramallah hospital), Jenin, Tulkarem, Jericho and Qalqilia.

Table 3.1: public hospitals participated in this study with its location.

Hospital	Location
Palestine Medical Complex	**Ramallah**
Jenin	**Jenin**
Jericho	**Jericho**
ALHussein	**Bethlehem**
Tulkarem	**Tulkarem**
Qalqilia	**Qalqilia**
Hebron (Princess Alia)	**Hebron**

To achieve the goal of this study, the researcher was quantified the number of all patients who underwent CT examinations of the abdomen and pelvis in the study duration as described below.

3.4. Study duration:

Participants were chosen for this study, all patients who underwent abdomen and pelvis or renal CT scan procedures from DEC 2019 to FEB 2020 and from JUN 2020 to AUG 2020.

3.5. Study design:

Quantitative retrospective cohort study was chosen to fulfill the aim of this study.

3.6. Study population:

The population that was targeted in this study all patients who were underwent abdomen and pelvis or renal CT scan examinations in the governmental hospitals in time period extend from

first day of December 2019 to last day of February 2020 and from the first day of June 2020 to last day of August 2020. Study population was included all patients' ages, who undergoing routine abdominal-pelvis or renal CT examinations in the public hospitals in Palestine.

3.7. Study sample:

To do this retrospective study and for generalize the researcher was chose random representative sample size which approximately 892 patients who underwent abdomen and pelvis CT scan examinations in the governmental hospitals of Palestine.

3.7.1. Sampling technique (Sample size of the study):

The total patients population whose underwent abdomen and pelvis CT scan through the study duration from seven Palestinian governmental hospitals was 2800 patients.

After using the sample size calculator from the web site (www.raosoft.com), the sample size was 892).Sample Size Calculator by Raosoft, Inc., n.d(.

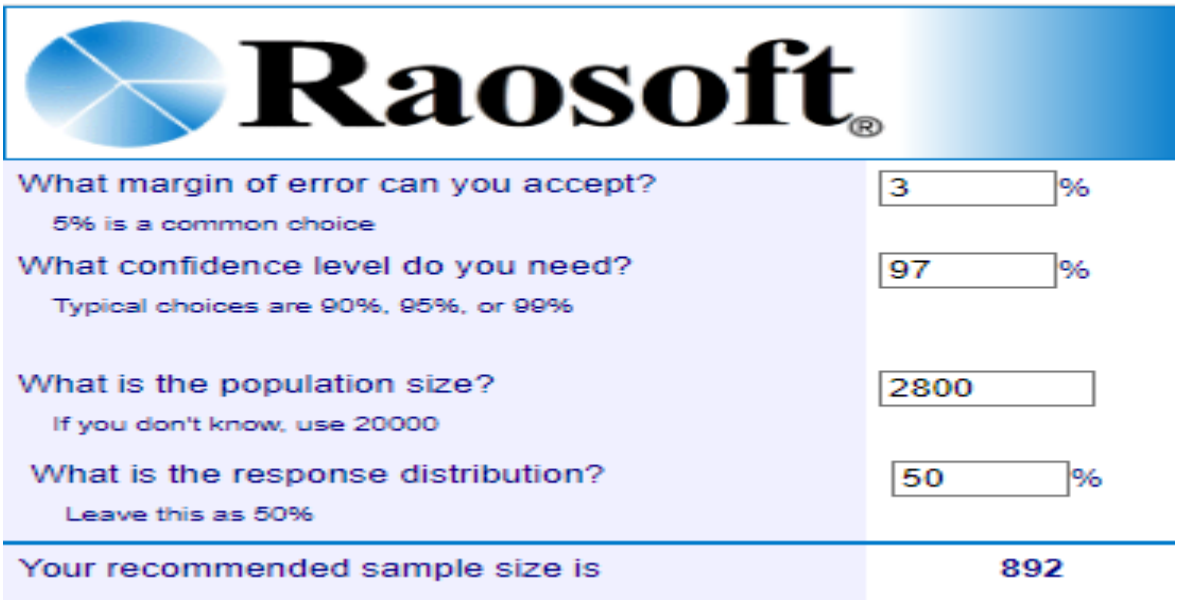

Figure 3.2: web site of raosoft to calculate the sample size.

3.7.2. Sample size of each Hospital

For representative sample the researcher was selected the sample for each hospital.

The sample size of participants from every hospital was calculated by proportional method. According to percentage of participants of every hospital from the total sample (population).

The sample size was 892 participants; it's represented (31.8%) of the total population which was 2800 participants.

The percentage of representation for each hospital from the sample size equal to The total population of patients from every hospital divided by total population (2800) multiplying by (100) %.

Formula (2): to calculate the Ratio of representation of each hospital from the sample size.

Ratio of representation for each hospital = number of patient for hospital of interest / total population * 100%

Formula (3): To determine the number of participants for each hospital.

Sample size of each hospital = ratio of representation * total sample size

3.8. Inclusion criteria for this study as the follow:

- All patients who underwent abdomen and pelvis or renal CT scan procedures from DEC 2019 to FEB 2020 and from JUN 2020 to AUG 2020.
- All patient ages.
- The abdomen and pelvis CT scan include anatomy of all organs from the diaphragm to the symphysis pubis.

3.9. Exclusion criteria in this study as the follow:

- A patient with an incorrect identification number or file number, incomplete information, or any error in the medical files.
- Any hospital not had PACS or HIS was not including in this study.
- Any patient who had more than one CT exam of the abdomen and pelvis, only the first exam was included and the other excluded.
- Any hospital not had CT scanner or not had sufficient sample.

3.10. Process of data collection:

3.10.1. Study tool

- **Patient's file:**

Any data about Patient's gender and age, with contrast or not, patient history, patient report, were extracted from file of patients for each participant in the study.

- **Global equation:**

To calculate the sample size for each hospital.

- **PACS and HIS system**

  its software programming for saving patient files and images.

- **Three radiologists**

3.10.2. Ethical consideration

- The researcher has an ethical approval from Al-Quds University – medical imaging department review board to obtain approval and permission to conduct the study.

- Also, the researcher has an ethical approval from Palestinian ministry of health to collect the data information.
- No need for patient consent form because its retrospective study and the patient name unknown
- The collected data's confidentiality was protected. There were no distinguishing features, such as codes, names, or even numbers that may link personal data to a particular patient. There shouldn't be any conflicts of interest in the study.

3.10.3. Data collection

After the researcher obtained an ethical approval to conduct this study. He was started to collect the data by using hospital information system (HIS) and PACS or stradus program.

Usually after the radiologic technologist completion the CT scan examination, he sent the CT exam to the PACS and the radiologist will write a report for this examinations. After that, the radiological records of patients will be referral to the hospital information system for archiving (HIS).

The patient medical file which records all the observations about the interest patient. The data that were collected from patients medical files which include patient age, gender, clinical history, radiologist report, previous imaging modalities, the exam done with contrast or without contrast, the referring doctor either Specialist or (GP) General Physicians and department of referral. The researcher was reviewed all medical files of the selected patients in the sample.

For this retrospective study the researcher design Special excel sheet to fit his work, which include Participants age, gender, the exam done with contrast or without contrast, referring

department, referral doctor either specialist or general physician, patient medical history, previous medical exam results if it present and the CT exams with radiological report or not.

By using PACS system and stradus program the data was filtered to fit the study requirements during study duration.

3.11 Method of justification of the CT exam:

Three radiologists' experts with American college of radiology (ACR) guidelines for abdomen and pelvis CT scan. Two of them (main radiologists) were reviewed separately the clinical indications for each patient included. And the role of third radiologist only to reach the consensus if there are any discrepancies between two main radiologists.

The radiologists were asked to evaluate the abdomen and pelvis justification of each referral based on the clinical indication provided and any relevant previous medical imaging.

The radiologists recorded the justification status of every scan on an excel spreadsheet. And the following two options were available to them: one of them justified and the other unjustified.

For every CT exam, the results of the independent evaluation were compared together. If the consensus was not reached between the initial two radiologists, other opinion by third radiologist to made the decision of justification and to reach the consensus.

These justification guidelines will be described later on in the next page and these guidelines used in the world and it does not conflict with the policies of the Palestinian Ministry of Health.

The referrals were grouped by patient gender, patient age, geographical location, specialist doctor or GP or unknown referral physician (in the cases, where the referring physician icon was empty of choices either specialist physician or GP physician, we considered the referral physician unknown)

After that the CT exam was analyzed and divided into two groups: one of them justified and the other unjustified. And the percentage of each group was calculated.

Microsoft excel was used to collect the data and representation of results by charts and The Statistical Package for the Social Sciences (SPSS) was used for analysis and for test the significance of hypothesizes.

The researcher compared between the justified and unjustified referrals as the follow:

Firstly, the researcher compared between the total number of justified referrals and unjustified referrals irrespective to the hospital. Secondly, he compared between justified and unjustified referrals according to each hospital.

Thirdly, the researcher was compared between justified and unjustified according to functions of contrast status (either with contrast or without contrast), pediatric age and adults, specialty status (either GP or specialist physician).

Because the sample was large and there are two categorical variables Chi square test was used to examine the significance of parameters. If the p value less than 0.03 it considered statistically significant.

3.11.1. American College of Radiology (ACR)indications guidelines for abdomen and pelvis CT (American College of Radiology (ACR) et al., 2021).

These guidelines according to the American College of Radiology were included an evaluation or monitoring of the following but are not limited to:

1. Assessment of abdominal and pelvic, colic or flank pain, including evaluation of known or suspected urinary tract calculi and acute appendicitis.

2. In case of abdominal and pelvic trauma the CT scan used for more assessment.

3. Evaluation of renal or adrenal masses or lesions and of urinary tract abnormalities with CT urography.

4. Evaluation of suspected abdominal or pelvic masses or lesions, including gynecological masses as well as free fluid collections.

5. Evaluation and determine of any primary or metastatic malignancies, including small lesion, identify staging, and treatment monitoring.

6. Observation following after loco-regional therapies in abdominal malignancies and including percutaneous ablation as well as intra-arterial therapies (transarterial chemoembolization, selective interstitial radiation therapy).

7. in case for evaluation of recurrence tumors after surgical resection.

8. To find any pathological complications following post abdominal and pelvic surgery (for example abscess formation, lymphocele, any radiation change, and fistula/sinus tract formation.

9. In case of biliary system disease and diffuse liver disease (for example liver cirrhosis) the CT scan used for more evaluation and assessment.

10. In case of inflammatory process of abdominal and pelvic the CT uses for assessment.

11. Assessment of any abnormalities in the vascular structures of the abdominal and pelvic.

12. Explain and Clarification of pathological findings from other medical imaging procedures or medical laboratory abnormalities.

13. Assessment of any suspected or known congenital abnormalities of abdominal and pelvic organs.

14. Assessment for any small and large bowels obstruction.

15. In colonic polyps and cancers with CT colonography it uses for screening and diagnostic assessment.

16. In interventional procedures or therapeutic procedures within the abdomen and pelvis, the CT scan it used as guidance.

17. In case of follow-up assessment after therapeutic and interventional procedures within the abdomen or within the pelvis, which often involving abscess drainage.

18. in radiation therapy and chemotherapy for treatment planning also in evaluation of tumor response to treatment.

19. Pre- and post-operation of transplant evaluation.

3.11.2. Specific scale that fit this retrospective study:

This type of justification scale can be applied with the time it took to deal with the patients. However, this justification scale cannot be applied because of this work is on the retrospective study. The researcher, in cooperation with three certified radiologists, and they experts at least three years in ACR CT indications, they summarized the above described 19 indications for abdomen and pelvis CT into five sets of groups, to justify the procedure. And these five sets of groups were verified by three radiologists to be comprehensive for the above described indications, which are as follows:

Group (1) G1: Abdomen and pelvis CT examination of Cases related to abdominal and pelvic trauma and its involvement with road traffic accidents (RTA), motor vehicle accidents (MVA) and falling down cases or any strong abdominal trauma.

Group (2) G2: Abdomen and pelvic CT examinations for unexplained diagnosis of abdominal and pelvis pain after insufficient diagnostic information in abdomen and pelvis ultrasound report.

Group (3) G3: Abdomen pelvic CT examinations for patient of known tumor or suspected cases.

Group (4) G4: Abdomen pelvic CT examinations after surgery (postoperative), urinary system calculi, inflammatory process of abdominal organs, as well as appendicitis.

Group (5) G5: Abdomen pelvic CT examinations for evaluation of arteries and veins problems or other pathology.

It is important to note that the three experts radiologists participated to summarize and verified these five groups have experience as the follow:

- Two radiologists have certified boarded in radiology and they have an experience at least three years in ACR CT guidelines.
- The third radiologist has an American board of radiology and has an experience of at least 22 years in radiology and expert in ACR CT guidelines.
- Consent was obtained from the three radiologists in writing to participate in the current scientific research without writing their names except the years of experiences.

3.12. Data analysis:

The collected data was arranged, and then coded to fit the Statistical Package for the Social Sciences (SPSS) version 20.Tables was used for descriptive analysis of results. Bar chart was used for representation of frequency of justified and unjustified referrals according to each hospital. Pie chart was used for geographical distribution of included referrals. Chi-square test was used to examine the significance of the parameters and for any association between variables if present. In the quantitative data the mean value of the results will be compared by using independent sample Chi square test. When the p value less than 0.05 it will be consider statistically significant. Cohen kappa test was used for inter-rater reliability (to measure the agreement range between two main radiologists).

Chapter Four

Results and Discussions

This chapter determines the results of the study, which includes number of justified studied, number pediatric patient underwent abdomen and pelvis CT, number of report done for the exams, number of patient done in summer or winter seasons and number of justified exam with contrast for total population with discussion of the results, recommendations and limitations of the study and suggested future study.

4. Results

4.1. Geographical distribution of the included referrals.

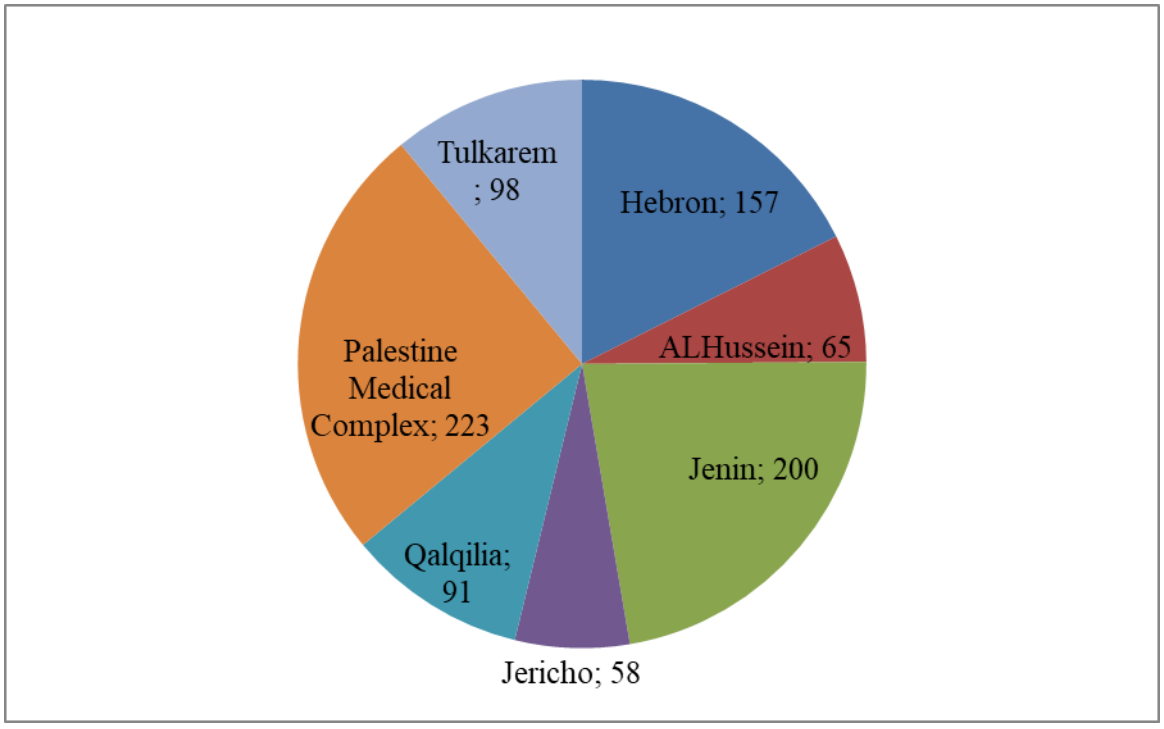

Figure 4.1: Pie chart show the geographical distribution of the included referrals according to the hospitals.

This pie chart show the distribution of 892 included referrals in this study according to the number of referral participated by each hospitals. So as to, the percentage of representation for each hospital as the follow:

- Palestine Medical Complex: 223 referrals which represent 25 %
- Qalqilia: 91 referrals which represent 10.2%
- Jericho : 58 referrals which represent 6.5%
- Jenin: 200 referrals which represent 22.4%
- ALHussein : 65 referrals which represent 7.3 %
- Hebron : 157 referrals which represent 17.6%
- Tulkarem : 98 referrals which represent 10.98%

4.2. Description Analysis

Table 4.1: distribution of the included referrals according to the pediatric age (≤ 16 years).

Pediatric			
		Frequency	Percent
Valid	Adult	820	92.0
	Pediatric	72	8.0
	Total	892	100.0

It is important to note that the word (Valid) which typed in the most tables means that the true numbers of referrals participated to each parameter in the study that was measured (to ensure no missing of data)."In general, the pediatric population involve patients age from

birth to 16 years, including age groups often called neonates, infants, children, and adolescents"(https://premierconsulting.com/resources/blog/pediatrics-what-are-the-appropriate-age-ranges/, n.d.).

According to the table 4.1 the number of pediatric referrals≤ 16 years was 72 patients which represent 8 % of the included referrals. And the rest of 92 % of referrals which represent adults referrals.

Table 4.2: distribution of the included referrals according to the gender.

Gender			
		Frequency	Percent
Valid	Female	458	51.3
	Male	434	48.7
	Total	892	100.0

According to the table (4.2) the numbers of female referrals was 458 patients which represent of 51.3 % of the included referrals. Whereas the number of male referrals was 434 patients which represent of 48.7 % included referrals.

Table 4.3: distribution of the included referrals according to the referring doctor either specialist or GP.

Referral doctor			
		Frequency	Percent
Valid	GP	406	45.5
	Specialist	434	48.7
	Unknown referral physician	52	5.8
	Total	892	100.0

According to the table (4.3) the number of examinations referring by specialist physicians was 434patients which represent 48.7% of the included referrals. Whereas, the number of examinations referring by GP physicians was 406 patients which represents of 45.5 % of the included referrals. As well as 52 referrals were unknown theirs referring physicians which represents of 5.8 % of included referrals.

It is important to note that the unknown referral means that the CT examinations can be requested by some other medical staffs whose have an access to HIS to request the CT examination.

Table 4.4: distribution of the included referrals according to the examinations done with contrast or without contrast.

Examination contrast			
		Frequency	Percent
Valid	With Contrast	409	45.8
	Without Contrast	483	54.2
	Total	892	100.0

According to the table (4.4) the number of referrals done with contrast media was 409 referrals which represents of 45.8 % of the included referrals. Whereas the number of referrals done without contrast media was 483 referrals which represents of 54.2 % included referrals.

Table 4.5: Cross tabulation for the Cohen Kappa test which used to measure the inter-rater agreement between two separate radiologists.

Rater 1 * Rater 2 Cross tabulation				
Count				
		Rater 2		Total
		Unjustified	Justified	
Rater 1	Unjustified	401	125	526
	Justified	62	304	366
Total		463	429	892

Table 4.6: Cohen Kappa value to measure the agreement strength between two main radiologists.

Symmetric Measures					
		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Measure of Agreement	Kappa	.578	.027	17.435	.000
Number of Valid Cases		892			
a. Not assuming the null hypothesis.					
b. Using the asymptotic standard error assuming the null hypothesis.					

It is important to note that the Kappa test used to examine the agreement and the inter-raters reliability (two main radiologists). So the kappa value represent the agreement strength between two raters (two radiologists).(Statistics - Inter-Rater Agreement in Python (Cohen's Kappa) - Stack Overflow, n.d.)

Table 4.7: illustrate the meaning of corresponding Kappa value.

Kappa value	Interpretation
Less than zero	No agreement
0.00- 0.2	Slight agreement
0.21- 0.4	Mild agreement
0.41- 0.6	Moderate agreement
0.61-0.8	Substantial agreement
0.81- 1	Perfect agreement

The p-value is a probability that measures the evidence against the null hypothesis. Lower p-values provide stronger evidence against the null hypothesis (Statistics - Inter-Rater Agreement in Python (Cohen's Kappa) - Stack Overflow, n.d.).

In our study the p-value 0.000 which less than 0.05, this means accepting the alternative hypothesis that says that there is an agreement between the raters (two main radiologists), and the value of the Kappa test is 0.578 which is mean a medium-strength agreement.

In our study the Cohen Kappa test used only for measuring the agreement between the two main radiologists participated to determine the exam justified or unjustified separately. On the other hand, the role of third radiologist was only to reach the consensus between the two main radiologists if there were any discrepancies. In our study the discrepancy was in 117 referrals

which the role of third radiologist to determine if it's justified or unjustified and to reach the consensus.

Table 4.8: distribution of the included referrals according to the examinations status justified or unjustified.

Examination justified			
		Frequency	Percent
Valid	Unjustified	523	58.6
	Justified	369	41.4
	Total	892	100.0

According to the table (4.8) the number of unjustified examinations much more than justified examinations. The difference between justified and unjustified examinations was about 17.2%.

Table 4.9: illustrate the number of CT examinations done with radiological report or not

Examination with Radiological Report			
		Frequency	Percent
Valid	Without report	568	63.7
	With report	324	36.3
	Total	892	100.0

The number of CT examinations where the report written by the radiologist were 324 referrals which represents of 36.3 % of the included referrals. This is decline in the number of examinations with reports may be due to shortage in the number of radiologists in the Palestinian Public Hospitals or due to verbal non documented reports at HIS as well as, may be sometimes the referrals comes from the private sector outside the public hospitals clinics and the patient comes only to get CT images without report.

A radiologist is a physicians who is specialized and trained to interpret the radiological images, while the medical imaging technologist are registered healthcare professionals specialized and trained to perform a wide range of medical imaging by operating at different imaging modalities. When a patient has a request for radiology examination, a radiologist who has undertaken especial training to report on different radiology examinations, will usually report on the medical images. Some medical images may be reported on by a subspecialist doctor in other fields in medicine. The report will conclude their findings and make advises and recommendations for treatment. This radiological report is sent to the referring doctor who referred the patient for the radiology examination, for them to discuss the radiological results with the patient and act on any findings. Relying on where the patient has been referred from and the type of examination, for example radiological requests from outpatient clinics or the emergency department, medical images may be reviewed by the referring physicians before a formal radiological report is written by radiology staff. However, the referring doctor who referred the patient will not usually have expert radiological training in reviewing such medical images and will depend on an expert radiologist opinion, which the radiology report provides (Commision, 2018).

In quality aspect, According to the key performance indicators organizations in England had in place to monitor radiological report. 90 % from radiological reports should performed within 24 hours (Commision, 2018).

Our present study showed that 63.7% of included referrals not have radiological reports after at least two years from the CT examinations performed.

4.3. Statistics

Table 4.10: show the statistical analysis of the patients' age.

Statistics	
	Age (years)
Mean	45.35
Std. Deviation	20.29
Minimum patient age	0
Maximum patient age	96

The mean age of referrals was 45.35 years with standard deviation ± 20.2. The maximum age was 96 years while the minimum age was zero years (infant patient).

Table 4.11: distribution of referrals according to justification status for public hospitals.

Hospital * Examination justified Cross- tabulation					
			Examination justifying		Total
			Unjustified	Justified	
Hospital	Hebron	Count	70	87	157
		% within Hospital	44.6%	55.4%	100.0%
	ALHussein	Count	49 (75.4)	16 (24.6%)	65 (100.0%)
	Jenin	Count	133 (66.5%)	67 (33.5%)	200 (100.0%)
	Jericho	Count	44 (75.9%)	14 (24.1%)	58 (100%)
	Qalqilia	Count	55 (60.4%)	36 (39.6%)	91 (100%)
	Medical Palestine Complex	Count	125 (56.1%)	98 (43.9%)	223 (100%)
	Tulkarem	Count	47 (48%)	51 (52%)	98 (100%)
Total		Count	523	369	892
		% within Hospital	58.6%	41.4%	100.0%

Table 4.12: Chi square tests for testing the significance difference between justified and unjustified referrals by hospitals.

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	37.831[a]	6	.000
Likelihood Ratio	38.610	6	.000
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 23.99.			

The p-value < 0.05, so we reject the null hypothesis and accept the alternative hypothesis, which says that there is significant difference in the number of justified and unjustified by hospital.

523 referrals were unjustified according to American college of radiology which represent of 58.6% of included referrals. The most frequent indications of unjustified examination were abdominal pain, colic, acute pain. The radiologists considered these indications unjustified due to no evidence of any previous medical imaging modalities done to justify the CT examination and some of these indications can be diagnosed by used ultrasound of the abdomen and pelvis.

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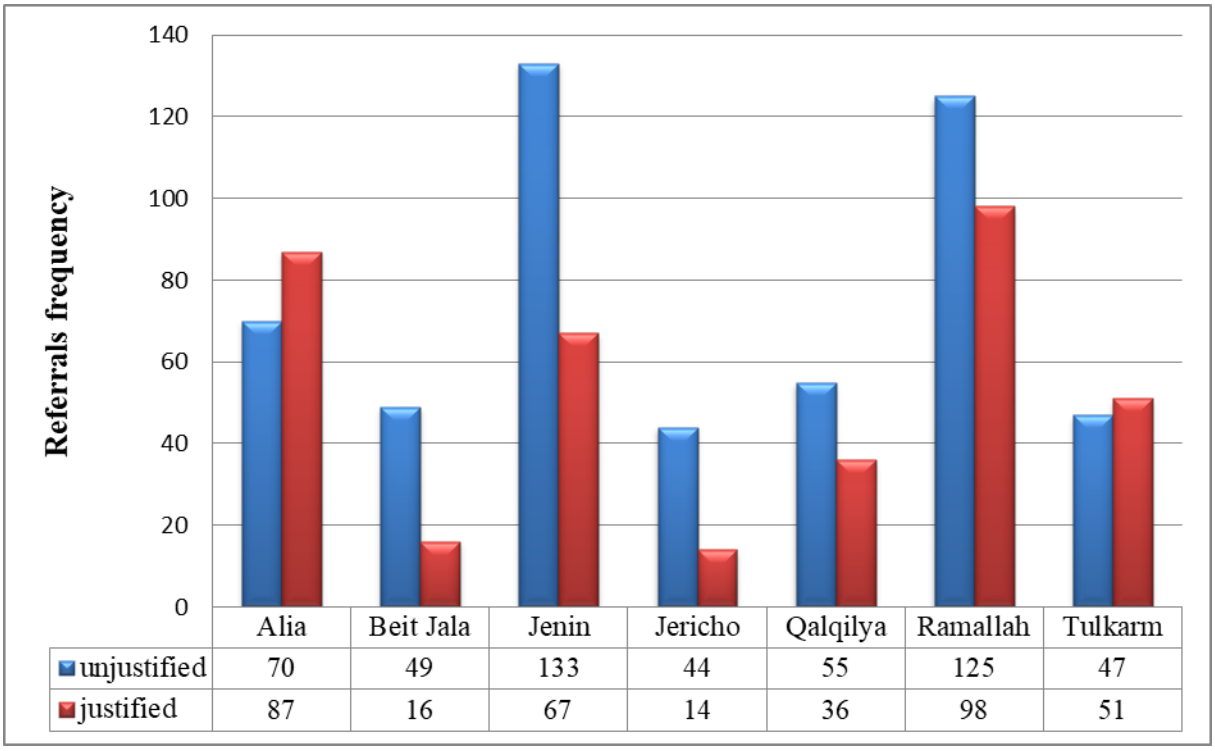

Figure 4.2: Clustered column (bar chart) show the distribution of referrals according to justification status over seven public hospitals.

Of these 892 referrals, 369 were considered to be justified by the radiologists, whereas the unjustified referrals were 523 referrals. The matching between two radiologists was 86.8% and the discrepancies between them were in 117 referrals about 14.2% which other third radiologist justification decision was taken to reach the consensus. The height justification rate was at Alia hospitals 55.4% and the lowest justification rate was at Jericho hospital 24.1 %.

Our present study shows the total rate of justification in all hospitals in the Palestinian public sector was 41.4 %.In compared our results to the results of study published in November 2018 in Northern Ireland which stated that the justification rate of abdomen and pelvis was 88 % in Northern Ireland(A Retrospective Review of Justification of Computed Tomography Examinations in Northern Ireland, 2018). we are notice a big difference in the rate of justified

referrals in Palestine and Ireland. This difference may due to educational level and cultures either for referring physicians or patients as well as the systematic requesting of CT scan on HIS integrated with CT guidelines.

On the other hand, in compared of our results to results of other study was done in public hospitals in Qatar and published in 2020,(Al Naemi et al., 2020).We notice more unjustified referrals of abdomen and pelvis CT in Palestinian public hospitals which about 58.6 % in compared to 47 % in Qatar hospitals.

There is mild to moderate difference in justified referrals between Palestine and Qatar which is may be due to the educational program for referring physicians in Qatar is more efficient than Palestine despite of approximately the same Arabian culture.

Our present study showed that the percentage of justified CT examinations performed in Palestinian public hospitals for abdomen and pelvis was the lowest in compared to the results of studies that were done in Qatar and Northern Ireland. Therefore, in Palestine we need to put Palestinian guidelines for requesting CT scan examinations.

In the abdominal and pelvis CT scan, our present study showed that 523 referrals were unjustified referrals which represent of 58.6 % the sample. Most of these examinations could have been performed with ultrasound instead. Most of unjustified examinations had indications of general abdominal pain, colic, flank pain. Whereas the indications of the justified cases were suspicion of acute abdominal infection, suspected or confirmed malignancy, calculus stone in the urinary tract, intestinal occlusion and others. As well as The examination was justified if there was an ambiguous results in the ultrasound examination, such as suspected of kidney trauma, suspected malignancy.

According to the American college of radiology the guidelines of abdomen and pelvis ultrasound were as the follow: in case of abdominal pain , flank and back pain, hematuria, jaundice, palpable abnormalities, abnormal laboratory tests, suggestive from other imaging modalities, evaluation of biliary system and inflammation of abdominal organs, cirrhosis, abdominal trauma, pretransplant evaluation, planning for invasive procedure, assessment of hypertension, assessment of urinary tract system, for tumors (This et al., 2021).

In the past three decades, a lot successful work has been faithful to developing technical optimization, However with respect to clinical justification or its implementation, fewer attempts and trials have been made, and those attempts and trials have not yet been sufficiently successful (Malone, 2009) (Malone et al., 2012).

Technical optimization of the CT dose is very extremely necessary, but careful election of patients for the CT scan by follow CT guidelines (clinical justifications) is also necessary, whenever possible, the use of alternative medical imaging modalities without ionizing radiation, may be more effective tools to avoid the patients from hazard of ionizing radiation.

There are only a little other studies published on the justification of CT procedures, and articles on the effect of various interventions on the paradigm shifts of the clinical justification process are sparse (Clarke et al., 2001).

In the few earlier studies that showed clinical indications or medical request forms for CT procedures, in Qatar a notable number of CT procedures were unjustified and could have been accomplished instead using ultrasound or plain X-ray and MRI(Al Naemi et al., 2020)(Leitz et al., 2009).In our study the researcher assessed all the corresponding patient medical files in

addition to the medical request forms in order to have the same data as the referring physician had while requesting the procedures. According to the American college of radiology on justification of CT examinations

There have been some studies evaluating the impact of the computerized physician request entry system with opinion and decision support on medical imaging modalities services. Some reports illustrated that the number of CT examinations decreased and the use of clinical guidelines in the test-ordering or requesting process improved. for our knowledge, there are rare other studies on the impact of more traditional interventions on the level of justification of CT examinations. (Carton et al., 2002)

In general, it is may be impossible to reach 100% justification. However, it is still necessary to develop justification processes by updating regularly of referral policies or guidelines and their use and increased patient information about issues of radiological examinations could also participate to increased justification.

Finally, the researcher have demonstrated that it is possible to reduce the number of abdomen and pelvis CT examinations and to improve their clinical justification in young patients by education regularly, guideline implementation and increased ultrasound capacity as well as other safe medical imaging modalities.

Table 4.13: show the distribution of justified examinations according to groups of justification guidelines.

Justification guidelines groups	Distribution of justified referrals according to each group after being justified by radiologists.
Group 1	33
Group 2	57
Group 3	85
Group 4	140
Group 5	54

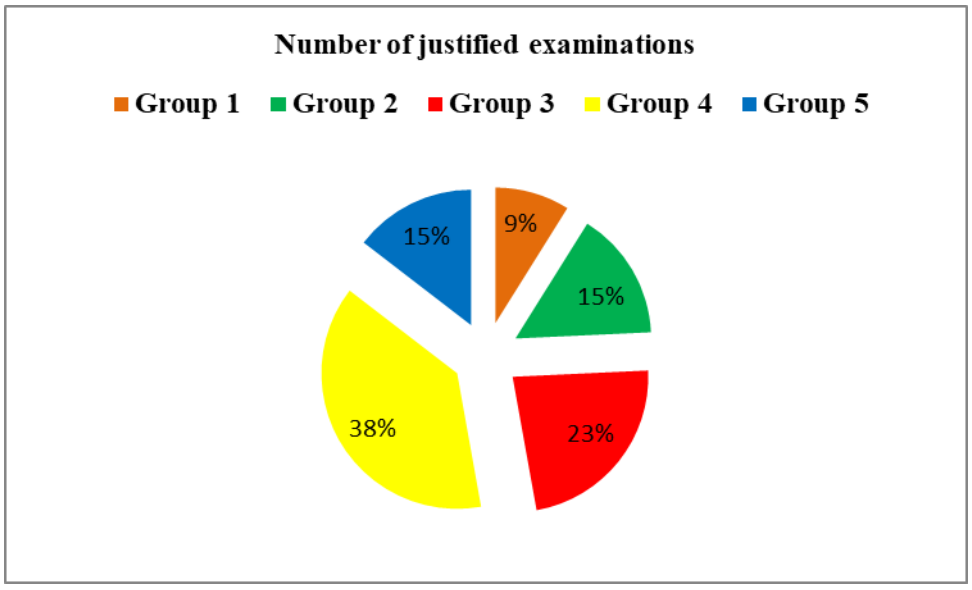

Figure 4.3: percentage distribution of justified examinations according to groups of justification guidelines.

The most frequent justified group was group 4 which state that CT examination can be justified if the referral indication was complained from urinary tract stone, to rule appendicitis, post operation and abdominal inflammatory process. The number of referral of these groups

was 140 referrals (38%) and the most indication was urinary tract stone and the next frequent indication was to rule out appendicitis.

The next frequent justified group was group 3 which stated that CT examination can be justified if the referrals have diagnosed with tumor or suspected tumor. The number of justified referrals in this group was 85 referrals (23%).

Group 1 have less frequent than other groups which state that the CT examination can be justified if the referrals exposed to any type of trauma and falling down and the number of referral in this group was 33 patients (9%). This percentage low may be due to most of falling down and trauma patients go to the private sector or to the nongovernmental hospitals.

Table 4.14: distribution of referrals according to justification status for pediatric and adults patients.

Pediatric * Examination justifying					
			Examination justified (1) / unjustified (0)		Total
			Unjustified	Justified	
Age status	Adults	Count	486	334	820
		% within Pediatric	59.3%	40.7%	100.0%
	pediatric	Count	37	35	72
		% within Pediatric	51.4%	48.6%	100.0%
Total		Count	526	371	892
		% within Pediatric	58.6%	41.4%	100.0%

Table 4.15 : Chi square test for testing the significance of justified and unjustified referrals according to age status.

Chi-Square Tests					
	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.697[a]	1	.193		
Fisher's Exact Test				.213	.120
Linear-by-Linear Association	1.695	1	.193		
N of Valid Cases	892				
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 29.78.					
b. Computed only for a 2x2 table					

The p-value > 0.05, therefore the researcher accepts the null hypothesis, which says that there is no significant difference in the number of justified and unjustified between pediatric and adults.

Our present study showed that the justified and unjustified examinations were low in pediatric age. It is likely that referring physicians or pediatricians pay high attention to justification and consult radiologists before requesting any CT scan procedure or examination. However, the total number of pediatric CT procedures was small in our study.

In compared our present study results to the results of study done in Oulu University Hospital in Finland which published in 2013 (Tahvonen et al., 2013). both studies were reached to the same results that is a few number of pediatric patients were performed CT scan examination and exposed to CT scan radiation, in our study the pediatric age represent 8% of our sample, whereas in Finland study the pediatric age represent 15 % of the study sample. but the discrepancies between both studies was there is difference in the proportion of CT scan pediatric justification, so as to the proportion of pediatric justified examination in Palestine was 48.6 %, whereas the proportion of pediatric justified examination in Finland was 80%.

Table 4.16: show the distribution of referrals according to justification status as a function of specialist or GP physicians.

Referral doctor * Examination justifying					
			Examination justified (1) / unjustified (0)		Total
			Unjustified	Justified	
Referral physicians	GP physician	Count	239 (58.9%)	167 (41.1%)	406 (100%)
	Specialist physician	Count	237 (54.6%)	197 (45.3%)	434 (100%)
	Unknown physician	Count	47 (90.4 %)	5 (9.6%)	52 (100%)
Total		Count	526	371	892
		% within Referral doctor	58.6%	41.4%	100.0%

Table 4.17: Chi square test for testing the significance difference between justified and unjustified referrals between GP and specialist physicians.

Chi-Square Tests					
	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.513[a]	1	.219		
Fisher's Exact Test				.238	.123
Linear-by-Linear Association	1.512	1	.219		
N of Valid Cases	892				
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 175.85.					
b. Computed only for a 2x2 table					

The p-value > 0.05, therefore the researcher accept the null hypothesis, which says that there is no significant difference in the number of justified and unjustified between GP & Specialist physicians. The results of the above described analysis indicated that there is small difference between referrals which refers either by specialist or general physicians but this difference it's not significant. According to study published in 2021 by Winder M. which stated that the non-specialists physicians made errors in requesting CT exams and in primary diagnosis more frequently than specialists physicians. A total of 76.9% of all referrals from non-specialists

and 62.5% of all referrals from specialists were errors in request of examination, respectively. Lack of knowledge regarding the primary diagnosis affected 26.5% of referrals from non-experts and 8.2% of referrals from specialists physicians, which was the biggest difference between the two groups (Winder, 2021). when compared our present study results to results of Winder study in 2021, our study results indicated there is no significant difference between number of referrals between specialist and general physicians (non - specialist physicians). This is may be due to some of general physicians used the user name and password of the specialist doctor at HIS in requesting of examinations instead of theirs user name and password. Requesting of CT can be by other medical staff (who is not physician) and this is evident by 52 of CT referrals were unknown referral physicians, 5 referrals of them were justified whereas 47 referrals were unjustified.

Table 4.18: distribution of referrals according to justification status as function of contrast status.

Examination contrast * Examination justifying Cross tabulation					
			Examination justifying		Total
			Unjustified	Justified	
Examination contrast status	With Contrast	Count	262	147	409
		% within Examination justifying	50.1%	39.8%	45.8%
	Without Contrast	Count	261 (49.9%)	222 (60.2%)	483 (54.2%)

Table 4.19: Chi square test for testing the significance difference between justified and unjustified referrals according to the contrast status.

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	9.786[a]	1	.002
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 169.99.			

The p-value was 0.002, therefore the researcher reject the null hypothesis and accept the alternative hypothesis, which says that there is a significant difference in the number of justified and unjustified examinations between with contrast and without contrast. So, there is relationship between the examination justification and contrast status. The exact relation remain unclear, but the relation may be as the follow, as the number of CT examinations done with intravenous contrast increase without clinical justification the number of unjustified examinations also increase.

According to the table 16, about 262 referrals with intravenous contrast unjustified whereas, the total referrals unjustified was 523 referrals. The unjustified referrals with contrast represent 50.1% of unjustified referrals. This unjustified referrals lead to increase hazards of ionizing radiation to the patients due to many sequences were done.

CT scan is a powerful device and highly flexible diagnostic tool enable of making radical changes to the patient clinical management. The most appropriate use of CT scan depends on a

lot of factors which must be considered every time a CT scan is justified. In certain cases the results of such consideration can be that the CT scan is not performed and an alternative medical imaging examination that does not include the use of ionizing radiation is used to answer the clinical diagnosis question. The aim of this study was to evaluate the justification of abdomen and pelvis CT scan referrals carried out within a 6months period across ten public hospitals in Palestine. The process of justification according to American college of radiology guidelines is weighing up the predicted net benefits of the radiation exposure against the possible radiation detriment or damage of the associated radiation dose. The study retrospectively evaluated the clinical history provided on CT scan referrals and taking into account any related previous medical imaging modalities. The scope of this retrospective study did not involve the patients clinical outcomes. It is also necessary to note that oral discussions that occurred between the practitioner and referrer doctor, which may have informed the justification process, were not registered or recorded and were therefore outside the scope of this retrospective study.

When compared our present study results to a study was done in Qatar hospitals and published in 2020(Al Naemi et al., 2020).Our results found that 50.1% of unjustified examinations were with intravenous contrast media were injected, the results from Qatar study showed approximately small difference in results with 47% of all CT referral with contrast were unjustified. Both studies found there is a small degree of justification varied depending on the abdomen and pelvic CT being examined.

According to the same study in Qatar which showed that Higher radiation dose penalty with unjustified phases were associated to the more frequent acquisition of unjustified portal venous phase imaging which is related to a higher radiation dose compared to the unjustified non-contrast phase (Al Naemi et al., 2020).

Some difference was found when analyzing the unjustified referrals according to hospital location. Hebron hospital had the lowest percentage of unjustified referrals with 44.6 % compared to Jericho hospital where the percentage of unjustified referrals was 75.9 %. ALHussein hospital also had the highest number of unjustified scans where the percentage of unjustified examination was 75.4 % where ultrasound and plain X-Ray would have been a more appropriate medical imaging modality. This difference in justifications status between hospitals may be due to load of work but It is not possible to identify the exact reason for this difference or variation from the data reviewed.

The number of unjustified CTs scan of the abdomen and pelvis increase significantly this may be due to our radiologists were not consulted regularly before abdominal and pelvis CT was requested for patients.

Chapter Five

5. Conclusion and Recommendations

5.1. Conclusions:

In conclusion, our present study showed high number of unjustified examinations in the Palestinian public hospitals was noted. The number of pediatric patients in acceptable range in compared to the number of other age groups included in the study.

There is significant difference in the number of justified and unjustified between CT examinations with contrast and without contrast. The results of our study highlights the necessity for raising awareness amongst both referring physicians and the radiologists about the need for better and correct clinical indications for abdomen-pelvis CT in the all patients included in our study.

Misused of CT scan referrals and unjustified referrals results in increase of health care public costs and reduce quality of provided services this is evident by the high number of CT examinations done without radiological reports.

It's important to introduce abdomen and pelvis CT guidelines in HIS to reduce the number of unjustified referrals and reduce the waiting time interval to do the CT scan.

5.2. Recommendations:

1) Qualified expert physicians should request the abdomen and pelvis CT scan in HIS according to abdomen and pelvis CT scan guidelines. And the radiologists should be reviewed the requests before the scan done.

2) Requesting of CT scan examinations must be depend on ALARA principle, patient safety, diagnosis quality.
3) It's important to introduce Palestinian CT scan guidelines by construction of committee from different medical specialty.
4) Persistent teaching and training for general and specialist physicians, radiologists, and medical imaging technologist about CT scan dose risks and it's benefits, whom to choose the most suitable modality, and how to justify CT scan examination as clinically indicated.
5) It's important from Palestinian ministry of health to constitute scientific research team to perform regular studies that reevaluate the CT scan justifications every year.

6) Referring patient's him/herself and his/her family should be more educated and aware about the possible risks and adverse health effects. More efforts should be perform to increase people's knowledge on this issue.

7) Increase number of radiologists in the Palestinian public hospitals and the radiologists must write a report on each CT case performed.

5.3. Future studies:

1) A Retrospective Study to Measure the Justification for CT Scans of the Abdomen and pelvis in Palestinian Public Hospitals.

2) Technical optimizations for dose reduction of abdomen and pelvis CT scan by using special filter.

5.4 Limitations of study:

The study dealt with abdomen and pelvic or renal CT examinations only. The data collection need to deal with the referrals or patients at the time of an examination to determine which patients justified and fitted the guidelines.

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APPENDICES

APPENDIX A: ethical approval from Al-Quds University to conduct the study.

Al Quds University
Faculty of Health Professions
Jerusalem –Abu Dis

جامعة القدس
كلية المهن الصحية
القدس – أبو ديس

Research Ethics Subcommittee of Faculty of Health Professions
Letter of approval

March. 12, 2023
Ref. No.: RESC/2023-16

Dear Applicants, (**Dr. Mohammad Hjouj, Mr. Ashraf Najajrah**)

Program: **MSc Medical Imaging Department**

The Research Ethics subcommittee of the Faculty of Health Professions has recently reviewed your proposal entitled (**A retrospective study of justification of Abdomen and pelvis Computed Tomography Examinations in Palestinian public Hospitals**) submitted by (**Dr. Mohammad Hjouj**). Your proposal is deemed to meet the requirements of research ethics at Al-Quds University, but further assessment is required by the Central Research Ethics Committee of Al-Quds University. We wish you all best for the conduct of the project.

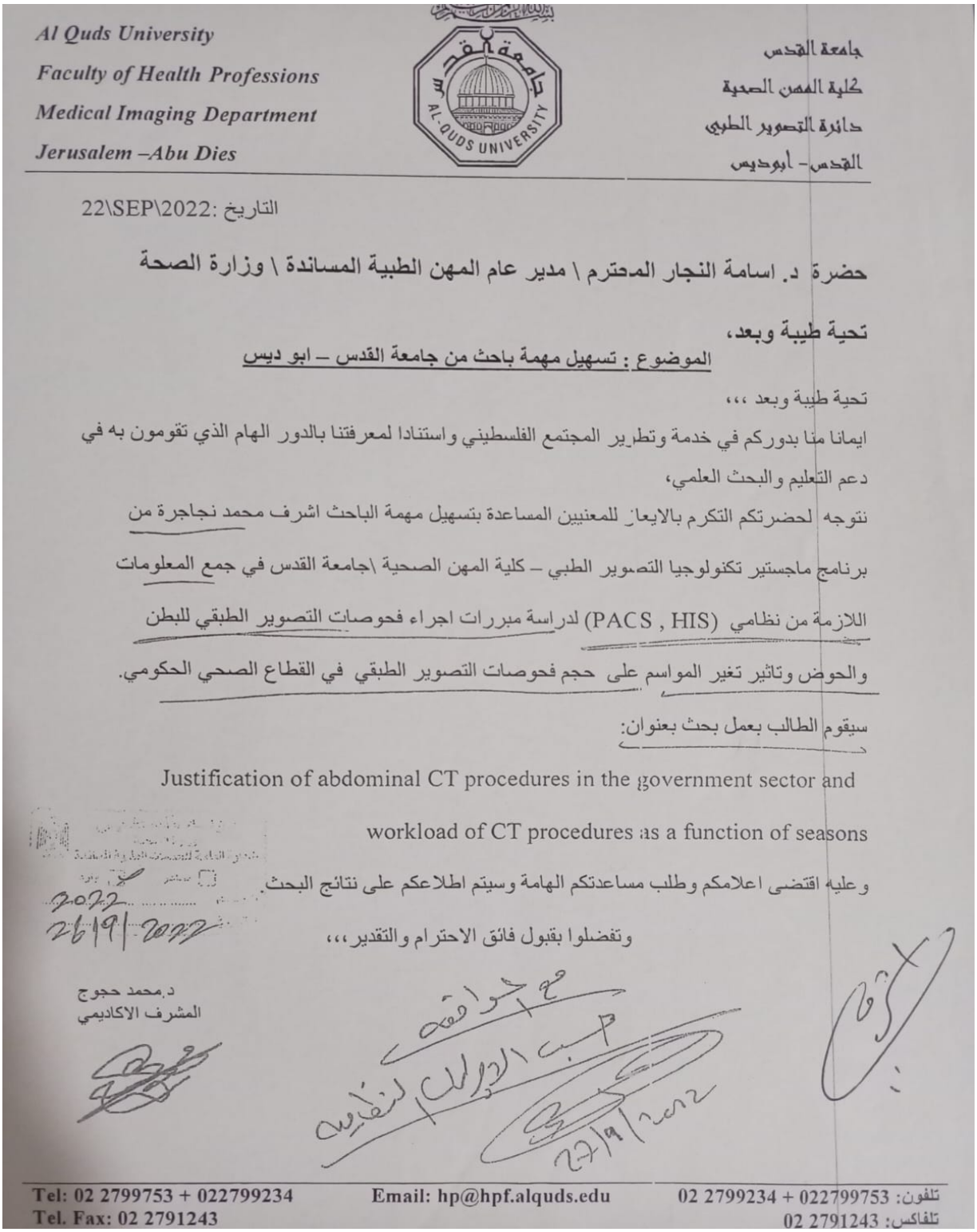
Hussein ALMasri, PhD
Associate Professor of Medical Imaging
Research Ethics Subcommittee Chair
Faculty of Health Professions

Hussein ALMasri

CC: File
CC: Committee members

Tel. Fax: 02 2791243 Email: dean@hpro.alquds.edu تلفاكس: 02 2791243

APPENDIX B: ethical approval from Palestinian ministry of health to conduct the study.



Al Quds University
Faculty of Health Professions
Medical Imaging Department
Jerusalem –Abu Dies

جامعة القدس
كلية المهن الصحية
دائرة التصوير الطبي
القدس- ابوديس

التاريخ :22\SEP\2022

حضرة د. اسامة النجار المحترم \ مدير عام المهن الطبية المساندة \ وزارة الصحة

تحية طيبة وبعد،

الموضوع : تسهيل مهمة باحث من جامعة القدس – ابو ديس

تحية طيبة وبعد ،،،

ايمانا منا بدوركم في خدمة وتطوير المجتمع الفلسطيني واستنادا لمعرفتنا بالدور الهام الذي تقومون به في دعم التعليم والبحث العلمي،

نتوجه لحضرتكم التكرم بالايعاز للمعنيين المساعدة بتسهيل مهمة الباحث اشرف محمد نجاجرة من برنامج ماجستير تكنولوجيا التصوير الطبي – كلية المهن الصحية \جامعة القدس في جمع المعلومات اللازمة من نظامي (PACS , HIS) لدراسة مبررات اجراء فحوصات التصوير الطبقي للبطن والحوض وتاثير تغير المواسم على حجم فحوصات التصوير الطبقي في القطاع الصحي الحكومي.

سيقوم الطالب بعمل بحث بعنوان:

Justification of abdominal CT procedures in the government sector and workload of CT procedures as a function of seasons

وعليه اقتضى اعلامكم وطلب مساعدتكم الهامة وسيتم اطلاعكم على نتائج البحث.

وتفضلوا بقبول فائق الاحترام والتقدير،،،

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دراسة استرجاعية لقياس مبررات التصوير الطبقي للبطن والحوض في المستشفيات العامة الفلسطينية

إعداد : أشرف محمد حرب نجاجره

المشرف: د. محمد حجوج

الملخص:

التصوير المقطعي المحوري هو إجراء تصوير تشخيصي غير جراحي يستخدم مزيجًا من تقنيات الكمبيوتر والأشعة السينية لإنتاج صور محورية (غالبًا ما تسمى شرائح) لأعضاء الجسم البشري. يعد التصوير المقطعي جهازًا قويًا وأداة تشخيصية مرنة للغاية تمكن من إجراء تغييرات جذرية على الإدارة السريرية للمريض. يعتمد الاستخدام الأمثل للأشعة المقطعية على الكثير من العوامل التي يجب أخذها في الاعتبار في كل مرة يتم فيها تبرير إجراء التصوير المقطعي. يعتبر التصوير المقطعي أكبر مساهم في إجمالي جرعة الأشعة للسكان، ففي الولايات المتحدة يتم إجراء أكثر من 60 مليون فحص بالأشعة المقطعية سنويًا. وإذا تناول المريض جرعة فعالة يزيد خطر الإصابة بالسرطان. ويهدف الباحث من هذه الدراسة الاسترجاعية إلى تحديد ما إذا كان إجراء الفحص بالأشعة المقطعية على البطن والحوض في المستشفيات العامة الفلسطينية مبرراً أم لا. في هذه الدراسة الاسترجاعية، كان حجم العينة 892 إحالة، منهم 458 أنثى و 434 ذكر من سبعة مستشفيات عامة في فلسطين. شارك ثلاثة أخصائيين أشعة في هذه الدراسة, اثنان منهم قاموا بشكل منفصل في الحكم على ما إذا كان الفحص مبررًا أم غير مبرر وفقًا لمعايير التبرير، وشارك أخصائي أشعة ثالث للوصول إلى الإجماع في حالة وجود أي اختلافات بين الأخصائيين السابقين. تم استخدام اختبار مربع كاي وكذلك برنامج Excel و برنامج SPSS في التحليل الإحصائي. هناك فرق ذو دلالة إحصائية بين الفحوصات المبررة وغير المبررة في المستشفيات العامة في فلسطين حيث كانت نسبة الفحوصات غير المبررة 58.6% وقيمة (p.value) تساوي0.00. كما أن هناك فرقاً معنوياً في عدد الفحوصات المبررة وغير المبررة باستخدام مادة التباين وبدون استخدام مادة التباين وكانت قيمة (p.value) تساوي 0.02 . أما باقي المؤشرات التي تم قياسها لم تظهر أية دلالة إحصائية ذو فرق معنوي. في الختام أظهرت دراستنا الحالية ارتفاع في عدد فحوصات الطبقية الغير المبررة في المستشفيات العامة الفلسطينية. وكان عدد المرضى الأطفال

الذين تم تصويرهم صورة طبقية للبطن والحوض ضمن النطاق المقبول (8%) مقارنة بعدد المرضى الكبار (92%) المشمول في الدراسة. هناك فرق كبير في عدد الفحوصات المبررة وغير المبررة بين فحوصات الأشعة المقطعية التي تم فيها استخدام مادة التباين وكذلك التي لم يتم استخدام فيها مادة التباين. من المهم إدخال مؤشرات فلسطينية لطلب الأشعة المقطعية وكذلك زيادة الوعي لدى أهالي المرضى حول مخاطر الإشعاع. ومن ناحية أخرى يجب تقديم التدريب المستمر للفريق الطبي للتعرف على مبررات الأشعة المقطعية ومخاطرها وخاصة الأطباء المسؤولين عن تحويل المرضى للأشعة المقطعية.