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Cost Awareness of Radiological Studies Amongst Doctors at Universitas Academic Hospital, Bloemfontein

by

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Declaration

I, Dr. Khanyisa Nothemba Mrwetyana declare that the coursework Master's Degree mini-dissertation that I herewith submit in a publishable manuscript format for the Master's Degree qualification Clinical Imaging Sciences at the University of the Free State is my independent work and that I have not previously submitted it for a qualification at another institution of higher education.

25/07/2020

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Abstract

Background:

South Africa has high healthcare expenses, implementing cost-consciousness would translate to a reduction in costs which will reduce government spending on healthcare.

Objectives:

To determine cost awareness of radiological studies amongst doctors. To assess whether there are differences in cost estimation accuracy according to the level of training and speciality amongst doctors working at Universitas Hospital. To determine whether the participants have undergone any prior education or training related to cost awareness of radiological studies and if there is a desire to learn about the cost of radiological imaging.

Methods:

This study was a cross-sectional survey by means of an anonymous questionnaire. The study was conducted in six clinical departments at Universitas Academic Hospital. The questionnaire was aimed at determining cost awareness of five radiological studies amongst doctors. Doctors were given six different cost ranges to choose from for each imaging study with only one correct option. The costs were based on South Africans National Department of Health's 2019 Uniform Patients Fee Schedule (UPFS). Questionnaires were distributed in person by principal investigator.

Results:

195 questionnaires were distributed and 131 (67.2%) returned. There was an overall low cost estimation accuracy, with 45.2% of the participants getting none of the costs correctly. None of the participants estimated all five costs correctly. There was no significant difference in cost estimation accuracy according to the level of training or speciality. The majority of participants (88.6%) would like to learn about the cost of imaging. Only 2.3% of the participants have received prior education or training related to cost awareness of radiological studies.

Conclusion:

Doctors were consistently inaccurate in estimating the cost of the radiological studies. As doctors are largely responsible for health care expenditure, the result of this research suggest that educating doctors about the cost of radiological imaging can have a positive effect on healthcare expenditure.

Keywords

Cost, Awareness, Radiological studies, South Africa, Uniform Patients Fee Schedule

Abbreviations

ACR	American College of Radiology Appropriateness Criteria
AIDS	Acquired Immunodeficiency Syndrome
CT	Computed Tomography
CTPA	Computed Tomography Pulmonary angiogram
HIV	Human Immunodeficiency Syndrome
MRI	Magnetic Resonance Imaging
UPFS	Uniform Patients Fee Schedule

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Chapter 1- Literature Review

It is estimated that the patient-care decisions doctors make is responsible for more than 80% of health care expenditure (1). Doctors are responsible for the radiological studies requested and can therefore act as gatekeepers to ensure that resources are used judiciously and efficiently. South Africa is a developing country that has limited resources and a high burden of poverty; with the current financial situation, the South African government will benefit from the mitigation of fruitless and wasteful expenditure on health care costs. For this to be realised, it has to start with incorporating cost-consciousness into medical practice (2).

When doctors are aware of the costs of radiological studies, it may result in a reduction of the number of studies requested, which in turn would translate into a reduction of health care costs (3)(4). An educational intervention study on abdominal imaging, performed in San Diego in 2010, incorporated the American College of Radiology Appropriateness Criteria lectures on general principles of cost-conscious medicine, along with a discussion of actual hospital costs for commonly ordered abdominal investigations. They compared the number of abdominal investigations that were requested pre-intervention and post-intervention; it showed a notable reduction in the average abdominal CT scans ordered per patient post-intervention (4). This proves that cost-consciousness among healthcare professionals does reduce costs.

Implementing cost-consciousness in South Africa would translate to a reduction in costs, which in turn will reduce government spending on healthcare. South Africa has high healthcare expenses with a total healthcare expenditure of 8.8% of the gross domestic product in 2014, which is in exess of 3.8% of the World Health Organisation recommendation. Increasing healthcare costs is concerning for governments, patients, health economists and the medical profession around the world (5). Reducing unnecessary costs would mean that these funds can be saved, reallocated and made available for other critical healthcare burdens in South Africa such as Tuberculosis, Human Immunodeficiency Syndrome (HIV) and Acquired Immunodeficiency Syndrome (AIDS)(6). There has been a great improvement in the public sector post 1994 when it comes to access, rationalization of heath management and fair health expenditure; these achievements are now being threatened by an increased disease burden related to HIV/AIDS(7). There is also an increase in the burden of chronic disease prevention and management on health systems (7).

International studies show that the number of requested radiological studies have increased drastically in the past 20 years. Medical imaging utilisation has grown rapidly, faster than any other medical service that is putting a strain in the healthcare expenditure and can result in unstainability of the health care system (8)(9)(10)(11). This is in part due to the appropriate use of new imaging techniques, for example, CT abdomen is now an

investigation of choice in a hemodynamically stable trauma patient rather than a more invasive exploratory laparotomy,however, clinical examination is also a “dying art” which results in overutilization of radiological studies (8)(12). Overutilisation of radiological studies adds to fruitless and wasteful expenditure and contribute to unjustifiable costs to the healthcare system. Overutilisation is defined as the employment of radiological studies in a clinical situation where the radiological study will not improve or contribute to the patient’s clinical outcome (10)(12). In a summit that was held by the American Board of Radiology Foundation in 2009, the effects and causes of the overutilisation of radiological studies were discussed. The overutilisation was found to result from practice behaviour of referring doctors i.e. uncertainty or knowledge gaps among requesting physicians about radiological indications, financial incentives, self-referral, defensive medicine, patient expectations and lack of availability of prior images due to non-existent linkage between multiple hospital systems, which leads to duplication of imaging (12)(13). Of concern is that some studies have shown that about 33% of health care spending is duplicative, fruitless or worsens the patient’s clinical condition (10). Overutilisation of radiological studies also exposes patients to unnecessary radiation doses.

Inappropriate use of radiological studies add to health care costs without improving the quality of health care for patients. According to the South African Competition Commission’s Health Market Inquiry claims from medical aids for radiological studies increased approximately by 10.98% per year between 2011 and 2014 (14). Yet, the majority of doctors are not aware of the costs of radiological studies they request. Several studies have also shown that doctors inaccurately estimated the cost of radiological studies they request and are unlikely to fully consider the effects of over investigating on the patients and the healthcare system (2)(15)(16)(17). Only 3.4% of surgeons were cognisant of the costs of radiological studies in Saudi Arabia (2). A Canadian study also showed that emergency physicians had restricted awareness of the costs of pharmaceutical, laboratory and radiological studies. These physicians overestimated pharmaceutical drugs and laboratory costs and frequently underestimated the costs of radiological studies. This is attributed to a lack of health economics teaching in medical schools and a lack of training on costs during residency, which contribute to a complete disregard of costs related to eg radiological studies (17).

Doctors are gatekeepers of healthcare spending and play a critical role in healthcare use; they have an ethical obligation to render high value , high-quality care and decrease unnecessary health care that does not improve patient’s clinical outcome. This, therefore, means medical educators must incorporate cost-consciousness into their teaching in medical schools and cost-consciousness must be part of general competency for medical students and registrars (18). Currently, there are six general competencies of graduate medical education which include patient care and procedural skills, medical knowledge, interpersonal skills and communication, professionalism, practice-based learning and

improvement, and systems-based practice (19). Physicians should be taught not only the benefit or effectiveness of radiological studies and drugs but also their value. Cost consideration must be explicit, transparent and consistent. When cost consciousness is instilled and incorporated in the medical school curriculum, physicians will better understand the need for management of resources; this will contribute to a reduction in the overutilisation and improper use of radiological studies and therapies that do not improve patient care but add to health care expenditure. Secondly, medical school programs should also expose their students and registrars to healthcare management, health service delivery and how medical care is financed, so that they are aware and conscious of the health care systems they work in, empowering them to make informed decisions (18).

Overutilisation and misuse of radiological studies also expose patients to increased ionizing radiation. Exposure to medical imaging radiation predisposes patients to increased cancer risk. There has been a link between low dose ionizing radiation exposure and the development of solid cancers and leukemia(10). Studies have estimated that 2% of future cancers could be related to CT scans. Ionization causes the biological effects of x-rays. Ionizing radiation can damage the DNA in one of two ways, directly or indirectly.The majority of DNA damage is indirectly. Indirect damage is by hydroxyl radicals that are produced by the interaction of ionizing radiation and water molecules. Water is the most abundant constituent of the human body making up 45-75% of total body weight (20). Ionization of these water molecules can produce free radicals that may interact with DNA. This interaction may result in strand breaks and or base damage which can lead to cancer. Secondly, ionizing radiation can interact and damage the DNA directly. There is often rapid repair of the radiation-induced damage but misrepairs can occur and result in chromosome translocation, point mutations and gene fusion which result in cancer induction (21). Doctors should have a basic understanding and awareness of this risk and should consider them when making radiological referrals. Although doctors claim to consider the risks associated with radiation before ordering scans, a study performed in 2012 showed that there was a paucity of knowledge about radiation doses amongst the specialties (22). To reduce patient radiation dose the doctor should consider not requesting a study; this decision can be informed by a knowledge of the clinical criteria to perform the particular study and a review of previous imaging which may answer the current clinical question. Another way to reduce the dose of ionizing radiation to patients is to perform a radiological study that does not use ionizing radiation.

The average radiation dose from radiological and nuclear medicine studies has increased greater than 6-fold, whereas the mean radiation dose from natural background sources has remained unchanged (10). The biggest contributor to this increased medical ionizing radiation exposure is CT scans. The number of CT scans performed in central Karoo districts of the Western Cape Province in South Africa doubled from 2011 to 2013 (11). The practice of repeat CT scan studies in the same patient and multi-phase scans where the same organ

is imaged multiple times, cause cumulative CT radiation exposure and adds to baseline cancer risk. Ionizing medical imaging such as plain radiography, several nuclear medicine studies and CT studies causes a radiation dose below 10 mSv, which does not have an increased cancer risk according to epidemiological data. Due to a lack of direct epidemiological data, the increased cancer risk from low dose radiation has been assessed using models based on the linear, no-threshold theory. The theory says that excess cancer risk related to radiation has a linear relationship to dose meaning it is directly proportional to the radiation dose received. Review of previous imaging is important when a radiological study is considered; this review can reveal high cumulative radiation exposures, which may alter future imaging studies. One study showed that patients with chronic illnesses and recurrent medical conditions were exposed to total effective doses of more than 50 mSv from imaging done over 3 years (21). Studies furthermore suggest that if appropriate clinical criteria were adhered to 20-40% of CT scans could be avoided (10).

It is also noted that radiology residents have limited knowledge of the cost of radiological studies they provide (15). A study by Vijayasarathi *et.al.* showed that radiology trainees had poor knowledge of cost of radiological studies, with 45.1% of the participants not estimating any of the costs correctly; only 0.3% of the participants estimated all five given examination costs correctly(15).

Radiologists often contribute to the overutilisation of imaging services; they often do not review requested examinations for appropriateness or fail to consult the referring doctors where indications for a radiology study is unclear (12). Where medical aids are involved, studies have shown that where acquiring pre-authorization was mandatory before radiology studies such as CT and MRI could be performed, it resulted in a significant reduction in utilisation and radiological costs (11). The role of the radiologist has evolved over the years, from being someone who just generates and interprets diagnostic images to an economic gatekeeper, political advocate and a safety officer, to mention a few.

As an economic gatekeeper, a radiologist can facilitate the appropriate allocation of resources by educating clinicians. This includes having regular interdepartmental meetings involving clinicians and radiologists, and lectures which could greatly enhance clinicians' ability to use imaging appropriately radiology, as radiology is always evolving due to rapid technological advances. These meetings can be used as a way of updating clinicians on new radiological technologies, for example, a clinician might order a specific radiological study and a radiologist might feel there is a more suitable investigation to answer the clinical question. In these interdepartmental meetings, guidelines on imaging can be developed with collaboration between the radiologist and clinician. This will lead to the performance of the appropriate radiological study which can save the patient and or Government cost whilst protectiong the patient from unnecessary radiation. Also in the role of a gatekeeper,

a radiologist can advise primary health care physicians on the appropriate referrals to specialists and follow up imaging.
Radiologists acting as political advocates can reduce the rising costs of healthcare by being involved in policy decisions and implementation of imaging protocols.

Radiologists acting as safety officers can limit the number of inappropriate CT scans, the number of phases (ie arterial, portovenous, nephrographic and delayed phases) performed in a CT study depending on the clinical indication, thereby reducing exposure to radiation and also limiting follow up CT scans to the area of pathology; alternatively they can utilise radiological studies that do not require ionizing radiation such as Magnetic Resonance Imaging and ultrasound (23).

None of the above studies were conducted in South Africa, which brings us to our research question of how aware are the South African consultants and registrars, particularly in Bloemfontein, of radiological studies costs and is there a desire to learn about radiological costs. In a teaching institution, it is mostly registrars and interns (under the supervision of registrars) who request investigations for patients (24). Nethathe *et. al.,* conducted a study on cost awareness among healthcare professionals at Chris Hani Baragwanath Academic Hospital,South Africa where they assessed the cost awareness of drugs, intravenous fluids, disposable items and laboratory tests; radiological studies were unfortunately not included in this study. The study showed that the health care professional's estimation of costs was inaccurate (16). Another study surveyed Internal Medicine physician's knowledge of healthcare charges and similarly found that physicians had a poor knowledge of the topic (25).

When it comes to radiological studies, a cheaper study can potentially yield the same result (or sometimes even better results) than a more expensive study. For example, in a patient presenting with acute respiratory illness; according to the American College of Radiology Appropriateness Criteria a chest x-ray is the initial investigation of choice and is cost-effective. It can exclude causes such as pneumonia, pleural effusion, pneumothorax etc before requesting a more advanced study such as Computed Tomography Pulmonary Angiogram to exclude a pulmonary embolism (26). This type of decision making however requires a good clinical history, meaning that radiological imaging does not replace a good clinical history and examination. This translates to savings of about R7000 for the government per patient. In the example above, costs are drastically reduced without compromising the quality of care, with the added benefit of a lower radiation dose. Conventional radiography doses are much lower than CT scan doses, with chest CT scans doses 100-1000 times more than chest radiographs (10). CTPA increases the relative risk of breast cancer and lung cancer, especially in younger women.

There are several clinical imaging guidelines that clinicians can use to justify the request of a particular radiological study. Justification in radiology refers to the appropriate utilization of radiologic imaging modalities. Though we do not have such guidelines specifically for South Africa; there are guidelines available that have been developed in 1st world countries such as the United Kingdom and the United States of America (27). Examples of these guidelines include the Royal College of Radiology guidelines and the American College of Radiology Appropriateness Criteria respectively (28)(29). When clinicians familiarise themselves with one of these clinical imaging guidelines for different medical or surgical conditions, it will assist them with the choice of radiological study relevant for a particular medical condition. Individual hospitals or the community of South African radiology can decide on which of these guidelines should be used in South African hospitals so that there is uniformity. These are evidence-based guidelines that were developed to assist primary physicians in making the most appropriate decision about imaging and management of patients. Applying these guidelines assist clinicians to improve the quality of care, guarantees advantageous use of radiology and reduces health care expenditure (11)(30). An American Health insurance plan report claimed that almost half of all high-tech imaging is unnecessary because it provides no useful information (9). A retrospective international study analyzed the appropriateness of outpatient CT and MRI based on Americal College of Radiology Appropriateness Criteria and found that 26% of the studies were inappropriate (31). A South African study from 2014 showed 6.4% of scans performed in the central Karoo district of the Western Cape Province were inappropriate and 5.4% of scans ordered by consultants were inappropriate; the oncology department requested most of the inappropriate scans. Determination of appropriateness of the scans was assessed using both the American College of Radiology Appropriateness Criteria and the Royal College of Radiology Guidelines (11). There is no recent appropriateness study in South Africa.

To avoid these unnecessary radiological studies computerized clinical decision support systems can be implemented. Clinical decision support refers to improving the physician's investigation requesting habits towards mitigating cost, guarantees the safety of the patient and improving the quality of health care (10). With computerized radiology order entry and decision support, doctors enter information, such as the presenting complaints, physical examination findings, known and previous medical conditions, prior laboratory findings, and prior radiological studies into the system and an immediate decision support feedback is given in the form of an appropriateness score (10). The decision support is consistent and standardized. Physicians can also select intermediate to high test probability which increases the sensitivity and specificity of the investigating examinations. The computerized radiology order entry and decision support reduce the issues of overutilization of medical imaging by reducing the number of inappropriate radiological studies, which in turn reduces health care spending and costs, and false-positive examinations (that may result in reimaging, anxiety, surgical intervention and morbidity) (10).

The United States government has implemented the above clinical decision support to decrease inappropriate imaging investigations and ensure evidence-based guidelines are followed when ordering radiological studies. This requires the ordering physician to consult appropriately and use criteria before requesting advanced diagnostic imaging such as CT, MRI, general nuclear medicine and Positron Emission Tomography (PET). The clinical decision support imaging software takes input from the requesting physician, which is commonly a clinical sign or symptom and, based on the input, lists the different imaging modalities that are appropriate for that particular sign or symptom; the requesting physician then selects an imaging study from this list. The clinical decision support software that is used in the United States is based on the American College of Radiology Appropriateness Criteria (9). A system similar to this one will benefit the South African health care system as it will ensure the appropriateness of the requested radiological studies, saving costs and improve patient care.

To the best of the authors' knowledge, no radiological cost awareness studies performed in South Africa has been published. This study will aim to determine cost awareness of radiological studies amongst doctors at Universitas Academic Hospital, Bloemfontein and the objective is two-fold:

1. To determine whether there are differences in cost estimation accuracy according to levels of training, specialty and involvement in private practice.
2. To determine the desire to learn more about the cost of imaging and the prevelance of any prior education or training related to cost awareness of radiological studies.

The hypothesis, based on international data presented above, is that the requesting doctors, radiology registrars and radiologists have limited knowledge of common radiological studies.

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Chapter 2- Publishable Article

2.1 Title:

Cost awareness of radiological studies amongst doctors at Universitas Academic Hospital Bloemfontein

2.2 Abstract:

Background:

South Africa has high healthcare expenses; implementing cost-consciousness would translate into a reduction in costs that will reduce government spending on healthcare.

Objectives:

The aim of the study was to determine cost awareness of radiological studies amongst doctors at Universitas Academic Hospital, Bloemfontein. The objectives were to assess whether there are differences in cost estimations accuracy according to the different levels of training and speciality, to determine whether the participants have undergone any prior education or training related to cost awareness of radiological studies and if there is a desire to learn about the cost of radiological imaging.

Methods:

This study was a cross-sectional survey by means of an anonymous questionnaire. The study was conducted in six clinical departments at Universitas Academic Hospital. The questionnaire was aimed at determining cost awareness of five radiological studies amongst doctors. Doctors were given six different cost ranges to choose from for each imaging study with only one correct option. The costs were based on South Africans National Department of Health's 2019 Uniform Patients Fee Schedule (UPFS). Questionnaires were distributed in person by the principal investigator.

Results:

195 questionnaires were distributed and 131 (67.2%) returned. There was an overall low cost estimation accuracy, with 45.2% of the participants getting none of the costs correctly. None of the participants estimated all five costs correctly. Only Internal Medicine demonstrated a significant difference between registrars (median correct answers 0) and consultants (median correct answer 1) for the number of correct answers ($p=0.04$). No significant differences were found between specialities, stratified by registrar/consultant. The majority of participants (88.6%) would like to learn about the cost of imaging. Only 2.3% of the participants have received prior education or training related to cost awareness of radiological studies.

Conclusion:

Doctors were consistently inaccurate in estimating the cost of the radiological studies. As doctors are largely responsible for health care expenditure, the results of this research suggest that educating doctors about the cost of radiological imaging can have a positive effect on healthcare expenditure.

2.3 Introduction

It is estimated that patient-care decisions that doctors make are responsible for more than 80% of health care expenditure (1). Doctors are responsible for the radiological studies requested and can therefore act as gatekeepers to ensure that resources are used judiciously and efficiently. South Africa is a developing country that has limited resources and a high burden of poverty; with the current financial situation, the South African government will benefit from the mitigation of fruitless and wasteful expenditure on health care costs. For this to be realised, it has to start with incorporating cost-consciousness into medical practice (2).

When doctors are aware of the costs of radiological studies, it may result in a reduction of the number of studies requested, which in turn would translate into a reduction of health care costs (3)(4). Reducing unnecessary costs would mean that these funds can be saved, reallocated and made available for other critical healthcare burdens in South Africa such as Tuberculosis, HIV, and AIDS (5). Inappropriate use of radiological studies adds to health care costs without improving the quality of health care for patients. According to the South African Competition Commission's Health Market Inquiry claims from medical aids for radiological studies increased approximately by 10.98% per year between 2011 and 2014 (6). International studies show that the number of requested radiological studies have increased drastically in the past 20 years. Medical imaging utilisation has grown rapidly, faster than any other medical service that is putting a strain on the healthcare expenditure and can result in unsustainability of the health care system. This is in part due to the appropriate use of new imaging techniques but mostly due to overutilisation of radiological studies. Overutilisation of radiological studies add to fruitless and wasteful expenditure and contribute to unjustifiable costs to the healthcare system (7)(8)(9)(10). Overutilisation of radiological studies also exposes patients to unnecessary radiation which predisposes patients to an increased cancer risk. Some studies have shown that about 33% of health care spending is duplicative, fruitless or worsens the patient's clinical condition (9). Yet, the majority of doctors are not aware of the costs of radiological studies they request. Several studies have also shown that doctors inaccurately estimate the cost of radiological studies they request and are unlikely to fully consider the effects of over investigating on the patients and on the healthcare system (2)(11)(12)(13). Only 3.4% of surgeons were cognisant of the costs of imaging investigations in Saudi Arabia (2). A Canadian study also showed that emergency physicians had restricted awareness of the costs of pharmaceutical, laboratory and radiological studies. These physicians overestimated pharmaceutical drugs and laboratory costs and frequently underestimated the costs of radiological studies. This is

attributed to a lack of health economics teaching in medical schools and a lack of training on costs during residency, which results in a complete disregard for costs related to e.g. radiological imaging (13).

To the best of the authors' knowledge, no radiological cost awareness studies have been published in South Africa.

The aim of the study was to determine cost awareness of radiological studies amongst doctors at Universitas Academic Hospital, Bloemfontein. The objectives were to assess whether there are differences in cost estimations accuracy according to the different levels of training and speciality, to determine whether the participants have undergone any prior education or training related to cost awareness of radiological studies and if there is a desire to learn about the cost of radiological imaging.

2.4 Research method and design

Study design:

This study was a cross-sectional study aimed at assessing cost awareness of radiological studies amongst registrars and consultants.

Research setting and sampling method:

The study was conducted in six clinical departments at Universitas Academic Hospital, Bloemfontein South Africa. The participants were from the following departments: Clinical Imaging Sciences, Internal Medicine, Paediatrics, General Surgery, Oncology and Obstetrics and Gynaecology.

Data collection:

A questionnaire, which was in English, was developed to collect the data.

The questionnaire had three sections:

1) Demographic data- Age, sex, speciality, level of training, involvement in private practise.
2) Estimation of radiological study cost: Five different imaging studies were included- Two view chest x-ray, uncontrasted CT brain, MRI brain without contrast, contrast enhanced CT of the abdomen and pelvis and abdominal ultrasound. These modalities were chosen because they are amongst the most requested radiological studies. Doctors were provided with six different cost ranges to choose from for each modality with only one being the correct option. The costs were based on the South African National Department of Health's 2019 Uniform Patients Fee Schedule (UPFS). The UPFS is a fee schedule used to bill patients using public hospitals across South Africa. Radiological studies on the UPFS are categorised from category A to E, A as least expensive and E as most expensive. Each category has two prices: a facility fee (depends on the level of the hospital) and a professional fee (depending on the level of training of the healthcare professional who performs or interprets the radiological study). The 2019 UPFS radiological fees are presented in Table 1 (14). Prices in bold applies to Universitas Academic Hospital (this study) and R105 as added for contrast in all studies requiring contrast.
3) Doctors' desire to learn about imaging costs and any prior education or training related to cost awareness of radiological studies.

   195 doctors qualified to participate in this study. The questionnaires were distributed and collected by the principal researcher at the academic meetings of the various departments. The questionnaires were completed immediately and anonymously, after which the completed forms were placed in a sealed box.

Table 1: 2019 Uniform patient fee schedule radiology studies tariffs according to hospital level (14).

Category of investigation	Professional fee	Facility fee		
		Level 1	Level 2	Level 3
Category A		R80	R80	R89
Allied health practitioner	R77	R157	R157	R166
General medical practitioner	R78	R158	R158	R167
Specialist medical practitioner	R146	R226	R226	**R235**
Category B		R219	R219	R250
Allied health practitioner	R205	R424	R424	R455
General medical practitioner	R210	R429	R429	R460
Specialist medical practitioner	R409	R628	R628	**R659**
Category C		R507	R507	R579
General medical practitioner	R326	R833	R833	R905
Specialist medical practitioner	R1 000	R1 507	R1 507	**R 1579**
Category D		R1 013	R1 013	R1 156
General medical practitioner	R649	R1 662	R1 662	R2 169
Specialist medical practitioner	R1 997	R3 010	R3 010	**R3 153**
Category E		R2 582	R2 582	R2 952
General medical practitioner	R2 391	R4 973	R4 973	R5 343
Specialist medical practitioner	R4 985	R7 567	R7 567	R7 937

Data analysis:

The principal researcher entered the data on an Excel spread sheet. Analysis was done by the Department of Biostatistics, Faculty of Health Sciences, University of Free State. In cases where a cost estimation question was not answered, it was assumed that the respondent did not know the correct answer. Categorical variables were summarised by frequencies and percentages, and numerical variables by medians and percentiles. Subgroups were compared using, chi-squared or Fisher's exact tests (categorical variables) and median tests (numerical variables).

Ethical considerations:

Ethical approval was obtained from the Health Sciences Research Ethics committee of the University of Free State (Ethical clearance number UFS-HSD2018/1588/2304). Permission to perform the study was obtained from the University of Free State authorities (gate keeper's approval) and the various heads of departments involved in this study. All questionnaires were anonymous and completion of the questionnaire implied consent.

2.5 Results

195 questionnaires were distributed and 131 (67.2%) completed and returned. The highest percentage of participants was male (59.2%) and most of the participants were between 26 and 35 years of age (48.9%). Most respondents were from the Paediatrics and Internal Medicine clinical departments with both at 22.9%, followed by General Surgery (20.6%); Clinical Imaging Sciences made up only 12.2% of the study sample (Table 2). Clinical Imaging Sciences had 16 participants of which 15 (93.8%) were registrars whilst Internal Medicine had 30 participants of whom 16 (53.3%) were registrars (Table 3). Most of the surveyed doctors were registrars (67.9%) and 28.1% of them were in their 4th year of training, whilst 32.1% of the study sample were consultants of whom 39% were involved in private practise. Clinical Imaging Sciences had three consultants and only one (33.3%) consultant participated in the study. There were a total of 25 consultants in Internal Medicine and 14 (56%) participated. Paediatrics had 22 consultants and 13 (59.1%) participated in the study. The response rate of consultants in Obstetrics and Gynaecology, Surgery and Oncology was 30% (3/10), 70% (7/10) and 100% (4/4) respectively. There was 100% (15/15) response rate of Clinical Imaging Sciences registrars and Paediatrics had the lowest response rate of registrars with 17 (56.7%) participating in the study out of a total of 30 registrars. Surgery, Obstetrics and Gynaecology, Oncology and Internal Medicine registrar response rate was 83.3%, 82.4%, 77.8% and 61.5% respectively. Therefore, there was a good registrar response rate compared to consultants.

Table 2. Demographics of surveyed doctors

Demographics	N (%)
Gender (n=125)	
Male	74 (59.2)
Female	51 (40.8)
Age group (n=131)	
<25-25years	2 (1.5)
26-35years	64 (48.9)
36-45years	40 (30.5)
46-55years	17 (13)
56-60years	2 (1.5)
>60years	6 (4.6)
Clinical department (n=131)	
Clinical Imaging Sciences	16 (12.2)
Internal medicine	30 (22.9)
Paediatrics	30 (22.9)
General Surgery	27 (20.6)
Obstetrics and Gynaecology	17 (13)
Oncology	11 (8.4)

Position (n=131)	
Registrar	89 (67.9)
Consultants	42 (32.1)

Table 3. Type of respondent per department.

Department	Registrars n (%)	Consultants n (%)
Clinical Imaging Sciences (n=16)	15 (93.8)	1 (6.3)
Internal Medicine (n=30)	16 (53.3)	14 (46.7)
Paediatrics (n=30)	17 (56.7)	13 (43.3)
General Surgery (n=27)	20 (74.1)	7 (25.9)
Obstetrics and Gynaecology (n=17)	14 (82.4)	3 (17.7)
Oncology (n=11)	7 (63.6)	4 (36.4)
Total (n=131)	89 (67.9)	42 (32.1)

There was an overall low cost estimation accuracy with 45.0% of the participants getting none of the costs correctly. None of the participants estimated more than three correctly. Of the 131 completed questionnaires, 37.4% of the participants estimated only one radiological study cost correctly with only 3.1% estimating three costings correctly. The median number of correct responses was one, with interquartile range 0 to 1. It was only Internal Medicine that demonstrated a significant difference between registrars (median correct answers 0) and consultants (median correct answer 1) for the number of correct answers (p=0.04). No significant differences were found between specialities, stratified by registrar/consultant.

The majority of participants (75.6%) underestimated the cost of a two view chest radiographs and only 13.7% correctly estimated the cost (Table 4). There were only 12.2% who correctly estimated the cost of an abdominal and pelvis ultrasound, with 68.7% overestimating its cost. There were 24.4% of participants who correctly estimated the cost of an uncontrasted CT brain and 46.6% underestimated its cost. Only 19.8% of respondents correctly estimated the cost of an uncontrasted MRI brain and 51.9% underestimated it. Only 5.3% correctly estimated the cost of post contrasted CT abdomen and pelvis.

Table 4. Cost estimation

N=131 N (%)

Radiological study (Price category)	Correct estimation	No answer provided	Underestimation	Overestimation
Chest X-ray: PA and lateral (B)	18 (13.7)	1 (0.8)	99 (75.6)	13 (9.9)
Abdomen & pelvic U/S (B)	16 (12.2)	2 (1.5)	23 (17.6)	90 (68.7)
Uncontrasted CT brain (D)	32 (24.4)	1 (0.8)	61 (46.6)	37 (28.2)
Uncontrasted MRI brain (E)	26 (19.8)	1 (0.8)	68 (51.9)	36 (27.5)
CT abdomen and pelvis with contrast (D)	7 (5.3)	2 (1.5)	11 (8.4)	111 (84.7)

The majority of participants (88.6%) indicated an interest in learning about the cost of radiological studies. An open question on why they would want to learn about the cost of radiological studies was included in the questionnaire. 17.2% of respondents did not provide answers to this question (did not indicate why they would like to learn about cost of radiological studies) and 29.2% of those who did answer the question indicated that they want to be cost effective, better gatekeepers and manage resources effectively. Approximately 6.3% of the participants indicated that they want to be better advisors of patients and clinicians. Of those participants who would like to learn about the cost of radiological studies, 7.3% said that they want to be cost conscious or cost aware, 3.2% indicated that it would improve patient care and clinical judgement. There were 2.1% participants who wanted to learn about cost of radiological studies because this information would be beneficial when they work in private practise. There were 11.4% of participants who indicated that they did not have interest in learning about the cost of radiological studies and 26% of them indicated that cost is irrelevant when a radiological study is indicated. Only 2.3% of the participants have received prior education or training related to cost awareness of radiological studies.

2.6 Discussion

The results of this study were similar to the international studies done on cost awareness of radiological studies and a local study done for cost awareness of medical consumables among healthcare professionals (2)(11)(12)(13). These studies have shown that healthcare professionals are unaware of the costs (2)(11)(12)(13). A study by Vijayasarathi et. al. showed that radiology trainees had poor knowledge of cost of radiological studies with 45.1% of the participants not estimating any of the costs correctly; this is comparable with the findings from our study. In their study only 0.3% of the participants estimated all five examinations correctly whereas in our study none of the participants estimated all five examination costs correctly (11).

The poor knowledge of costs is mostly attributed to the fact that there is no cost awareness education in medical schools, neither is it incorporated in the postgraduate registrar-training programme. In our study only three (2.3%) of the participants had received prior education or training related to cost awareness of radiological studies; two of them being consultants. Physicians are gatekeepers of healthcare spending and play a critical role in healthcare use. They have an ethical obligation to render high value, high-quality healthcare and limit unnecessary health care that does not improve a patient's clinical outcome (15).

Healthcare professionals should be taught not only the benefit or effectiveness of diagnostic investigation and drugs but also their cost. The majority of participants (88.6%) in this study indicated an interest in learning about the cost related to radiological imaging. Cost should be a consideration when requesting a radiological investigation. When cost consciousness is incorporated in the medical school curriculum, physicians will have a better understanding of the need for financial resource management, curbing the unnecessary and improper use of diagnostic investigations and therapies that do not improve patient care but add to health care expenditure. Secondly, medical school programs should also expose their students and registrars to healthcare management, health service delivery, and how medical care is financed so that they will be conscious of the health care systems they work in, empowering them to make informed decisions (15).

When doctors are aware of the costs of radiological studies, it may lead to a more judicious use of radiological studies, reducing the number of unnecessary investigations, which translates to a reduction of (unnecessary) health care expenditure (3)(4). An educational intervention study on abdominal imaging was performed in San Diego in 2010 which incorporated the American College of Radiology appropriateness criteria, lectures on general principles of cost-conscious medicine along with discussion of actual hospital costs for commonly ordered abdominal investigations. They compared the number of abdominal investigations that were requested pre-intervention and post-intervention, which showed a notable reduction in the average abdominal CT scans ordered per patient (4). Kruger et. al conducted a pre and post interventional study where they displayed radiation exposure and cost of diagnostic imaging on the electronic order form. The study showed a decreased in the number of CT scans and MRIs ordered compared to ultrasound, after the radiation exposure and costs related to the investigations were known. Most of the surveyed clinicians wanted the displays to continue, as it influenced their ordering behaviour, though most of them admitted that the radiation exposure influenced their decision more than the cost (16). This proves that cost-consciousness among healthcare professionals does reduce costs.

The increase in the usage of radiological studies is in part due to the availability of more advanced and high tech imaging modalities but overutilisation also plays a role (7)(17). Overutilisation of radiological studies add to fruitless and wasteful expenditure and also adds unjustifiable costs to the healthcare system. Amongst many reasons for overutilisation, uncertainty or knowledge gaps among requesting doctors about imaging indications that result in the inappropriate use of imaging studies, plays a very big role (17)(18). There are several clinical imaging guidelines that clinicians can use to justify the performance of a particular radiological study. Justification in radiology refers to the appropriate utilisation of radiologic imaging modalities. Although we do not have guidelines developed for South Africa; these guidelines have been developed in several first world countries such as the United Kingdom and the United States of America (19); these are the Royal College of Radiologists guidelines and the American College of Radiology appropriateness criteria respectively (20)(21). Familiarising themselves with one of these clinical imaging guidelines for the different medical or surgical conditions, will assist clinicians in choosing the imaging study most suitable for a particular medical condition. Individual hospitals or the community of South African radiology can decide on which of these guidelines can be followed in South African hospitals so that there is uniformity. These are evidence-based guidelines that were developed to assist primary physicians in making the most appropriate decision about imaging and management of patients. Applying these guidelines assist clinicians to improve the quality of care, guarantees advantageous use of radiology and reduces health care expenditure (10)(22).

An American Health insurance plan report claimed that almost half of all high-tech imaging is unnecessary because it provides no useful information (8). A retrospective international study published in 2010 analysed the appropriateness of outpatient CT and MRI based on American College of Radiology appropriateness criteria; this study showed that 26% of the studies were inappropriate (23). A South African study done in 2014 in the central Karoo district of the Western Cape Province showed 6.4% of scans were inappropriate (10).

Limitations:

The other objectives of the study was to assess whether there are differences in cost estimations accuracy according to level of training, involvement in private practise and the number of years in practise; the numbers were too small to investigate these and participant number representation in different specialities differed vastly.

2.7 Conclusion

Doctors were consistently inaccurate in estimating the cost of the radiological studies. As doctors are largely responsible for health care expenditure, the results of this research suggest that educating doctors about the cost of radiological imaging can have a positive effect on healthcare expenditure.

It is encouraging that the majority of doctors indicated an interest in learning about the cost of imaging, which would have a positive impact on resource management. Studies have proved that incorporating cost consciousness into medical practice does reduce the number of requested imaging which translates to a reduction in health care costs. Developing or using existing clinical imaging guidelines to justify the performance of a particular radiological study will also contribute to a reduction in wasteful expenditure.

2.8 Acknowledgements

The authors would like to thank Noxolo Mrwetyana for designing the questionnaire for the study as well as Mr Mpendulo Mamba from the Department of Biostatistics, University of the Free State, for his assistance in data analysis.

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Appendices

Appendix A Research Protocol

1. TITLE

Cost awareness of radiological studies amongst doctors at Universitas Academic hospital Bloemfontein

2. RESEACHERS

Principal researcher:	Dr Khanyisa Nothemba Mrwetyana
	Registrar in the Department of Clinical Imaging Sciences
Study leader:	Dr Fekade Gebremariam
	Head of Department of Clinical Imaging Sciences

3. INTRODUCTION

It is estimated that more than 80% of healthcare costs results from patient-care decisions that doctors make.(1)Doctors are responsible for diagnostic tests done and therefore can act as gatekeepers to ensure that resources are used effectively. For this to be possible it would start with incorporating cost consciousness into medical practice.(2)

When doctors are aware of costs of diagnostic tests, a reduction in the number of tests would result which translates to reduction of costs(3). This will reduce the government spending on healthcare and/or these funds will be available for other critical healthcare burdens in South Africa such as HIV and AIDS. The South African Competition Commission's Health Market Inquiry found that medical aid claims relating to imaging investigations increased by an average of 10.98% per year between 2011 and 2014.(4) Yet, most doctors do not know the costs of the diagnostic tests they order.

Several studies have shown that doctors inaccurately estimated the cost of diagnostic studies they order and may not fully consider the effects of over investigating on both patients and the health care system.(2)(5)(6)

Only 3.4% of surgeons were fully aware of the costs of imaging studies in Saudi Arabia.(2)Nethathe at al. conducted a study on cost awareness among healthcare professionals at Chris Hani Baragwanath academic hospital, they assessed the cost awareness of drugs , intravenous fluids, disposable items and laboratory tests which showed that healthcare professionals estimation of costs were inaccurate.(6)Another study surveyed internal medicine physician's knowledge of healthcare charges which showed poor knowledge.(7)

When it comes to radiological studies a cheaper diagnostic test can yield potentially the same result or even better than a more expensive test.

According to our knowledge no radiological cost awareness studies have been conducted in South Africa.

AIM AND OBJECTIVE

Aim:

Determine cost awareness of radiological studies amongst doctors at Universitas Academic Hospital.

Objectives:

To determine whether there are differences in cost estimations accuracy according to levels of training, speciality and involvement in private practise.

To determine desire to learn more about cost of imaging and any prior education or training related to cost awareness of radiological studies.

METHODOLOGY

STUDY DESIGN

This will be a cross-sectional study involving Registrars and consultants from Universitas Academic Hospital, Bloemfontein South Africa.

STUDY SAMPLE/PARTICIPANTS

Registrars and consultants working in clinical departments at Universitas Academic hospital.

Inclusion criteria:

Registrars and consultants of departments that request almost all imaging modalities included in the study.

All registrars and consultants working in the following departments will be included:-

-Clinical Imaging sciences.

-Internal medicine.

-Paediatrics.

-General surgery.

-Obstetrics and gynaecology

-Oncology.

Sample size:

The estimated number of participates who would qualify for inclusion in the study is estimated to be around 170; 122 registrars and 48 consultants.

MEASUREMENT

A questionnaire which will be in English will be developed to collect data and will be distributed in person by the principal researcher at academic meetings of various departments.

The questionnaire will be completed immediately and anonymously and placed in a box after completion.

The questionnaire will have three sections:

1. Demographic data- Age, sex, speciality, level of training, involvement in private practise.

2. Estimation of cost to the patient of five different imaging studies- Two view chest x-ray, uncontrasted CT brain, MRI brain without contrast, contrast enhanced CT of the abdomen and pelvis and abdominal ultrasound.

Doctors will be given six different cost ranges to choose from. These costs will be based on Discovery Health Medical Scheme rates which is a document used to bill private patients at Universitas Academic Hospital; therefore these are costs to the patient.

3. Doctors desire to learn about imaging costs and any prior education or training related to cost awareness of radiological studies.

METHODOLOGICAL AND MEASUREMENT ERRORS

Bias may occur during data collection:

Not all qualifying registrars and consultants may attend the departmental meeting.

Some may refuse to participate in the study.

The document used to determine the cost specifies the cost to the patient and not cost to the department. According to our knowledge there is no document that quantifies the total cost to the Department of Health which would be an ideal document to use in this study.

PILOT STUDY

A pilot study will be performed on five Clinical Imaging sciences registrars after ethics approval has been obtained, to determine the user friendliness of the questionnaire.

The results of the pilot study will be included in the main study if no changes are made to the questionnaire or methodology after the pilot study.

ANALYSIS

The researcher will enter the data in Excel. Analysis will be done by Department of Biostatistics, Faculty of Health Sciences, UFS. Categorical variables will be summarised by frequencies and percentages, and numerical variables by medians and percentiles and/or means and standard deviations. Subgroups will be compared using 95% confidence intervals for differences in means, medians or percentages, with appropriate hypothesis testing.

TIME OF SCHEDULE

The study is approximately going to take a period of 10 months to complete.

The timeframe estimated to be as follows:

Submission to ethics committee	November 2018
Submission Free state Department of Health	December 2018
Pilot study	January 2018
Data collection	01 Feb 2019-31 March 2019
Data entry	April 2019
Data analysis	May 2019-31 June 2019
Manuscript preparation and writing	01July 2019-31 August 2019

BUDGET

The principal researcher will pay for the study costs.

Item	**Motivation**	**cost**
Stationery	Paper and ink for questionnaires	R400
	Pens for data entry	R100
Internet	Data for literature search and review	R300.00
Total cost		**R800**

ETHICAL ASPECTS

The study will be conducted under the rules and regulations of the Department of Health.

The Health Sciences Research Ethics committee, University of Free State approval will be requested.

Permission to perform the study will be obtained from the head of the Department of Radiology.

Department of Health approval will only be granted after Health Sciences Research Ethics approval from the University of the Free State.

All questionnaires and information will be anonymous.

Completion of questionnaire implies consent.

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Appendix B HSREC Approved Amendment Letter

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

Health Sciences Research Ethics Committee

23-Mar-2020

Dear **Dr Khanyisa Mrwetyana**

Ethics Number: UFS-HSD2018/1588/2304

Ethics Clearance: **Cost awareness of radiological studies amongst doctors at Universitas Academic Hospital Bloemfontein** Principal Investigator: **Dr Khanyisa Mrwetyana**

Department: **Clinical Imaging Sciences Department (Bloemfontein Campus)**

SUBSEQUENT SUBMISSION APPROVED

With reference to your recent submission for ethical clearance from the Health Sciences Research Ethics Committee. I am pleased to inform you on behalf of the HSREC that you have been granted ethical clearance for your request as stipulated below:

1. Change of supervisor-Previous supervisor has left the institution. New study leader is Dr Janse van Rensburg.
2. The cost of the imaging studies in this study will be based on the 2019 Uniform Patient Fee Schedule(UPFS) rather than the Discovery Health Medical Scheme rates- we choose the UPFS because it is the document used to bill patients in the public sector and is a South African National document.

The HSREC functions in compliance with, but not limited to, the following documents and guidelines: The SA National Health Act.

No. 61 of 2003; Ethics in Health Research: Principles, Structures and Processes (2015); SA GCP(2006); Declaration of Helsinki; The Belmont Report; The US Office of Human Research Protections 45 CFR 461 (for non-exempt research with human participants conducted or supported by the US Department of Health and Human Services- (HHS), 21 CFR 50, 21 CFR 56; CIOMS; ICH-GCP-E6 Sections 1-4; The International Conference on Harmonization and Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH Tripartite), Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines, Constitution of the HSREC of the Faculty of Health Sciences.

For any questions or concerns, please feel free to contact HSREC Administration: 051-4017794/5 or email EthicsFHS@ufs.ac.za.

Thank you for submitting this request for ethical clearance and we wish you continued success with your research.

Yours Sincerely

Dr. SM Le Grange
Chair : Health Sciences Research Ethics Committee

Health Sciences Research Ethics Committee
Office of the Dean: Health Sciences
T: +27 (0)51 401 7795/7794 | E: ethicsfhs@ufs.ac.za
IRB 00011992; REC 230408-011; IORG 0010096; FWA 00027947

Block D, Dean's Division, Room D104 | P.O. Box/Posbus 339 (Internal Post Box G40) | Bloemfontein 9300 | South Africa www.ufs.ac.za

Appendix C Ethics Approval

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

Health Sciences Research Ethics Committee

12-Apr-2019

Dear **Dr Khanyisa Mrwetyana**

Ethics Clearance: **Cost awareness of radiological studies amongst doctors at Universitas Academic Hospital Bloemfontein**

Principal Investigator: **Dr Khanyisa Mrwetyana**

Department: **Clinical Imaging Sciences Department (Bloemfontein Campus)**

APPLICATION APPROVED

Please ensure that you read the whole document

With reference to your application for ethical clearance with the Faculty of Health Sciences, I am pleased to inform you on behalf of the Health Sciences Research Ethics Committee that you have been granted ethical clearance for your project.

Your ethical clearance number, to be used in all correspondence is:**UFS-HSD2018/1588/2304**

The ethical clearance number is valid for research conducted for one year from issuance. Should you require more time to complete this research, please apply for an extension.

We request that any changes that may take place during the course of your research project be submitted to the HSREC for approval to ensure we are kept up to date with your progress and any ethical implications that may arise. This includes any serious adverse events and/or termination of the study.

A progress report should be submitted within one year of approval, and annually for long term studies. A final report should be submitted at the completion of the study.

The HSREC functions in compliance with, but not limited to, the following documents and guidelines: The SA National Health Act. No. 61 of 2003; Ethics in Health Research: Principles, Structures and Processes (2015); SA GCP(2006); Declaration of Helsinki; The Belmont Report; The US Office of Human Research Protections 45 CFR 461 (for non-exempt research with human participants conducted or supported by the US Department of Health and Human Services- (HHS), 21 CFR 50, 21 CFR 56; CIOMS; ICH-GCP-E6 Sections 1-4; The International Conference on Harmonization and Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH Tripartite), Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines, Constitution of the HSREC of the Faculty of Health Sciences.

For any questions or concerns, please feel free to contact HSREC Administration: 051-4017794/5 or email EthicsFHS@ufs.ac.za.

Thank you for submitting this proposal for ethical clearance and we wish you every success with your research.

Yours Sincerely

Dr. SM Le Grange
Chair : Health Sciences Research Ethics Committee

Health Sciences Research Ethics Committee
Office of the Dean: Health Sciences
T: +27 (0)51 401 7795/7794 | E: ethicsfhs@ufs.ac.za
IRB 00006240; REC 230408-011; IORG0005187; FWA00012784

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Appendix D University of the Free State Gatekeeper's Approval

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA
UFS UV

Office of the Vice-Rector: Research and Internationalisation
Kantoor van die Viserektor: Navorsing en Internasionalisering

26-Mar-2019

Dear Applicant

UFS AUTHORITIES APPROVAL

Research Project Title:

Cost awareness of radiological studies amongst doctors at Universitas Academic Hospital Bloemfontein

This letter serves as confirmation that your request to collect data from students and/or staff members at the University of the Free State for your research project has been approved **provided that you also have ethical clearance for the research from the ethics committee at the University of the Free State**.

Please make sure that you also obtain your ethics clearance letter containing your reference number from the ethics committee after you have received this letter before you conduct your research.

Kind Regards

PROF RC WITTHUHN VICE-RECTOR: RESEARCH & INTERNATIONALISATION CHAIR: SENATE RESEARCH ETHICS COMMITTEE

205 Nelson Mandela Drive/Rylaan
Park West/Parkwes
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South Africa/Suid-Afrika

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WitthuhnRC@ufs.ac.za
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Appendix E Information Document

INFORMATION DOCUMENT

Study title: Cost awareness of radiological studies amongst doctors at Universitas Academic Hospital Bloemfontein.

Introduction:
I am Dr Khanyisa Nothemba Mrwetyana, registrar in the Department of Clinical Imaging Sciences (Radiology). I am conducting a research study on cost awareness of registrars and consultants to radiological studies.

Invitation to participate:
We are inviting you to participate in this research study by completing the attached questionnaire. Completion of the questionnaire will take approximately 5 minutes.

This study will help determine if doctors are aware of cost of radiological examinations.
Doctors are responsible for diagnostic tests done and therefore can act as gatekeepers to ensure that resources are used effectively.

There are no risks associated with participation in this study.
Kindly note that your participation is voluntarily and that you may withdraw from the study at any time.

Completion of the questionnaire implies consent. All information will be kept confidential and anonymous.

The results from the study may be presented at conferences and/or published in an applicable journal.

For further information / reporting of study related issues, please contact Dr Khanyisa Mrwetyana at 073 325 0863 or email: rnrwetyanak@yahoo.com at any time.

K.N. Mrwetyana

Signature of Researcher

7 November 2018

Date

Appendix F Questionnaire

COST AWARENESS OF RADIOLOGICAL STUDIES AMONGST DOCTORS AT UNIVERSITAS ACADEMIC HOSPITAL, BLOEMFONTEIN

You have been asked to participate in the research study. Please note that by completing this questionnaire you are voluntarily agreeing to participate in this research study. You will remain anonymous and your data will be treated confidentially at all times. You may withdraw from this study at any given moment during the completion of the questionnaire. There will be no costs or payments involved in participating in the study. The results of the study may be published.

SECTION 1 – DEMOGRAPHIC DATA

Q1.1 Sex *(Circle)*	**1.** Male	**2.** Female		
Q1.2 Age *(Tick the applicable box)*	<25-25 years	☐	26-35 years	☐
	36-45 years	☐	46-55 years	☐
	56-60 years	☐	>60 years	☐
Q1.3 Which department are you from? *(Please tick)*	Clinical Imaging Sciences	☐	Internal Medicine	☐
	Paediatrics	☐	General Surgery	☐
	Obstetrics & Gynaecology	☐	Oncology	☐
Q1.4 What is your medical profession? *(Circle)*	**1.** Registrar	**2.** Consultant		
	(If Registrar: ***Go to Q1.5;*** *If Consultant:* ***Go to Q1.6)***			
Q1.5 What is your year of training?	1st	☐	2nd	☐
	3rd	☐	4th	☐
	5th	☐		
Q1.6a How long have you been a consultant?	<3 years	☐	3-5 years	☐
	5-10 years	☐	>10 years	☐
Q1.6b Are you involved in private practice?	1. Yes	2. No		

SECTION 2 – ESTIMATION OF RADIOLOGICAL COSTS *Please note that all amounts in this section are in South African Rand (ZAR)*				
Q.2.1 Chest X-ray: PA and Lateral	R100 - R200		R201 - R400	
	R401 - R600		R601 – R800	
	R801 – R1 000		R1 001 – R1 200	
Q.2.2 Ultrasound – whole abdomen and pelvis	R400 – R600		R601 – R800	
	R801 – R1 000		R1 001 – R1 200	
	R1 201 – R1 400		R1 401 – R1 600	
Q.2.3 CT Brain - Uncontrasted	R1 000 – R1 500		R1 501 – R2 000	
	R2 001 – R2 500		R2 501 – R3 000	
	R3 001 – R3 500		R3 501 – R4 000	
Q.2.4 MR Brain Without Contrast	R3 000 – R4 000		R4 001 – R5 000	
	R5 001 – R6 000		R6 001 – R7 000	
	R7 001 – R8 000		R8 001 – R9 000	
Q.2.5 CT Abdomen and Pelvis with Contrast	R2 000 – R3 000		R3 001 – R4 000	
	R4 001 – R5 000		R5 001 – R6 000	
	R6 001 – R7 000		R7 001 – R8 000	

SECTION 3 – DESIRE TO LEARN ABOUT IMAGING COSTS	
Q3.1 Would you like to learn more about imaging costs?	1. Yes 2. No
Q3.2 Give reason(s) for your above answer	
Q3.3 Have you received any prior education or training related to cost awareness of radiological studies?	1. Yes 2. No

Appendix G SAJR Submission Guidelines

SOUTH AFRICAN JOURNAL OF RADIOLOGY SUBMISSION GUIDELINES

An original article provides an overview of innovative research in a particular field within or related to the focus and scope of the journal, presented according to a clear and well-structured format.

Word limit - **3000 words** (excluding the structured abstract and references)
Structured abstract - **250 words** to cover a Background, Objectives, Method, Results and Conclusion
References - **60 or less**
Tables/Figures - **no more than 10 Tables/Figure**
Ethical statement - should be included in the manuscript
Compulsory supplementary file - ethical clearance letter/certificate

1. **Title**: The article's full title should contain a maximum of 95 characters (including spaces).

2. **Abstract**: The abstract, written in English, should be no longer than 250 words and must be written in the past tense. The abstract should give a succinct account of the objectives, methods, results and significance of the matter. The structured abstract for an Original Research article should consist of five paragraphs labelled Background, Objectives, Method, Results and Conclusion.
   2.1. Background: Why do we care about the problem? State the context and purpose of the study. (What practical, scientific or theoretical gap is your research filling?)
   2.2. Objectives: What problem are you trying to solve? What is the scope of your work (e.g. is it a generalised approach or for a specific situation)? Be careful not to use too much jargon.
   2.3. Method: How did you go about solving or making progress on the problem? State how the study was performed and which statistical tests were used. (What did you actually do to get the results?) Clearly express the basic design of the study; name or briefly describe the basic methodology used without going into excessive detail. Be sure to indicate the key techniques used.
   2.4. Results: What is the answer? Present the main findings (that is, as a result of completing the procedure or study, state what you have learnt, invented or created). Identify trends, relative change or differences on answers to questions.
   2.5. Conclusion: What are the implications of your answer? Briefly summarise any potential implications. (What are the larger implications of your findings, especially for the problem or gap identified in your motivation?)
   2.6. Do not cite references and do not use abbreviations excessively in the abstract.

3. **Introduction**: The introduction must contain your argument for the social and scientific value of the study, as well as the aim and objectives:
   3.1. Social value: The first part of the introduction should make a clear and logical argument for the importance or relevance of the study. Your argument should be supported by use of evidence from the literature.
   3.2. Scientific value: The second part of the introduction should make a clear and logical argument for the originality of the study. This should include a summary of what is already known about the research question or specific topic, and should clarify the knowledge gap that this study will address. Your argument should be supported by use of evidence from the literature.
   3.3. Conceptual framework: In some research articles it will also be important to describe the underlying theoretical basis for the research and how these theories are linked together in a conceptual framework. The theoretical evidence used to construct the conceptual framework should be referenced from the literature.
   3.4. Aim and objectives: The introduction should conclude with a clear summary of the aim and objectives of this study.

4. **Research Methods and Design**: This must address the following:
    4.1. Study design: An outline of the type of study design.
    4.2. Setting: A description of the setting for the study; for example, the type of community from which the participants came or the nature of the health system and services in which the study is conducted.
    4.3. Study population and sampling strategy: Describe the study population and any inclusion or exclusion criteria. Describe the intended sample size and your sample size calculation or justification. Describe the sampling strategy used. Describe in practical terms how this was implemented.
    4.4. Intervention (if appropriate): If there were intervention and comparison groups, describe the intervention in detail and what happened to the comparison groups.
    4.5. Data collection: Define the data collection tools that were used and their validity. Describe in practical terms how data were collected and any key issues involved, e.g. language barriers.
    4.6. Data analysis: Describe how data were captured, checked and cleaned. Describe the analysis process, for example, the statistical tests used orsteps followed in qualitative data analysis.
    4.7. Ethical considerations: Approval must have been obtained for all studies from the author's institution or other relevant ethics committee and the institution's name and permit numbers should be stated here.

5. **Results**: Present the results of your study in a logical sequence that addresses the aim and objectives of your study. Use tables and figures as required to present your findings. Use quotations as required to establish your interpretation of qualitative data. All units should conform to the SI convention and be abbreviated accordingly. Metric units and their international symbols are used throughout, as is the decimal point (not the decimal comma).

6. **Discussion**: The discussion section should address the following four elements:
    6.1. Key findings: Summarise the key findings without reiterating details of the results.
    6.2. Discussion of key findings: Explain how the key findings relate to previous research or to existing knowledge, practice or policy.
    6.3. Strengths and limitations: Describe the strengths and limitations of your methods and what the reader should take into account when interpreting your results.
    6.4. Implications or recommendations: State the implications of your study or recommendations for future research (questions that remain unanswered), policy or practice. Make sure that the recommendations flow directly from your findings.

7. **Conclusion**: Provide a brief conclusion that summarises the results and their meaning or significance in relation to each objective of the study.

8. **Acknowledgements**: Those who contributed to the work but do not meet our authorship criteria should be listed in the Acknowledgments with a description of the contribution. Authors are responsible for ensuring that anyone named in the Acknowledgments agrees to be named. Refer to the acknowledgement structure guide on our Formatting Requirements page.

9. **Additional**: Also provide the following, each under their own heading:
    9.1. Competing interests: This section should list specific competing interests associated with any of the authors. If authors declare that no competing interests exist, the article will include a statement to this effect: The authors declare that they have no financial or personal relationship(s) that may have inappropriately influenced them in writing this article. Read our policy on competing interests.
    9.2. Author contributions: All authors must meet the criteria for authorship as outlined in the authorship policy and author contribution statement policies.
    9.3. Funding: Provide information on funding if relevant
    9.4. Data availability: All research articles are encouraged to have a data availability statement.
    9.5. Disclaimer: A statement that the views expressed in the submitted article are his or her own and not an official position of the institution or funder.

10. **References**: Authors should provide direct references to original research sources whenever possible. References should not be used by authors, editors, or peer reviewers to promote self-interests. Refer to the journal referencing style downloadable on our Formatting Requirements page.

Appendix H Turnitin Report

Cost awareness of radiological studies amongst doctors at Universitas Academic hospital

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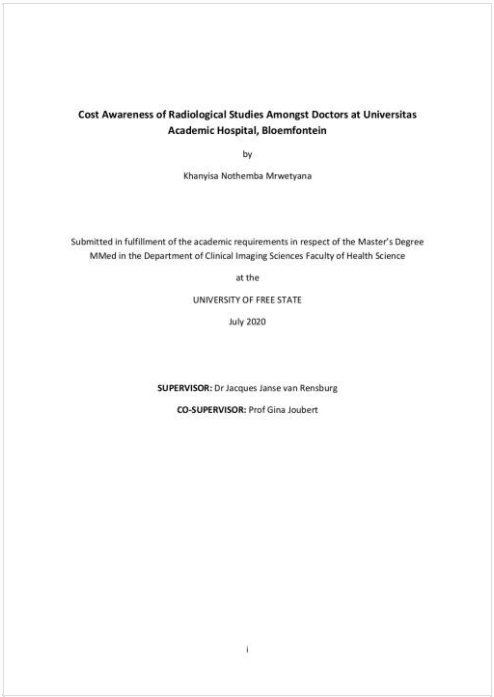

Cost Awareness of Radiological Studies Amongst Doctors at Universitas Academic Hospital, Bloemfontein

by

Khanyisa Nothemba Mrwetyana

Submitted in fulfillment of the academic requirements in respect of the Master's Degree MMed in the Department of Clinical Imaging Sciences Faculty of Health Science

at the

UNIVERSITY OF FREE STATE

July 2020

SUPERVISOR: Dr Jacques Janse van Rensburg

CO-SUPERVISOR: Prof Gina Joubert