APPROPRIATENESS IN IMAGING STUDIES SELECTION AMONG EMERGENCY MEDICINE POST-GRADUATE STUDENT IN HOSPITAL UNIVERSITI SAINS MALAYSIA

DR MUHAMMAD HANIF BIN ABDUL MALEK

Dissertation Submitted in Partial Fulfillment of The Requirements for The Degree of Master of Medicine (Emergency Medicine)

UNIVERSITI SAINS MALAYSIA

2020

PUSAT PENGAJIAN SAINS PERUBATAN
UNIVERSITI SAINS MALAYSIA

PENYERAHAN DISERTASI MUTAKHIR
SARJANA PERUBATAN / SURGERI / PATOLOGI

BAHAGIAN A (Untuk diisi oleh calon)

Nama : Muhammad Hanif bin Abdul Malek
Bidang : Sarjana Perubatan (Perubatan Kecemasan)

Bersama-sama dengan ini saya kemukakan dalam bentuk berjilid, dua (2) naskah disertasi dan 3 keping CD bertajuk

APPROPRIATENESS IN IMAGING STUDIES SELECTION AMONG EMERGENCY MEDICINE POST-GRADUATE STUDENT IN HOSPITAL UNIVERSITI SAINS MALAYSIA

yang telah dibuat pembetulan sepertimana yang diperlukan.

2. Saya juga mengesahkan bahawa disertasi tersebut telahpun disemak oleh Penyeliasaya dan komen beliau adalah seperti di bawah.

Sekian, terima kasih.

…… Tarikh : 06/05/2021
(Tandatangan calon)

BAHAGIAN B (Untuk diisi oleh Penyelia)

Saya telah menyemak semua pembetulan/pindaan yang dilaksanakan oleh calon yang tersebut. Saya ingin mengesahkan bahawa :-

i) Saya berpuashati dengan pembetulan / pindaan yang dilaksanakan oleh calon.

…….. Tarikh:……
(Nama dan tandatangan Penyelia

Pin.1/2015

AKU JANJI

Diperakui bahawa disertasi yang bertajuk APPROPRIATENESS IN IMAGING STUDIES SELECTION AMONG EMERGENCY MEDICINE POSTGRADUATE STUDENT IN HOSPITAL UNIVERSITI SAINS MALAYSIA merupakan kerja dan penyelidikan yang asli dari MUHAMMAD HANIF BIN ABDUL MALEK, No Kad Pengenalan: 870918-03-5135, No Matrik: P-UM 0064/17 dari tempoh 2017 hingga 2021 adalah di bawah penyeliaan kami. Disertasi ini merupakan sebahagian daripada syarat untuk penganugerahan Sarjana Perubatan Kecemasan, segala hasil penyelidikan dan data yang diperolehi adalah hak milik terpelihara Universiti Sains Malaysia.

_____

Tandatangan Pelajar

_____	_____
Tandatangan Penyelia Tandatangan	Tandatangan Ketua Jabatan
Pensyarah Jabatan Perubatan Kecemasan	Jabatan Perubatan Kecemasan
Pusat Pengajian Sains Perubatan	Universiti Sains Malaysia
Universiti Sains Malaysia	

ACKNOWLEDGEMENTS

First and foremost, I would like to express my utmost gratitude to my supervisors, Dr. Normalinda Yaacob and Dr. Mohd Boniami Yazid, for their guidance and useful engagement since the very beginning of this dissertation. This dissertation would not be completed without their support and encouragement.

My sincere appreciation also to the Head of Department and all the Department of Emergency Medicine lecturers, Hospital Universiti Sains Malaysia, who has been directly or indirectly involved in the completion of this study.

I also would like to express my indebtedness to my colleagues and course mates for their cooperation and contribution in data collection throughout this study.

Finally, I would like to thank my family and close friends, who have supported me throughout the entire process, and give the encouragement that I needed until this study is completed.

TABLE OF CONTENTS

LIST OF ABBREVIATIONS

ED Emergency Department

FAST Focused Assessment with Sonography in Trauma

CT Computed Tomography

USG Ultrasonography

HUSM Hospital Universiti Sains Malaysia

HIV Human Immunodeficiency Virus

ABSTRAK

Latar Belakang

Pengimejan radiologi adalah penting dalam proses penilaian pesakit di jabatan kecemasan. Justeru itu, kecekapan dalam pemilihan pengimejan radiologi yang betul untuk pesakit adalah penting bagi staf di jabatan kecemasan.

Objektif

Objektif kaji selidik ini adalah untuk menentukan tahap kompetensi pelajar pascasiswazah dalam pemilihan pemeriksaan radiologi serta hubungannya dengan tahun pengajian dan pengalaman klinikal.

Tatacara

Pelajar pascasiswazah perubatan kecemasan telah di rekrut dari Hospital Universiti Sains Malaysia dan mereka di beri borang soal selidik yang mengandungi 10 soalan klinikal. Soalan soalan tersebut telah dipilih dari ‘American College of Radiology appropriateness criteria’ dan rujukan silang di buat dengan garis panduan lokal. Keputusan dari kajian kemudian di kaji secara menyeluruh dan strata mengikut tahun pengajian dan pengalaman klinikal di buat menggunakan analisis variasi dan ujian T bebas.

Keputusan

Sejumlah 92 responden telah menjalani kaji selidik ini. Purata jawapan betul adalah 7.61 (SD, 1.41). Bagi tahun pengajian dari tahun satu ke tahun empat, keputusan adalah 6.88 (SD, 0.85), 7.29 (SD, 1.04), 7.23 (SD, 1.41), dan 9.13 (SD, 1.13). Analisis inferens mendapati hubungan antara kecekapan dan tahun pengajian adalah ketara manakala hubungan antara kecekapan dan pengalaman klinikal adalah tidak ketara.

Kesimpulan

Peningkatan yang ketara di lihat pada kecekapan mengikut tahun pengajian. Walaubagaimanapun, keputusan secara menyeluruh yang tidak sempurna menunjukkan kurikulum yang lebih bersepadu dan kebiasaan dalam penggunaan garis panduan dapat membantu dalam melahirkan pakar perubatan kecemasan yang lebih mahir.

Kata Kunci

Perubatan Kecemasan; American College of Radiology Appropriateness Criteria; Pengimejan Radiologi; Pelajar Pascasiswazah

ABSTRACT

Background

Radiological imaging has played a significant role in evaluating patients in the emergency department (ED). Thus, emergency department personnel needs to be competent in selecting appropriate radiological imaging for the patients.

Objectives

This study aims to determine competency in appropriate imaging studies selection among the postgraduate students and look for association in this matter with their academic year and clinical experiences.

Methods

Emergency medicine postgraduate students were recruited from Hospital Universiti Sains Malaysia and were given a set of questionnaires that consist of 10 common clinical scenarios. The questions were selected from American College of Radiology appropriateness criteria, and cross-reference was made using the local guideline. The results were then graded as a whole and stratified by academic year and clinical experiences using analysis of variance and independent T-test.

Results

A total of 92 respondents completed the survey. The mean of the overall correct answer was 7.61 (SD, 1.41). First to fourth year postgraduate students scored 6.88 (SD, 0.85), 7.29 (SD, 1.04), 7.23 (SD, 1.41), and 9.13 (SD, 1.13). The inferential analysis found a significant association between competency and academic year and a non-significant difference between competency and clinical experiences.

Conclusion

Significant improvement was noted in the competency throughout the program. However, the average score that was not perfect concludes that a more structured curriculum and familiarization towards appropriateness guidelines might help in producing a more proficient emergency physician.

Keywords

Emergency Medicine; American College of Radiology Appropriateness Criteria; Radiological Imaging; Postgraduate student

CHAPTER 1: INTRODUCTION

1.0 INTRODUCTION

Radiological imaging studies have played an essential role in evaluating and assessing patients in the emergency department (ED) (Levin et al., 2014). Nevertheless, the decision to make a correct initial imaging examination has taken a greater value and significance, given the risk of ionizing radiation and the financial concern of the selected imaging studies (Brink and Amis Jr, 2010, Simonet, 2009).

The knowledge and comprehension of appropriate imaging examinations in various emergency department clinical situations are mainly based on medical practitioners' clinical experience, local practice, and consultation from the expert physicians and radiology consultation. However, the availability of various imaging modalities and studies nowadays has made the decision to select the most appropriate and proper initial imaging more challenging.

In many major postgraduate programs, including emergency medicine, the student has not received adequate teaching and training, emphasizing radiological imaging (Choy and Novelline, 2013, Shuaib et al., 2014). This may cause unnecessary and inappropriate initial imaging studies to be requested, which in turn will lead to waste of money, delaying of patient care and overcrowding in ED (Dunnick et al., 2005, Collins, 2014), increase in workload as well as some examination might be baleful to the patient, for example, pregnant women and children.

Given the lack of radiology training in the emergency medicine master of medicine program, the use of appropriateness criteria would be helpful in this matter. American College of Radiology (ACR) Appropriateness Criteria, which was introduced in 1993, with many revisions has been done since it can help physicians select the most appropriate initial imaging in various clinical scenarios (American College of Radiology, n.d.).

1.1 PROBLEM STATEMENT

Radiological imaging studies have evolved rapidly for the past decades, and utilization of imaging has grown most extensively in ED. This has made it more challenging for medical practitioners in ED to select and opt-out the most appropriate imaging modalities for patient care. Traditionally, most of the imaging studies requested by ED medical practitioners are based on experience, indirect teaching, and consultation from experts and radiologists.

Studies have been done among emergency medicine residents and conclude for more training and education to be provided to emergency medicine residency programs in this area (Dolatabadi et al., 2018, Dym et al., 2013). However, due to different background of medical training and clinical practice in Hospital Universiti Sains Malaysia (HUSM) emergency medicine Master of Medicine program from the previous study done, the result and conclusion might be different in our setting. The purpose of this study is to determine if emergency medicine postgraduate students in HUSM are capable enough to select the most appropriate imaging studies for better patient care.

1.2 RESEARCH QUESTION

i. Does the emergency medicine postgraduate student in HUSM competent enough in choosing appropriate initial imaging in the common clinical scenarios in ED?

ii. Does the competency of emergency medicine postgraduate students in HUSM in choosing appropriate imaging studies improve over the course of their academic year?

iii. Do years of clinical experience before joining the postgraduate program determine the competency of emergency medicine postgraduate students in HUSM in choosing appropriate imaging studies?

1.3 OBJECTIVES

1.3.1 General objective

To determine appropriateness in imaging studies selection among emergency medicine postgraduate students in HUSM.

1.3.2 Specific objectives

i. To determine the competency of emergency medicine postgraduate students in HUSM in selecting appropriate initial imaging modalities in common clinical scenarios in ED.

ii. To identify the association between competency of emergency medicine postgraduate students in selecting appropriate initial imaging modalities with their academic year.

iii. To identify the association between competency of emergency medicine postgraduate students in selecting appropriate initial imaging modalities with years of clinical experience before joining the program.

1.4 RESEARCH HYPOTHESIS

Hypothesis 1

H_0: There is no association between the competencies of emergency medicine postgraduate students in selecting initial imaging modalities with their academic year.

H_1: There is an association between the competencies of emergency medicine postgraduate students in selecting initial imaging modalities with their academic year.

Hypothesis 2

H_0: There is no association between the competencies of emergency medicine postgraduate students in selecting initial imaging modalities with years of clinical experience.

H_1: There is an association between the competencies of emergency medicine postgraduate students in selecting initial imaging modalities with years of clinical experience.

1.5 JUSTIFICATION OF STUDY

1.5.1 Justification of study to ED and HUSM

This study measures the capability of Hospital Universiti Sains Malaysia (HUSM) emergency medicine postgraduate student in opting-out the most appropriate initial imaging studies for specific defined clinical scenarios. This will allow the department and faculty to identify measures to prevent overutilization of imaging modalities if needed, which may avoid a waste of money, time, and staff workload.

1.5.2 Justification of study to the participant

This study is crucial as it can reflect the academic value in terms of student competency in choosing appropriate initial imaging modalities in different clinical scenarios commonly encountered in ED. Furthermore, many studies have shown lack of exposure and training in radiology in most major residency programs, including emergency medicine, causes overutilization of imaging modalities (Choy and Novelline, 2013, Shuaib et al., 2014, Collins, 2014). This study may help show the importance of radiology posting and training for emergency medicine postgraduate students and draft a new study proposal for the emergency medicine fraternity to include radiological posting in their curriculum.

1.5.3 Justification of study to patients

Introduction and familiarization towards appropriateness criteria as a tool in aiding the selection of imaging studies can benefit patient care. We can avoid unnecessary imaging studies from being ordered, which will prevent delays in

patient care and overcrowding in ED. This will also avoid inappropriate imaging, which will not help in the final decision to be carried out, as radiation can be harmful to a certain group of patients such as children and pregnant women.

1.6 LITERATURE REVIEW

Over recent decades, radiological imaging has been the most rapidly growing field in medical service (Levin et al., 2014). A previous study also showed that utilization of non-invasive imaging grew most rapidly in ED relative to other settings, including hospital inpatient, hospital outpatient, and private office (Levin et al., 2014, Rao et al., 2011). The fast-growing of imaging modalities has also caused an increase in the public's cumulative exposure to radiation, which may increase cancer potential. Recommendations have been addressed, which includes to appropriately select radiating imaging study to minimize this risk (Amis Jr and Butler, 2010).

Imaging services overutilization includes studies indicating that they are ordered but not likely to improve patient outcome. Publications suggested that as many as 20-50% of imaging done failed to benefit patient outcome and welfare (Hendee et al., 2010). Inappropriate use of imaging studies not only would not improve the quality of health care but also increase in financial burden, wasting of time, increase in workload, and delay in the diagnostic workout for the patient (Dunnick et al., 2005). Other than that, ionizing radiation used for children in diagnostic imaging is increasing in trend. They might give rise to cancer risk as they have higher radiosensitivity and potential repeated

exposure in their longer lifetime (Applegate and Cost, 2013). A study also shows that radiation to the uterine may cause infertility and also poor pregnancy outcome in a certain dose (Teh et al., 2014). This shows that inappropriate imaging study done will cause more harm than good to the patient.

Despite the fast-growing and evolution of emergency radiology, a large and immense number of students and trainees still have not received dedicated training or courses, which emphasis on radiological imaging (Shuaib et al., 2014). The ACR appropriateness criteria is a scientific-based tool developed to guide physicians on the selection of favorable diagnostic imaging studies (American College of Radiology, n.d.). However, a study has shown that the tool is still not fully utilized by physicians and underused (Bautista et al., 2009).

An earlier study done in Albert Einstein College of Medicine in New York found out that emergency medicine residents do not show notable improvement in their proficiency in selecting the most appropriate imaging studies in different clinical scenarios over their academic year (Dym et al., 2013). A more recent study done in Shahid Beheshti University of Medical Science, Tehran, Iran, showed a low average score in the competency of the emergency medicine resident in choosing appropriate diagnostic imaging in common clinical scenarios in ED (Dolatabadi et al., 2018)

1.7 CONCEPTUAL FRAMEWORK

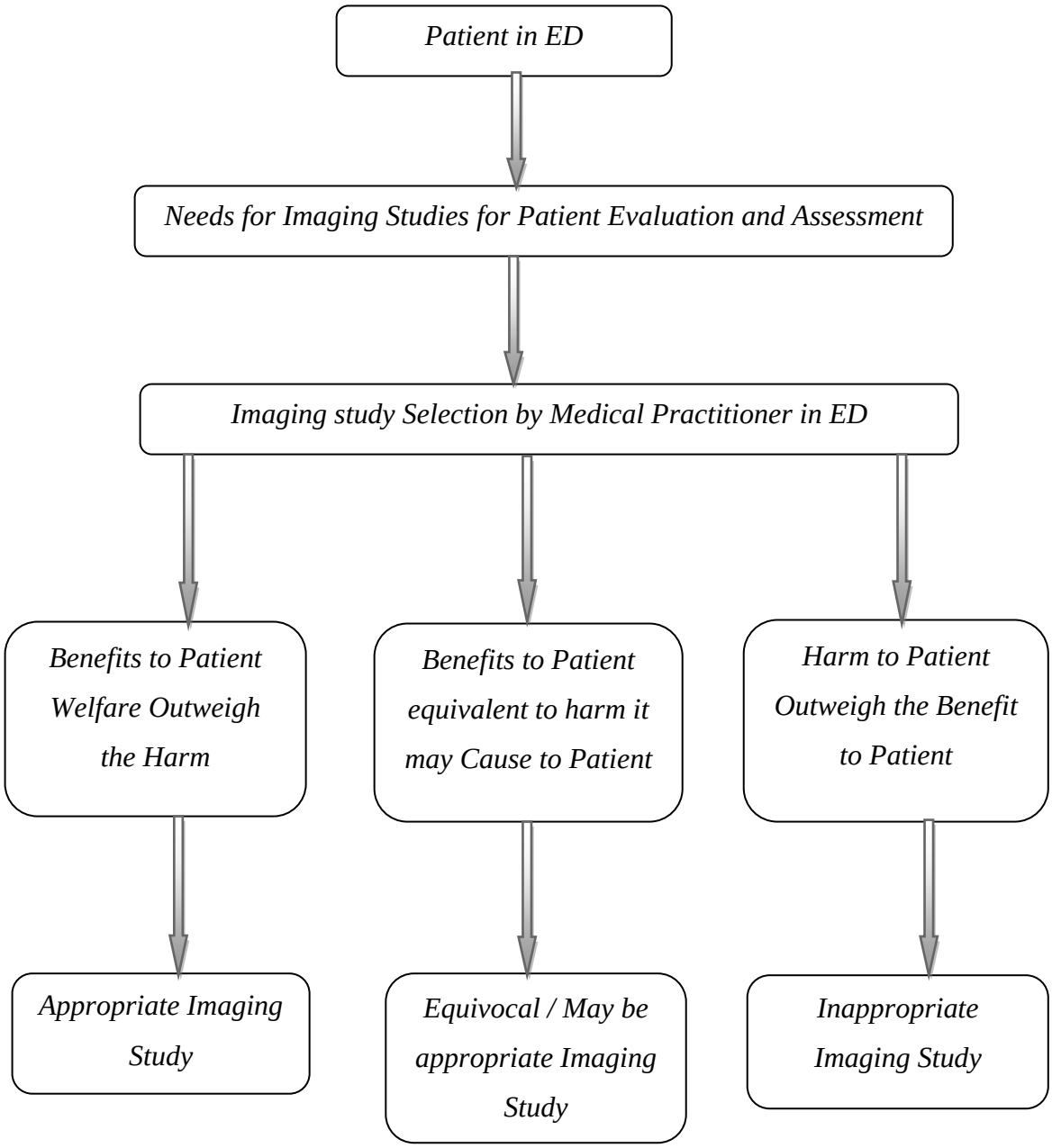

Figure 1: The Conceptual Framework

1.8 THEORETICAL FRAMEWORK

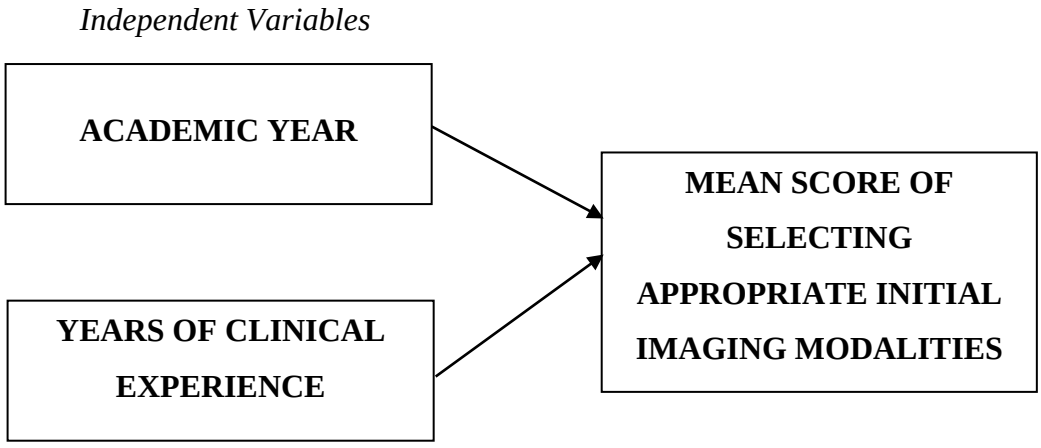

Figure 2: The Theoretical Framework

The theoretical framework above consists of two independent variables and one dependent variable. The independent variables are the academic year and the years of clinical experience. The dependent variable in the framework is the mean score of selecting appropriate initial imaging modalities.

CHAPTER 2: STUDY PROTOCOL

2.0 RESEARCH METHODOLOGY

The main objective of this research is to explore appropriateness in imaging studies selection among emergency medicine postgraduate students in HUSM. There are several methods and mechanisms adopted in drawing up this study to obtain a significant result. This chapter describes the methods used in meeting the objectives of this study. As known, research methodology refers to an explanation about research design, methods to collect data, sampling design, and statistical technique for analysis of data. These methodology elements must be appropriately selected to reflect a reliable result to fulfill the research objectives.

2.1 RESEARCH DESIGN

Research design can be defined as a plan for collecting and utilizing data so that desired information can be obtained with enough precision or so that a hypothesis can be adequately tested.

This study will be a cross-sectional study. It will involve data of a target population to be gathered at a defined time. Other than that, the researcher will be using descriptive and quantitative (inferential) methods. Both mentioned methods are effective in gaining useful and relevant information, which later is going to be used in getting a reliable result.

2.1.1 Descriptive Statistics

This study will use a descriptive method. A descriptive method refers to the technique used to observe and obtain data through questionnaires that describe the characteristics of the population that already exist and determine the reasons that contribute to those characteristics.

The competency of postgraduate emergency medicine students in HUSM in selecting appropriate initial imaging studies will be measured and described using mean and standard deviation.

2.1.2 Quantitative (Inferential) Analysis

This study will also use the quantitative approach as a research design. The quantitative method is a measurement, which generates numerical for a statistical review. Therefore, after constructing the set of questionnaires, it will be disseminated to all selected respondents. The results of this process could then be used to examine the association between independent and dependent variables.

In this study, the quantitative (inferential) analysis will be used to identify the association between competency of postgraduate emergency medicine students in HUSM in selecting appropriate initial imaging studies with their academic year and also their years of clinical experience.

2.2 SAMPLING DESIGN

Sampling design is the specific planning that consists of the study area, study population, sampling frame, sampling technique, and sampling size. According to (Lohr, 2009), the reason for sampling design is to understand the characteristics of the population.

2.2.1 Study area:

Emergency Department Hospital Universiti Sains Malaysia

2.2.2 Study population

The reference/target population for this study is the postgraduate students in master of medicine (emergency medicine) program.

The study population for this study is postgraduate students in master of medicine (emergency medicine) program in HUSM at the time of data collection. This includes postgraduate students from year 1 to year 4 of the program.

2.2.3 Study duration

The study is going to be performed from December 2018 to May 2019 (6 months).

2.2.4 Subject criteria

Inclusion criteria: Postgraduate students in master of medicine (emergency medicine) program in HUSM at the time of data collection.

Exclusion criteria: Postgraduate students in master of medicine (emergency medicine) program in HUSM who refuse to involve in this study.

2.2.5 Sampling Frame

The sampling frame is a list used to represent the researcher's population of interest. According to (Hair, 2007), the sampling frame is defined as a list of elements from which a sample may be selected. In this research, the sampling frame consists of name list emergency medicine postgraduate students in HUSM who are eligible to participate in the study (Appendix I).

2.2.6 Sampling Technique

This study will use a stratified sampling technique. The population will be divided into four strata (year 1, year 2, year 3, and year 4) and randomly sampled from each stratum. An online computerized generator will be used to choose samples from the sample frame from each stratum randomly.

2.2.7 Sample size calculation

Population size of emergency medicine postgraduate students in HUSM during data collection are 107 (N = 102). According to (Daniel, 1999), formula used for the sample size (n) calculation according to population proportion is:

$$n = \frac{(N)(X)}{X+N-1} \quad \text{where, } X = \frac{Z^2_{\alpha/2} * p * (1-p)}{(Margin\ of\ Error)^2}$$

$Z_{\alpha/2}$ = Critical value of the Normal distribution at $\alpha/2$

p = sample proportion = 50% Confidence level = 95%

N = Population Size = 107 n = Sample Size

Margin of error = 5%

Sample size determined from above formula will be

n = 82 + 10% non-response ≈ 90

However, the population and sample size might differ later as the data collection will start in December 2018. Population size will be different at the time of data collection due to the start of the new academic semester, and new students will enroll in the postgraduate program as well as some students will graduate.

Table 1: Sample size based on strata using the stratified sampling method

Year	**Population size**	**Sample size**
1	23	$\frac{23}{103} \times 90 = 20.09 \approx 20$
2	32	$\frac{32}{103} \times 90 = 27.96 \approx 28$
3	21	$\frac{21}{103} \times 90 = 18.35 \approx 18$
4	27	$\frac{27}{103} \times 90 = 23.59 \approx 24$
Total	103	90

2.3 DATA COLLECTION METHOD

Data collection is the process of gathering and measuring information on variables of interest in an established systematic fashion that enables one to answer stated research questions, test hypotheses, and evaluate outcomes. The researcher will approach participants individually, and explanations will be given regarding the study. The researcher will approach the participant during their convenient free time. For out-campus students, they will be approached during their free time once they come back for the intensive course in HUSM. For in-campus students, they will be approached during break time during the weekly continuous medical education session in ED every Tuesday. The researcher will ask beforehand if the time is convenient for them and will approach the participant at another time if they are not free at that moment. A questionnaire using a direct questionnaire method will be hand over to them if they consent to participate in the study. They are expected to complete the questionnaire individually in the researcher's presence within 5 minutes duration and hand over the answered questionnaire to the researcher. The questionnaire and consent will be handled in the English language as all the eligible participants have good English proficiency as a part of the requirement for the postgraduate program in HUSM.

After the questionnaires from all participants are submitted back to the researcher, a detailed, correct option with explanations based on the ACR Appropriateness Criteria will be delivered to the participant. Documents will be kept in a safe place and will be destroyed after five years post-study, according to standard record-keeping procedure.

2.3.1 Primary Data

In this study, the researcher will use primary data. Primary data is data collected firsthand for subsequent analysis to find solutions to the purpose of the study. The sources of primary data will be gathered from the questionnaire, which is designed to get the information about the appropriateness in imaging studies selection among emergency medicine postgraduate students in HUSM.

2.3.2 Questionnaire Design

Questionnaires are formulated written sets of questions to which respondents record their answers, usually within closely defined alternatives. A multiple-choice questionnaire that has been designed from the previous study done in Imam Hossein Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran, will be used in this study. An email was sent to the author of the study requesting permission to use the questionnaire (Appendix II), which was granted (Appendix III).

The questionnaire was designed to consist of 10 common clinical scenarios in the ED, and they were selected from the ACR Appropriateness Criteria. Up until today, the ACR appropriateness criteria are currently the most complete evidence-based guidelines in radiological imaging investigation and intervention. The ACR has allowed for individual use of the ACR appropriateness criteria for

research, scientific, and informational purposes (American College of Radiology, n.d.).

The questionnaire will be tailored to best suit the study population and environment using the ACR appropriateness criteria and guidelines for clinical practice in radiology by Malaysian Radiological Society as cross-reference (Malaysian Radiological Society, 2000, American College of Radiology, n.d.).

Afterward, a group of experts (emergency physicians and lecturers in the emergency department) will be gathered to review the new tailored questionnaire and give their opinions regarding the items in the questionnaire. Emergency physicians and lecturers are chosen as expert panels given their expertise in radiological imaging selection in common clinical scenarios in ED. During the meeting, they will discuss on any better improvement that can be made to the questionnaire. The expert will judge on how relevant and related the items in the questionnaire to the concept and if adequate items are used to cover the concept of the study. Series of corrections will be done based on the expert discussion to fulfill the purpose of the study. The final corrected questionnaire will be used for this study (appendix IV).

Apart from the clinical scenarios, a few preliminary demographic questions are also included in the questionnaire. The structured questionnaire consists of two sections:

i. Section A

The questions relate to the general information of the respondents, which is sociodemographic details such as gender, age, the current academic year in the emergency medicine training program, and years of clinical experience before joining the program.

ii. Section B

It consists of 10 clinical scenario questions representing a cross-section of common scenarios usually encountered in ED. Each of the questions will be followed by four different possible options of initial imaging and the fifth option of ‘no imaging required’. The participant is required to select only one most appropriate initial imaging modality from the options given.

Table 2: Summary of the common scenarios along with the correct answer based on ACR appropriateness criteria.

Clinical Scenario	**Most Appropriate Initial Imaging**
Urolithiasis	Ultrasound of kidneys and bladder
Suspected pulmonary embolus with negative D-dimer and intermediate pretest probability	Chest x-ray
Suspected acute cholecystitis	Ultrasound of abdomen
Respiratory illness in an HIV-positive patient	Chest x-ray
Uncomplicated low back pain in a young, healthy patient and no red flags	No imaging required
Stable blunt abdominal trauma with a positive focused assessment with sonography for trauma	CT of abdomen and pelvis with IV contrast agent
Suspected osteomyelitis of the foot	Foot x-rays
Palpable breast mass in a teenager	Breast ultrasound
Simple febrile seizure	No imaging required
Recurrent sinusitis	CT of paranasal sinuses

Table 3: References on questionnaire items based on section.

Section	Items	References
Section A	A1, A2, A3, A4	(Dolatabadi et al., 2018)
Section B	B1, B2, B3, B4, B5, B6, B7, B8, B9, B10	(Dolatabadi et al., 2018, American College of Radiology, n.d., Malaysian Radiological Society, 2000)

2.4 DEFINITION OF OPERATIONAL TERM

2.4.1 Radiological imaging studies

According to (U.S. National Library of Medicine, 2018), radiology is defined as a branch of medicine that uses radiation energy or radioactive material in the diagnosis or treatment of a disease.

Among radiological imaging studies that commonly used to diagnose or treat disease are X-ray radiography or plain X-ray, ultrasound, computed tomography (CT), nuclear medicine imaging including positron emission tomography (PET), and magnetic resonance imaging (MRI). All of these modalities have their advantage and disadvantage over one another.

2.4.2 Master of medicine (Emergency Medicine) postgraduate program

Based on (Department of Emergency Medicine School of Medical Science, 2018) website, the emergency medicine postgraduate program in HUSM is a structured program that aims to provide adequate training to produce competent future Emergency Physician. They will be an excellent resource for the country in the Emergency Medicine field.

One of the objectives of this program is to create emergency physicians who are capable of conducting clinical procedures, investigations, and making the correct diagnosis quickly and precisely for patient care in the field of Emergency Medicine. Thus, proficiency and competency in radiological imaging investigations play an important role as this will help in swift and precise patient care and management in ED (Department of Emergency Medicine School of Medical Science, 2018).

2.4.3 Competency in appropriate imaging studies selection

For this study, a consensus was made among experts (ED lectures and emergency physicians in HUSM), and it is decided to take a mean of 7.1, corresponding to an average score of 71% as a cut-off point of good competency in appropriate imaging studies selection. Mean value lesser than 7.1 for the total score of the whole batch of master student in ED and any mean value of lesser than 7.1 for each stratum (year 1, year 2, year 3, year 4) will be considered lacking in competency.

The value is taken based on the previous study (Dym et al., 2013) done among emergency medicine residents in the United States to determine competency in appropriate imaging study selection, which was described in mean and standard deviation. According to (Dym et al., 2013), The competency level in mean from the study was 7.1 (S.D,1.2), corresponding to the average score of 71%

2.4.4 Appropriateness and appropriate care in health system

Appropriateness is defined as if the expected benefit for patient health outweighs the expected harm to the patient by a clear margin that the procedure is worth doing, exclusive of the cost (Fitch et al., 2001). For this study, imaging modalities selected by the participant in the questionnaire are considered appropriate if the benefit outweighs the harm and are considered inappropriate if the harm outweighs the benefit to the patient. All of the decision if the modalities selected is appropriate or not is based on the latest evidence which was made and reviewed annually by the American College of Radiology using the Appropriateness Criteria (American College of Radiology, n.d.).

2.4.5 American College of Radiology (ACR) Appropriateness Criteria (AC)

The ACR AC are guidelines developed by the American College of Radiology to help medical practitioners in selecting the most appropriate imaging for specific clinical scenarios. Using these guidelines, radiology medicine can be utilized more efficiently, and medical practitioners can enhance the quality of care to the patient. The guidelines were developed

in 1993, and an annual review was done by expert panels in radiology and other specialties.

In developing the ACR AC, the ACR Task Force on Appropriateness Criteria subsumed elements for developing good medical practice guidelines based on the Agency for Healthcare Research and Quality (AHRQ). These elements include validity based on good quality scientific evidence, reliability, clarity, as well as clinically applicable.

For the purpose of imaging selection, the ACR AC is the most well-rounded evidence-based guidelines available. They encompass current evidence for selecting appropriate imaging for numerous clinical conditions (American College of Radiology, n.d.).

2.5 PROCEDURE OF DATA ANALYSIS

The data collected will be analyzed using IBM SPSS version 24.0. It will be examined using frequency, independent T-test, and analysis of variance (ANOVA) or F test. Therefore, the data is explained in three forms: demographic information, descriptive analysis, and inferential analysis.

2.5.1 Descriptive Analysis

For descriptive statistics, data is compiled, organized, summarized, and presented in suitable visual forms, which are easy to understand and suitable for use. Various tables, graphs, charts, and diagrams are used to

exhibit the information obtained from the data. A descriptive statistic table will be used to summarize the independent variable (gender, age, current academic year, and years of clinical experience before joining the postgraduate program) and dependent variable (mean (SD) or median (IQR) number of the correct answer of initial imaging selection, based on their normality distribution). Therefore, the data will be transformed into a meaningful form so that researchers can make conclusions based on a quick look at visual presentations.

2.5.2 F Test / Analysis of variance (ANOVA)

F-test is used to test group variance against the null hypothesis and is often used to determine whether any group of trials differs significantly from an expected value. To calculate the F-test value, find the degrees of freedom of each sample and the desired confidence interval. If the calculated ratio is less than the table value, accept the null hypotheses that the variance is not significantly different. The researcher will use ANOVA test to identify the association between competency of emergency medicine postgraduate students in selecting appropriate initial imaging modalities with their academic year as there were multiple independent variables (year 1, year 2, year 3, year 4).

2.5.3 Independent T Test

The T-test is used to determine whether there is a significant difference between the dependent variables and each of the independent variables. It is a technique to compare T-Value and T-Distribution Table.