



UNIVERSITY OF NAIROBI

**THE PREVALENCE, PRACTICE AND ATTITUDE TOWARDS
TELERADIOLOGY BY RADIOLOGISTS AND RADIOLOGY
RESIDENTS IN KENYA**

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STUDENT'S DECLARATION

I, **Dr. Calvin Moyo**, do hereby declare that the work contained herein is my original idea and has not been presented at any other university or institution of higher learning to the best of my knowledge.

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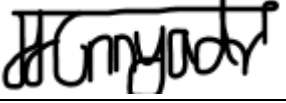
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LIST OF ABBREVIATIONS AND ACRONYMS

ACR –	American College of Radiology
CME –	Continual medical education
CT –	Computerized Tomogram
DICOM -	Digital Imaging and Communications in Medicine
ESR –	European Society of Radiology
FDA –	Food and Drug Administration
HPCSA -	Health Professions Council of South Africa
ICT –	Information and communications technology
KMPDC -	Kenyan Medical practitioners and Dental Council
MES –	Managed Equipment Service
MRI –	Magnetic Resonance Imaging
PACS -	Picture archiving and communication system
RANZCR -	Royal Australian and New Zealand College of Radiologists
TAM –	Technology Acceptance Model
US –	United States
WHO –	World Health Organisation

OPERATIONAL DEFINITIONS

Teleradiology –	The transfer of medical images between two geographically located places so that they can be viewed and interpreted by a radiologist
Tele-radiologist –	A radiologist who practice Teleradiology
Night Hawkers –	Tele-radiologists that work at night
Outsourcing –	When a radiology center has their images interpreted by an external radiologist who is not part of their team.
Intramural Teleradiology –	Occurs when the radiologist involved works for, or is contracted to the site that generates the images, regardless of the geographical location.
Extra-Mural Teleradiology –	Occurs when the interpreting radiologist works for a Teleradiology company that offers Teleradiology services or is not usually affiliated to the hospital where the films originate from.

ABSTRACT

Background: Teleradiology occurs when a radiologist interprets images away from the centre where the images were generated. Teleradiology started in the United States, but the practice has grown globally and is now part of the services offered in most radiology centres worldwide. As most hospitals in Kenya have been equipped with at least a CT scan machine, amongst many other radiological services offered, it is often the expertise that is often the drawback in these facilities. Teleradiology has the potential to mitigate the problem of unavailability of radiologists in most hospitals by providing access to radiologist's services remotely.

Broad Objectives: This study assessed the prevalence of Teleradiology currently being practised in Kenya and investigated the practice and attitude of radiologists and radiology residents towards Teleradiology.

Study Design and Population: A cross sectional descriptive study was carried out. The study targeted a population of all registered radiologists in Kenya and radiology residence undertaking their studies in Kenya.

Methodology: A structured questionnaire was used to interview participants and capture primary data. The questionnaire begun by requesting consent from the respondents, followed by giving a brief introduction to Teleradiology and the definition of a few technical terms that were used to aid respondents understanding of the concept of Teleradiology. The questionnaire was divided into three sections. The first section covered the demographic information of the participants. Section B was made up of questions on the current scope of Teleradiology being practised by the participants. The last section, C, was made up of questions on the opinion towards Teleradiology by the participants. The data was analysed using IBM SPSS (version 26).

Results: A significant number of participants had adopted the use of teleradiology in their institutions (n=100, 79%). With regards practice of teleradiology, it was slightly high in radiologists, compared to residents, 81.8% by radiologists, compared to 76.2% by residents. There was a strong relationship between the availability of PACS and practice of teleradiology. 87% of institutions with PACS were practising teleradiology, with a P value of 0.0001, which was statistically significant. The laptop was the commonest device used for reporting when carrying out teleradiology services. Majority of the participants, 77.3% indicated that insourcing teleradiology had a positive impact to their radiology departments. Both radiologists and residents gave varying opinions on their professional bodies supporting teleradiology. Forty percent of radiologists said no, their professional bodies does not support

teleradiology, whereas 28% answered yes and 32% indicated they did not know. Almost all the radiologists and residents had no knowledge of existing guidelines, with regards to teleradiology, with 98% residents and 95% of radiologists indicating there were not aware of any regulations. There were several perceived advantages of teleradiology by participants, including greater efficiency, improved distribution of workload and making easier for teaching. Disadvantages of teleradiology highlighted included teleradiology being too impersonal and insufficient communication with clinicians.

Conclusion: The results from this study revealed that many radiology practices across Kenya have integrated teleradiology in their day-to-day activities. Radiology practices in urban and rural areas were using teleradiology, and both residents and consultant radiologists were practicing teleradiology. There were a lot of perceived advantages and disadvantages of teleradiology.

Recommendations: Involvement of administrators and regulators of both KAR and KMPDC to assess their opinion of teleradiology, and their views regarding regulations in teleradiology.

1.0 CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

The field of Radiology has undergone momentous changes in the last two decades, due to advancements in technology, both in the field of Radiology and in the telecommunication field. The ability to carry out imaging quickly and provide better images, because of advancement in imaging machines has resulted in an increase in the number of radiological tests being ordered by physicians. This has directly increased the workload of Radiologists. However, many countries in the world struggle with shortages of Radiologists as a profession. The demand for radiological services gave birth to Teleradiology to try and mitigate the shortages faced by many radiological departments.

Teleradiology has been defined in a similar way, by both the European Society of Radiology (ESR) and the American College of Radiology (ACR). Teleradiology can be defined as the digital transmission of radiological images, between geographically different areas to provide primary interpretation, expert opinion or clinical review. A tele-radiologist refers to the radiologist offering these services from a distance. According to the ACR or the ESR, a tele-radiologist can work for the organisation where the images are taken or can exclusively work for a Teleradiology company providing Teleradiology services. (1) (2). The Royal Australian and New Zealand College of Radiologists (RANZC) defines Teleradiology as interpreting services offered by a Radiologist from a different geographical area who does not work for the centre where the image was taken. If a Radiologist works for the same organisation where the images were acquired, it is termed network radiology. (3)

According to the ESR, Teleradiology can further be divided into intra-mural vs. extra-mural. Intramural Teleradiology occurs when the physician involved works for or is contracted to the site that generates the images, regardless of the geographical location. Extra-mural Teleradiology occurs when the interpreting radiologist works for a Teleradiology company that offers Teleradiology services or is not usually affiliated with the hospital where the films originate from. (2)

1.2 Practice of Teleradiology in Kenya

According to data from the Kenyan Medical Practitioners and Dental Council (KMPDC), there were 155 registered Radiologists as of March 2021(4). Most doctors in Kenya, including Specialists were located more big cities such as Nairobi and Mombasa with lesser numbers in the rural areas (5). There are three training institutions for radiology, which are University of

Nairobi, Moi University and Aga Khan University. There are about 75 radiology residents in these institutions.

There has been great effort by the Kenya government to empower radiology centres in level 4, 5 and 6 public hospitals, as evidenced by the Managed Equipment Service. MES project of 2016 and the further acquisition of 37 CT scan machines for the counties in 2020. All the 47 level 4 and 5 county hospitals in Kenya have at least a CT scan machine, amongst other radiological services offered. The acquiring of the 37 CT scan machines facilitated the launch of the Kenya National Imaging Cloud Centre by Neosoft Medical Systems in March 2020. The National server is located at Kenyatta National hospital, the biggest referral hospital in the country, and it enables access to images of all 37 linked CT scan machines in different counties. This can facilitate reporting of images from different centres by radiologists. (6)

Kenyatta National Hospital is the biggest referral hospital in Kenya, and this is where the national server for the national imaging cloud, which was installed by Neosoft medical systems is stationed. The Neosoft system allows for radiologists to report from anywhere, as long as they are connected to the internet and all the Teleradiology being done is intra-mural, where Kenyatta national hospital radiologists can access the server and report cases, especially emergency cases away from the hospital. (6)

Aga Khan University hospital, which is one of the two largest private referral hospital in Kenya has developed a Picture archiving and communicating system, PACS, which enables their satellite hospital and other institutions to send imaging for reporting and for second opinion with their radiologists. (7)

1.3 Perception Towards Teleradiology

The progress and development in Teleradiology has been intertwined with developments in the information and technology industry. Initially in its infancy, there were concerns that teleradiology would result in reduced quality in radiological services offered by external radiologists, reduction in reimbursements paid to radiology groups and less interaction with other doctors. (8) However, it has been recognized that teleradiology also resulted in improving after hours coverage of radiology departments, access to specialty services and improved coverage of isolated rural areas. (8) In a survey carried out in Italy in 2016, 60% of radiologists had a positive opinion on teleradiology, stating that teleradiology had resulted in better distribution of workloads throughout organisations, improved collaborative networks, reduced costs and had made the profession more attractive to young cadres to join. (9) however, in the same survey, about 63% of respondents felt that teleradiology has resulted in instability in the

job market in radiology, 43% expressed concern about reduction in the quality of reports generated by tele-radiologists and 34% felt it had a negative effect on residence training. (9) In a comparable study, carried out in Kenya, Nairobi (2013), looking at the factors influencing adoption of telemedicine in Kenya, costs and availability of internet connectivity was seen as a major limiting factor in hospitals in Nairobi. However, of the interviewed doctors, about 60% thought that telemedicine was easy to use, improved services rendered to the patient and was generally a useful tool. (10)

This study aimed to evaluate the level of Teleradiology being practiced in Kenya and what were the thoughts of Radiologists and residents towards Teleradiology

2.0 CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Teleradiology being the practice of reporting images offsite is further divided by ESR into intramural versus extra mural Teleradiology. If a radiologist works for an organization that has a relationship with the patient and generate the images for the patient, services rendered are considered intramural. Extramural Teleradiology occurs when the radiologist worked for a company that has no relationship with the patient or the hospital where the images are generated (2).

Three essential requirements for the process of Teleradiology to function are an image acquiring, processing, and sending station; a reliable and fast transmission network and a receiving station, that is well equipped with display screens and reliable internet. Teleradiology was initially started in developed countries due to the need for emergency radiological services or cover of after work hours. However, these days, many hospitals have adopted Teleradiology as part of routine services. (11)

2.2 History of Teleradiology

The most performed Radiological examination in most departments is the plain radiography. Historically, a special film was used for acquiring and storing the images. The film would require to be put on a light viewer box for interpretation. Teleradiology during this era existed primarily as physical film copies that were mailed to the radiologist, which would take days to weeks before a report could be received. The invention of digital radiography in the 1980s paved way for digital images, which could be stored and read on the computer. Digital images could also be manipulated by windowing, zooming and allow for usage of image processing and analysis tools. Digital images can easily be sent from one workstation to another, resulting in a report being generated timeously. (12)

The first documented evidence of Teleradiology in literature is accredited to Radiologists Joseph Gershon-Cohen and Austin Cooley who tried telephonic transmission of radiographs, between Chester Hospital and Philadelphia, 28 miles apart in the United States in 1948. About a decade later in 1957, Radiologist Albert Jutras showed the practicality of transmitting images between Hotel Dieu and Jean-Talon hospitals, 5 miles apart using coaxial cable. (12)

Teleradiology systems first became commercially available in the early 1980s from several vendors but however, they were limited in quality. These early systems involved photographing or video graphing of selected hard-copy images for subsequent digitization and image transfer. The low performance of computer systems, high costs of data transmission, and lack of affordable digital image handling systems was a hindrance to the growth of Teleradiology during this period. (13)

In 1994, the ACR released the first regulations on Teleradiology in the US, the ACR Standard for Teleradiology. It was required by the ACR for the tele-radiologist to hold a license in both the initiating and receiving sites. (14)

Another important breakthrough came in the beginning of the 1980s, with the development of picture archiving and communications systems (PACS) and the establishment of the DICOM in the United States, which were crucial for the storage and transmission of images via networks. PACS was a centralized database of all images, which made it possible to transmit radiological reports and films digitally to physicians. PACS made possible the systematizing, archiving, retrieving, distributing, and transferring images to different healthcare centres. The acquiring of CT, MRI, and Fluoroscopy images were mainly computer-based, hence images were captured and processed by computers before being uploaded in to the PACS. (15)

Parallel advancements in the world of ICT were central to the development of Teleradiology. The easy accessibility of the Internet, computers and mobile telecommunication in the late 90s and the new millennia resulted in improved speed of communication and easy exchange of images online, which dramatically reduced the cost of Teleradiology. (13)

2.3 Epidemiology of Teleradiology

Teleradiology has now been integrated into most radiological practices across the world. Currently, different models of Teleradiology exist, for example: after-hours 24/7 coverage, radiology services in remote areas, and subspecialty readings or expert readings.(11)

Most radiology practices in the US have adopted Teleradiology, though usage varies slightly with the size of the practice. A survey carried out in 2019 showed that radiologists group of <10, 79.1% were using Teleradiology compared to 94.4% in groups of >100 radiologists. (8). The use of Teleradiology has been steadily increasing compared to about 20 years ago. In a study carried out in the USA in 1999, 71% of radiologist group practices had incorporated the Teleradiology systems and used them for about 5% of their studies. For solo Radiologists, only 30% had invested in Teleradiology; and used them for 14% of their studies. 92% of the Teleradiology work done was mainly for on-call interpretation of images.(16)

There are many commercial Teleradiology companies that offer both day and night services. One survey showed that almost 70% of on-call radiology, at night for hospitals in the US was being done by 'night hawkers', a phrase which refers to the tele-radiologists that work at night. International Teleradiology companies such as Teleradiology Solutions, NightHawk Radiology Services, and Virtual Radiologic were providing the coverage. Most international Teleradiology in the US provides preliminary reports which got to be verified by internal radiologists during the day. However domestic Teleradiology provided final reports which do not need verification.(17)

In Europe, a survey carried out in 2012 demonstrated that nearly 65% of Radiologists were practicing Teleradiology mainly for reading images from home, overnight or on weekends; or as a way of outsourcing their services and also to seek expert opinion. (18) Commercial Teleradiology remains relatively low in Europe compared to the US mainly due to fear that it drives down Radiology tariffs. The ESR recommended that the onsite radiologist has to be involved in the decision-making process of outsourcing. (2)

A survey carried out in Switzerland in 2005 showed that amongst the Radiologists who responded, 41.2% were currently using Teleradiology, 35.3% were planning to use it in the near future, and 14.5% had no plans to use it. (19)

A more recent survey that was carried out in Italy, in 2016, where a total of 1599 radiologists responded showed that 55% were using Teleradiology in their practices. Most users adopted intramural Teleradiology for coverage of emergencies (47 %), of night and weekend shifts (37 %) or to even out distribution workload (33 %). There was concern among radiologists of Teleradiology being impersonal(40%) and about 39% of respondents thought Teleradiology was responsible for insufficient communication with the referring clinicians. (9)

In India, the first successful use of Teleradiology was in 1996, by a private imaging centre called Jankharia Imaging in Mumbai. A system of transferring images to the individual home of Radiologists was set up, which enabled coverage at night. Teleradiology Solutions was the first Teleradiology company to be set up in Bangalore, India, in 2002. It was hiring Indian based radiologists who were licenced in the USA to report images for USA based hospitals (20). Indian Teleradiology companies have an advantage in the international Teleradiology market because of the low costs of professional service fees in India. The annual salary of a radiologist is approximately 350 000 USD, compared to around 60 000 USD for a radiologist in India, hence US hospitals find it cheaper to have some of their work done by registered Indian radiologists. The time difference between the USA and India is a distinct advantage, especially for nighthawk services. They have been challenges to the growth of the Indian

Teleradiology market due to the high cost of installing radiology equipment and also due to the ‘third world status’ of India, hence most people in the developed countries are wary of their images being read in India. (20)

In Brazil, Teleradiology is well established with several companies offering their service to the country. Of the Teleradiology companies, named Telelaudo was covering more than 300 hospitals in 2016, and reporting up to 50 000 images per month. Brazil, like many other countries, has got shortages of radiologists in the rural areas and Teleradiology has been used to cover those areas of need.(21)

In sub-Saharan Africa, a few countries including Mali, South Africa, Togo and Ethiopia have adopted Teleradiology as a way to mitigate shortages of radiologists, especially in rural areas. In 2005, Mali developed a successful Teleradiology network, linking hospitals in Bamako the capital city with hospitals in Geneva, Switzerland and Marseille, France. (22)

Teleradiology in South Africa was first practised in 1999, in three provinces, namely, Free State, Mpumalanga and the Northwest. It has since been expanded to include other rural provinces. The tele-radiologists are mainly based at centres in the main cities. (23)

In Kenya, there is a paucity of published work on Teleradiology. However, many hospitals are utilizing these services to help their patients. Tenwek Hospital is a mission hospital located in Bomet, Kenya, about 230 km west of Nairobi. Teleradiology services have been used at the hospital since 2014. The hospital has a CT Scanner machine and high-speed internet of 40Mbs to upload their images. The images are loaded into a web-based secure image exchange service called Radconnect where Radiologists mainly based in the US can assess the images and interpret on a volunteer basis. (24)

2.4 Current International Practice and Legislature

Different International Radiology boards have released different guidelines to try and regulate the practice of Teleradiology. The ACR first released guidelines in 1994 and a revision of the guidelines was released in 1996, 2002 and 2007. (1)

For a tele-radiologist to practice in the USA, it is required by law that they be certified first in terms of their initial training. Then they need to be licensed to practice in the State where the patient images are being transmitted from. Lastly, they should participate in quality improvement programs and Continuing Medical Education (CME). (1)

Recommendations to the practice of Teleradiology by the ACR in 2013 included:

- a) Patients should be the principal focus; meaning all Teleradiology practices should be patient-based. The need for financial gains should not supersede proper patient care

- b) Onsite radiology coverage is preferred over Teleradiology. Teleradiology should complement not replace onsite radiology
- c) Maintenance of high professional quality of care by both tele-radiologists and onsite radiologists(1)

It is a requirement by the ACR for Teleradiology equipment to be vetted and be approved by the FDA. With regards to licensing, it is a requirement by the ACR that a Radiologist interpreting images to be licensed to practice in the State or Country where the images originate from. (1)

In Europe, the ESR recommends that a tele-radiologist be registered in the Member State where they practice, not in the Member State where the patient underwent imaging. It is also a requirement to obtain informed consent by the patient. Patients must be told if their images will be interpreted by a tele-radiologist, including the reporting radiologist' qualifications before they accept. (2)

The Royal Australian and New Zealand College of Radiologists (RANZCR) officially released its position and requirements for Teleradiology in 2014. RANZCR differentiates Network Radiology from Teleradiology. Network radiology is defined as remote reporting within a Radiology group, whereby a radiologist can have access to images from a center he/she works for, which is similar to intra mural Teleradiology according to ESR. For RANZCR, Teleradiology occurs when the reporting radiologist works for a third party. It is a requirement for RANZCR for any radiologist practicing Teleradiology to be appropriately registered in the jurisdiction of both the acquisition and reporting sites and have malpractice insurance that covers that covers both the acquisition and reporting areas. (3)

In Malaysia, a Tele-medicine Act was passed in 1997, which requires tele-radiologist practitioners to be registered by the Malaysian Medical Council to practice in Malaysia. A basic minimum number of 100 examinations must be reported by the radiologist per month to maintain competence and the tele-radiologist must bear ultimate responsibility for the Teleradiology service. Equipment to be used for Teleradiology has to be vetted and needs to meet minimum specifications requirement. (25)

In South Africa, a radiologist needs to be registered and licensed with the Health Professions Council of South Africa (HPCSA) to practice Teleradiology. (26)

In Kenya, there are no specific regulations with regards to Teleradiology practice, but it is a requirement by the KMPDC for radiologists practicing in Kenya to be fully registered with the council. (4).

2.5 Tools used in Teleradiology

A basic Teleradiology system consists of 3 components: an image sending station, transmission network and a receiving/ image review station. For a radiological image to be transmitted over networks it needs to be in digital form. All radiological machines are now DICOM compliant, which facilitate capture of images and ease transmission via networks. High transmission speeds are essential for a transmitting station. (27). Transmitting and receiving workstations need to be equipped with high performance computing facilities, user interfaces, and it is also desirable to have a PACS at both ends of the communicating links.(28)

2.6 Confidentiality and Security

The transmission of radiological data over open networks increases the risk of breach in confidentiality and the integrity of patient information. There is need for well-defined policies to safeguard the confidentiality of patients and reduce the risk of information obtained during Teleradiology exchange being used for other purposes, besides the intended primary purpose of formulating a diagnosis (29).

Both the ACR and the ESR requires due diligence when it comes to the security and confidentiality of patient information in Teleradiology. Three issues regarding data security include privacy, authenticity, and integrity. Both the sender and receiver have the responsibility of maintaining data security. (30) Security issues relating to increased risk of improper disclosure of records, breach of confidentiality, access to records, alteration or elimination of records from a remote site, vulnerability of computer-stored data to accidental erasure, and methods of ensuring verification of the above are some of the problems that need to be addressed in Teleradiology. Data encryption and use of highly secured passwords is required to control access to patient files. Digital watermarking is an authentication method which has been adopted by in Teleradiology in order to protect the images from being tempered with. (31) In Kenya, the Data Protection act of 2019 is used to protect online use of patients' data. The individuals or organization collecting personal data have an obligation to make sure the data is secure. Also, individuals need to give consent to transportation of data across borders. (32)

2.7 Quality in Teleradiology

There has been concern on whether the quality in Teleradiology is equivalent to onsite radiology. The ACR is of the opinion that traditional practice model of having onsite radiologists and local radiology groups better serve the interest of communities than Teleradiology. This is because tele-radiologists mainly focus on delivering radiology reports and they interact minimally with other hospital physicians, hence radiology has will be

commoditized into producers of reports only, other than being an integral member of teams managing patients. (1).

There have been studies carried out to demonstrate that Teleradiology can be effective, and quality can be high. A study by Hohmann et al assessed the quality of their radiology outsourcing of after-hours CT at the Central London University Hospital. The study included a retrospective review of 1,028 in-house patients referred for imaging in the evening between 7pm and 9pm and the cases were read by tele-radiologists elsewhere in the UK and Australia. The reports were then reviewed by onsite radiologists in the morning using a five-point scale, where 5 was “no disagreement” and 1 was “definite omission or misinterpretation with unequivocal potential for serious morbidity or threat to life.” The results showed that in 79% of cases, there was no disagreement between onsite radiologist and tele-radiologist, in 16% there was disagreement over style of reports and failure to describe clinically insignificant findings (rating = 4); in 4% there was “clinical significance of disagreement, likelihood of harm low” (rating =3); and in 1.3% there was “definite omission or interpretation of finding with strong likelihood of moderate morbidity but not threat to life” (rating =2). There were follow up category 2 cases, and results showed that (0.8%) were correctly diagnosed by the in-house radiologist, (0.2%) by the tele-radiologist, and (0.3%) were unresolved. Thus there was only a 0.8% proven serious misinterpretation rate. (33)

In another study in the US in 2005, a total of 124 870 radiological studies, which were interpreted by 10 tele-radiologists in 2003, for the company Teleradiology Diagnostic Services, (TDS, California) were reviewed and compared to the final report of the onsite radiologists. The studies were comprised of CT scans (74%), ultrasound (19.6%), radiographic studies (3.8%), nuclear imaging (1.5%), and MRI (0.8%). There were 1367 (1.09%) discordant reports. Of these 469 (0.38%) were categorised as informational only, 740(0.59%) as minor disagreements and 158 (0.13%) as major disagreements. Overall, there was almost 99% agreement between tele-radiologists and onsite radiologists. (34)

2.8 Ethical and Legal Issues in Teleradiology

There are ethical and legal issues in Teleradiology that remains unclear. There is need of clarity on issues to do with accountability, responsibility, and liability of negligence. The doctor to patient relationship is different in Teleradiology, and there might be several people involved in decision making. There is need of clarity on who maintains overall patient responsibility. For example, if there was a case of negligence, how liability would be apportioned between the concerned parties. (30)

Since the doctor and the patient are in different geographical locations, sometimes different countries, or continents, how is a legal case going to be conducted. Is it the patient who visited the doctor or is it the doctor who visited the patient? In any case, states might have different laws and requirements, hence which state laws should be applied, from the patient's state or doctor's state? (30,35)

Teleradiology is heavily dependent on technology, which sometimes fails and makes errors. If there is a case of misdiagnosis or delay in diagnosis due to equipment failure, a question arises in that who is reliable. Is it the company that supplied the equipment, is it the Teleradiology company that employed the radiologist or is it the radiologist using the equipment? Hence there is need of clear contractual obligations in Teleradiology. (35)

Lastly, should a patient be made to consent to the use of Teleradiology as part of their treatment or it is the responsibility of the imaging centre to provide an adequate report, regardless of where the report was generated from? A case in point has been made in surgery, where patients give consent to the operation not to the actual surgeon doing the procedure. The ESR is of the opinion that informed consent is only obtained if the patient is fully informed that the primary imaging site might have reports generated through Teleradiology. This is important because the use of Teleradiology might carry with it an additional risk in the management of the patient. (2,36)

2.9 Benefits of Teleradiology

As the demand for radiological services keep increasing worldwide, because of the increased demand for diagnostic imaging studies by referring clinicians, there remains an acute shortage of Radiologists. The ratio of radiologists per population serviced is low in most parts of the world, including Sub-Saharan Africa. For example, Nigeria the most populous country in the region has 1: 566,000 (37) and Kenya has a ratio of 1: 389,255 (5). Most peri-urban and rural parts of Africa are under serviced in terms of Radiology as Radiologists prefer to settle in urban areas. (22)

Teleradiology can play a significant role in allowing Radiologists to provide their expertise to rural healthcare facilities without the need for the Radiologists to be present in the same location. This means remote and smaller hospitals that labor to get adequate radiology coverage can improve on their services by having images interpreted more quickly than would otherwise be possible. This generally results in improved health care delivery, as decisions are made quickly especially in the setting of emergency conditions and sometimes it also reduce the need for unnecessary referrals to tertiary institutions, reducing cost to patients.

Teleradiology played a significant role in the diagnosis of paediatric respiratory infections, especially tuberculosis in HIV burdened parts of South Africa. In a pilot program ran by MSF in South Africa between July 2012 and March 2013, about 1600 paediatric radiographs were sent to radiologists in 17 different countries, allowing access to specialist radiology to districts that had no radiologist services. (38)

One of the major impacts of Teleradiology has been in improving service levels in emergency radiology and decreasing turnaround time of reports, especially at night. International Teleradiology has made it possible for radiologists in different time zones to cover each other's night hours. A radiologist working dayshift in Australia could cover the graveyard night shift in the USA. This day-night model reduces need to work at night, hence increasing productivity and quality of work done by radiologists as they are always working at their peak during the day. (39)

Teleradiology can also be a way by which Radiologists can collaborate with each other. This can be paramount especially in the management of patients, as it is often important to get a second opinion from a colleague when one is in doubt. Radiologists who have subspecialized, like neuro-radiologist or pediatrics radiologists are even scarcer. Teleradiology also allows the less experienced radiologist to seek expert advice from the senior or subspecialist radiologists, all improving patient care management.

The competitive nature of Teleradiology has resulted in quality of Radiology care improving, as noted in the USA, as providers of Teleradiology services need to demonstrate high quality levels to remain in business. Also, small local radiology groups have improved their output in order not to lose business to tele-radiologists, thus overall, improving the quality of work in radiology. (39)

Lastly, Teleradiology has been adopted by some universities in the United States for teaching purposes and as a way of earning extra income for Radiology Departments. As the Covid-19 pandemic has reduced interactions amongst people and has affected classes, Teleradiology has become beneficial in conducting classes online, as both students and lecturers have access to files online. University Radiology departments have set up Teleradiology teams, which compete with for profit Teleradiology companies. Universities outsource their extra time reading images for private hospitals, increasing their income.

2.10 Challenges of Teleradiology

One of the drawbacks of Teleradiology is that it is heavily dependent on technology, which is expensive to install, especially in remote rural settings. Challenges with power cuts and slow internet congestion can make it difficult. (13)

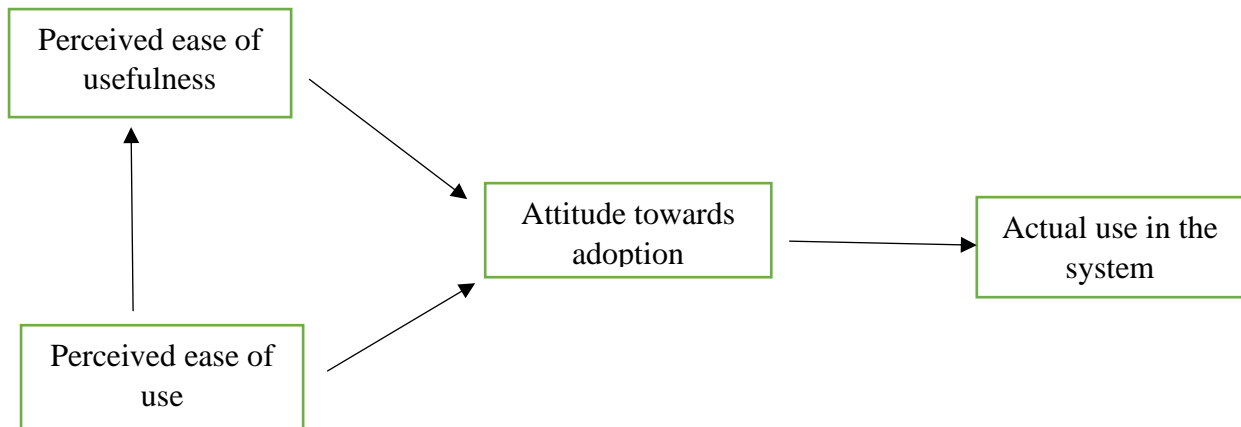
Another challenge with Teleradiology is that the doctor–patient relationship is different. Conventional radiology allows the radiologists to carry out a physical exam if necessary or evaluate patient’s file, if necessary, for formulation of a diagnosis. Lack of interaction with patient or access to past files and past images in Teleradiology may increase the risk of missed diagnosis or misdiagnosis. (12)

Teleradiology also results in less interaction between the referring physician and the Radiologist. Most likely the physician and the radiologist have never met, which compromise the necessary trust needed in making critical decisions in patient management. Direct discussion of some cases with clinicians and participating and contributing in multidisciplinary meetings are important components of radiologists’ work, which is difficult to obtain with Teleradiology. This in turn diminishes the clinical role of radiologists. (40)

Teleradiology companies mainly focus exclusively on report delivery alone. This means there is no guidance on the proper radiological examinations and protocols to be done before imaging, which might result in wrong tests or unnecessary exams. Because of the need to push numbers, there is insufficient adherence to regulations, and predatory practices, which are economic and investor-driven rather than in the interests of patient, compromising the overall quality. (12)

2.11 Theoretical Framework

The research investigated the practice and attitude by radiologists in Kenya, towards Teleradiology, which is an innovation in the field of Radiology. Both the technology acceptance model and the diffusion of innovation theory because they explain factors that influence acceptance of innovation. Technology acceptance model, TAM, describe three primary factors that are influential to an individual to use new technology: perceived ease of use, perceived usefulness and attitude towards the new technology. (41) Perceived usefulness and ease of use of new technology are the primary determinants of an individual’s behavior towards new technology. In this study, the attitude of radiologist towards the new technology being used in Teleradiology will be evaluated.



*Source: Davies, F.D (1989), Technology Acceptance Model

Figure 2. 1: Technology acceptance Model

The diffusion of innovation theory is also important in this study as it explains stages that occur as people adopt a new idea or practice. It was established by Rogers, who classified individuals into five categories, based on their willingness to adopt to innovation. The categories are innovators, early adopters, early majority, late majority, and laggards.

There are five factors that influence adoption of an innovation, and each of these factors play a different extent in the five adopter categories. The factors are relative advantage, compatibility, triability, observability and complexity. The diffusion of innovation theory is important in this study to help determine the characteristic of radiologists as they adopt to new innovation of Teleradiology. (42)

2.12 Justification

The UK, with a population of about 66 million has about 4000 radiologists, a ratio of 1 radiologist per 16 500 people, yet Radiologists remain listed as one of the specialties which is still understaffed (43). Kenya, with a population of 47,5 million has a ratio of 1 radiologist per 389 225 people, which is very low, as compared to developed countries. In addition, most of the radiologists in Kenya are found in the cities and in the private practice, resulting in scarcity of radiology services in remote and under-resourced communities. (5)

Advancement in the information, communication and technology sector has resulted in most hospitals in Kenya, both in the cities and remote centres having access to internet. Availability of internet makes it easy for communication and exchange of patient images between different centres which is the bedrock for Teleradiology.

Most of these hospitals have at least a CT scan machine, hence the right diagnostic tools are often available, but it is the expertise to interpret the images that is often lacking. Teleradiology has the potential to mitigate that by having access to radiologists in geographically different regions.

The findings of this research were going to be important in providing perception on attitude of radiologist and radiology residence towards Teleradiology and the extend of adoption of the practice in Kenya. The research will also provide information on factors influencing the adoption of Teleradiology in Kenya. The findings in this research will benefit government and policy makers in evaluation of Teleradiology as an option to mitigate the shortage of Radiologists in the country. Hospital administrators and private institutions will also benefit by evaluating if Teleradiology can be adopted to cover demand for radiological services at their centres. Radiologists opening their own practices can also consider Teleradiology as an option to broaden their scope of practice. Other researchers can also use the findings in this research in their own studies or carry out more research guided by the limitations of this study.

2.13 Research Question and Hypothesis

What is the prevalence of Teleradiology in Kenya and what is the attitude of radiologists and radiology residence towards the practice of Teleradiology?

2.14 Broad Objective

The general objective of the study is to determine the practice of Teleradiology by radiologists and radiology residents in Kenya as well as their attitude towards it.

2.15 Specific Objectives

The specific objectives of the study are to:

- a) Determine prevalence of Teleradiology in radiology practices
- b) Determine the attitude towards Teleradiology in Kenya by radiologists and radiology residents

3.0 CHAPTER THREE: METHODOLOGY

3.1 Study Area

The research was carried out in Kenya and applied to every radiologist practising in Kenya and all radiology residents undertaking their postgraduate studies in Kenya. There are three institutions training radiology in Kenya, which are University of Nairobi, Moi University and Aga Khan University. Most of the radiologists in Kenya are concentrated in the cities, with an estimated 76% concentrated in the three major cities of Nairobi, Mombasa and Kisumu. (44)

3.2 Study Design

Descriptive-survey research was used in this study. The objective of the study was to determine the attitude of radiologists and radiology residence towards the practice of Teleradiology and factors which influence adoption, all which suite a descriptive study.

3.3 Target Population

The target population in this research were all registered radiologists and radiology residents in Kenya. Radiologists practising in government hospitals, private hospitals, university and mainly doing research all qualified for the research.

3.4 Inclusion

All qualified radiologists and radiology residents, who were currently working in Kenya qualified to participate in the research, regardless of where they were located.

3.5 Exclusion Criteria

Radiologists and residents who chose not to take part in the online survey.

3.6 Sample Size and Sampling

Total Population Sampling was used because the target population was small and well defined. There were 155 radiologists registered with KMPDC and about 75 students at the three universities offering Radiology in Kenya. The target population estimated to around 230.

3.7 Data Management

3.7.1 Data Collection Procedure

An anonymized survey was administered, which included 3 sections: an introduction of the study and definitions of technical terms was discussed in the preamble, section 1 was made up of demographics questions, section 2 consisted of questions related to the current level of Teleradiology being practiced by the respondent.

The last section was composed of questions related to opinion of the respondent to Teleradiology. Guided questions in which opinions were graded with a scale were asked. The standardized questionnaire was packaged in an electronic form and hosted on forms for 6

weeks, with participants being reminded on a weekly basis to improve response rate. The link was shared to eligible members via WhatsApp platforms with a brief description outlining the purpose and rationale for the survey. Participants were requested to give consent before taking up the survey. To minimize bias, every computer IP address was only allowed to give one response.

3.7.2 Data Analysis

Data analysis was conducted using IBM SPSS (version 26). The data collected was analysed based on the research objections. Data from Section A, which related to demographic data was analysed using pie charts, frequencies, and percentage tables. Section B and C was analysed using mean scores, standard deviations, and factor analysis.

3.8 Study dissemination

The findings of the study will be shared with relevant stockholders such as the Ministry of Health, Kenya Association of Radiologists as well as international community through relevant journals.

3.9 Ethics Consideration

Ethical approval was received from the KNH - UON ethics and research committee before commencing the study. Ethical guidelines were employed in line with the World Medical Association Declaration of Helsinki. Informed consent was obtained from the respondents before conducting the study, retaining anonymity, ensuring confidentiality of responses, and observing the participants' rights of withdrawing from the study at any time. The data obtained was only accessed by the primary researcher and supervisors. No additional cost was incurred by the respondents by participating in the study.

3.10 Limitations of the Study

There were few previous studies in Kenya and Africa on the topic of teleradiology. This granted an opportunity for the study to be one of the pioneers for research in this topic.

4.0 CHAPTER FOUR: RESULTS

4.1 Introduction

The data analysis, presentation and interpretation are presented in this chapter. A total of 230 radiologists and residents were invited to participate in the survey using WhatsApp platforms for a period of 6 weeks. One hundred responses were received, giving a response rate of 43.5%. All responses met the inclusion criteria, and none was disqualified.

4.2 Socio Demographic Data

A presentation of the socio-demographic data is given in the table 4.1 below which showed majority responses were females, making up 65% of the responses. Consultant radiologists represented 58% responses, and residents 42%. Majority (88%) of responses showed that there were from an urban set up, whilst 12% were from rural areas.

Table 4. 1: Socio demographic characteristics.

Variable (n)	Characteristics	Frequency	Percentage %
Responses (100)	Consultants	58	58
	Registrars	42	42
Gender (100)	Females	65	65
	Males	35	35
Demographics (100)	Urban	88	88
	Rural	12	12
Year of study for resident (42)	First year	6	14
	Second year	13	31
	Third year	14	33
	Fourth year	9	21
Years of experience for consultants (58)	Less than 5 years	22	38
	6 to 10 years	16	28
	11 to 15 years	6	10
	16 to 20 years	5	9
	More than 20 years	9	16
Level of Consultants (58)	General radiologists	48	83
	Subspecialized	10	17
Place of employment (63)	Exclusively public hospitals	17	27
	Exclusively private hospital	13	21
	Both private and public hospitals	22	35
	Teaching University	1	2
	Research	1	2
	Locum in private hospitals	9	14
Level of facility in public hospitals by radiologists. (45)	Level 6	25	56
	Level 5	14	31
	Level 4	6	13

4.3 Usage of Teleradiology

This section aimed at finding out if the respondents are practicing teleradiology at their facilities and to what extent were they practicing it. Of the 100 responses received, 79% were using teleradiology in their clinical practice as demonstrated in table 4.2 below. PACS was available to 69% of the respondents.

Table 4. 2: Practice of teleradiology

Variable		Frequency	Percentage
Does your institution use any type of teleradiology	Yes	79	79
	No	21	21
	Total	100	100
Does your institution have a PACS	Yes	69	69
	No	31	31
	Total	100	100

4.3.1 Usage of Teleradiology by Different Groups

The usage of teleradiology was compared for different groups as shown in table 4.3 below. The usage was slightly higher in radiologist, 81.1% (n=47) as compared to residence, 76.2% (n=32). Also, the practice of teleradiology was significantly higher, at 81.8% in urban radiology facilities compared to rural facilities with a usage of 58.3%.

Table 4. 3: Usage of teleradiology by different groups

Variable (n)	Characteristic	Institutional use of teleradiology		Total	p-value
		Yes (%)	No (%)		
Qualifications(100)	Radiologist	47 (81.1)	11 (18.9)	58	0.28
	Resident	32 (76.2)	10 (23.8)	42	
Location	Rural	7 (58.3)	5 (41.7)	12	0.045
	Urban	72 (81.8)	16 (18.2)	88	
Age	20 – 35 years	34 (75.6)	11 (24.4)	45	0.92
	36 – 45 years	29 (82.9)	6 (17.1)	35	
	46 – 55 years	11 (78.6)	3 (21.4)	14	
	56 – 65 years	4 (80)	1 (20)	5	
Gender	Above 65 years	1 (100)	0	1	0.204
	Female	53 (81.5)	12 (18.5)	65	
	Male	26 (74.3)	9 (25.7)	35	
PACS availability	No	19 (61.3)	12 (38.7)	31	0.003
	Yes	60 (87)	9 (13)	69	

Chi square tests for association was carried out for the variables to ascertain if there was association between each variable and the Institutional use of Teleradiology, alternatively the Fisher's Exact test was used if the Expected cell value was less than 5. A p-value < 0.05 showed that there was an association, and the results were statistically significant. In this case Location

and PACS both showed that there was association with Institutional use of Teleradiology and this was statistically significant.

4.3.2 Usage of Teleradiology by Counties

Responses were received from 17(36.2%) out of the 47 counties in Kenya. As shown by Table 4.4 below, a total of 12 counties indicated there were practicing teleradiology. Nairobi county had the most responses, with 62 (84.9%) out of 73 responses indicating usage of teleradiology. All the four (100%) responses from Kiambu indicated they were practicing teleradiology, whilst Kitui only had 1 (25%) response out of 4 using teleradiology. Single responses were received from most of the counties show distribution by various counties.

Table 4. 4: Teleradiology by County

County	Institutional use of teleradiology		prevalence of teleradiology %	Total
	No	Yes		
Nairobi	11	62	84.9	73
Kiambu	0	4	100	4
Uasin Gishu	2	2	50	4
Kitui	3	1	25	4
Kericho, Machakos.	0	2	100	4
Kisumu, Kajiado, Elgeyo Marakwet, Nyeri, Taita taveta, Meru.	0	1	100	6
Kirinyaga, Muranga, Samburu, Eldoret, Laikipia.	1	0	0	5
Total	21	79		100

4.3.3 Devices Used for Teleradiology

As shown in table 4.5 below, the laptop was the commonest device being used for teleradiology, with 85 (85.9) responses. Fully assembled monitors and phones were the second frequently used devices, with 11 (11.1%) responses each. 2(2%) responses for monitors and 5 responses indicated none.

Table 4. 5: Type of device used for reporting away from the station (multiple answers possible)

Device	Frequency	Percentage
Laptop	85	85.9
Tablet	6	6.1
Phone	11	11.1
Fully assembled monitors	11	11.1
PC	2	2.0
Viewers	1	1.0
Able to access images via VPN, but cannot report	1	1.0
None	5	5.1
Total	122	100

4.3.4 Teleradiology Insourcing

Table 4.6 below was seeking to find out reasons why radiologists and residents practiced intra-mural teleradiology. A total of 29 responses indicated no or I do not know to the use of intra-mural teleradiology, hence 71 (71%) were practicing a form of teleradiology. The highest responses were 46(46%), who indicated yes, mainly for calls and weekend cover. Second highest group, 22(22%) responses said yes to all type of work being done. There were three responses each for CT and MRI only.

Table 4. 6: Reason for Insourcing Teleradiology

insourcing/ intra-mural Teleradiology	Freq.	Percent
No	22	22.00
I don't know	7	7.0
Yes, for calls and weekend cover	46	46.0
Yes, for all type of work	22	22.0
CT and MRI	3	3.0
Total	100	100

4.3.5 Insourcing Amongst Different Categories

Table 4.7 below compared the practice of insourcing teleradiology amongst different groups. Insourcing was high in urban areas at 82% as compared to rural areas at 58%. Qualified Radiologists had a higher prevalence 81% for insourcing Teleradiology as compared to Residents 76%. Level 6 Public Hospital facility had the highest teleradiology insourcing prevalence at 88%. Institutions that had a PACS system practiced more insourcing at 87%, compared to those that did not have a PACS, 61%.

Table 4. 7: Comparison of insourcing teleradiology in various groups

Characteristic	Variable	Insourcing teleradiology		Total	Prevalence %	P value
		No	Yes			
Rural/ Urban	Rural	5	7	12	58.33	0.230
	Urban	16	72	88	81.82	
Qualification	Resident Radiologists	10	32	42	76.19	0.142
		11	47	58	81.03	
Resident year of study	Year 1	3	3	6	50	0.241
	Year 2	3	10	13	76.92	
	Year 3	3	11	14	78.57	
	Year 4	1	8	9	88.89	
Radiologist years of practice	Less than 5 years	5	9	22	86.36	0.216
	6 – 10 years	5	11	16	68.75	
	11- 15 years	1	5	6	83.33	
	16 – 20 years	1	4	5	80	
	More than 20 years	1	8	9	88.89	
Main Professional Activity	Radiologist in University	1	7	8	87.50	0.476
	Radiologist in public hospital	5	12	17	70.59	
	Radiologist in both Public and Private hospital	3	16	19	84.21	
	Radiologist exclusive private hospital	2	11	13	84.62	
	Research	0	1	1	100	
Public hospital facility level	Level 4	2	4	6	66.67	0.191
	Level 5	3	11	14	78.57	
	Level 6	3	22	25	88	
PACS	No	12	19	31	61.29	0.0001
	Yes	9	60	69	86.96	

Chi square tests for association was carried out for the variables to ascertain if there was association between each variable and the Institutional use of Teleradiology, alternatively the Fisher’s Exact test was used if the Expected cell value was less than 5. A p-value < 0.05 showed that there was an association, and the results were statistically significant. In this case PACS availability both showed that there was association with Teleradiology Insourcing and this was statistically significant.

4.3.6 Outsourcing Teleradiology

Table 4.8 below was seeking to find out reasons why radiologists and residents practiced intra mural teleradiology. Majority, 74 (74.5%) responses said no, or I do not know to practicing teleradiology outsourcing. 9(9%) responses said they do outsource for calls and weekend cover. 6(6%) responses said for backlog. 7 responses were for second or expert opinion and 1 response each for research, for all work and when the radiologist is on leave.

Table 4. 8: Teleradiology outsourcing

Teleradiology Outsourcing	Freq.	Percent	Cum.
No	64	64.65	64.65
I don't know	10	10.10	74.75
for backlog	6	6.06	80.81
night and weekends	9	9.09	89.90
expert opinion	7	7.07	96.97
annual leave	1	1.01	97.98
All work	1	1.01	98.99
Research	1	1.01	100.00
Total	99	100.0	100.00

The follow up question was asking if there was any form of quality assurance monitoring done on the work done by the offsite radiologist. There were 100 responses, of which only 15 said yes to carrying out quality assurance for offsite teleradiologists. 39 responses indicated no, meaning offsite teleradiology was allowed to be done without any quality assurances.

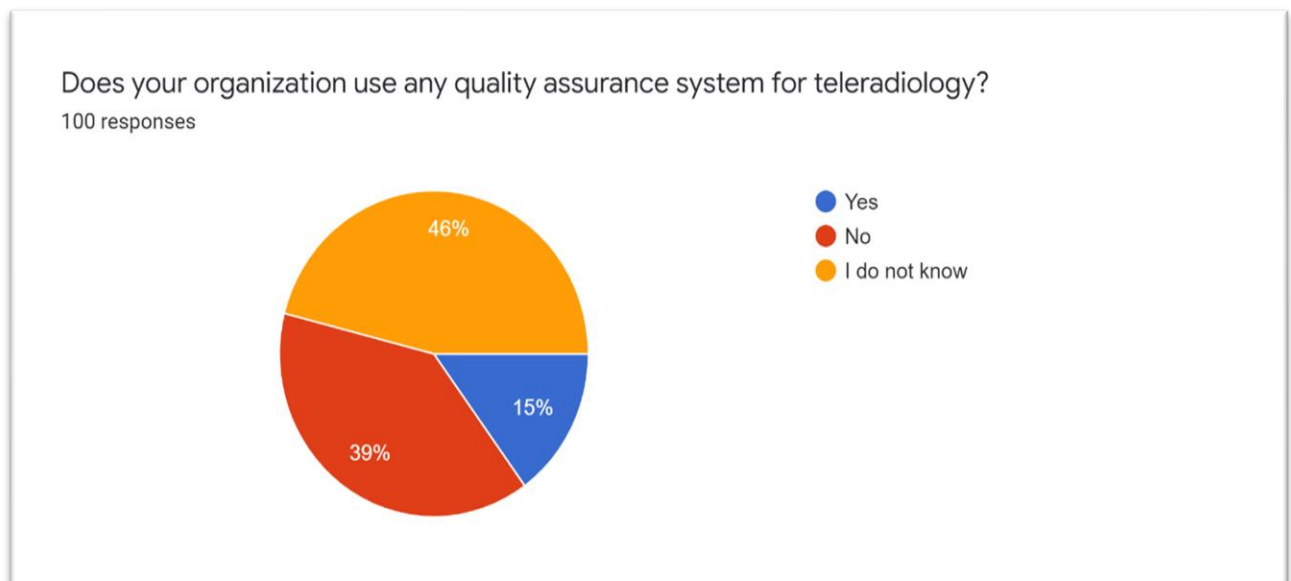


Figure 4. 1: Quality assurance for offsite teleradiologist

4.3.6 Providing Teleradiology Services to Other Centres

The participants were asked if they did provide teleradiology services to other centres and their experience with that.

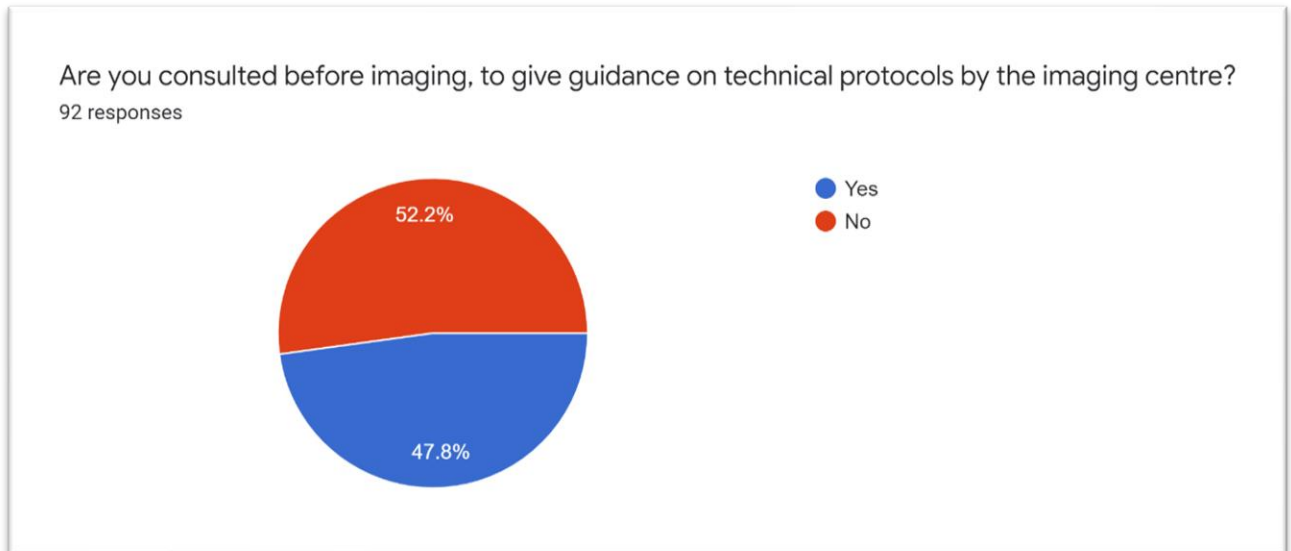


Figure 4. 2: Protocoling for services provided to other centres

92 responses were received, of which 44 (47.8%) said yes, they were consulted, and 48 (52.2%) said no, there weren't consulted.

The follow up question asked the radiology personnel if they were able to communicate directly with referring physicians of the centres, where they were offering their services to get more clinical information or to discuss the results.

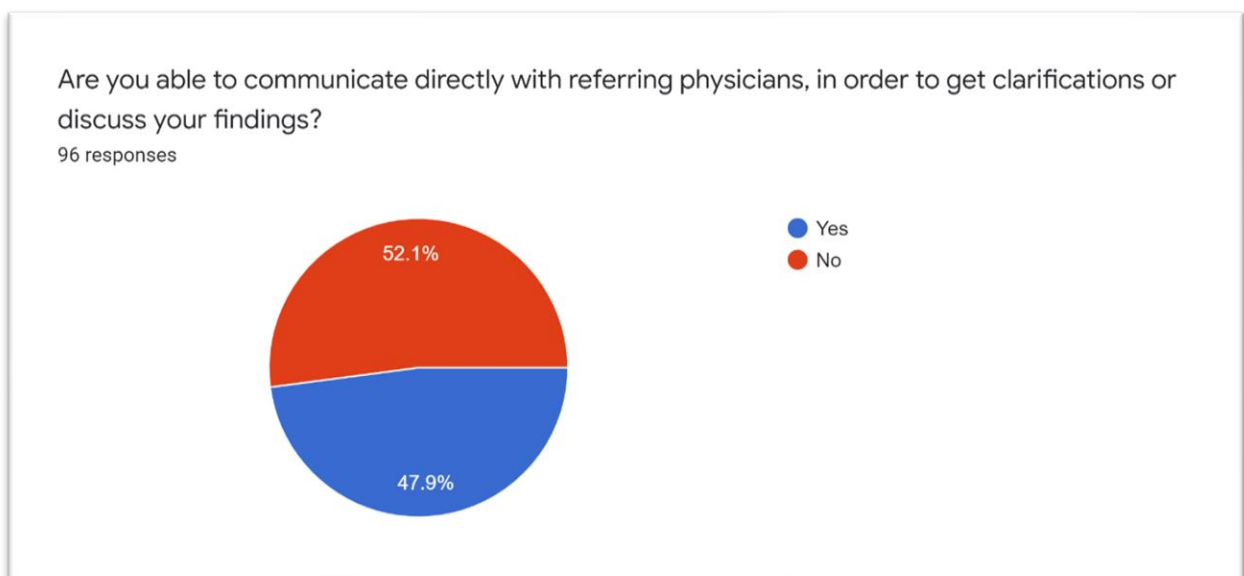


Figure 4. 3: Communication with referring physicians

Of the 96 responses received, 50(52.1%) answered no, and 46(47.9%) answered yes. Those providing offsite teleradiology services were further asked if clinical data, or previous images were easily available for comparisons when needed.

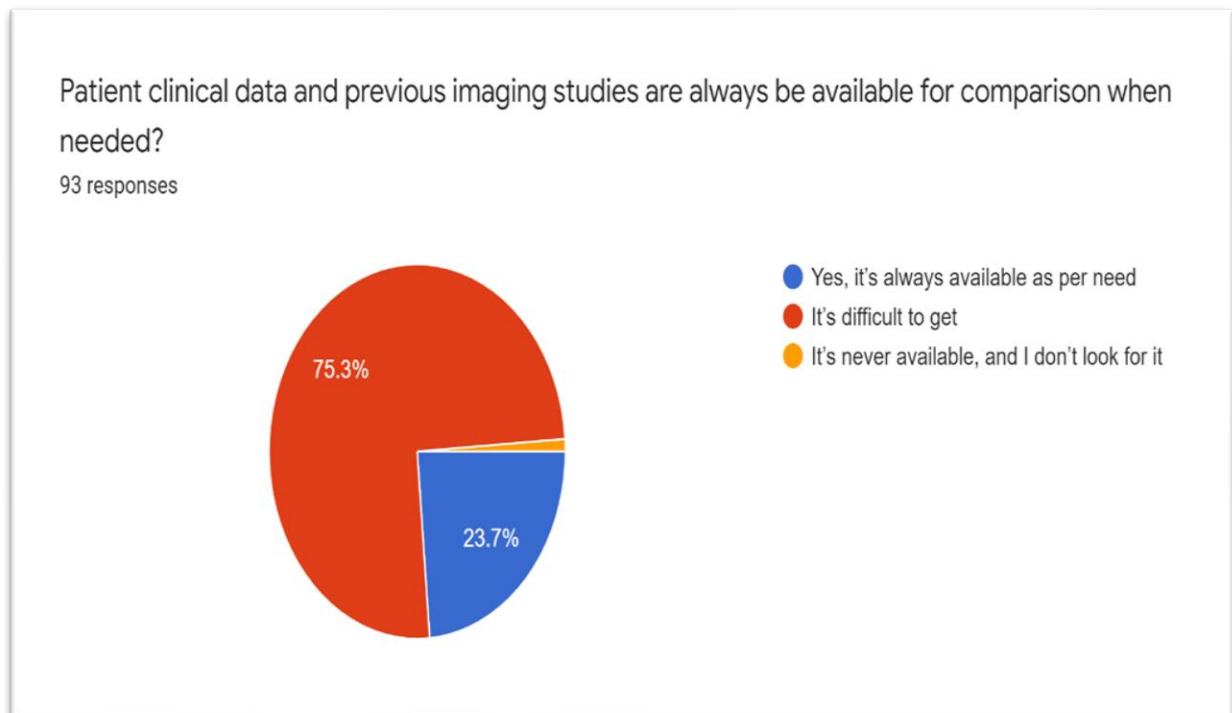


Figure 4. 4: Availability of previous images or clinical data when reporting

Of the 93 responses received, the majority, 70(75.3%) indicated that it was difficult to get previous images. 22(23.7%) responses indicated that it was always available, and 1 response indicated it was never available and they don't look for it.

The last question on those providing teleradiology to other centres was asking which modalities they mainly reported on. Multiple answers were permitted. As illustrated by figure 4,6 below, there were 98 responses, and CT was the most common modality, with 90 responses saying they do report CT, followed by plain radiographs with 68 and MRI with 49. Both ultrasound and mammography had 40 responses each. There were single responses for HSGs and Nuclear imaging. One response was unsure.

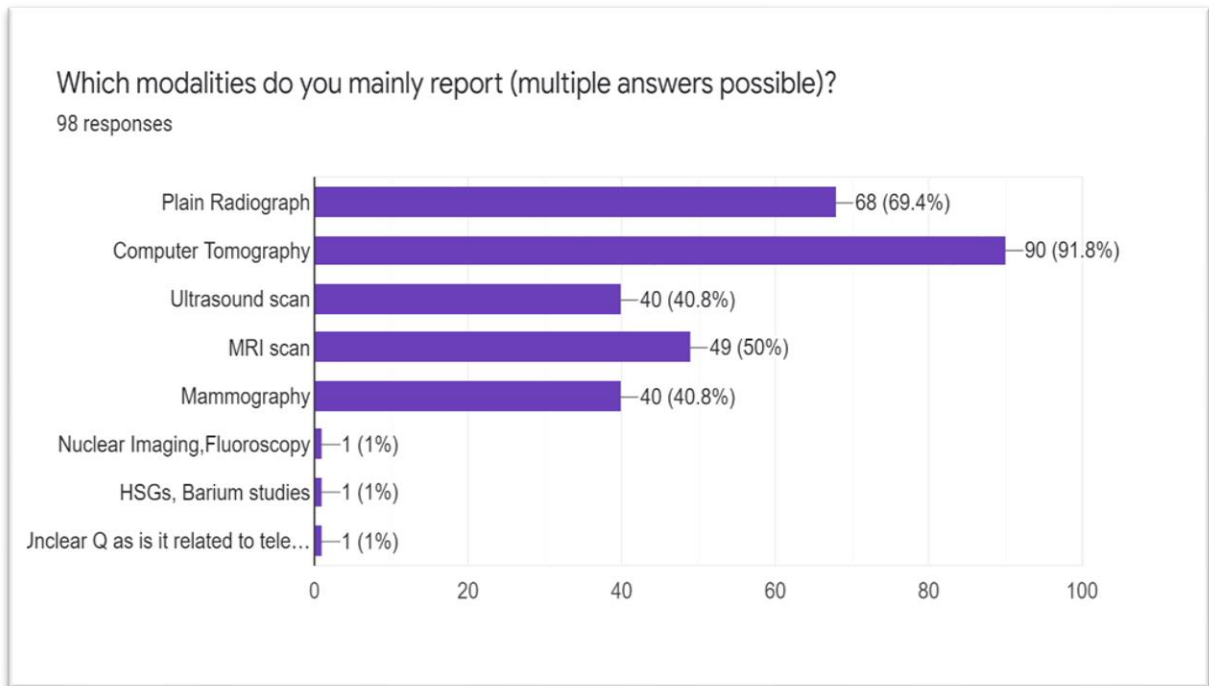


Figure 4. 5: Modalities reported on at the different sites

4.4 Opinion on Teleradiology

The last section was seeking to evaluate the opinions of the respondents towards the practice of teleradiology.

The first question was seeking to see what impact insourcing teleradiology had on those practicing it. Table 4.9 illustrate the responses received. 97 responses were received, of which 75(77.3%) said it had a positive impact on their work, 17(17.5%) did not know, and 5 (5.2%) responses indicated no positive impact on their work.

The next question was asking respondents whose organizations outsource their images to outside radiologists, to see if this had a positive impact on their organizations. 86 responses were received, and 41(47.7%) responses were not sure, 30(34.9%) responses said yes, and 15(17.4%) responses said no.

Table 4. 9: Impact of teleradiology

Variable		Frequency	Percentage
Does insourcing teleradiology have a positive impact on your department and work experience	Yes	75	77.3
	No	5	5.2%
	I do not know	17	17.5%
	Total	97	100
Does outsourcing teleradiology have a positive impact on your department and work experience	Yes	30	34.9
	No	15	17.4
	I do not know	41	47.7
	Total	86	100

4.4.1 Legislation on Teleradiology Outsourcing

Fig 4.8 below illustrate knowledge of whether the main professional organizations for radiologists and residents support teleradiology.

Forty percent (n=23) of radiologists answered no to their professional organization supporting teleradiology support as compared to 33% (n=14) of residents. Radiologists that answered yes were 28% (n=16) as compared to 29% (n=12) of residents. Thirty two percent 32% (n=19) of radiologists did not know as compared to 38% (n=16) of residents. On average 37% (n=37) of both radiologists and residents answered no, 28% (n=28) answered yes and 35% (n=35) did not know if their professional organization supported teleradiology.

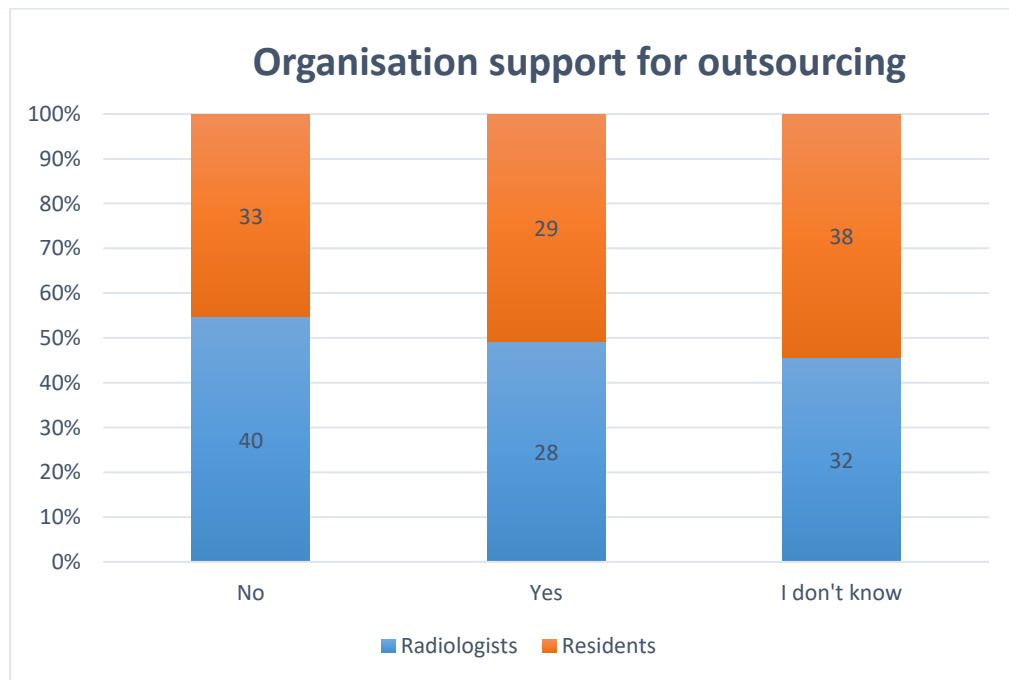


Figure 4. 6: Professional organization support for teleradiology

The diagram below shows that 98% (n=41) of residents did not know any regulations, guidelines or legislation in the sector as compared to the 2% (n=1) of residents that did. Ninety-five 95% (n=55) of radiologists did not know any regulations, guidelines or legislation in the sector as compared to the 5% (n=3) of radiologists that did. On average 96% (n=96) of both radiologists and residents did not know the regulations, guidelines or legislation in the sector as compared to the 4% (n=4) of residents and radiologists that did.

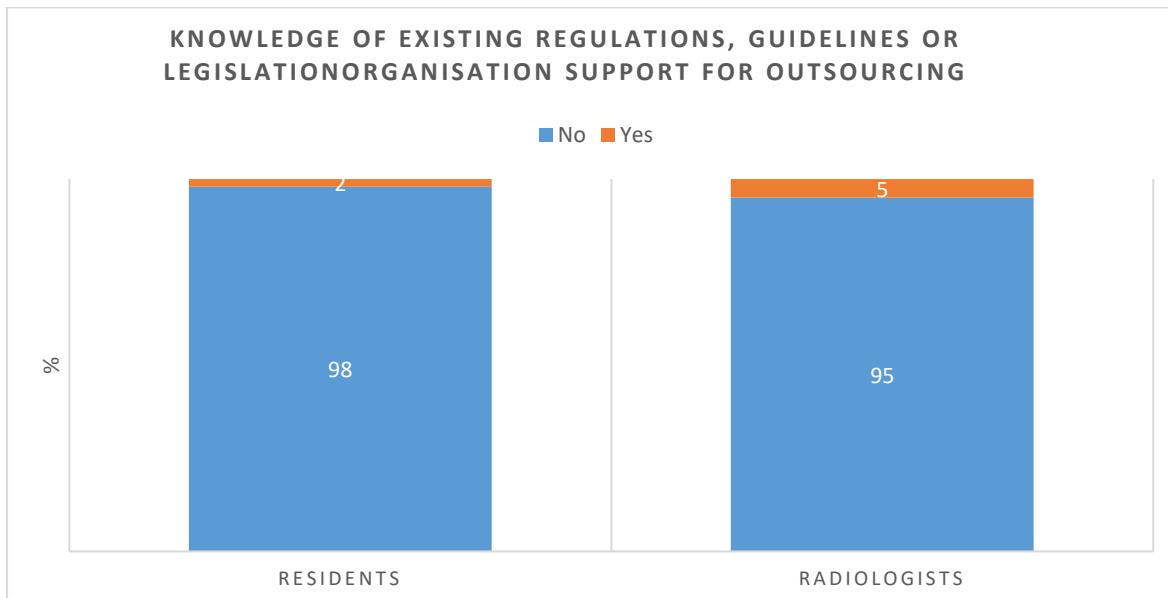


Figure 4. 7: Knowledge of existing guidelines on teleradiology

4.4.2 Opinions

Fig 4.8 below demonstrates the opinions on the impact of insourcing teleradiology by the radiologists in various sectors.

Seventy five percent 75% (n=6) of radiologists in university agreed that teleradiology insourcing had a positive impact as compared to 25% (n=2) who either disagreed or did not know. Seventy-one percent 71% (n=12) of the radiologist in public hospitals agreed that teleradiology insourcing had a positive impact as compared to 29% (n=5) who either disagreed or did not know.

On average of all the radiologists in both private and public practice 76% (n=44) agreed that teleradiology insourcing had a positive impact as compared to 14% (n=14) who either disagreed or did not know.

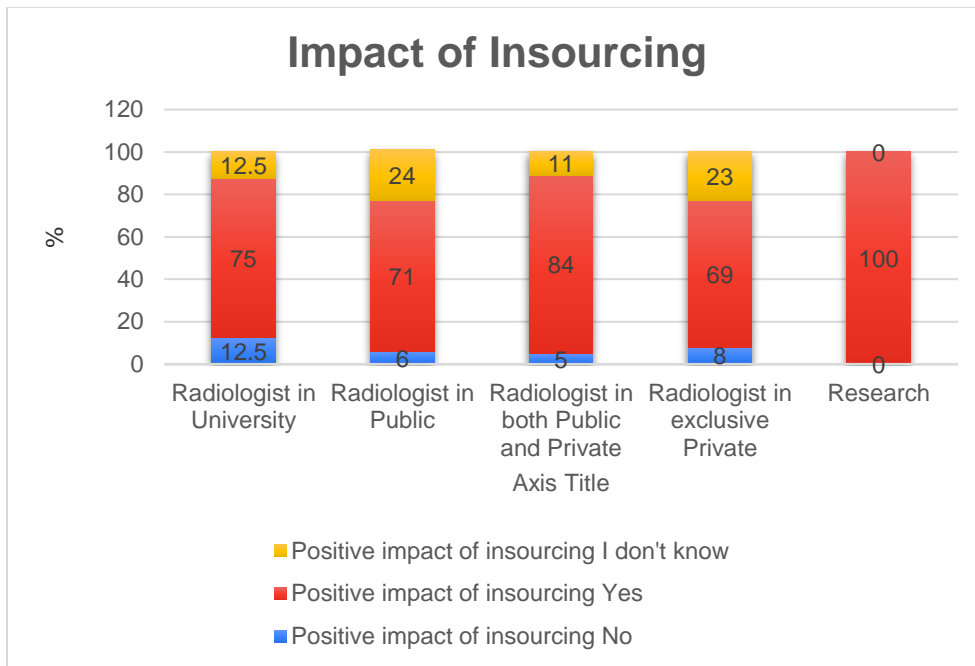


Figure 4. 8: Impact of Insourcing on radiologist

Fig 4.9 below demonstrates the opinions on the impact of outsourcing teleradiology by the radiologists in various sectors.

Of the radiologists in university 38% (n=3) agreed that outsourcing had a positive impact to teleradiology usage as compared to 62% (n=5) who either disagreed or did not know. Thirty percent 30% (n=5) of the radiologist in public hospitals agreed that teleradiology outsourcing had a positive impact as compared to 70% (n=12) who either disagreed or did not know.

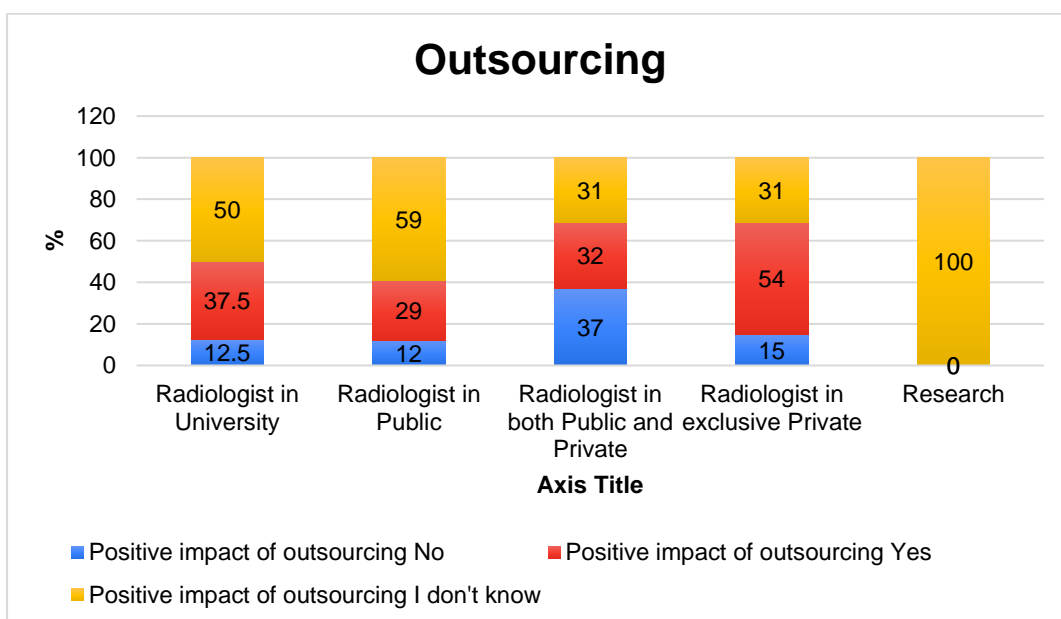


Figure 4. 9: Impact of Outsourcing

4.4.3 Opinions and attitudes of Residents and Radiologists on the use of Teleradiology

A five-point Likert scale was used to gather information on the opinions and attitudes of Residents and Radiologists on the use of Teleradiology in their respective areas of practice. The weights assigned to the Likert scale are Strongly Disagree=1, Disagree=2, Neither Agree nor Disagree=3, Agree=4, Strongly Agree=5.

The mode and median of the responses were recorded for advantages, disadvantages, opinions, and perceived threats. The values were interpreted according to the five-point Likert scale weights for example a value of the mode of 3.18 is in the range 2.5-3.4 and is therefore closer to three and thus is interpreted as “Neither Agree nor Disagree”.

4.4.4 Advantages of Teleradiology

Table 4.10 below illustrate the perceived opinions of radiologists and residents towards the advantages of teleradiology.

The following variables had a mode of 4, Greater efficiency and improved radiology services; possibility to discuss cases in a collaborative network; Teleradiology can alleviate shortage of radiologists and makes teaching or learning easier, this shows that respondents agreed that these variables were an advantage of the use of Teleradiology. However, respondents neither agreed nor disagreed that teleradiology had an advantage of better distribution of workload or the profession is now more attractive for young newcomers as shown by a mode of 3 respectively. All the variables had P values greater than 0.1, hence none was statistically significant.

Table 4. 10: Advantages of teleradiology

Advantage	Mode	Median	P values
Greater efficiency and improved radiology services	4	3	0.61
Better distribution of workload	3	3	0.11
possibility to discuss cases in a collaborative network	4	3	0.49
profession is now more attractive for young newcomers	3	3	0.50
Teleradiology can alleviate shortage of radiologists	4	3	0.23
makes teaching or learning easier	4	3	0.11

4.4.5 Disadvantages of Teleradiology

Table 4.11 below illustrate the perceived opinions of radiologists and residents towards the disadvantages of teleradiology.

The following variables had a mode of 3: too impersonal, insufficient communication with referring clinicians and insufficient quality assessment. Technology too expensive and insecure had a mode of 2, and a P value of 0.056 which was statistically significant.

Table 4. 11: Disadvantages of teleradiology

Disadvantage	Mode	Median	P value
too impersonal	3	3	0.79
insufficient communication with referring clinicians	3	3	0.97
Insufficient integration of patient history/ previous studies	3	3	0.76
technology too expensive and insecure	2	2	0.056
insufficient quality assessment	3	2	0.70

4.4.6 Opinions and Perceived Threats of Teleradiology

Table 4.12 below illustrate the opinions and perceived threats of teleradiology. The following variables had a mode of 3: Should there be specific regulations for teleradiology, and would you work with teleradiologists from other countries? The variable, is teleradiology a threat to hospital-based radiology? Had a mode of 1. None of the P values were statistically significant.

Table 4. 12: Opinions on teleradiology

Opinions	Mode	Median	P value
Is teleradiology a threat to hospital-based radiology?	1	1	0.44
Should there be specific regulations for teleradiology?	3	3	0.21
Would you work with teleradiologists from other countries?	3	3	0.11

With regards to perceived threats of teleradiology, results were as illustrated by table 4.13 below. Variables radiologists could lose their jobs and instability of jobs and/ or income for radiologists had a mode 3. Loss of quality radiology reports, negative effect on training of residents and loss of radiology skills had a mode of 1. Loss of quality radiology reports ($p = 0.0474$) came out as the only statistically significant variable that was perceived as a threat for Teleradiology use after carrying out Fisher's Exact test for Association.

Table 4. 13: Perceived Threats of teleradiology

Threat	Mode	Median	P value
Radiologists could lose control of their business	3	3	0.91
Instability of jobs and/or income for radiologists	3	2	0.86
Loss of quality radiology reports	1	2	0.047
negative effect on training of residents	1	2	0.57
Loss of radiological skills	1	1	0.45

5.0 CHAPTER FIVE: DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Discussion

This study had a response rate of 43.5% which is acceptable, and a good response rate for an online survey was about 33% according to literature. (45) . The findings from our study have shown that the majority of radiologists and radiology residents that were practicing in Kenya are females at 65% which is comparable to a 2019 study on radiology demographics in Kenya (46). This is however different from South Africa where males constituted about 69% of the radiologists (47). Regarding qualification category, the majority of the consultants, 83% (48/58) were general radiologists. Only 17.5 % had subspecialized which differs from western countries where such as USA with about 45% of radiologists having subspecialized (48).

Majority of consultants were working in both public and private sectors (34.9%), with 27% working exclusively in public hospitals. There were more consultants in level 6 hospitals (55.6%) compared to level 5 (31.1%) and level 4 (13.3%) hospitals. The percentage distribution is quite comparable to a study which was carried out in Europe in 2013, where radiologists in public hospital constituted 38%, University radiologists were 36%, private practice radiologists were 30% (49).

Regarding the level of usage of teleradiology in radiology practices in Kenya this study found that 79% of radiologists had adopted teleradiology in their practice, which is comparable to developed countries such as US (78%) in 2019, and 65% in Italy in 2016 (50,51). A possible reason for the high usage could be developments in technology and advancement of internet speeds, which makes transfer of image quick.

There were slightly more radiologists (81.1%) practicing teleradiology, compared to residents (76.2%). As residents were not yet licensed practitioners to operate independently, and were working under supervision, their work was mainly intramural teleradiology, where they reported images from the PACs under guidance of consultants.

The practice of teleradiology was significantly lower (58.3%) in respondents that were staying in rural areas compared to those in urban areas (81.8%). This could be attributed to the fact that teleradiology is heavily reliant on good internet, and expensive equipment, which is found more in urban settings, (52).

The availability of PACs system in radiology departments was seen to contribute more to the extent teleradiology was being practiced. 69% of responses indicated they have a form of PACs system in place, and 31% did not have PACs. The practice of teleradiology was found

to be 87% in those with PACs, compared to 61% usage in those without PACs. This is comparable to findings in an Italian study, where teleradiology usage was higher in institutions that had a PACs (50).

In terms of geographical location, responses were received from 17 (36.2%) out of the 47 counties in Kenya. A total of 12 counties (70.6% of responses) indicated there were practicing teleradiology and five counties (29.4% of responses) were not. Nairobi county had the most responses, with 62 (84.9%) out of 73 responses indicating usage of teleradiology. This could be attributed to Nairobi being the capital city of Kenya, hence it has got better infrastructure and more reliable internet (52).

Teleradiology insourcing was significantly higher, being used by 71% of both residents and radiologists compared to outsourcing that was used 25% only. This is different from findings in Europe 66.6% of radiologists were outsourcing their work, one way or another (53). Teleradiology insourcing was mainly used for coverage of calls and weekend cover (46%) and this is comparable to Europe where insourcing was used for out of hours reporting (52%). Multidisciplinary work contributed about 15% use in Kenya, which differed from Europe, where it had the highest percentage of insourcing usage at 56%. (53). Outsourcing in Kenya was mainly done for calls and weekend coverage (16.1%) followed by seeking second opinion at 12.1%. In Europe outsourcing is mainly done for out of hours coverage (50%) and as part of normal day time services in 41.6%.

For radiologists and residents providing their services to other centres, 47.8% indicated that they were consulted before imaging, to give guidance on technical protocols by the imaging centre, and 52.2% were not consulted. For those outsourcing their services, only 47.9% indicated there were able to get direct communication with the referring clinician if need arise, and only 23.7% indicate that previous images were available for comparisons as per need. This is quite low, because both direct communication with the clinicians and comparisons with previous images are essential for informed decisions when reporting patient images.

CT scan was the main modality reported on (91.4%) by those outsourcing their services, followed by plain radiographs (69.4%) then MRI (50%) and Ultrasound (40.8%). The findings were similar from a survey in Switzerland in 2005, where CT was the most frequent teleradiology study. (54)

There are two professional bodies guiding radiology professionals in Kenya, the Kenya Association of Radiologists and the Kenya Medical Practitioners and Dentists Council (KMPDC). The participants were asked if teleradiology, especially outsourcing was supported by the professional organization. Only 27.8% (n=27) indicated that teleradiology outsourcing

was supported by their professional organization. One out of 42 residents and 3 out of 58 radiologists, making up 4% of the total responses indicated that they were aware of existing guidelines governing teleradiology practice in Kenya. 96% of residents and radiologists did not know any regulations on teleradiology. This could be attributed to the fact that teleradiology is a new practice in Africa. Efforts to get guidelines from both professional bodies was fruitless, due to lack of clarity on whose mandate was it to oversee teleradiology practice between KAR and KMPDC. Compared to European and US countries, most studies indicated radiologists were aware of regulations and there were clear guidelines have been developed by the ESR in Europe and by the ACR in USA. (55) (56)

When it comes to advantages of teleradiology, more than 80% of radiologists and residents agreed or strongly agreed that teleradiology had advantages of greater efficiency, better distribution of workload and it also made collaboration with other radiologists easier. This is comparable to the Italian survey which showed that about 84.7% of radiologists agreed or strongly agreed that teleradiology made collaboration easier and 65% thought that teleradiology improved efficiency of provision of radiological services.(50) More than 65% of radiologists, and 75% of residents agreed that teleradiology had made the profession more attractive for young incomers. This could be due to the flexibility offered by teleradiology, where one is able to report images after hours from home.

Despite its widespread adoption and positive reviews, numerous disadvantages of teleradiology were also highlighted. About 60% (n=35) of all the radiologists and 56% of residents interviewed agreed or strongly agreed that teleradiology had a disadvantage of being too impersonal, limiting interaction with other radiology colleagues in the department. Seventy percent 70% (n=41) of all the radiologists also agreed or strongly agreed that teleradiology had resulted in insufficient communication with referring clinicians. This resulted in radiologists being seen as commodity providers rather than part of the clinical team in the management of patients, which is comparable to findings of a study in Switzerland (57). About 67% of all the radiologists agreed or strongly agreed that teleradiology had a disadvantage that integration of patient history/ previous studies is difficult.

Regarding future threats to the practice of radiology by teleradiology, about 53% of radiologists and 62% of residents disagreed or strongly disagreed that teleradiology was a threat to hospital-based radiology. This is because many regarded teleradiology as a system that improve efficiency of delivering radiology services in hospitals. About 50% of all the radiologists and 60% of residents however agreed or strongly agreed that teleradiology was a threat in that radiologists could lose control of their business. About 51% of all the radiologists and 40% of

residents interviewed agreed or strongly agreed that teleradiology resulted in a threat of instability of jobs and or income for radiologists. This could be due to the fear that the radiology market could be saturated by cross boarder radiologists offering their services at competitive market prices. Forty-six percent 46% of all the radiologists agreed or strongly agreed that teleradiology resulted in a threat of loss of quality. This is comparable to the Italian survey, where 38.6 % respondents agreed or strongly agreed about loss of quality, and 38% disagreed or strongly disagreed, and 16.8% were neutral.(50) Thirty-one percent 31% of all the radiologists interviewed agreed or strongly agreed that teleradiology resulted in a threat of loss of radiology skills, whilst 60% of residents disagreed. This could be attributed to teleradiology jobs from high income countries attracting radiologists from third world countries, hence resulting in brain drain.

5.2 Conclusion

The survey revealed that many radiology practices across Kenya have integrated teleradiology in their day-to-day activities. Radiology practices in urban and rural areas were using teleradiology, and both residents and consultant radiologists were practicing teleradiology. Both insourcing and outsourcing were being practiced, though insourcing was more popular compared to outsourcing. There were a lot of advantages attributed to teleradiology, in which most respondents indicated greater efficiency, better distribution of workload in organizations and possibility to discuss cases in a collaborative way. Also, teleradiology was deemed to make the profession attractive to young newcomers.

However, disadvantages of teleradiology remained that it was impersonal, and it resulted in loss of interaction between the radiologist and the referring clinician. There were also perceived threats of teleradiology, in which majority of radiologists believed teleradiology threatens their job security and will also result in loss of control in many radiology businesses. Lastly, there was a gap noticed in the regulation of teleradiology in Kenya, where most practitioners were not aware of existing regulations in teleradiology.

5.3 Recommendations

The study established that most radiology practitioners have a positive attitude towards teleradiology hence insourcing can be used to provide radiology coverage to the understaffed radiology department in the country. There is need to make sure that patients' records or previous images are easily accessible to the reporting radiologists.

There is need for clear guidelines in the practice of teleradiology, and both KAR and KMPDC show give attention to this important matter. As radiology practices increasingly rely on offsite interpretation, attention is warranted to ensure a maintained level of quality.

5.4 Limitations of The Study

Although the response rate for the interviewed radiologists was about 46%, most responses were from Nairobi County, and only 17 counties out of a total of 47 counties in Kenya were represented. This did limit a true reflection of the whole country.

5.5 Suggestions for Further Studies

The study recommends that further studies should be done on challenges faced by radiologists in implementing teleradiology. Also, future studies can try to incorporate opinions of key administrators of both KAR and KMPDC to assess their opinion of teleradiology, and their views regarding regulations in teleradiology.

REFERENCES

1. Silva E, Breslau J, Barr RM, Liebscher LA, Bohl M, Hoffman T, et al. ACR White Paper on Teleradiology Practice: A Report From the Task Force on Teleradiology Practice. *J Am Coll Radiol*. 2013 Aug;10(8):575–85.
2. European Society of Radiology (ESR). ESR white paper on teleradiology: an update from the teleradiology subgroup. *Insights Imaging*. 2014 Feb;5(1):1–8.
3. Scott-Murphy K. RANZCR Response to MCNZ Consultation on Special Purpose Scope of Practice (Teleradiology). 2000;11.
4. Duncan Mwai. Licensed Radiologists for 2021. 2021.
5. Ministry of Health. Kenya Health Workforce Report. 2015.
6. Mageka H. New CT scan centre to help monitor virus [Internet]. *People Daily*. 2020 [cited 2021 May 1]. Available from: <https://www.pd.co.ke/news/national/new-ct-scan-centre-to-help-monitor-virus-29444/>
7. Aga Khan Radiology. Aga Khan Radiology Department.
8. Rosenkrantz AB, Hanna TN, Steenburg SD, Tarrant MJ, Pyatt RS, Friedberg EB. The Current State of Teleradiology Across the United States: A National Survey of Radiologists' Habits, Attitudes, and Perceptions on Teleradiology Practice. *J Am Coll Radiol*. 2019 Dec;16(12):1677–87.
9. Coppola F, Bibbolino C, Grassi R, Pierotti L, Silverio R, Lassandro F, et al. Results of an Italian survey on teleradiology. *Radiol Med (Torino)*. 2016 Aug;121(8):652–9.
10. Shituma S. ADOPTION OF TELEMEDICINE IN HOSPITALS IN NAIROBI COUNTY. :73.
11. Barneveld Binkhuysen FH, Ranschaert ER. Teleradiology: Evolution and concepts. *Eur J Radiol*. 2011 May;78(2):205–9.
12. Bashshur RL, Krupinski EA, Thrall JH, Bashshur N. The Empirical Foundations of Teleradiology and Related Applications: A Review of the Evidence. *Telemed J E Health*. 2016 Nov 1;22(11):868–98.
13. Thrall JH. Teleradiology Part I. History and Clinical Applications. *Radiology*. 2007 Jun 1;243(3):613–7.
14. ACR Technical Standard for Teleradiology. :11.
15. Alhajeri M, Aldosari H, Aldosari B. Evaluating latest developments in PACS and their impact on radiology practices: A systematic literature review. *Inform Med Unlocked*. 2017 Jan 1;9:181–90.

16. Larson DB, Cypel YS, Forman HP, Sunshine JH. A Comprehensive Portrait of Teleradiology in Radiology Practices: Results from the American College of Radiology's 1999 Survey. *Am J Roentgenol*. 2005 Jul 1;185(1):24–35.
17. Wachter RM. The “Dis-location” of U.S. Medicine — The Implications of Medical Outsourcing. *N Engl J Med*. 2006 Feb 16;354(7):661–5.
18. Ranschaert ER, Binkhuysen FHB. European Teleradiology now and in the future: results of an online survey. *Insights Imaging*. 2013 Feb;4(1):93–102.
19. Lienemann B, Hodler J, Luetolf M, Pfirrmann CWA. Swiss teleradiology survey: present situation and future trends. *Eur Radiol*. 2005 Oct 1;15(10):2157–62.
20. Burute N, Jankharia B. Teleradiology: The Indian perspective. *Indian J Radiol Imaging*. 2009 Feb;19(1):16–8.
21. Salim A. Teleradiology company helps solve radiologist shortage in Brazil [Internet]. IDG Connect. 2016 [cited 2021 May 10]. Available from: <https://www.idgconnect.com/article/3577100/teleradiology-company-helps-solve-radiologist-shortage-in-brazil.html>
22. Sangaré M, Tanner L, Voss S, Laureys F, Hollow D, Touré M. A national teleradiology programme in Mali: implementation and results. *J Telemed Telecare*. 2015 Apr;21(3):131–8.
23. Essop H, Kekana M. The experiences of teleradiology end users regarding role extension in a rural district of the North West province: A qualitative analysis. *Afr J Prim Health Care Fam Med* [Internet]. 2020 Mar 19 [cited 2021 May 1];12(1). Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7136798/>
24. Larrison M. Teleradiology Service for Mission Hospitals: Initial Experiences. *Christ J Glob Health*. 2016 May 15;3(1):86–8.
25. Malaysian Radiological Society. Guidelines On Teleradiology In Malaysia. 2002.
26. Roux AL. Telemedicine: a South African legal perspective. 2008;16.
27. Giles W Boland. Review Teleradiology: Another Revolution in Radiology? 1998.
28. Orphanoudakis SC, Kaldoudi E, Tsiknakis M. Technological advances in teleradiology. *Eur J Radiol*. 1996 Jun;22(3):205–17.
29. Caramella D, Reponen J, Fabbrini F, Bartolozzi C. Teleradiology in Europe. *Eur J Radiol*. 2000 Jan;33(1):2–7.
30. White P. Legal issues in teleradiology—distant thoughts! *Br J Radiol*. 2002 Mar;75(891):201–6.

31. Krupinski EA. Teleradiology: current perspectives. *Rep Med Imaging*. 2014 Jan 8;7:5–14.
32. Ministry of Information, Communication and Technology. National Information, Communications and Technology (ICT) Policy. 2019.
33. Hohmann J, de Villiers P, Urigo C, Sarpi D, Newerla C, Brookes J. Quality assessment of out sourced after-hours computed tomography teleradiology reports in a Central London University Hospital. *Eur J Radiol*. 2012 Aug;81(8):e875–9.
34. Wong WS, Roubal I, Jackson DB, Paik WN, Wong VKJ. Outsourced Teleradiology Imaging Services: An Analysis of Discordant Interpretation in 124,870 Cases. *J Am Coll Radiol*. 2005 Jun;2(6):478–84.
35. Berger SB, Cepelewicz BB. Medical-legal issues in teleradiology. *Am J Roentgenol*. 1996 Mar;166(3):505–10.
36. Ashcroft RE, Goddard PR. Ethical issues in teleradiology. *Br J Radiol*. 2000 Jun;73(870):578–82.
37. Idowu BM, Okedere TA. Diagnostic Radiology in Nigeria: A Country Report. *J Glob Radiol*. 2020 Jun 29;6(1):1072.
38. Andronikou S. Pediatric Teleradiology in Low-Income Settings and the Areas for Future Research in Teleradiology. *Front Public Health* [Internet]. 2014 [cited 2021 May 1];2. Available from: <https://www.frontiersin.org/articles/10.3389/fpubh.2014.00125/full>
39. HealthManagement.org. Radiology Management, ICU Management, Healthcare IT, Cardiology Management, Executive Management [Internet]. HealthManagement. [cited 2021 May 1]. Available from: <https://healthmanagement.org/c/healthmanagement/issuearticle/the-role-of-teleradiology-in-emergency-radiology-provision>
40. Boland GWL. Teleradiology Coming of Age: Winners and Losers. *Am J Roentgenol*. 2008 May 1;190(5):1161–2.
41. Davis FD. Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Q*. 1989;13(3):319–40.
42. Diffusion of Innovation Theory | Canadian Journal of Nursing Informatics [Internet]. [cited 2021 May 1]. Available from: <https://cjni.net/journal/?p=1444>
43. The Royal College of Radiologists. *clinical-radiology-uk-workforce-census-report-2018.pdf*. 2018.

44. Dhoot R, Humphrey JM, O'Meara P, Gardner A, McDonald CJ, Ogot K, et al. Implementing a mobile diagnostic unit to increase access to imaging and laboratory services in western Kenya. *BMJ Glob Health*. 2018 Oct;3(5):e000947.
45. Nulty DD. The adequacy of response rates to online and paper surveys: what can be done? *Assess Eval High Educ*. 2008 Jun;33(3):301–14.
46. Mwaniki EK. The Role of Artificial Intelligence in Diagnostic Radiology: Knowledge, Attitude, and Practice of Radiologists and Radiology Residents in Kenya. :47.
47. Mkhize N, Tiwari R, Chikte U, Pitcher R. Temporal Trends in the South African Diagnostic Radiology Workforce (2002-2019). *Cureus*. 14(7):e27148.
48. Rosenkrantz AB, Wang W, Hughes DR, Duszak R. Generalist versus Subspecialist Characteristics of the U.S. Radiologist Workforce. *Radiology*. 2018 Mar;286(3):929–37.
49. Ranschaert ER, Binkhuysen FHB. European Teleradiology now and in the future: results of an online survey. 2013;10.
50. Coppola F. Results of an Italian survey on teleradiology. *Radiol Med*. :9.
51. Mpa ABR. The Current State of Teleradiology Across the United States: A National Survey of Radiologists' Habits, Attitudes, and Perceptions on Teleradiology Practice. *J Am Coll Radiol*. 2019;12.
52. Mureithi M. The Internet Journey for Kenya: The Interplay of Disruptive Innovation and Entrepreneurship in Fueling Rapid Growth. In: Ndemo B, Weiss T, editors. *Digital Kenya: An Entrepreneurial Revolution in the Making* [Internet]. London: Palgrave Macmillan UK; 2017 [cited 2022 Sep 11]. p. 27–53. (Palgrave Studies of Entrepreneurship in Africa). Available from: https://doi.org/10.1057/978-1-137-57878-5_2
53. ESR teleradiology survey: results. 2016;17.
54. Hodler BLJ, Pfirrmann CWA, Lienemann B, Luetolf M. Swiss teleradiology survey: present situation and future trends. :7.
55. Silva E. ACR White Paper on Teleradiology Practice: A Report From the Task Force on Teleradiology Practice. :11.
56. White P. Legal issues in teleradiology—distant thoughts! *Br J Radiol*. 2002;6.
57. Ashcroft RE, Goddard PR. Ethical issues in teleradiology. *Br J Radiol*. 2000;5.

APPENDICES

Appendix I: Consent Form

Participant Information and Consent Form for Enrollment in The Study

Title of Study: “The prevalence, practice and attitude towards Teleradiology by radiologists and radiology residents in Kenya”

Principal Investigator and institutional affiliation:

**Dr. Calvin Moyo,
University of Nairobi**

Co-Investigators and institutional affiliation:

**Dr. Gladys Mwangi,
University of Nairobi**

Introduction:

I would like to tell you about a study being conducted by the above listed researchers. The purpose of this consent form is to give you the information you will need to help you decide whether to be a participant in the study. Feel free to ask any questions about the purpose of the research, what happens if you participate in the study, the possible risks and benefits, your rights as a volunteer, and anything else about the research on this form that is not clear. When we have answered all your questions to your satisfaction, you may decide to be in the study or not. This process is called 'informed consent'. Once you understand and agree to be in the study, I will request you to sign your name on this form. You should understand the general principles which apply to all participants in medical research: i) Your decision to participate is entirely voluntary ii) You may withdraw from the study at any time without necessarily giving a reason for your withdrawal. We will give you a copy of this form for your records.

May I continue? YES / NO

This study has approval by The Kenyatta National Hospital-University of Nairobi Ethics and Research Committee protocol.

What Is This Study About?

The researchers listed above are interviewing individuals who are qualified radiologists licensed to practice in Kenya, and radiology residents in University of Nairobi, Moi University and Aga Khan University. The purpose of the interview is to find out information on the perceived thoughts of the Radiologist and residents towards the practice of Teleradiology. Participants in this research study will be asked questions about from a questionnaire. We are asking for your consent to consider participating in this study.

What Will Happen If You Decide to Be In This Research Study?

If you agree to participate in this study, the following things will happen:

You will be sent a link to a questionnaire which can be opened with a mobile phone, a laptop or a tablet. The questionnaire is divided into three sections, section A covers demographics information, section B covers the practice of Teleradiology, and the last section enquires about the perception of the respondent towards Teleradiology. The interview will last approximately 5 minutes.

Are There Any Risks, Harms Discomforts Associated with This Study?

Medical research has the potential to introduce psychological, social, emotional, and physical risks. Effort should always be put in place to minimize the risks. One potential risk of being in the study is loss of privacy. You will remain anonymous in the interview and the information obtained is for the purpose of the research only. We will keep everything you tell us as confidential as possible. Also, answering questions in the interview may be uncomfortable for you. If there are any questions you do not want to answer, you can skip them. You have the right to refuse the interview, or any questions asked during the interview.

Are There Any Benefits Being in This Study?

The information you provide will help us better understand the practice of Teleradiology in Kenya. This information is a contribution to medical practice in Kenya.

Will Being in This Study Cost You Anything?

No monetary expenses will be incurred by the respondent.

What If You Have Questions in Future?

If you have further questions or concerns about participating in this study, please call or send a text message to the study staff at the number provided at the bottom of this page. For more information about your rights as a research participant you may contact the Secretary/Chairperson, Kenyatta National Hospital-University of Nairobi Ethics and Research Committee Telephone No. 2726300 Ext. 44102 email uonknh_erc@uonbi.ac.ke.

The study staff will pay you back for your charges to these numbers if the call is for study-related communication.

What Are Your Other Choices?

Your decision to participate in research is voluntary. You are free to decline participation in the study and you can withdraw from the study at any time without injustice or loss of any benefits.

Consent Form (Statement of Consent)

Participant’s statement

I have read this consent form or had the information read to me. I have had my questions answered in a language that I understand. The risks and benefits have been explained to me. I understand that my participation in this study is voluntary and that I may choose to withdraw any time. I freely agree to participate in this research study.

I understand that all efforts will be made to keep information regarding my personal identity confidential.

By signing this consent form, I have not given up any of the legal rights that I have as a participant in a research study.

I agree to participate in this research study: **Yes** **No**

Date:.....

Researcher’s statement

I, the undersigned, have fully explained the relevant details of this research study to the participant named above and believe that the participant has understood and has willingly and freely given his/her consent.

Researcher ‘s Name: Dr Calvin Moyo

Signature: Date:

For more information contact:

Principal Investigator:

Dr. Moyo Calvin

Tel: 0771118989

Email: cmoyo@students.ounbi.ac.ke

Or

Supervisor:

Dr. Gladys N. Mwangi,

Lecturer Department of Diagnostic Imaging and Radiation Medicine,
University of Nairobi.

Tel: 0720127553

Email: Gladys.mwangi@uonbi.ac.ke

Or

Chairperson,

KNH/UON Ethical Review Committee,

TEL: 020-2726300/0722829500/0733606400/EXT 44102.

P.O. Box 20723, Nairobi.

Appendix II: Questionnaire

Section A: Biodata

1. Age

2. Gender

3. Do you live in the city or county?

City County

4. Are you a qualified radiologist or resident?

Radiologist Resident

If a resident, what level are you in.....

5. If a qualified radiologist, how many years have you practiced?

6. Have you subspecialized?

Yes No

7. What is your main professional activity? (multiple answers possible)

Radiologist in public hospital

Radiologist in exclusively in private practice

Radiologist in both private and public practice

Radiologist in university

Other (please specify below)

.....

If working in Public, what is the level of the facility?

Level 6

Level 5

Level 4

Level 3

Other (please specify below)

.....

Section B: Teleradiology Practice

8. Does your institution have a PACS?

Yes No

9. Does your organisation use any type of Teleradiology?

Yes No

10. If you answered No above, and your organisation is not using Teleradiology, do you plan to use it in the near future?

Yes No

11. What type of device do you use for reporting away from the station?

Laptop	<input type="checkbox"/>
Tablet	<input type="checkbox"/>
Mobile phone	<input type="checkbox"/>
Fully assembled monitors at home	<input type="checkbox"/>

Others (please specify below)

.....

12. Does your organisation do intra-mural Teleradiology?

(Intramural Teleradiology refers to reporting of image generated by the organisation you work for, away from site)

No	<input type="checkbox"/>
Yes, for calls and weekend cover	<input type="checkbox"/>
Yes, for all type of work	<input type="checkbox"/>
For online multidisciplinary meetings	<input type="checkbox"/>
I don't know	<input type="checkbox"/>

13. Does your organisation do Teleradiology outsourcing? (multiple answers possible)

(Outsourcing occur when you look for Radiologist who does not work for your organization to read images produced by your organisation)

- No
- Yes, when we have backlog in our workload (due to capacity problems)
- Yes, on-call work at night and weekends
- Yes, for a second or expert opinion from a colleague with another sub-specialty
- I don't know
- Others (please specify below)

.....

14. Is Teleradiology used for any other purpose? (Multiple answers allowed)

- Not at all
- I don't know
- For teaching purposes
- For proving expert opinion to colleagues
- For providing expert opinion to patients

If you provide Teleradiology services to other centres

a) Are you consulted before imaging, to give guidance on technical protocols by the imaging centre?

- Yes No

b) Are you able to communicate directly with referring physicians, in order to get clarifications or discuss your findings?

- Yes No

c) Patient clinical data and previous imaging studies is always be available for comparison when needed?

- Yes, it's always available as per need
- It's difficult to get
- It's never available, and I don't look for it

d) Which modalities do you mainly report?

- Plain radiographies
- CT scans
- MRI scans
- Ultrasound scan
- Mammographs
- Others (please specify)

Section C: Opinions on Teleradiology

15. Concerning Teleradiology practice, which level of experience are you in?

- Currently using Teleradiology
- Planning to use it in the near future
- No plans at all to use it

16. What do you think are the advantages of the practice of Teleradiology?

Statement	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Greater efficiency and improved radiological services					
Better distribution of the workload throughout the organization					
Possibility to discuss cases in a collaborative network					
Profession is now more attractive for young newcomers					
Teleradiology can alleviate the shortage of radiologists					
There aren't particular advantages of the use of Teleradiology					
It makes teaching or learning easier					

17. What do you think are the disadvantages of Teleradiology?

Statement	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Too impersonal, no contact with radiographer and radiologist					
Insufficient communication with referring clinicians					
Insufficient integration of patient history/ previous studies					
Technology is too expensive and insecure					
Insufficient quality assessment					

18. Opinions towards Teleradiology

Statement	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Do you think that Teleradiology is a threat to hospital-based radiology?					
Do you think that there should be specific regulations on Teleradiology.					
Would you work with tele-radiologists from other countries to help you with your work load?					

19. Potential threats of Teleradiology

Statement	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Radiologists could lose control of their business					
Instability of jobs and/or income for radiologist					
Loss of quality radiological reports					
Negative effect on training of residents					
Loss of radiological skills					

Appendix III: KNH/UoN-ERC Letter of Approval



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Website: <http://www.erc.uonbi.ac.ke>
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KENYATTA NATIONAL HOSPITAL
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Fax: 725272
Telegrams: MEDSUP, Nairobi

Ref: KNH-ERC/A/435

15th November 2021

Dr. Calvin Moyo
Reg. No.H58/34308/2019
Dept. of Diagnostic Imaging and Radiation Medicine
Faculty of Health Sciences
University of Nairobi



Dear Dr. Moyo

RESEARCH PROPOSAL: THE PREVALENCE, PRACTICE AND ATTITUDE TOWARDS TELE-RADIOLOGY BY RADIOLOGISTS
AND RADIOLOGY RESIDENTS IN KENYA (P599/07/2021)

This is to inform you that KNH-UoN ERC has reviewed and approved your above research proposal. Your application approval number is P599/07/2021. The approval period is 15th November 2021 – 14th November 2022.

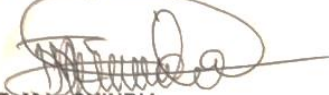
This approval is subject to compliance with the following requirements;

- i. Only approved documents including (informed consents, study instruments, MTA) will be used
- ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by KNH-UoN ERC.
- iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to KNH-UoN ERC 72 hours of notification
- iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH-UoN ERC within 72 hours
- v. Clearance for export of biological specimens must be obtained from relevant institutions.
- vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
- vii. Submission of an executive summary report within 90 days upon completion of the study to KNH-UoN ERC.

Protect to discover

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) <https://research-portal.nacosti.go.ke> and also obtain other clearances needed.

Yours sincerely



PROF. M.L. CHINDIA
SECRETARY, KNH-UON ERC

c.c. The Dean-Faculty of Health Sciences, UoN
The Senior Director, CS, KNH
The Chairperson, KNH- UoN ERC
The Assistant Director, Health Information, KNH
The Chair, Dept. of Diagnostic Imaging and Radiation Medicine, UoN
Supervisor: Dr. Gladys N. Mwangi, Dept.of Diagnostic Imaging and Radiation Medicine, UoN

Appendix IV: Certificate of Plagiarism

The Prevalence, Practice And Attitude Towards Tele-Radiology By Radiologists And Radiology Residents In Kenya

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