The determination of the need for after- hours diagnostic radiological reporting in emergency departments

by

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Dissertation submitted in fulfilment of the requirements for the degree

Master of Science: Radiography

in the Faculty of Health and Wellness Sciences

at the Cape Peninsula University of Technology

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Bellville campus

October 2019

DECLARATION

I, Seshree Chetty, declare that the contents of this dissertation represent my own unaided work, and that the dissertation has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

2 October 2019

Signed Date

ABSTRACT

Introduction

After-hours diagnostic imaging is essential in the majority of large public hospitals, as it plays a vital role in the treatment and management of patients. Radiologists are not always available after hours to provide reports on radiographic images since, nationally and globally, there is a shortage of these professionals. Radiographic images are frequently interpreted by emergency physicians after hours. Thus, while diagnostic imaging represents an essential component in patient care (including management and treatment), according to the literature, a significant cause of clinical error occurs through the misinterpretation of radiographic images by emergency physicians. The aim of this study was to determine emergency physicians' views on whether there was a need for an after-hours diagnostic radiology reporting service in emergency departments at some public hospitals, in the Durban Metropole. It is important to note that in addition to the above, this study calculated the number of radiographic examinations performed after-hours, and the number that was reported by the radiologist during office hours, since there was no radiology cover after hours.

Methods

A descriptive cross-sectional quantitative survey design was employed using a self-administered questionnaire as a data collection instrument completed by emergency physicians at four public hospitals. In addition, additional data was collected to determine the number of radiographic examinations that had been performed after hours, at the selected four public hospitals over a period of three months, as well as the number of radiographic examinations that was reported on. This enabled the authors to determine the number of radiographic examinations that went unreported during this study period.

Results

A total of 39 emergency physicians participated in the survey, with a mean and median age of 39.46 and 38 years, respectively (SD = 9.11 years). The results of this study showed that between 0.1% and 0.6% of radiographic examinations performed after hours were reported on by radiologists during office hours, for this study period. This implies that less than 1% of all examinations produced after hours at the four public hospitals, received a radiology report. Emergency physicians felt that the interpretation of images took up valuable time. The survey found that there was near total consensus amongst respondents on whether they prefer after-hours reporting to be performed by a radiologist as 46.2% (n = 18) of the respondents strongly agreed and 41.0% agreed (n = 16). Furthermore, a total of 35.9%

(n=14) of respondents agreed and 43.6% (n=17) strongly agreed, that having a reporting radiographer reporting on radiographic images after-hours, would benefit patient flow. The survey also found that 92% of the sampled emergency physicians agreed (59.0% strongly agreed and 33.3% agreed, respectively) that there was a need for further training in the interpretation of radiographic images.

Discussion

From the above results, it is evident that since the majority of radiographic examinations went unreported after hours, the task to interpret the radiographic images is left to the emergency physicians as part of their patient management. Conceivably, this added image interpretation results in a further increase in the workload of emergency physicians. It is therefore not surprising that emergency physicians preferred that after-hours reporting of radiographic images be done by radiologists. According to the literature, reporting radiographers also play a role in alleviating the workload of emergency physicians and improving patient flow, by providing a report for the radiographic images during after-hours. Thus, reporting radiographers afford emergency physicians additional time to concentrate on patient treatment, resulting in faster patient throughput. Reporting on radiographic images is not yet included in the scope of the South African radiographer. The findings of this study, though, suggested that there was a need for emergency physicians to undergo training in the interpretation of radiographic images.

Conclusion:

The study recommends that an after-hours reporting service be considered for the four public hospitals concerned. It is recommended that the heads of the emergency and radiology departments further consider offering courses on radiographic image interpretation for emergency physicians.

Keywords:

Emergency physician, after-hours, radiographer, radiologist, reporting, ‘Red dot’ system, pattern recognition.

ACKNOWLEDGEMENTS

- Firstly, I would like to thank God, for enabling me to pursue this task and completing it. I would like to thank HIM for all his guidance and blessings upon me throughout my life.
- Thank you to my supervisors Mr. Aladdin Speelman and Mrs. Dalene Venter for their ongoing support, guidance, motivation and encouragement. This would not have been possible without you.
- To my parents Mr. Thiagrajan Poonsamy Chetty and Mrs. Poomoney Chetty, thank you for being wonderful parents, always motivating me and encouraging me to reach for my dreams. I am where I am today because of you.
- To my brothers Magan and Kal, I would like to thank you for all of the support.
- To my brother Kregan, thank you for motivating me and always being there for me.
- To my sisters in law Deshnee and Thiroshini, thank you for all the support.
- To my cousin Desigan Reddy, thank you for accommodating me whilst I was in Cape Town.
- To Dr. Preston Padayachee, thank you for your assistance in editing this thesis.
- Special thanks go out to all the radiography and emergency heads of departments, as well as the respondents in the Durban Metropolis.

DEDICATION

I dedicate this dissertation to my parents. Mum and Dad, we did it!

I also dedicate this dissertation to my nieces, Devinaa D. Chetty, Rianka Chetty and my nephew, Dhruven Chetty.

This work is just a fraction of what you all will accomplish. Reach for the stars!

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CHAPTER ONE

INTRODUCTION

1.1 Introduction

In South Africa the provision of health care is reliant on the private and public sectors. The private sector serves 16% of the population, while the public sector serves 84% (Adeniji & Mabuza, 2018:219). After-hours diagnostic imaging is crucial in the majority of the large public hospitals, as it plays a vital role in the treatment and management of patients (Gardiner & Zhai, 2016:75). Radiologists are not always available after hours to provide reports on radiographic images. Nationally and globally, there is a shortage of these professionals. In the absence of radiologists, radiographic images are frequently interpreted by the emergency physicians (Gqweta, 2012:22). It is therefore vital that the emergency physicians interpret the radiographic images correctly because they are the first, in many cases, to review the radiographic images when treating trauma patients (du Plessis & Pitcher, 2015:2; Brunswick et al., 1996:346). However, Woznitiza (2014:66) argues that the radiographer is the first health care professional to view each radiographic image and therefore, in the best position to provide their professional findings directly and timeously to the referring physician.

Overcrowding in emergency departments due to high patient rates after hours brings about inadequacies. This is because overcrowding increases the pressure on hospital resources, which consequently leads to the inadequate allocation of these resources, and subsequently results in a delay in patient care (Bruni et al., 2016:144). Annually, 70,000 South Africans are killed as a result of trauma, and 3.5 million patients require care due to trauma (Pillay et al., 2012:307). Dulandas and Brysiewicz (2018:84), commented that trauma is the leading cause of death in South Africa, where 28 per 10,000 people die as a result of road accidents.

Diagnostic imaging is often required for these patients after hours. However, there is far less report processing during these times due to a shortage of radiologists, and a lack of training for emergency physicians with regard to interpreting and writing accurate diagnostic reports (Hlongwane & Pitcher, 2013:638; Gardiner & Zhai, 2016:75). Emergency medicine in South Africa only became a speciality in 2003, with the first emergency medical specialists graduating in 2007. The programme includes a four-year Master of Medicine degree, a dissertation and two sets of examinations. Radiology is covered by a small module in the curriculum. Most experience in reporting on radiographic images for emergency medicine physicians is obtained via seminars and in-house tutorials (Chowa et al., 2017:15).

Thus, while diagnostic imaging represents an essential component in patient care (including management and treatment), according to the literature, a significant cause of clinical error occurs through the misinterpretation of radiographic images by emergency physicians (Snaith & Hardy, 2013:92). The aim of this study was to determine whether there is a need for an after-hours diagnostic radiology reporting service in emergency departments at public hospitals, in the Durban Metropole. For the purposes of this study, the term 'examination' refers to radiographic examinations, while the term 'image' refers to the graphical image that is created following the radiographic examination.

1.2 Background to the research

South African clinics that offer primary health care services to patients are short-staffed, overcrowded, have a lack of resources, and only operate for a certain number of hours in the day (Stott & Moosa, 2019:1-8). Thus, emergency departments in the government sector regional and tertiary academic hospitals are being overcrowded by the patients that are supposed to be treated at a primary care level (Van Wyk & Jenkins, 2014:1-6). This, in turn, results in a greater burden being placed on the government emergency departments. Patients visiting the emergency departments may present with a myriad of conditions such as having incurred trauma or having suffered from acute or chronic illnesses. The overcrowding in these emergency departments results in longer waiting times for patients, which may lead to poor treatment and an increase in patient deaths (Van Wyk & Jenkins, 2014:1-6; Augustyn, 2011:24; Nkombua, 2007:14a-14d).

In addition to caring for the patient, emergency physicians are burdened with the task of interpreting radiographic images, since the demands for imaging services greatly outweigh the number of radiologists that are available to provide these services. This additional task takes up time in which the patients can be seen to; and on occasion, the emergency physicians may also misinterpret these radiographic images (Aacharya et al., 2011:1-13; Gqweta, 2012:22; Hlongwane & Pitcher, 2013:638).

In order to overcome this, some radiology departments in South Africa (excluding the radiology departments in this study) and abroad, have adopted 'radiographers comment schemes', also known as 'hot reporting' and 'red-dotting' (Hlongwane & Pitcher, 2013:638). These methods enable the radiographers to contribute to the emergency department's decision-making process, when it comes to the management and treatment of patients. The comment scheme, for instance, allows the radiographer to flag a radiograph where a fracture, dislocation or other injury has been seen (Hardy & Culpan, 2007:65). A recent study has shown that radiographers in Queensland, Australia, still place a red sticker on a radiographic image, to show the referring physician that an abnormality has been identified

(Murphy and Neep, 2018:80). From this we can conclude that there are no changes in practice of the red-dot system or scheme.

In some countries, 'hot reporting' is done. This is the term given to reports made by reporting radiographers and radiologists (if they are available) after hours, when requested to do so by the physicians. This 'hot reporting' enables a diagnostic report on the radiograph to be obtained within a few hours (Snaith & Hardy, 2013:92). In some countries, 'hot reporting' is done by the physicians in the emergency departments (Gardiner & Zhai, 2016:75). "Red-dotting" is a system in the United Kingdom, where radiographers identify fractures or other abnormalities by placing a red dot on such diagnostic radiographic images. The 'red-dot' system is not compulsory for radiographers, as it is still the duty of the emergency physician to interpret the radiographic images (Hazell et al., 2015:302-308).

Education and training through tutorials and feedback improve the pattern recognition and image interpretation skills of qualified radiographers (Woznitza, 2014:67). South African radiographers require widespread formal training and additional certification, since providing a diagnosis on radiographic images is not in the scope of practice of South African radiographers (Williams, 2006:14). The Health Professions Council of South Africa's (HPCSA) scope of the profession for radiography, as contained in Booklet 2, Annexure 10, indicates that the scope of the profession for radiography in South Africa does not include formal radiographic image interpretation, or the provision of a formal diagnosis from radiographic images. The radiographer is, however, allowed to provide an opinion to the referring physician on any abnormalities observed, but may not provide a formal report (Health Professions Council of South Africa, 2016a:49). The advent of the current four year Bachelors degree in Radiography also only allows for pattern recognition, and not image interpretation by radiographers (South African Qualifications Authority, 2020).

The after-hours emergency departments in public hospitals in South Africa are especially busy, with limited health professionals available to attend to the patients (Williams, 2009:15; Hlongwane & Pitcher, 2013:638). In addition, there is often no provision of after-hours diagnostic reporting services in public hospitals, to an extent that the emergency physician is responsible for interpreting all requested radiographic images (Williams, 2009:15). As far as it could be ascertained, there is a lack of publications on whether emergency physicians at public hospitals in South Africa are confident and content to interpret radiographic images, after hours; or whether there is a fundamental need for an after-hours diagnostic reporting service in South African hospitals. This has presented the problem statement for this research study, which will be discussed next.

1.2.1 Statement of the problem

The occurrence of traumatic incidents in South Africa is a major problem, with the majority of trauma patients frequently arriving at the emergency department after hours. In most instances, these patients require radiographic examinations to be performed (Pillay et al., 2012:307). Nationally and internationally, the need for diagnostic imaging services surpasses the number of radiologists available to report on the radiographic images (Hlongwane & Pitcher, 2013:638; Gqweta, 2012:22). Most radiologists are employed in hospitals in urban areas, and mostly in the private sector (Moodley, 2017:5).Therefore, radiographic images are often returned to the emergency departments without a report; or the reports are returned too late to the emergency physicians by the radiologists, which compromises the patients' management (Gqweta, 2012:22; Williams, 2009:15).

In most emergency departments, the emergency physicians are responsible for the initial interpretation of radiographic images; while further interpretations by the radiologists sometimes follows at a later stage (Brunswick et al., 1996:346; Petinaux et al., 2011:18). Thus, while emergency departments are overcrowded, inexperienced emergency physicians often fail to identify abnormalities on the radiographic images (Guly, 2001:263), and failure to identify abnormalities on the radiographic images puts the patients at risk of misdiagnosis and mismanagement. It also puts the emergency physician at risk of medico-legal litigation. It can therefore be argued that research is required to ascertain whether a need exists for an after-hours diagnostic radiology reporting service in emergency departments at government hospitals in South Africa. This observation generated the primary research question of this study, as outlined next.

1.3 Research question

What are the views of emergency physicians on the need for an after-hours diagnostic radiology reporting service in emergency departments at public hospitals, in the Durban Metropole?

1.3.1 Research Aim

The aim of this study was to determine the emergency physicians' views on whether there is a need for an after-hours diagnostic radiology reporting service in emergency departments at public hospitals, in the Durban Metropole.

1.3.2 Research objectives

The objectives of this study were:

- To analyse the number of radiographic diagnostic examinations performed after hours in the selected public hospitals in the Durban Metropole.
- To determine the number of radiographic diagnostic examinations that go unreported in the selected public hospitals in the Durban Metropole.
- To determine whether the emergency physicians at public hospitals in the Durban Metropole feel confident at interpreting radiographic images.
- To ascertain whether the emergency physicians at these hospitals would prefer an after-hours reporting service, or not.

1.4 Significance of research

This study aimed to determine the emergency physicians' views on the need for after-hours diagnostic radiology reporting. The above questions were, at conception of the study, considered critical — given the historical context of limited-to-no after-hours radiology reporting services in many public hospitals. Furthermore, the study was justified in ascertaining the views of emergency physicians on the need for an after-hour reporting service given their central position within the chain of management for trauma patients. This cross-sectional study was thought to provide a snapshot of current thinking amongst this group of professionals, and would be best suited to guide future considerations for after-hours radiology reporting services.

As far as could be ascertained, no similar study has ever been conducted in South Africa, since a search of the Technikon Research Database (NAVTECH) on the 8th of February 2018 revealed that no such Master's or Doctoral studies had been conducted. Van de Venter et al. (2017:128) conducted a study in the Eastern Cape to explore the experiences of radiographers and medical physicians' during radiographers' after-hours reporting; however, no study was found that assessed the need for after-hours diagnostic radiological reporting services in emergency departments in the Durban Metropole.

1.5 Definition of terms and clarification of concepts

- After hours:

After hours refers to the engaging in, or running of activities after the normal or legally established operating hours of an establishment (Houghton Mifflin, 2000). After hours in this

study refers to the times between 4pm and 8am on normal weekdays, and the whole of Saturdays, Sundays and public holidays throughout the year.

- Emergency Physician:

An emergency physician is tasked with accident and emergency medicine, while being referred to as an emergency room (ER) doctor, and an accident and emergency (A & E) doctor in the United States (US) and United Kingdom (UK), respectively (Ausserer et al., 2017).

- Pattern recognition:

Radiographic images are evaluated by radiographers to identify normal and abnormal patterns of the anatomy and to recognise common pathology (South African Qualifications Authority, 2020).

- Radiographer:

A radiographer is a trained professional who positions patients, takes radiographs, and performs other diagnostic procedures (Medical Dictionary, 2018).

- Radiologist:

A radiologist is a specialised imaging physician who communicates examination findings to the referring physician and the patient by the means of a radiology report (Gunn et al., 2015:416).

- Reporting:

Reporting is the act of generating an official account of something that an individual has studied, observed, considered, and/or examined (Houghton Mifflin, 2000). In the context of this study, reporting means the interpretation and reporting of plain and specialised diagnostic x-ray images.

- ‘Red dot’ system:

The ‘red-dot’ system, is an activity where radiographers identify fractures or other abnormalities by placing a red dot on such radiographs. The ‘red dot’ system is not compulsory for radiographers to perform, as it is still the duty of the emergency physician to interpret the image (Hazell et al., 2015: 302-308).

1.6 Outline of the dissertation

Chapter one: This chapter provided an overview and background to the study. The chapter highlighted the shortage of radiologists in public hospitals and how this places on pressure on emergency physicians to interpret diagnostic images, especially those produced afterhours. The significance of the study, as well as the aims and research objectives were outlined.

Chapter two: The review was conducted to show that there is a gap in knowledge with regards to our understanding whether emergency physicians prefer after-hours diagnostic radiology reporting services, beginning with the global perspective, narrowing it down to the South African context and finally to the Durban Metropole.This review focuses on the number of radiographic examinations performed in public hospitals within the greater Durban Metropole, the number of examinations reported after hours, the expertise and training of radiologists in reporting radiographic images, and the views of emergency physicians on reporting radiographic images. The literature review presented in this chapter is linked to the problem statement.

Chapter three: The methodology chapter describes the methodology of the study, which includes the research design, data collection methods and data analysis procedures that were performed. The data collection instrument is presented in detail to provide for justification why this instrument was appropriate for this study. Reliability and validity of the data collection instrument, will also be discussed including the pilot study which was conducted to test the reliability of the questionnaire.

Chapter four: The results of the research project are documented and described. Comparisons and correlations between various statistical ~~these~~ tests conducted are presented. Patterns in the data pertaining to the problem statement are discussed.

Chapter five: The interpretation of the research results attained, are stated. The link between the results and the literature reviewed is discussed, and the implications for future radiology reporting services for emergency departments, as well as further research, are highlighted.

1.7 Conclusion

This chapter provided a brief background and rationale for the study. It included the aim of this study, namely to determine the emergency physicians' views on whether there is a need for after-hours reporting on diagnostic radiographic images in emergency departments at public hospitals, in the Durban Metropole. The background and rationale to the study, and the problem statement, were outlined. The context and burden on emergency departments and challenges with respect to diagnostic imaging services after hours in South Africa has been explained briefly. The functions of the emergency physicians and strain placed on them to partake in image interpretation due to the shortages of radiologist have also been highlighted. The literature review in the following chapter focuses on the number of radiographic images produced afterhours, the number of these images that are reported. Furthermore, the training of emergency physicians are contrasted against those of radiologists and radiographers with respect to the reporting of radiographic images. The chapter ends with a review of the views of emergency physicians towards the interpretation of radiographic images.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter provides a review of the literature related to the after-hours reporting of radiographic images. Peer reviewed articles were sourced relative to the topic to provide scientific publications on the workload and interpretation of radiographic images by emergency physicians. Science Direct, PubMed and Sabinet databases were search using the following key words: emergency physician, after-hours, radiographer, radiologist, reporting, 'Red dot' system and pattern recognition. The number of radiographic examinations performed after hours by radiographers will be discussed, as well as the number of radiographic images reported on after hours; the training of emergency physicians versus radiologists and radiographers in the reporting of radiographic images; the accuracy of emergency physicians versus radiologists and radiographers in the reporting of diagnostic images; and the emergency physician's views towards reporting on diagnostic images. The above topics are all aligned to the objectives of this dissertation and forms the framework for the data collected.

2.2 The number of after-hours radiographic examinations performed by radiographers

In the United Kingdom (UK) and the United States (US), eight percent and twelve percent, of patients that are admitted to hospitals respectively, are admitted due to injuries, whereas in South Africa such incidences are approximately thirty-three percent (Van Wyk & Jenkins, 2014:1-6). In South Africa, there is a high rate of physical trauma, with numerous traumatic incidents occurring daily on the road in the form of accidents, at informal settlements (commonly in rural areas), and in bars (Nicol et al., 2014:549). However, the majority of injuries are due to violence. Many of the patients seen at tertiary hospitals could have been assisted at a clinic during normal hours (Pillay et al., 2012:307). A total of 70,000 South Africans are killed by trauma each year, and 3.5 million patients require care due to trauma (Pillay et al., 2012:307). Dulandas and Brysiewicz (2018:84), stated that trauma is the leading cause of death in South Africa, where 28 per 10,000 people die as a result of road accidents. Currently, due to events such as xenophobic attacks, female genocide and crime in the country it stands to reason that these statistics has only increased since 2012. Imaging is often required for these patients after hours (Gardiner & Zhai, 2016:75).

Preliminary statistics obtained from a Durban regional hospital (R.K. Khan Hospital), where the researcher is employed, showed that an average of 70 patients per day undergo radiographic examinations, after hours. Roughly, this means that about 2170 patients undergo such radiographic examinations per month; although many emergency patients may receive multiple examinations, such as of the skull, spine, and so forth. For the month of February 2018, an actual number of 2483 examinations was requested (R.K. Khan, 2018). Patients treated at the emergency departments undergo multiple radiographic examinations, which means the number of radiographic examinations performed per month is more than the number of patients referred for diagnostic imaging.

Diagnostic imaging represents an essential role in the management and treatment of patients (Snaith & Hardy, 2013:92). Circumstantial evidence suggests that emergency physicians sometimes request unnecessary examinations (Gardiner & Zhai, 2016:75). However, from the above we can argue that there are many people frequenting the public sector hospitals after hours, and that diagnostic imaging is requested for most of these patients. One of the primary objectives of this study was therefore to ascertain how many radiographic examinations were requested after hours within four of public hospitals within the Durban Metropole. It is important for the reader to note that there are not many publications available on the number of radiographic examinations performed after hours. The next section highlights important literature pertaining to the second primary objective of how many radiographic examinations are usually reported on, after hours.

2.3 The number of radiographic examinations reported on after hours

Globally, and in South Africa, there is a huge shortage of medical practitioners, including radiologists. This shortage is due to an insufficient number of qualifying physicians, and to physicians leaving the country (Hoyler et al., 2014:269). Within the public sector, the number of physicians available is less than in the private sector. This imbalance is due to more physicians leaving the public sector for the private sector, possibly due to the health risks in public hospitals, excessive workloads associated with the public sector, as well as for better salaries obtainable at the private sector (Moodley, 2017:5; Mofolo & Botes, 2016:185).

Currently, there are 976 radiologists registered with the Health Professions Council of South Africa (HPCSA), and a total of 7089 registered diagnostic radiographers (Daffue, 2017). Statistics South Africa (2017) estimated the mid-year population for 2017 was at 56.52 million, while the estimated population for Durban was at 3,120,282. This makes the population-to-radiologist ratio very high (Gqweta, 2012:22). Upon obtaining a physical count, it was found that there were a total of about 25 radiologists practicing in the eThekwini public hospitals. These radiologists are employed at specific hospital and do not rotate between

health institutions. There is an average of two to three qualified radiologists at a specific hospital with specialist institutions having a greater number of radiologists.

An observation performed at R.K. Khan Hospital found that, in the month of February 2018, out of 2843 radiographic examinations performed after hours, only 155 examinations were reported on by radiologists; and these examinations were reported on during normal working hours. This means that clinical decisions on patient management would already have had to be made by the emergency physicians, even if they were not totally sure of the interpretations of the radiographic images (R.K. Khan Hospital, 2018). Therefore, if a different diagnosis was made by the radiologist the next day, the patient would have needed to be re-managed; and treatment would thus have been delayed. It must be noted that patients are asked to return during normal working hours at the discretion of the emergency physicians, for a formal report by the radiologist.

From the information in the preceding paragraphs, the researcher has demonstrated the observation made that not many radiographic images are reported on, since there is a wide shortage of radiologists (Moodley, 2017:5-6). It can also be argued that an additional workload is being placed on emergency physicians when it comes to making a clinical decision. The next section highlights the training of emergency physicians versus radiologists and radiographers in the reporting of radiographic images.

2.4 The training of emergency physicians versus radiologists and radiographers in the reporting of radiographic images

Emergency medicine in South Africa only became a specialty in 2003, with the first specialists graduating in 2007. The programme includes a four-year Master of Medicine degree, a dissertation and two sets of examinations; while radiology is only covered by a small module in the curriculum. Emergency physicians, instead, mostly gain experience in reporting from seminars and in-house tutorials (Chowa et al., 2017:15).

In South Africa, the radiology registrar training programme is a five-year programme following after the undergraduate medical degree. It consists of two parts: Part I includes radiology anatomy and radiological physics, and part II includes unit-specific training modules, such as plain-film reporting, fluoroscopy, interventional/vascular radiology, computed tomography (CT), general sonography, mammography, paediatric radiology, magnetic resonance imaging (MRI), nuclear medicine, obstetric ultrasound and Doppler ultrasound. Forty-two months of the training programme needs to be completed, and the minimum requirements in all module units need to be met, along with the submission of a research report in order to qualifying to write part II of the course. When this programme is completed, the registrar may apply for a consultant post (Stellenbosch University, 2013).

Many institutions abroad offer undergraduate and postgraduate training in the dedicated fields of diagnostic radiography. In Ontario, Canada, the Confederation College offers a comprehensive two-and-a-half-year undergraduate programme, which enables radiographers to gain entry into the profession. This institution presents graduates with postgraduate opportunities to major in ultrasound (US), MRI and CT. The College of Radiographers based in the UK offers a variety of postgraduate courses, up to doctorate level, in the various speciality fields of diagnostic radiography. Curtin University of Technology in Perth, Australia, offers a postgraduate course up to Master's level that includes a variety of career choices accessible for radiographers. This qualification affords an avenue for promotions in radiology departments to be granted to radiographers who are able to display established specialised theoretical and applied skills (Du Plessis et al., 2012:112).

In South Africa, clinical training, also known as work-integrated learning (WIL) for radiography students, is conducted at various HPCSA-accredited training hospitals. The diagnostic radiography programme was previously a three -year diploma programme, and was designed to comprise all aspects of general diagnostic imaging, such as conventional diagnostic imaging, paediatric imaging, fluoroscopy examinations that utilise contrast media administration, theatre and ward radiography, specialised examinations such as CT, MRI, mammography and angiography that include cardiac examinations (Du Plessis et al., 2012:112). The three year radiography diploma programme did, to some degree, prepare radiographers for the task of interpreting radiographic images. There was however a scarcity of formal training in radiographic image interpretation for South African radiographers, which necessitated an evaluation of the postgraduate courses (Williams, 2009:15).

In South Africa, red-dotting was introduced during the 1980s (Williams, 2006:14), and it is still used globally in many radiology departments (Woznitiza, 2014:66-68) as well as nationally (Hlongwane & Pitcher, 2013:638). As discussed previously, the red-dot system calls for radiographers to position a small red dot sticker on diagnostic radiographic images to make the referring physician aware of the presence of a supposed abnormality. Radiographers are not obligated to participate in this system as it is voluntary, and this could result in uncertainty when the emergency physicians view the diagnostic images (Hlongwane & Pitcher, 2013:638).This is because when emergency physicians who are used to the red-dot system receive images from radiographers who do not participate in the red-dot system, there is a higher probability of the emergency physicians misinterpreting the radiographic images; while the absence of a red-dot does not inherently specify the nonexistence of pathology (Hazell et al., 2015:302).

A study performed by Hlongwane and Pitcher (2013:638) showed that South African radiographers were able to detect abnormalities on radiographic images at a level that was

comparable to that of international radiographers, with a similar experience and no supplementary educational training in reporting. The argument presented by these authors was that radiographers are producers, and therefore able to detect abnormalities even without formal training.

When writing this dissertation, the three year national diploma in radiography has been replaced by a four-year professional degree course in a number of higher education institutions in SA. In this four year program, final year students can choose from a range of electives, one of which is pattern recognition (South African Qualifications Authority, 2020). The four year radiography course was registered with the South African Qualifications Authority in 2008, with two universities starting with the course in 2014 (Radiography & Clinical Technology Board, 2016:5-6). The South African Qualifications Authority (SAQA) has now recognized the South African radiography programme as a four year bachelor degree programme with an NQF level of 8 (South African Qualifications Authority , 2020).

Radiographers in the UK have the option of obtaining a postgraduate course in reporting, whereas South African diagnostic radiographers are offered no training in the reporting of diagnostic radiographic images at the time of writing this dissertation. Pattern recognition is available for radiographers which enable them to recognise abnormal from normal variations, as well as atypical diagnostic patterns on radiographic images. In South Africa, pattern recognition forms part of the undergraduate training programmes. However, due to regulations defining the scope of practice, radiographers are not allowed to diagnose; but they are allowed to convey their opinions regarding normal and abnormal appearances, to the referring physicians (Hazell et al., 2015:302). Speelman and Mdletshe (2019:8-9) go on to state that there would be basic reporting courses for radiographers in the future offered by higher education institutions.

From the preceding paragraphs, it can be argued that emergency physicians are not given adequate training in radiographic image interpretations compared to radiologists. This inadvertently places these categories of professionals at a disadvantage, when it comes to interpreting radiographic images (Chowa et al., 2017:15). The next section will highlight the accuracy in which emergency physicians, radiologists and radiographers can interpret radiographic images.

2.5 The accuracy of emergency physicians versus radiologists and radiographers in reporting radiographic images

Brunswick et al. (1996:346) conducted a study to assess the accuracy of diagnostic findings generated by emergency physicians, compared to those of radiologists. It was found that although the errors made by the emergency physicians in their study were low, there were

still errors that required re-management of the patients. A similar study conducted by Petinaux et al. (2011:18) found that emergency physicians most commonly missed fractures, dislocations and pulmonary nodules, while they were found to hardly miss any developing findings.

This re-management of patients has certain implications, as it suggests that the health resources have been wasted, and it may also be inconvenient for such patients to have to undergo a change of management. In the UK, it was found that the misinterpretation of radiographic images occurred irrespective of whether such interpretations had been performed by emergency nurses or emergency physicians. Mistakes in interpreting radiographic images may also lead to delayed or incorrect treatments; while the detection of previously-missed injuries often requires the patients to be called back (Snaith & Hardy, 2013:92).

Piper et al. (2005:27) performed a study to examine the accuracy in which radiographers interpreted radiographic images of the skeletal system, and it was found that the reports generated by the trained reporting radiographers had a high accuracy rate. Consequently, these authors concluded that radiographers can provide significant contributions to the reporting service. Buskov et al. (2013:55) supported the notion that trained reporting radiographers reporting on radiographic images of the skeletal system were useful in a clinical setting; as the radiographers in their study could detect bony injuries that had been missed by emergency physicians. This was further investigated by Hlongwane and Pitcher (2013:638), as mentioned previously, who found that South African radiographers were able to detect abnormalities on radiographic images at a level, which was comparable to that of international radiographers, without additional training in reporting.

Brealey and Scally (2008:46) stated that the reports of trained reporting radiographers were comparative to that of consultant radiologists when interpreting radiographic images of the appendicular and axial skeleton. Hardy et al. (2013:23) performed a study in the UK to determine the cost effectiveness of an immediate reporting service being made available to emergency departments. This study was done in response to a requirement in the UK for patients to receive a completed report on the same day that they visited an emergency department. A significant number of errors were observed to have been made by the emergency physicians, which clinically affected the patients; whereas, the errors made by the trained reporting radiographers did not clinically affect the patients. In that study, it was found that immediate radiographer-led reporting was cost effective; that the patients did not have to report for further management; and that fewer referrals were made to other departments (Hardy et al., 2013:23).

Radovanoic and Armfield (2005:32) reported that radiographers with no training in reporting were able to accurately diagnose 87% of patients, whilst emergency physicians made an accurate interpretation in 89.8% of cases. With formal training, the radiographers' reports could be comparable to those of radiologists (Radovanoic & Armfield, 2005:32). Brealey et al. (2005:232) undertook a study to examine the accuracy of radiographers' reporting, in a clinical environment. The study found that radiographers and radiologists trained in reporting at different levels of seniority, produced similar diagnostic reports (Brealey et al., 2005:232).

Buskov et al. (2013:55) performed a study in Denmark to compare the diagnostic reports made by radiographers trained in reporting of radiographic images to those of trainee radiologists. The study was performed out of the need for additional radiographic reporting by a different group of professionals, since there was a great shortage of radiologists in Denmark at the time. As was to be expected, the Buskov et al. study found that radiographers trained in reporting, interpreted accident and emergency radiographic images of the extremities with a high level of accuracy, and had a significantly-lower rate of missed fractures compared to the trainee radiologists. The sensitivity for correct diagnosis was 99% for reporting radiographers, and 94% for trainee radiologists; but the specificity was 97% for reporting radiographers and 99% for trainee radiologists. This is because the radiographers that had been trained in reporting had a higher degree of overcalling compared to the trainee radiologists; however, the overcalling was not very significant, nor did it impact the patients' management (Buskov et al., 2013:55).

Morrison et al. (1999:862) stated that reporting radiographers in the UK could assist the physician when it came to reporting on traumatic abnormalities of the musculoskeletal system; thus, aiding in better patient management. These authors stated, though, that not all radiographers were in a position to report on diagnostic images. For instance, Australian radiographers were noted to have expressed the view that they were not ready to undertake the task of reporting without undergoing an image interpretation training course (Morrison et al., 1999:862).

Parts of the UK have also introduced a system of radiology reporting called 'hot reporting', which was established in order for an expert opinion to be provided by in-house radiologists or reporting radiographers on radiographic images, at the same time that patients were admitted to the emergency departments for radiographic examination (Hardy & Culpan, 2007:65). The use of this hot reporting system has proven to reduce errors and clinical risks; whereby, in one study, radiographic interpretation that was provided by radiographers trained in reporting, showed a reduced rate of interpreted errors compared to the staff trained in reporting in the emergency department (Snaith & Hardy, 2013:92).

Du Plessis and Pitcher (2015:308) also performed a study comparing reports of trauma-related radiographic images of the appendicular system that were reported on by experienced radiographers without any training in reporting, and those that were reported on by the emergency physicians. The authors utilised a method in which nine radiographers and eight emergency physicians reported on identical trauma radiographic images of the appendicular skeleton. The standardised methodology used by these researchers enabled them to streamline their results; while the accuracy of the reporting was found to be 81.5% for radiographers and 67.8% for emergency physicians (Du Plessis & Pitcher, 2015:308).

The above study by Du Plessis and Pitcher (2015:308) has highlighted that radiographic images not reported on by radiologists, may result in errors, which could affect patient management. It therefore underscores the need for the current study, which broadly defined, set out to assess the views of emergency physicians towards the need for an after-hours reporting service. The above literature also highlighted the role that radiographers can play in after-hours reporting services.

The final section, next, highlights important literature on the emergency physicians' views on reporting radiographic images.

2.6 Emergency physicians' views towards reporting on radiographic images

Cox and Price (2013:131) conducted a study aimed at assessing the levels of general practitioners' (GPs) satisfaction with a diagnostic imaging service, in a neighbourhood based in the UK. This study established that, although the GPs were fundamentally content with the service they received, there were areas recognised for possible improvement. The GPs felt that reports should be made available at a quicker turnaround time; and that reports should be more detailed. The GP's in the above study expressed a need for the radiographic images to accompany the reports (Cox & Price, 2013:131).

In a study conducted by Snaith and Hardy (2013:92), the majority of the interns and registrar emergency physicians found that the presence of a reporting service prompted a boost in their personal development and confidence, with regards to radiographic image interpretation. A study done in Ireland also showed that junior physicians welcomed the opinion of the radiographer trained in reporting; and this resulted in an increase in patient management (Kelly et al., 2011:90).

In South Africa, Van de Venter et al. (2017:128) conducted a study in the Eastern Cape Province on the experiences of radiographers and medical physicians with regard to the after-hours reporting of trauma-related radiographic images. The results of the study concluded that the emergency physicians felt that reporting by radiographers played a vital

role in assisting them with workflow and patient care. The emergency physicians also felt that they were unable to make a final diagnosis without input from the radiographers. Furthermore, the emergency physicians felt that they lacked the knowledge, competence, and human resources, after hours, to be able to make final diagnoses (Van de Venter et al., 2017:128).

2.7 Conclusion

This literature review chapter highlighted the views of emergency physicians with regards to reporting on radiographic images, the accuracy with which emergency physicians can interpret radiographic images, and the training emergency physicians have in radiographic image interpretation. The above reviews have highlighted that emergency physicians have received limited exposure to image reporting during their undergraduate training; which conceivably, may not satisfy their professional needs.

The next chapter describes the methodology that was performed for this study, which includes the research design and data collection methods. The data analysis procedures and ethical considerations for this study will also be discussed.

CHAPTER THREE
METHODOLOGY

3.1 Introduction

This chapter will describe the research methods and techniques employed during this study. Included in this chapter are the research design, the location of the data collection sites, the population and sample selection considerations, the inclusion and exclusion criteria, as well as the data collection tools utilised. A discussion on the ethical principles considered for this study will then conclude the chapter.

3.2 Research design

A descriptive cross-sectional quantitative survey design was employed for this study using a questionnaire as the data collection instrument. This design was chosen because the research mainly assessed emergency physicians' perspectives on the need for after-hours diagnostic radiological reporting services for public hospitals within the Durban Metropole. A questionnaire was suitable for the research design as it enabled the researcher to gain rich and valuable information from the respondents. In addition, the study also aimed to analyse the number of radiographic examinations performed after hours, as well as the number of radiographic images that were reported on and not reported on during this period.

3.3 Pilot study

For this research project, a pilot study was performed to assess whether the questionnaire had any unclear questions. A convenience sampling method was used to recruit respondents for the pilot study. The questionnaire, together with the respondent information sheet, was distributed to a small sample of five emergency physicians employed at the pilot hospital in Durban. All five emergency physicians completed the pilot questionnaires, and all questions were answered by these physicians. The emergency physicians in the pilot study did not raise any issues with respect to ambiguity of the questions, or them being unclear. The five emergency physicians who participated in the pilot study were excluded from the final sample, as their inclusion in the final sample was considered to have increased the likelihood of biases in the final data collected. The pilot study for the questionnaires was performed a month prior to the researcher visiting the research sites, and handing over the questionnaires to the head of department of emergency departments.

3.4 Population and sampling

The data for this study was gathered from four public hospitals located in the Durban Metropole area of South Africa, namely: Hospital A, Hospital B, Hospital C and Hospital D

The target population for this study was all the physicians working after hours in the emergency departments of the aforementioned hospitals. For the main study, convenience sampling was employed. Through this sampling technique, the number of emergency physicians employed at each of the research sites was determined. There were 13 emergency physicians at each of the four hospitals. The sample size was ultimately determined by the number of emergency physicians willing to participate in the study.

Next, data pertaining to the number of radiographic examinations that had been performed after hours at the selected hospitals, as well as the number of radiographic examinations that were reported (examinations sent to the radiologist for a report during the day), and number of examinations which went unreported (examinations that were not sent to the radiologist for a report during the day). This data was compiled from the data in the diagnostic imaging department's' registers at the chosen hospitals for the three months identified. This data was selected by convenience, and it comprised the pre-recorded numbers of radiographic examinations that had been performed after hours at the selected hospitals, as well as the numbers of radiographic examinations performed after hours that had been reported on and remained unreported, for the months of October, November, and December, in 2017.

Data pertaining to the radiographic examinations of chest x-ray(CXR) (in which rib x-rays are included), abdomen x-ray (AXR), spine, extremities, skull x-ray (SXR), and pelvis x-ray (PXR), were captured from the four hospitals above, for the main study; and these 24 data points, for the three months of October, November, and December, in 2017 provided the total of 72 data points, each, for the hospitals' examinations performed, examinations reported on, and examinations not reported on, respectively (see Appendix J).

In this study, there were four hospitals studied, where the data points for six categories of radiographic examinations were captured for the three months of October, November, and December, 2017. In total, therefore, there were 72 individual data categories (four hospitals, with six radiographic categories, across the three months) for the hospitals' examinations performed; 72 individual facts of data for the examinations reported on; and 72 individual data categories for the examinations not reported on, respectively. This is illustrated in Appendix J.

3.4.1 Delineation of the research

The criteria below were used to delineate the research, and to define the respondents that would be included or excluded from the study.

3.4.1.1 Inclusion criteria

- Male and female emergency physicians of all races and age groups between 24 – 65 years.
- Emergency physicians working after hours in the emergency departments at the identified research sites.
- Only radiographic examinations performed after hours were considered, in order to determine the number of radiographic examinations that were sent unreported to the emergency department at the respective research sites.

3.4.1.2 Exclusion criteria

The following persons were excluded from this study:

- Student interns, due to their limited experience in emergency medicine.
- Physicians conducting their community service, due to their limited experience in emergency medicine.
- Physicians who did not give consent to participate in the study.

In addition, the following data were excluded:

- The number of radiographic examinations that went unreported during normal working hours at the identified research sites.

3.5 Data collection instrument

This study was conducted in the form of a survey, employing a questionnaire as the data collection instrument (please refer to Appendix A for a copy of the questionnaire). The questionnaire used questions with a five-point Likert-scale answer set, and respondents were asked to indicate their level of agreement by placing a tick on the five-point answers (strongly agree, agree, neutral, disagree, strongly disagree), as per the guidance of Snaith and Hardy (2013:92). The questionnaire was made up of two parts. The first part focused on demographic information like gender of the physicians, the age of the physicians, their years of experience, their highest qualifications, the name of the hospital in which they were

working, and the level of training the physicians had received in the reporting and interpretation of radiographic images. The questionnaire also assessed whether the emergency physicians felt confident in interpreting radiographic images, and whether they believed an after-hours reporting service should be introduced. It is important to note that the questionnaire format was guided by Snaith and Hardy (2013:92), and not the formulation of the questions. The questions were developed by the researcher with the support of the statistician.

3.6 Reliability and validity

Reliability pertains to how accurate the results of the study are, in reflecting the ideas being observed (Leung, 2015:324). It considers whether the data collection was precise, had very little errors in its collection, and that the results were a true reflection of what was being studied (Hu et al., 2016:532). There are generally four key forms of reliability that are important in research: internal consistency, parallel forms reliability, test-retest reliability and inter-rater reliability (McCrae et al., 2011:28). It can be argued that the questionnaire employed was reliable and questions posed achieved desired results with regards to emergency physicians views on their after- hours workload, their own perceived competencies in image interpretation and whether they will prefer an after-hour diagnostic radiology reporting service. Their responses enable the researcher to form meaningful conclusions relative to the aims and objectives of this research project.

Validity on the other hand considers whether the ideas that were studied were valid variables to be able to make conclusions for the questions asked (Kimberlin & Winterstein, 2008:2276). Validity, for instance, considers whether the variables that were studied would actually be able to answer whether there was a need for an after-hours diagnostic radiological reporting service in emergency departments of public hospitals in the Durban Metropole. When optimising the validity of a study, the three aspects of content validity, construct validity and criterion validity are considered important (Cooper et al. 2019:49). Convergent and divergent validity, for instance, are two types of construct validity, which maintain that variables with data of similar or comparable measurements, should be positively correlated, while variables with contrasting subjects or themes, should be negatively correlated (Postmes et al., 2013:597).

The various aspects of reliability and validity were ensured, in this study, through two main strategies: firstly, by efforts of the researcher in the design of the study and the collection of the data; and secondly, during the statistical data analysis portion of the study, where the reliability and validity were measured and verified.

The data collected at the pilot hospital during the pilot study was excluded from the main study's data analysis for the sake of maximising data reliability. During the data analysis portion, Cronbach's alpha was calculated to observe the internal consistency of the variables in the questionnaire, and to gauge the reliability of the data; with the entire Section 4.3.2.4 dedicated to the results of this analysis. Next, during the data analysis, the results confirmed parallel forms of reliability, convergent validity, and internal consistency among the data; as well as some pertinent correlations between the respondents' views, and their demographic and career-related backgrounds; whereby, as observed in the correlation analysis of Section 4.2.3 of the dissertation, the notions of convergent and divergent validity did not fail.

3.7 Data collection process

This section demonstrates the method of access to the research sites, the method of data collection for the questionnaires, as well as the method of data collection for the number of radiographic examinations performed.

3.7.1 Negotiating access to the research sites

Letters to obtain permission to conduct the study were personally delivered, by the researcher, to the respective Chief Executive Officers (CEO) of the target hospitals as well as the Head of Departments (HOD) of each emergency and radiology department of the target hospitals. Written permission was granted by the CEOs of each of the target hospitals (see Appendices B to F). Once permission had been granted to commence with the study, the researcher consulted with the HOD of each emergency department to determine the number of emergency physicians working there after hours. Then, the researcher personally visited HODs of the target hospitals to hand over the questionnaires and written informed consent letters for the respondents (see Appendix G). Questionnaires were handed over to the HOD of each emergency department, since the researcher could not assemble all emergency physicians together in one sitting. It was therefore more convenient to liaise with the HOD of each department to ensure that all emergency physicians who met the requirements, received the questionnaire.

3.7.2 Method of data collection for the questionnaires

The HOD of each emergency department was then asked to inform the emergency physicians of the purpose and nature of the study, and to distribute the questionnaires with the accompanying consent forms to the respondent emergency physicians. The emergency physicians were requested to sign the informed consent forms, and to complete the adjoining

questionnaires. All participating emergency physicians including those in the pilot study omitted the signing of the respondent consent; and even though the emergency physicians elected to not sign the consent form, implied consent was assumed after they elected to complete the questionnaire. After completion, the hard-copy questionnaires were stored in a closed box, within in a locked cupboard in the HOD emergency physicians' office, for safekeeping.

The researcher liaised with the HOD of each emergency department telephonically, and by email, to ensure that all emergency physicians working after hours had been given the questionnaire and consent form. Participation was voluntary, and the respondents had one week in which to complete the questionnaires.

3.7.3 Method of data collection for the radiographic examinations performed

Next, data pertaining to the number of radiographic examinations performed, and the number of radiographic examinations reported on and not reported on by a radiologist during normal working hours, were collected for three months (October, November and December) of 2017 from Hospitals A to D, to function as supporting data for the study. This was gathered, within the same week, from all the hospitals. To gather the data, the researcher used the departmental registers and radiographic examination request forms, to record the number of examinations that had been done, and the number of after-hours examinations that were reported, and which remained unreported. Once all the data had been gathered, it was analysed as explained later in the chapter.

3.8 Data management

The data pertaining to the questionnaire was retrieved after a month of issuing the questionnaires, due to a slow response rate from the participants. This was because some emergency physicians were on leave, and some emergency physicians had forgotten to fill in the questionnaire; so the researcher made numerous follow up calls and sent electronic mails to encourage their participation in the study.

Upon completion, the researcher then collected the sealed boxes of questionnaires, and stored them in a locked cabinet at home for data analysis. The collected statistics on the number of radiographic examinations was also kept in the locked cabinet.

3.9 Data analysis

To begin with, each of the hospitals was assigned an alphabetic code in the data to allow for comparisons to be made between the physicians' feedback (from A to D respectively) (see Appendix K). Only the researcher and statistician had access to the coded information, as well as to the direct identifiers. Then, to begin with, a descriptive analysis was done, followed by an inferential statistics analysis. This descriptive analysis calculated the mean number and type of radiographic examinations that had been requested after hours at each hospital, as well as the mean number and types of radiographic examinations that had been reported on by a radiologist during normal working hours and which went unreported. This generated the descriptive statistics section of the proposed study.

The Statistical Package for the Social Sciences (SPSS) program version 24.0 was used to statistically analyse the data. In SPSS, analysis of variance (ANOVA) was used to determine whether the emergency physicians from the different hospitals preferred an after-hours reporting service or not. ANOVA allows for comparisons of means between three or more groups (Kalla, 2009); and it allowed for pairwise comparisons to be made between all levels of all the variables used in this study. Chi-square, Cramer's V, likelihood ratio, correlation analysis, Welch's, Shapiro-Wilk's (for normality) and Levene's (for homoscedasticity) tests were done using the data obtained by the questionnaires. Tests performed using the hospital data obtained from the hospitals' registers included one-way ANOVA, correlation analysis, Welch's, Shapiro-Wilk's (for normality) and Levene's (for homoscedasticity). These tests were performed with the support of a statistician (see Appendix L). These results were presented using suitable graphs and tables, as shown in Chapter Four.

3.10 Ethical considerations

Prior to commencement of the study, ethical approval was obtained from the Research Ethics Committee (REC) of the Faculty of Health and Wellness Sciences at the Cape Peninsula University of Technology (CPUT) (see Appendix H) and the Kwa-Zulu Natal (KZN) Departmppent of Health (DOH) (see Appendix I). Since this study involved five hospitals in the eThekwini district, permission from the KZN Department of Health was considered to be adequate to go ahead with the study. However, even though ethics permission received from the KZN Department of Health would have sufficed, given the lines of authority over the hospitals mentioned, courtesy letters requesting ethical clearance were also forwarded to the CEOs of the five hospitals that were to be included in this study.

3.10.1 Ethical guidelines for researchers

The principles of the Helsinki Declaration (World Medical Association, 2013) and the Health Professions Council of South Africa (HPCSA) general ethical guidelines for health researchers were followed. The Helsinki Declaration "was developed by the World Medical Association (2013) as a statement of ethical principles to provide guidance to physicians and respondents in medical research involving human subjects". The HPCSA's general ethical guidelines for health researchers, as contained in Booklet number 14, also guided the researcher to perform the research while incorporating ethical values, standards and ethical principles (HPCSA, 2016b).

3.10.2 Privacy and confidentiality

According to Burkhardt and Nathaniel (2008:67-68), the concept of privacy and confidentiality are interlinked. Privacy relates to a respondent's right to control the information that is given to the researcher, while confidentiality requires nondisclosure of the respondents' information (Burkhardt & Nathaniel, 2008:67-68). The HPCSA (2016b:3) stipulates that "A participant's right to both privacy and confidentiality must be protected. The researcher must ensure that where personal information about research participants or a community is collected, stored, used or destroyed, this is done in ways that respect the privacy or confidentiality of participants or the community, and any agreements made with the participants or the community". Completion of the questionnaire was anonymous, and privacy was maintained by not recording or revealing the respondents' identities. The questionnaires did not require names of the respondents and the questionnaires were kept in a sealed box. Only the researcher had access to this information, as it could lead to identifying the respondents or the research sites. The completed questionnaires were kept in a locked cupboard at home to which only the researcher had access. Electronic data was kept private by being stored in a password-protected computer, to which only the researcher had access.

The demographic details of the respondents, including the names of the hospitals, were also coded and kept confidential. This was in keeping with Helsinki principle (24), which stipulates that privacy and confidentiality must be maintained during the execution of a research project (World Medical Association, 2013). Each hospital was assigned a code so that comparisons could be made between the views of emergency physicians employed at the respective research sites. Only the researcher had access to the direct identifiers (names of hospitals); and only the researcher and statistician had access to the coded numbers. The data has only been used for the intended purposes of this study, and will be destroyed five years after completion of the study.

3.10.3 Principle of beneficence

According to the HPCSA (2016b:2) “The benefits of health research must outweigh the risks to the research participants”. The ethical principle of beneficence obliges a researcher to act in a manner that will benefit its respondents (Burkhardt & Nathaniel, 2008:61-63). This suggests that a researcher should promote good care when dealing with the respondents, and there should be a balance maintained between the risks and benefits of the study. In this study, there was only the risk of anxiety and irritation due to the questionnaire assessing the respondents’ opinions on interpreting radiographic diagnostic images. However, the respondents had the option of being directed to a counsellor if they needed; and since the respondents could be classified as being vulnerable, a statement was added to the questionnaire, prompting the respondents to contact the researcher for assistance if they wished.

3.10.4 Autonomy

The HPCSA (2016b:2) identifies autonomy as a respondent’s right to independent decision making. Autonomy was ensured by giving the respondents an information sheet, and affording them the right to choose whether or not to participate in the study (see the sample of the respondent information sheet in Appendix G). This was in keeping with Helsinki principle (3), which specifies that the interest of the participant should always be considered first (World Medical Association, 2013). Respondents were requested to sign the cover page, ensuring that they consented to participate in the study; but since none of the emergency physicians signed the informed consent, it was assumed that consent was implied due to the respondents having completed the questionnaire. The respondents were also free to withdraw from the study at any time, without any penalties or consequence, if they wished.

3.11 Conclusion

Chapter Three explained the methodology for this study including the research design and data collection methods. The data analysis procedures and ethical considerations for this study were also discussed. The reliability and validity of the data collection instrument were highlighted. The pilot study which was conducted to test the questionnaire was also explained.

This study did not interfere with the daily routines of the departments or their patient management. Questionnaires were kept with the emergency departments’ HOD for the respondents to answer the questionnaire at their leisure. This study was also self-funded and

did not use any consumables of the public hospitals. The next chapter highlights the results of this research, which includes the outcomes of the various tests that were performed.

CHAPTER FOUR
RESULTS

4.1 Introduction

This chapter will describe the main results that were generated from the methodology outlined in Chapter Three. The first section of the chapter is committed to quantifying the data obtained at the four hospitals that were covered in the main study, namely Hospital A (543 bed), Hospital B (571 bed), Hospital C (1200 bed), and Hospital D (852 bed). The second section of this chapter focuses on analysing the data outlined in Chapter Three.

4.2 Overview of how statistics were calculated

This first section of Chapter Four is dedicated to providing answers to achieve the first two research objectives of the study, which were to determine the number of radiographic examinations performed after hours; and to determine the number of radiographic examinations that went unreported at the respective hospitals. In attempting to analyse whether the research project achieved these two objectives, the descriptive statistics related to the four hospitals are covered first; after which, the results of the inferential statistical analysis are outlined.

4.2.1 Descriptive statistics for objectives one and two

The data surveyed at the four hospitals mentioned above were collected over a three-month period, namely: October, November, and December, 2017. The number of examinations that were performed across six different categories of radiographic examinations were recorded, namely: CXR, abdomen x-ray (AXR), spine, extremities, SXR, and PXR. All rib examinations were calculated under the chest examinations. The number of examinations captured for these six categories of radiographic examinations was also combined to create the total number of examinations performed after hours at each hospital, for each of the three months surveyed. In addition, the total numbers of examinations that were reported by a radiologist during normal working hours and not reported on for each of the six categories of radiographic examinations were also recorded for the same periods.

As depicted in Figure 4.1, Hospital A performed n = 2659, n = 2955 and n = 3529 radiographic examinations in October, November and December, respectively, with the numbers of radiographic examinations performed at Hospital A seeming to rise from month-to-month over the three months studied (mean = 3048; SD = 442). Hospital B performed

slightly fewer radiographic examinations than at Hospital A in October (n = 2376), November (n = 2341) and December (n = 2432), and the change in the number of radiographic examinations performed at Hospital B over the three months studied was also far lower than Hospital A (mean = 2383; SD = 46) (See Appendix J). It is important to note that Hospital A is a 543 bed hospital, Hospital B is a 571 bed hospital, hospital C is a 1200 bed hospital and Hospital D is an 852 bed hospital. These hospitals also only have an average of 2 - 3 radiologists in their radiology departments.

Hospital C (1200 beds) performed the highest total number of radiographic examinations, each month (October n = 4687; November n = 4866; December n = 4961); though the difference in the number of radiographic examinations performed was quite small (mean = 4838; SD = 139). Hospital D (852 beds) performed a comparable total number of radiographic examinations to those at Hospital B (571 beds) (October n = 2485; November n = 1956; December n = 3194), while the difference in radiographic examinations performed from month-to-month at Hospital D was the highest of all the four hospitals studied (mean = 2545; SD = 621). More radiographic examinations were performed in December, 2017, for each of the four hospitals.

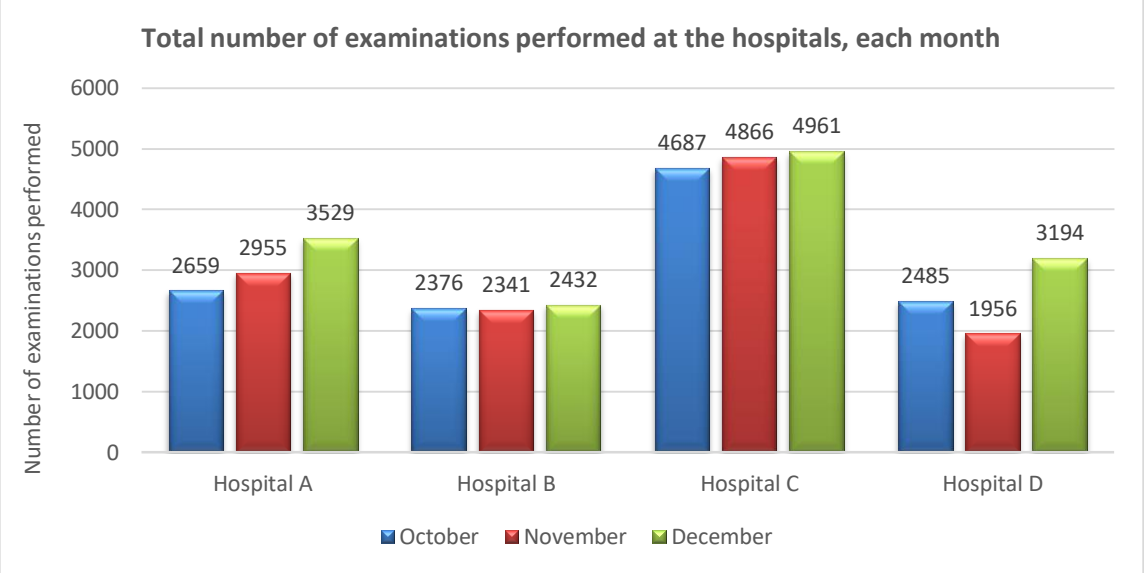

Figure 4.1: Total number of examinations performed at each hospital

To the contrary, the total numbers of radiographic examinations actually reported on each month by radiologists during normal working hours at the four hospitals was far lower, constituting only a fraction of the total number of examinations that had been performed (see Figure 4.2). Hospital C performed by far the highest number of examinations of the four hospitals after hours, but reported on the lowest number of examinations.

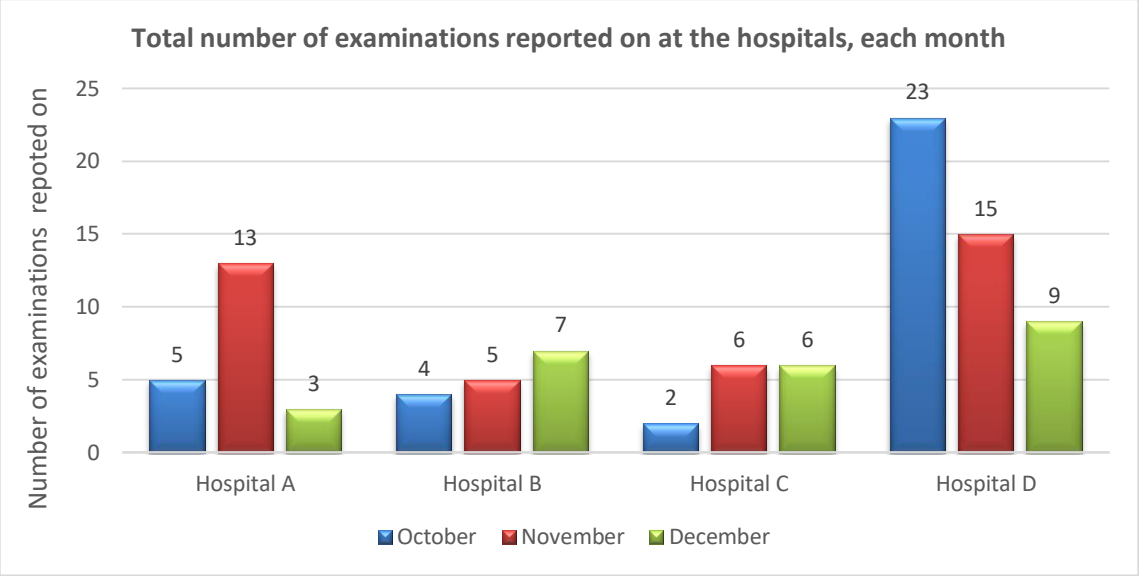

Figure 4.2: Total number of examinations reported on at each hospital

On the contrary, at Hospital D, which was described before to be performing among the fewest numbers of examinations out of the hospitals surveyed, the radiologists in fact appeared to be reporting on the most overall examinations of the four hospitals. That is, on average, 0.62% of the total number of examinations performed at Hospital D were being reported on; approximately six times as often as at Hospital C (the busiest hospital), where only 0.1% of the total number of examinations produced were being reported on by the radiologists, each month (refer to Figure 4.3 and Figure 4.4). It is important to note that despite this generally higher rate of reporting at Hospital D, the radiologists at Hospital D were still reporting on less than 1% of the total examinations performed — even in their most productive month of reporting (October n = 23, 0.93% of examinations performed) (refer to Figure 4.3).

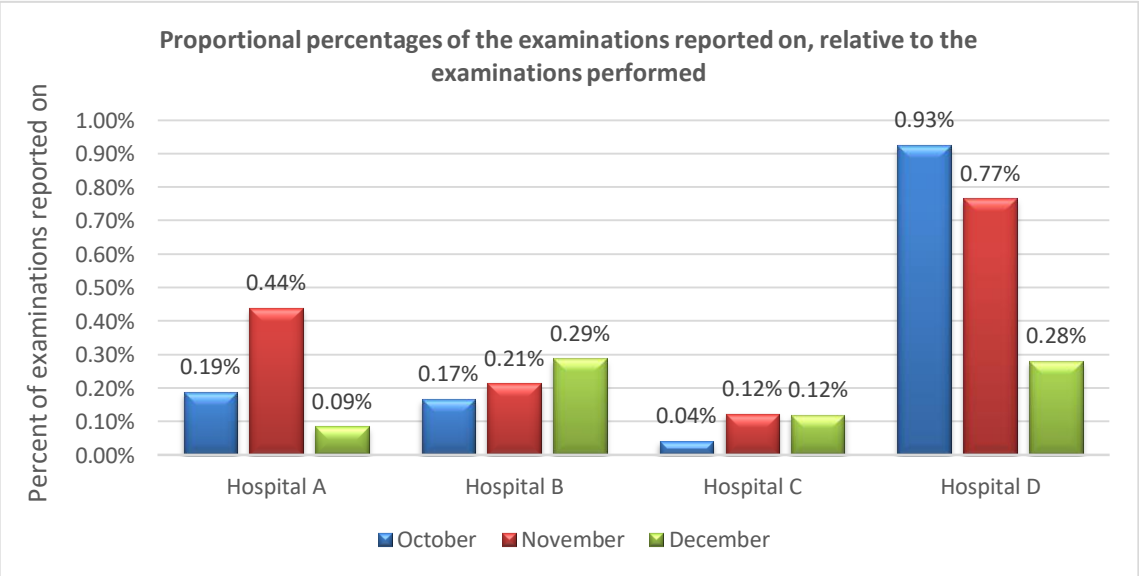

Figure 4.3: Proportional percentages of the examinations reported on

Figure 4.4, below, presents four separate pie charts of the mean percentages of examinations reported on versus the percentages of examinations that were not reported on by radiologists at each of the four hospitals. The charts clearly depict that the majority of radiographic examinations were left unreported.

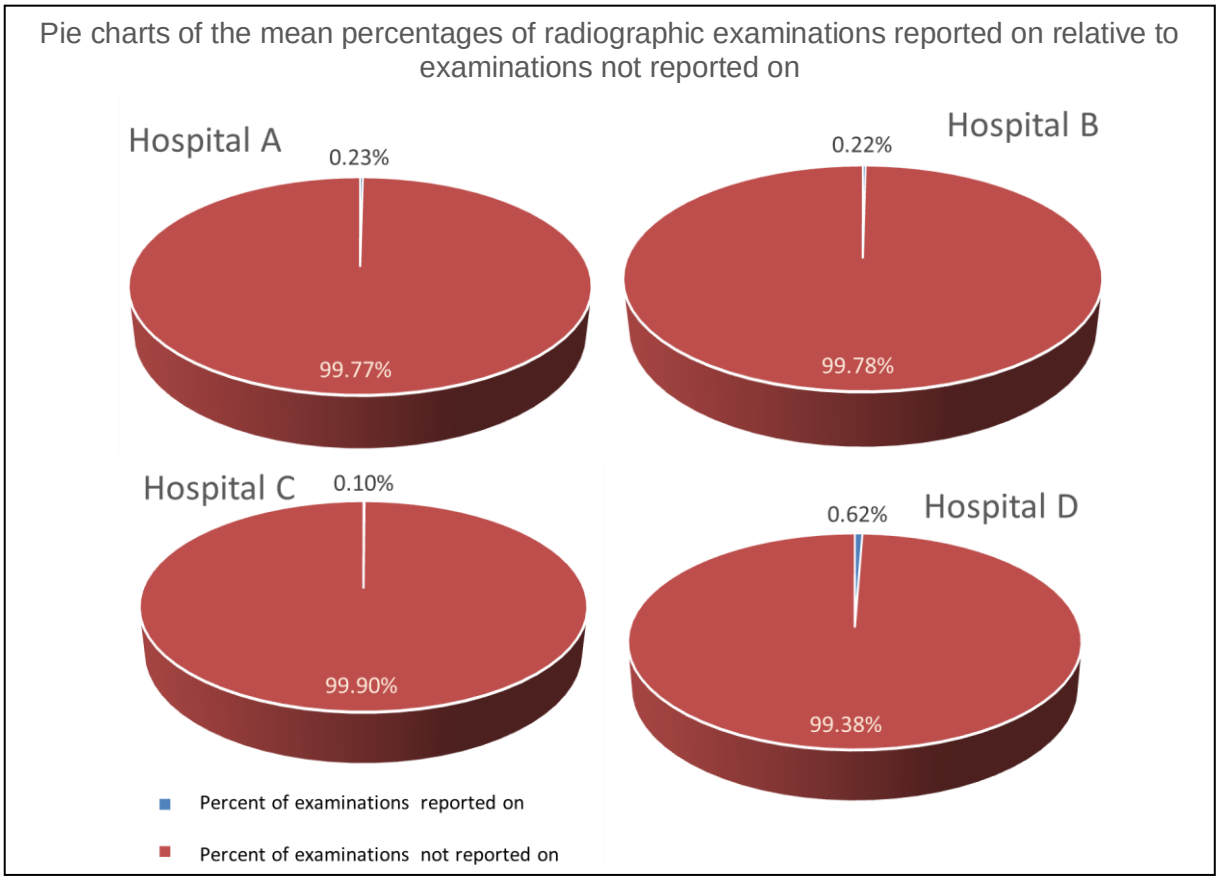

Figure 4.4: Mean percentages of radiographic examinations reported versus not reported on

The values for the total number of examinations performed, represented the accumulated total number of examinations of six different categories of radiographic examinations, namely: CXR, AXR, spine, extremities, SXR, and PXR. A sequence of statistical analytical tests was performed to perceive how the number of examinations done and reported varied between the different hospitals, as outlined next.

4.2.2 Inferential statistics for objectives one and two

This section describes the key results of the inferential statistics tests that were performed on the four hospitals' radiographic examination data, to gather whether any correlations or patterns existed across the data. Pearson's Product Moment Correlation Coefficient (PMCC), r, was calculated to confirm associations with the p-value below 0.05. A One-way ANOVA, was also calculated to detect any links or differences between the data with an F-statistic p-value that was also set at 0.05.

A series of assumption tests was then completed to confirm whether the assumptions for ANOVA were met, such as the assumption that the data was normally distributed — as observed by a Shapiro-Wilks' statistic above a p-value of 0.05. Welch's correction for heteroscedasticity was performed to cater for the small sample size, and non-parametric substitutes such as Kruskal-Wallis were performed, at an alpha below 5% ($p < 0.05$), in cases where the data was not observed to be normally distributed. Finally, post-hoc Bonferroni tests were also performed on ANOVA results that were statistically significant, to conclude how the hospital data was statistically unique, with p-values set at 0.05, in order to determine statistical significance for all of the above statistical tests [The appendices of results from the data analysis were extensive — consisting of more than 1500 pages of results. These pages are therefore not all printed here, and only key results of the study have been entered into the results chapter, with important supplementary results that add value to the conclusions, being entered in the appendices. The raw data for this study is available upon request].

4.2.3 Correlation analysis

The data sets from the four hospitals in the main study were firstly analysed to assess the strength of the linear relationships between the numerical variables. Pearson's 'r' can take on any value between -1 and +1, where a value of -1 represents a perfect negative correlation, and +1 represents a perfect positive correlation. As shown in

Table 4.1, correlations that were statistically important at alphas of 5% ($p < 0.05$) and 1% ($p < 0.01$), have been highlighted and marked with '*', and '**', respectively. The correlation analysis compared the 24 data points covering the six categories of radiographic examinations (CXR, AXR, spine, extremities, SXR, and PXR) at the four hospitals, each month, to compare whether there was an association between the number of CXR, AXR, spine, extremities, SXR, and PXR examinations performed in one month, and the number of CXR, AXR, spine, extremities, SXR, and PXR examinations performed at the same hospital in the other months.

A very strong positive correlation was detected between the number of examinations performed in October and November, November and December, and in October and December, across each radiographic category, and at each hospital ($r = 0.972$, $p = 0.000$; $r = 0.889$, $p = 0.000$; and $r = 0.957$, $p = 0.000$), respectively. Thus, an important finding from the correlation analysis was that the numbers of examinations performed across the six different

categories of radiology examinations assessed, remained comparatively constant at each hospital during the three months surveyed.

Table 4.1: Results of the Pearson's correlation analyses between the number of examinations performed and examinations reported on, across each of the six radiographic categories

		Oct. exams done	Nov. exams done	Dec. exams done	Oct. exams reported	Nov. exams reported	Dec. exams reported	μ of exams done	μ of exams done
October exams done	r	1	0.972**	0.957**	0.178	N/A	N/A	0.996**	N/A
	p		0.000	0.000	0.406	N/A	N/A	0.000	N/A
	N	24	24	24	24	N/A	N/A	24	N/A
November exams Done	r		1	0.889**	N/A	0.140	N/A	0.973**	N/A
	p			0.000	N/A	0.515	N/A	0.000	N/A
	N		24	24	N/A	24	N/A	24	N/A
December exams done	r			1	N/A	0.429*	0.242	0.970**	N/A
	p				N/A	0.036	0.254	0.000	N/A
	N			24	N/A	24	24	24	N/A
October exams reported	r				1	0.719**	0.110	N/A	0.882**
	p					0.000	0.607	N/A	0.000
	N				24	24	24	N/A	24
November exams reported	r					1	0.230	N/A	0.891**
	p						0.280	N/A	0.000
	N					24	24	N/A	24
December exams reported	r						1	N/A	0.461*
	p							N/A	0.023
	N						24	N/A	24
μ of exams done	r							1	0.328
	p								0.117
	N							24	24
μ of exams reported	r								1
	p								
	N								24
** = Correlation is significant at the 0.01 level (2-tailed).									
* = Correlation is significant at the 0.05 level (2-tailed).									
NA = Superfluous correlations that have no true value; and are therefore not worth reporting.									
r = The Pearson's Product Moment Correlation Coefficient, r									
p = Significance of the result (two-tailed).									
N = denotes the six categories of radiographic examinations multiplied by the four hospitals (the total number of categories of radiographic examinations analysed).									

In other words, it could be concluded that the proportional ratio of the different types of examinations performed at each hospital remained nearly unchanged from month to month, since there was a strong correlation between the number of CXR, AXR, spine, extremities, SXR, and PXR examinations performed in one month, and the number of CXR, AXR, spine, extremities, SXR, and PXR examinations performed at the same hospital in the other months (see Figure 4.5). The ANOVA section, next, delves deeper into the total number of examinations that were performed for each group, and which examinations were performed least and most.

4.2.4 ANOVA

ANOVA was executed on the data to detect whether there was a statistically significant difference between the ratio of examinations that were performed versus the number of examinations that were reported on in the same months. This was done by firstly calculating a continuous variable of the proportion of examinations reported out of the number of examinations that had been performed across all of the six radiographic categories of examinations. It offered a means of measuring whether there were any incidental variations for radiologists to report on certain radiographic categories over others.

To begin with, when considering the actual mean number of examinations performed within each radiographic examination category, for all four hospitals over the three months observed, the ANOVA analysis in SPSS confirmed that there was a statistically significant variation between the number of examinations performed for each category ($F(5,66) = 28.318$, $p = 0.000$). As shown in Figure 4.5, extremities were the most common examination category across the four hospitals for the three months, with a mean number of 1,244.8 examinations performed.

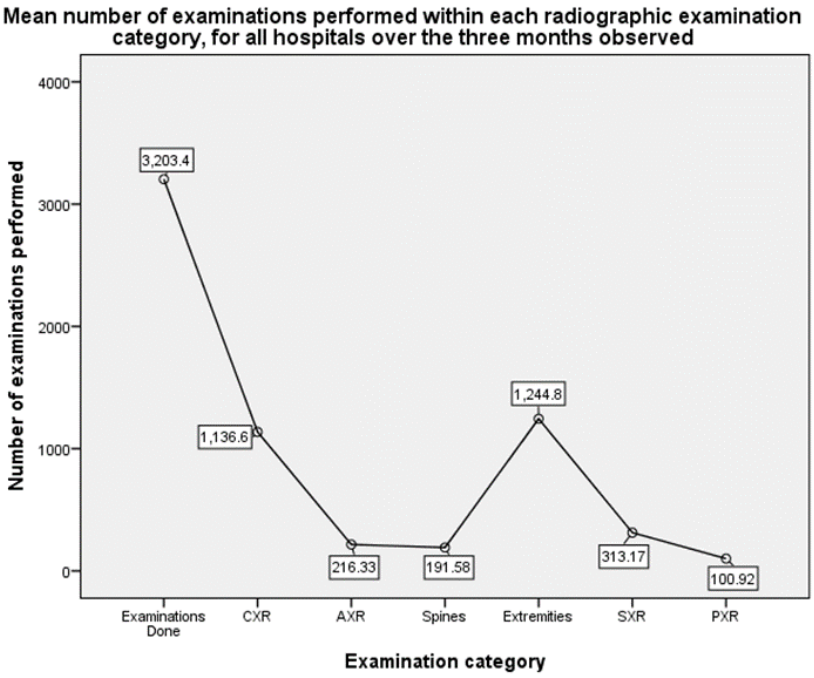

Figure 4.5: Mean number of examinations performed, by category

This was followed closely by CXR, where a mean number of 1,136.6 examinations were performed. Examinations for AXR, spines, SXR, and PXR were all performed far less, with averages for the three months, at the four hospitals, of 216.33, 191.58, 313.17, and 100.92, respectively.

Next, following the ANOVA calculations in SPSS, the results of the ANOVA could not confirm that there were any statistically significant incidental variations for radiologists at different hospitals to report on certain radiographic categories over others. This was confirmed by an ANOVA p-value above the 5% alpha ($F(5,66) = 1.319$, $p = 0.267$). This was in spite of the observation that the means of the different categories of radiographic examinations appeared to differ considerably (as shown in Figure 4.6), such that radiologists reported SXR examinations, on average, the most (0.898% report rate), and PXR examinations the least (0.00% report rate) out of the different radiographic categories. However, since the ANOVA result was not statistically significant, it meant that there was too much variability among the data points to confer statistical reliability, indicating that this observation should instead be interpreted as possibly having occurred due to chance.

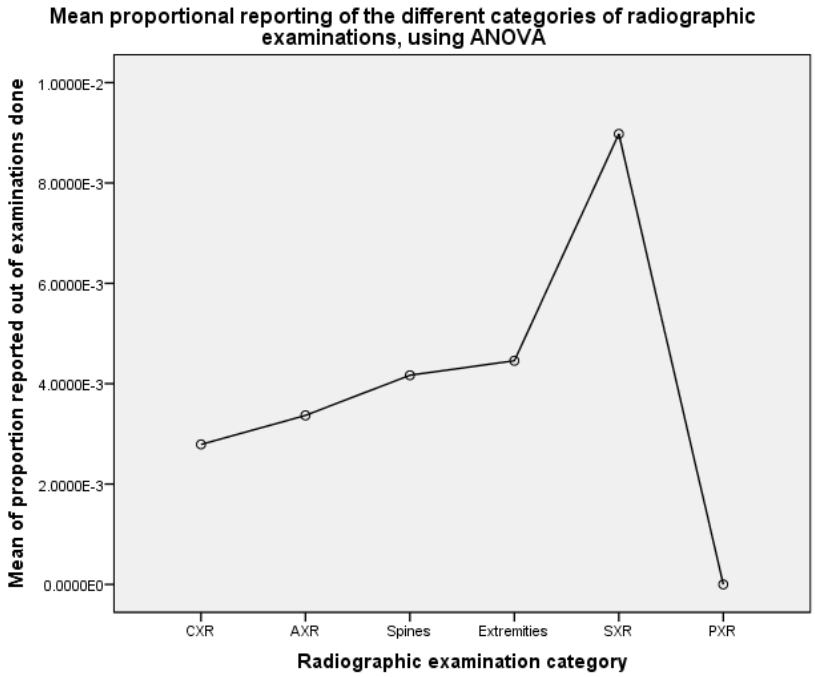

Figure 4.6: Mean proportional reporting of the different categories of radiographic examinations performed after hours

A post-hoc Games-Howell test confirmed a statistically significant difference between the mean ratio of CXR examinations reported on, and the mean ratio of PXR examinations reported on ($p = 0.000$); however, by convention, such post-hoc results are only contemplated if the ANOVA result is initially below the 5% alpha. In addition, in order for the results of the ANOVA to be considered reliable, the data needed to fulfil certain assumption criteria. That is, in order for a set of ANOVA results to be deemed accurate, the data must have followed a normal distribution, and they must have observed homogeneity of variance. To ensure that the data were parametric — following a normal distribution — Shapiro-Wilks' W was calculated to confirm that the data did not deviate from the normal, as observed by a

p-value above 0.05. To ensure that the data had equal between-groups variances, Levene's W was calculated to determine that the variances between the groups' data did not deviate from the mean, as observed by a p-value above 0.05. In research, it is widely accepted that if the data do not adhere to these core ANOVA assumptions, the results of the ANOVA test may be subject to producing type I or type II errors, where statistically significant associations may incorrectly be inferred, or missed, respectively.

Following these assumptions tests for this study, it was indeed determined that the data did not meet the ANOVA assumption for normality (Shapiro-Wilk's W (72) = 0.494, p = 0.000), since the p-value was below 0.05; and the data also did not meet the assumption for homogeneity of variance (Levene's W (5,66) = 3.947, p = 0.003), since the p-value for Levene's W was also below 0.05. Thus, the results of this set of ANOVA tests could not be relied upon to have identified the most authentic associations, to allow conclusions to be drawn for this study.

Since the normality assumption had failed, a second batch of non-parametric tests was contemplated, where the non-parametric equivalent for the one-way ANOVA was a Kruskal-Wallis test. When performing a Kruskal-Wallis (K-W) test, though, while the computation does not require the data to be normally distributed, it does still assume that the variances between the group data are equal (homogeneity of variance). As mentioned above, though, the data did not follow the assumption of homogeneity of variance (Levene's W (5,66) = 3.947, p = 0.003), since the p-value for Levene's W was below 0.05, making any further analyses superfluous.

The results of the analysis on the questionnaire's data are presented next.

4.3 Results related to the questionnaire

The following section of the chapter is committed to understanding the data obtained from the questionnaire issued to the emergency physicians at the four hospitals. This section is focused on answering the third and fourth research objectives of the study, which were to establish whether emergency physicians in public hospitals in the Durban Metropole felt confident at interpreting radiographic images; and whether or not they would prefer an after-hours reporting service. In trying to demonstrate how these two research objectives were addressed, this section first covers some descriptive statistics related to the respondents in the main study; after which, the results of the inferential analysis on these questionnaires will be presented.

4.3.1 Descriptive statistics for objectives three and four

The descriptive statistics begins by presenting the profiles of the respondents. This is followed, thereafter, by the perceived proficiencies of the respondents.

4.3.1.1 Profiles of the respondents

A total of **39** health professionals participated in the main study, with a mean and median age of 39.46 and 38 years, respectively (SD = 9.11 years), as shown in Figure 4.7. The gender distribution included 43.6% females (n = 17), and 56.4% males (n = 22); while the respondents had a mean and median of 11.73 and 10 years' experience working in hospitals (SD = 7.54 years), respectively (see Figure 4.8), and a mean and median of 7.63 and 5 years' experience working in emergency departments (SD = 6.47 years), respectively.

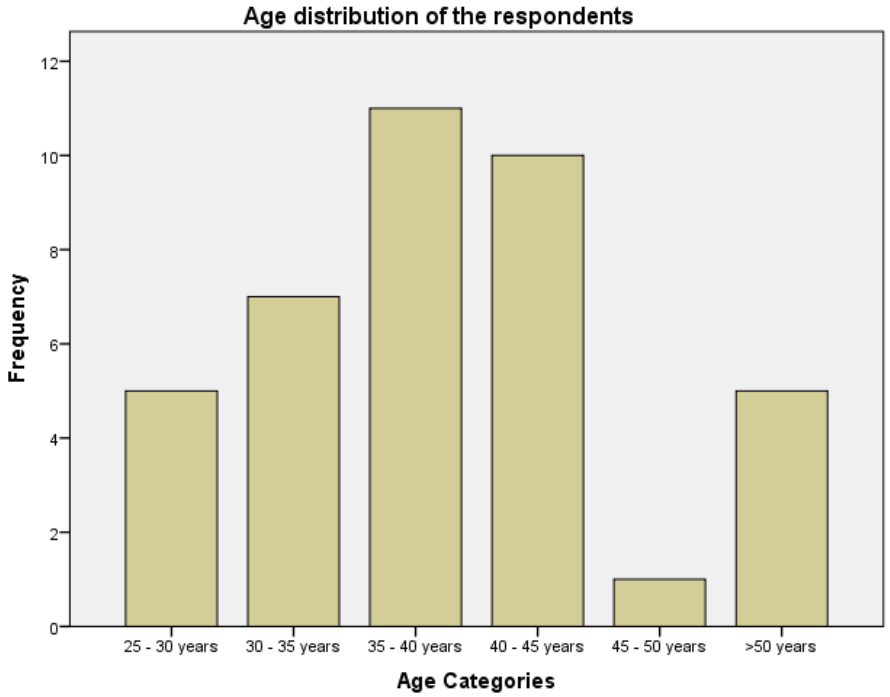

Figure 4.7: Respondents' age distribution

The qualifications of the respondents were almost all Bachelor of Medicine or Bachelor of Surgery (MBChBs; n = 32), while two respondents had both a MBChB and a Masters in Family Medicine (M FAM MED), two had both a MBChB and a Bachelor of Science (BSc), and one respondent had a Bachelor of Medicine and a Bachelor of Surgery (MBBS) degree. In terms of additional qualifications, one respondent was a specialist surgeon, while one respondent also had a Fellowship of the College of Surgeons of South Africa FCS (SA). There were 11 respondents from hospital A, five respondents from hospital B, 13 respondents from hospital C and ten respondents from hospital D (see Appendix K).

Figure 4.8: Respondents' years of experience in a hospital

In order to determine the average number of patients that the respondents attended to on quiet and busy after-hours shifts, the physicians were asked to indicate the respective quantities to these two questions. These quantities were then averaged to determine the mean numbers of patients on both a quiet and a busy after-hours shift, respectively. It was determined that respondents attended to a mean number of 37.03 patients (mode = 30) on a quiet after-hours shift (Q18), and 64.62 patients (mode = 50) on a busy after-hours shift (Q19). In order to confirm that the difference between the quiet and busy after-hours shifts was statistically significant, a paired-samples T-test was performed, and it confirmed that this difference was, indeed, statistically significant ($t(37) = -9.972$, $p = 0.000$).

Next, in order to observe the respondents' perceived need for after-hours reporting, the statistical analysis demonstrated that a mean of 41.24% of their patients' (mode = 50) radiographic images required after-hours reporting (Q20). When focusing on the training of the respondents, the emergency physicians noted receiving a mean of 299.24 hours of training in image interpretation and the reporting of radiographic images (mode = 0) over the course of their careers (Q21). As noted here (also see Figure 4.9), the modal number of hours of training was zero, since 30.8% of the respondents (n = 12) admitted receiving no training in the interpretation and reporting of radiographic diagnostic images at any time during the course of their careers; and 35.9% of the respondents (n = 14) declined to list any answers for this question. The remaining 13 participants claimed to have received at least some training, with 12.8% (n = 5) having received between one and six hours, 12.8% (n = 5) having received between seven and 792 hours, and 7.7% (n = 3) having received more than 793 hours.

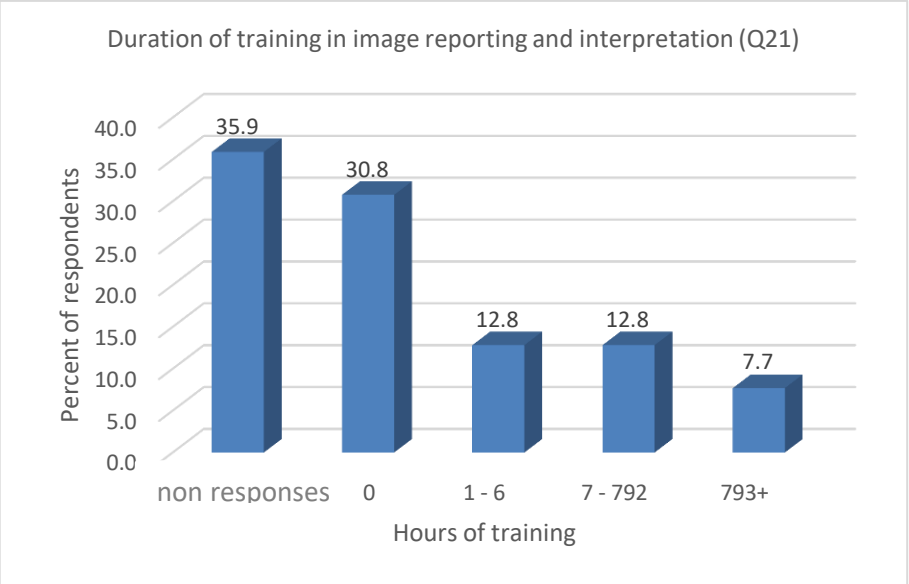

Figure 4.9: Duration of the respondents' training in image reporting

Almost all of the respondents (94.9%, n = 37) admitted to having never attended a radiographic image interpretation course or seminar (Q22 and Q23), and the two respondents who had attended such a course, had done so more than three months prior to this study (see Figure 4.10).

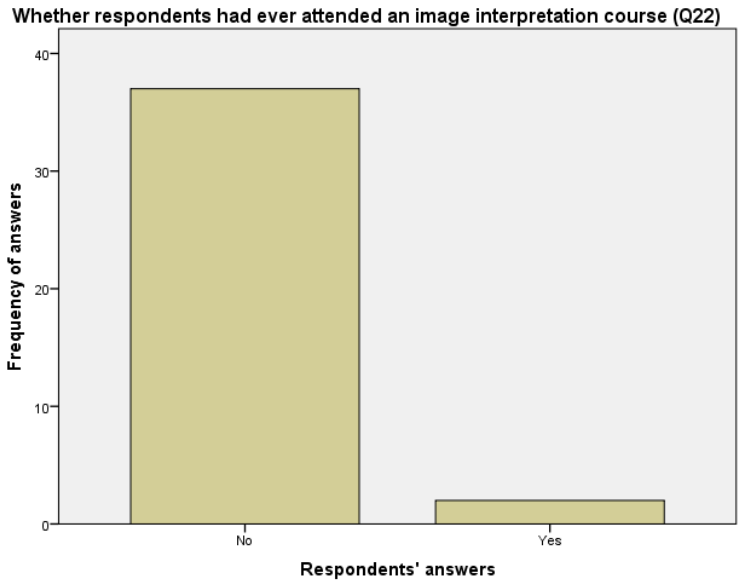

Figure 4.10: Respondents' attendance of image interpretation courses

4.3.1.2 Views of the respondents on perceived proficiencies

The questionnaire posed numerous questions to the participating emergency physicians to ascertain their views on after-hours reporting services, as well as their proficiencies with the

interpretation of radiographic images, and the need for after-hours reporting by professionals trained in radiology reporting. The first perception-related questions of the questionnaire, therefore, asked whether the respondents felt that the after-hours emergency workload was high (Q1). A greater portion of the respondents agreed (43.6%, n = 17), or strongly agreed (53.8%, n = 21), while one respondent strongly disagreed with this view, and none disagreed nor remained neutral, as shown in Figure 4.11.

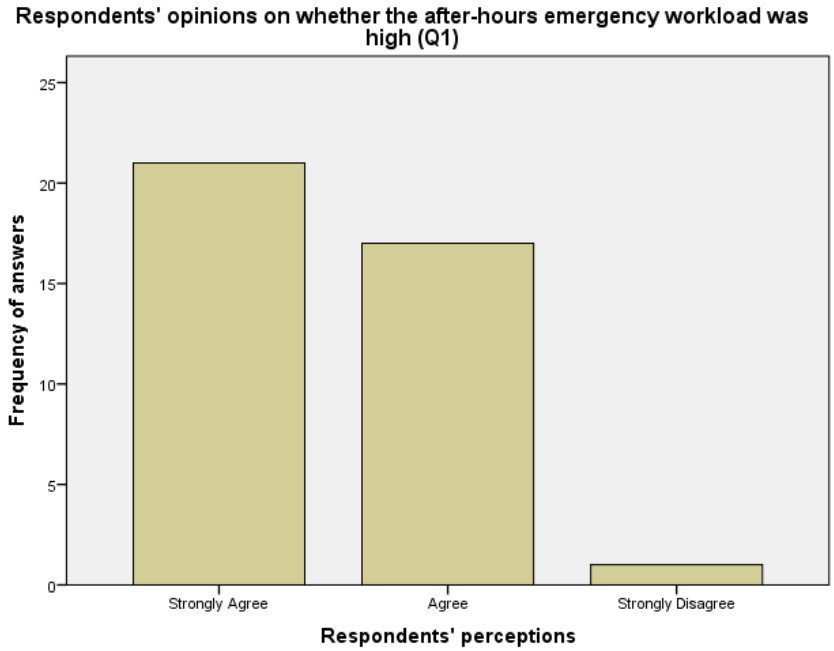

Figure 4.11: Respondents' opinions on the after-hours workload

The questionnaire next delved into the insights of the respondents regarding their own perceived proficiencies, from Questions Q2 to Q10. There was a wide spectrum of answers when it came to defining whether the respondents believed they were able to cope with the workload, where 38.5% of the respondents (n = 15) agreed, and 2.6% (n = 1) strongly agreed that they were able to cope with the workload in the emergency department after hours (Q2), as shown in Figure 4.12. The remaining respondents disagreed (30.8%, n = 9), strongly disagreed (5.1%, n = 2), or remained neutral (30.8%, n = 12) — neither agreeing nor disagreeing on whether they were able to cope with the workload.

A correspondingly broad spectrum of answers was observed relating to whether the respondents felt confident with the after-hours interpretation of radiographic images (Q3), with 35.9% (n = 14) of respondents indicating that they were confident (agreement = 25.6%) or strongly confident (strong agreement = 10.3%).

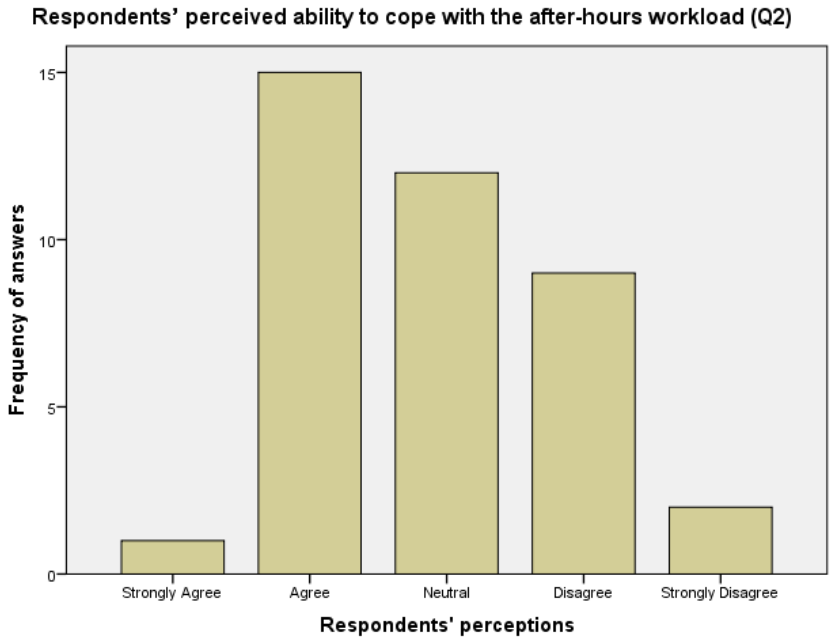

Figure 4.12: Respondents' opinions on the ability to cope with the workload, after hours

Most of the respondents remained neutral on whether they felt confident with the after-hours interpretation of radiographic images (41.0%, n = 16), while fewer respondents noted that they did not feel confident with the interpretation of those images (20.5%, or n = 8 disagreed, and 2.6%, or n = 1 strongly disagreed), as shown in Figure 4.13.

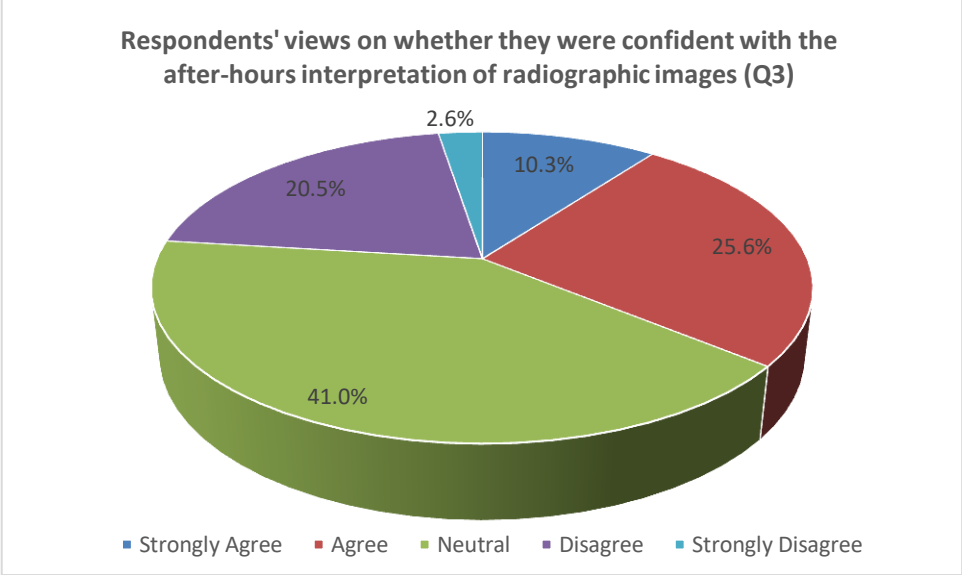

Figure 4.13: Respondents' confidence with radiographic image interpretation

Question four tested the respondents' views on whether they had experienced difficulties, in the past, interpreting diagnostic images. A total of 51.3% (n = 20) of respondents agreed with this statement, while 23.1% (n = 9) strongly agreed. A further 15.4% either disagreed (12.8%, n = 5), or strongly disagreed (2.6%, n = 1) that they had experienced difficulties in

interpreting diagnostic images, while 10.3% (n = 4) remained neutral, as shown in Figure 4.14.

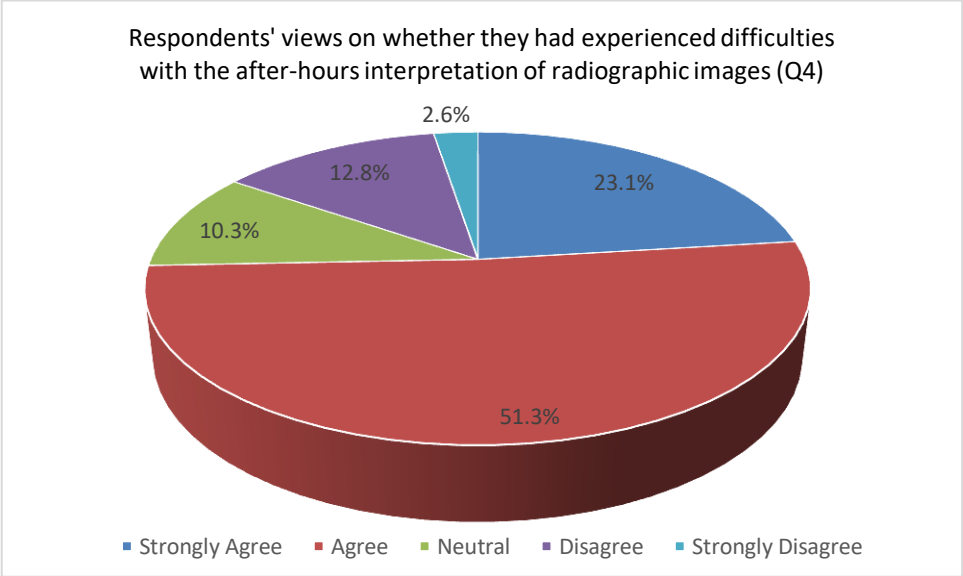

Figure 4.14: Respondents' perceived difficulties with radiographic image interpretation

Most respondents felt confident in identifying pathology on radiographic images (Q5), with 56.4% (n = 22) of respondents being confident and 12.8% (n = 5) being strongly confident. A few respondents, however, did not feel confident identifying pathological conditions, with 10.3% (n = 4) of respondents disagreeing, 2.6% (n = 1) showing a strong lack of confidence, and 17.9% (n = 7) of respondents remaining neutral. Higher proportions of the respondents felt confident identifying fractures on radiographic images (Q6), with 89.7% (n = 35) agreeing with being confident or strongly confident in identifying fractures on radiographic images, with 2.6% (n = 1) of respondents agreeing to not being confident, with 2.6% (n = 1) of respondents agreeing to being strongly not confident in identifying fractures on radiographic images, and 5.1% (n = 2) of respondents remaining neutral.

There was a general consensus over the need for additional training on the reporting of diagnostic radiographic images, with 59% (n = 23) of respondents strongly agreeing and 33.3% (n = 13) agreeing, while 5,1% (n =2) were neutral, and 2.6% (n = 1) disagreed. There were no respondents who strongly disagreed that there was a need for additional training on the reporting of diagnostic images, as shown in Figure 4.15.

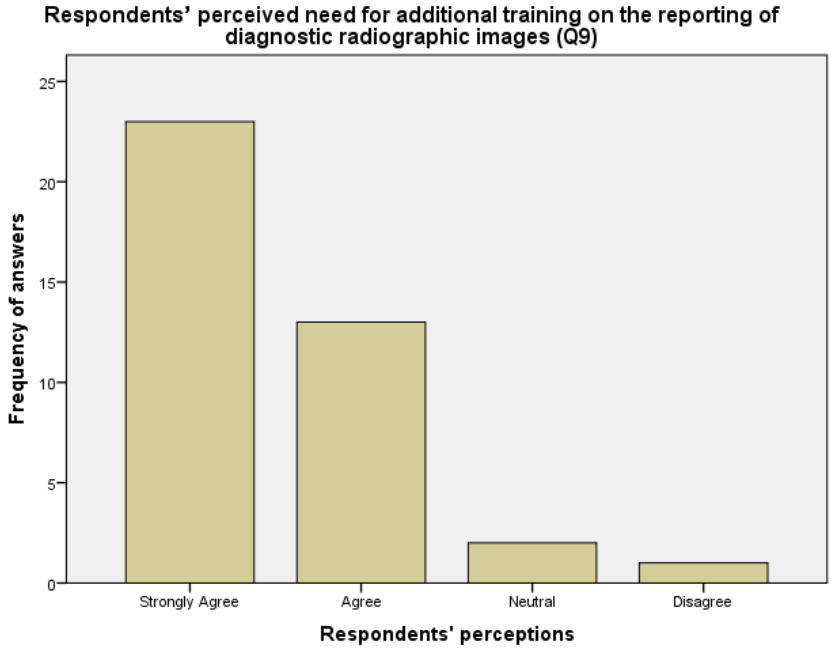

Figure 4.15: Respondents' perceived need for additional training

In the final question that delved into the insights of the respondents regarding their own perceived proficiencies, when asked whether the respondents felt they were in a position to teach colleagues on the interpretation of diagnostic radiographic images (Q10), 2.6% (n = 1) of the respondents strongly agreed and 38.5% (n = 15) agreed; while 30.8% (n = 12) of the respondents were neutral, 23.1% (n = 9) disagreed, and 5.2% (n = 2) strongly disagreed, as shown in Figure 4.16.

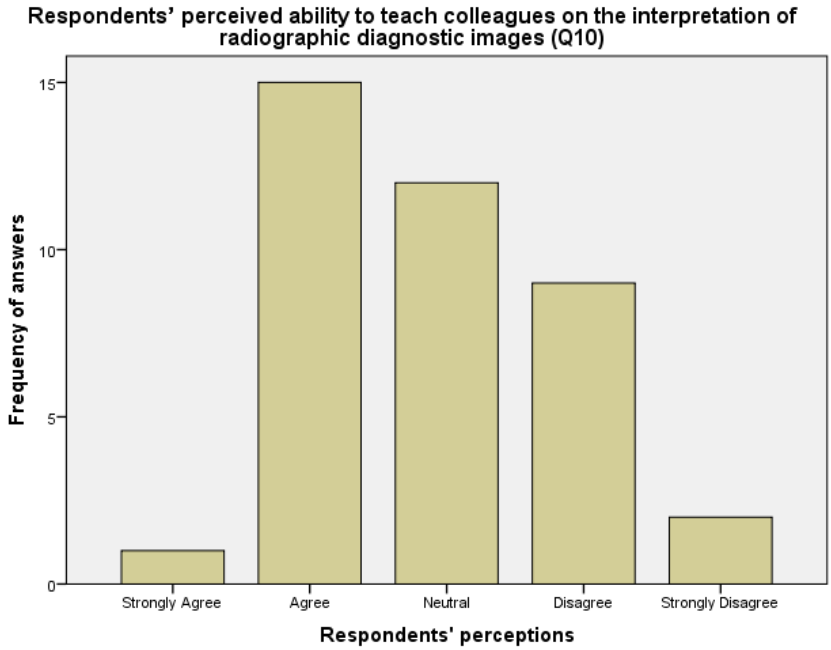

Figure 4.16: Respondents' perceived ability to teach image interpretation

There was no follow-up question on this matter, though, to determine why the respondents felt that they could not teach their colleagues on radiographic image interpretation. Discussions on the factors that may come into play, aside from a simple lack of knowledge, are presented in Chapter Five.

The questionnaire next considered aspects relating to the respondents' views on the current inefficiencies that existed in the interpretation of radiographic images. A total of 28.2% (n = 11) of the respondents agreed, 20.5% (n = 8) strongly agreed, 28.2% (n = 11) disagreed, 23.1% (n = 9) remained neutral, and no respondents strongly disagreed that the interpretation of radiographic images took up valuable patient time, as shown in Figure 4.17.

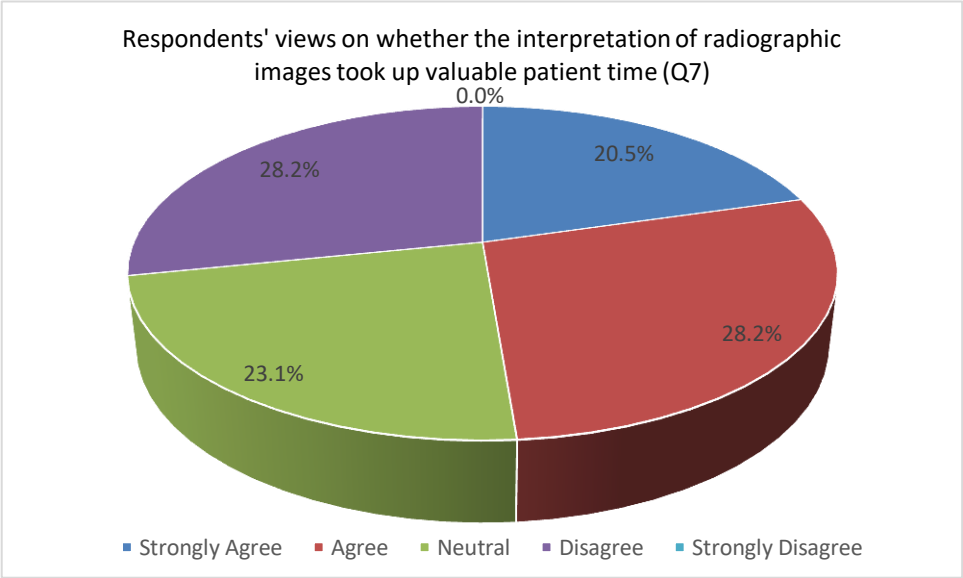

Figure 4.17: Respondents' perceived time wastage on radiographic image interpretation

When asked about the chances for pathologies to be misdiagnosed during the interpretation of images (Q8), there was a strong consensus, where 43.6% (n = 17) of the respondents agreed, and 48.7% (n = 19) strongly agreed with this concept. As shown in Figure 4.18, only 7.7% (n = 3) of the respondents did not agree with this consensus. The majority of the respondents were also in agreement on whether the patients treated at the emergency departments were often asked to return during non-emergency hours for a report by the radiologists (Q11), where 41.0% (n = 16) of the respondents agreed, and 20.5% (n = 8) strongly agreed. Conversely, 15.4% (n = 6) of the respondents disagreed and 5.1% (n = 2) strongly disagreed with this argument, while 17.9% (n = 7) remained neutral.

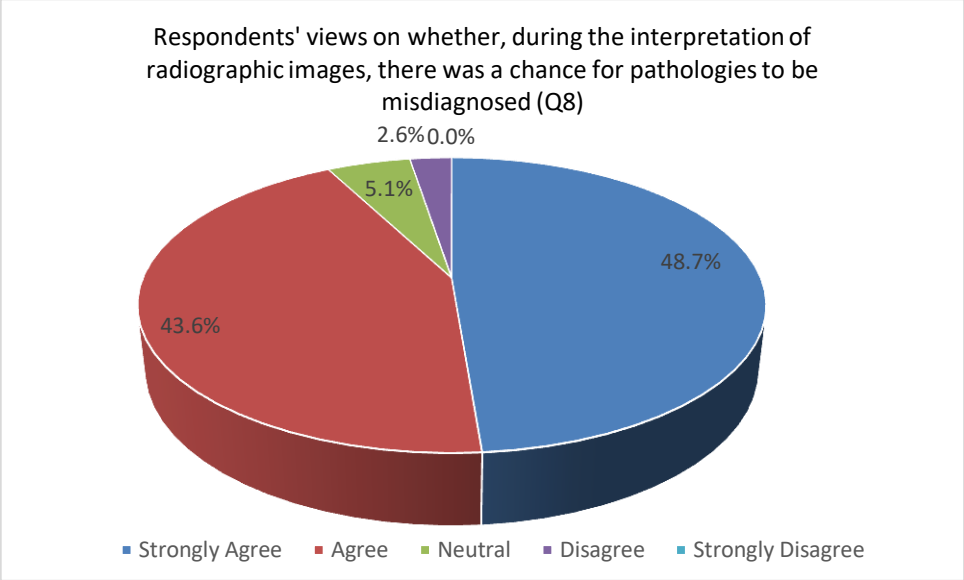

Figure 4.18: Respondents' perceived chances of misdiagnosis

The questionnaire also addressed the views of the respondents regarding the need for radiologists to conduct the reporting of radiographic images. When respondents were asked about their preferences for a radiologist to report on radiographic images produced after hours (Q12), there was almost complete consensus; where 46.2% (n = 18) of the respondents strongly agreed and 41.0% agreed (n = 16). The remaining 7.7% (n = 3) of respondents were neutral, 5.1% (n = 2) disagreed, and no respondents strongly disagreed, as illustrated in Figure 4.19.

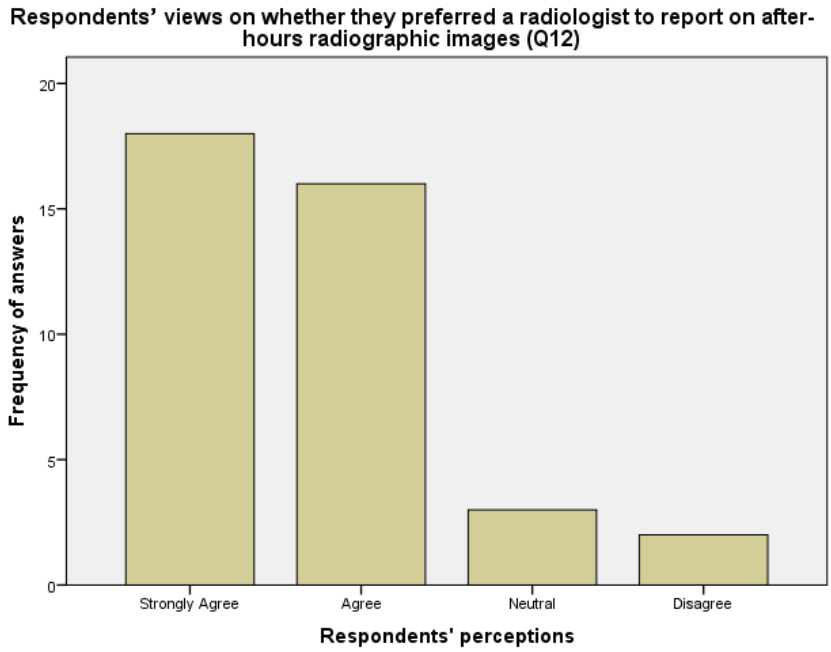

Figure 4.19: Respondents' preferences for radiologists' reports

Out of the respondents in this study, 2.6% (n = 1) argued that they would not be happy for images to be reported on after hours by a radiographer trained in imaging reporting (Q15), with 17.9% (n = 7) remaining neutral, 41.0% (n = 16) agreeing, and a similar number of 38.5% (n = 15) of the respondents strongly agreeing (see Figure 4.20).

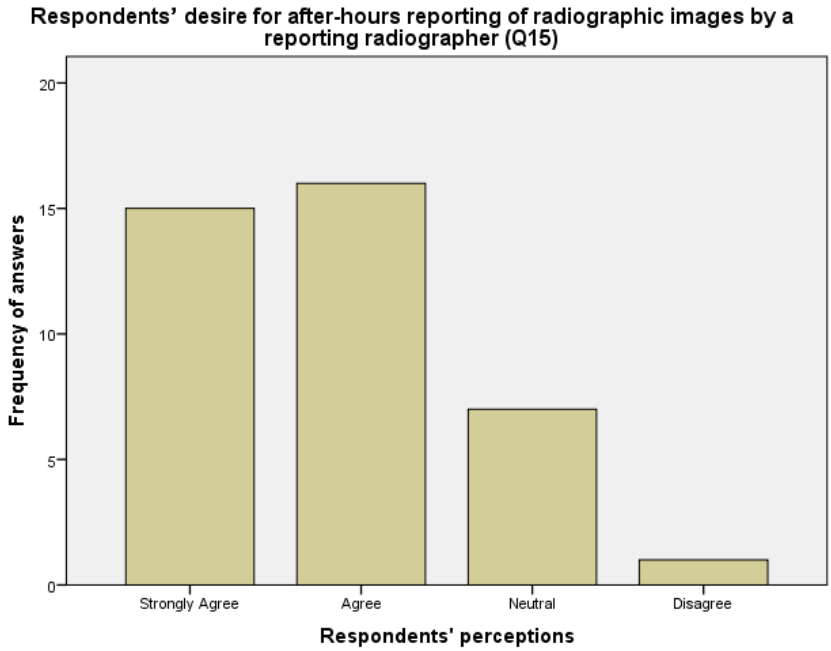

Figure 4.20: Respondents' preferences for a report to be provided by radiographers

In order to ascertain what the respondents perceived would be the benefits of having a reporting radiographer after hours, respondents were asked whether having a reporting radiographer reporting on images after hours would improve patient flow (Q13), and whether there would be greater productivity, in terms of patient flow and service delivery, by having a radiologist reporting after hours (Q14). A total of 35.9% (n = 14) and 43.6% (n = 17) of the respondents agreed and strongly agreed, respectively, that by having a reporting radiographer reporting on images after hours, there would be a benefit in patient flow (Q13). Conversely, only 10.3% (n = 4) of the respondents, each, were either neutral, or disagreed; and no respondents strongly disagreed with this notion.

In addition, 38.5% (n = 15) and 56.4% (n = 22) of the respondents either agreed or strongly agreed, respectively, that having a radiologist reporting after hours would increase productivity with regards to patient flow and service delivery (Q14), as shown in Figure 4.21. In support of question Q13, 2.6% (n = 1) of respondents, each, either disagreed or remained neutral, respectively, and none of the respondents strongly disagreed with the notion that having a radiologist reporting radiographic images after hours would increase productivity through patient flow and service delivery.

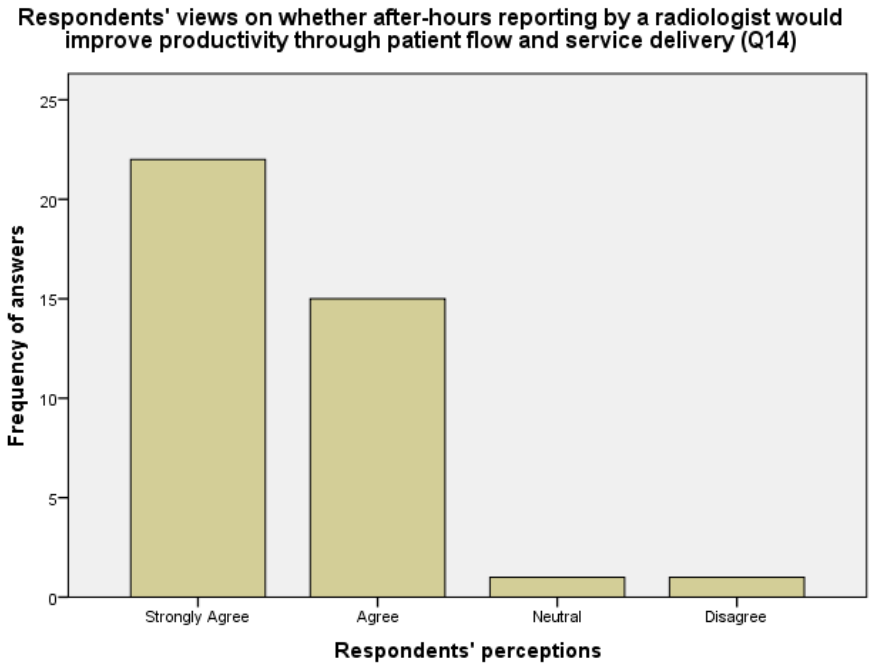

Figure 4.21: Respondents' perceived improvements in productivity with radiologist reporting

Building on this, the majority of respondents did not think that emergency physicians were comparable to radiologists in terms of the interpretation of images (Q16), with 38.5% (n = 15) disagreeing, 17.9% (n=7) strongly disagreeing, and 30.8% (n = 12) remaining neutral. A smaller number of 12.8% (n = 5) of the respondents, however, did think that emergency physicians were comparable to radiologists in terms of the interpretation of images (refer to Figure 4.22). None of the respondents strongly agreed that emergency physicians were comparable to radiologists. Discussions on these topics are presented in Chapter Five of the dissertation.

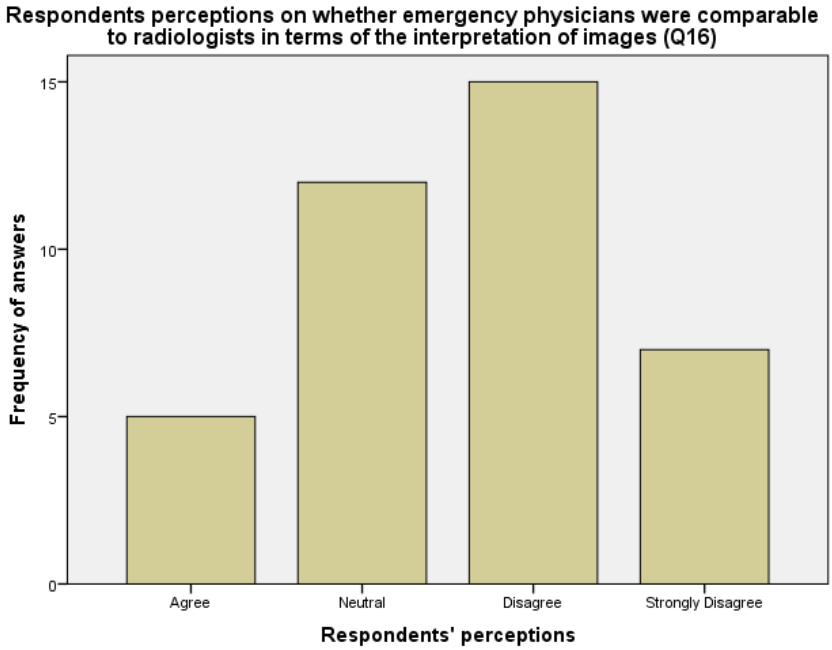

Figure 4.22: Respondents' views on the image interpretation capability of emergency physicians

Contrary to the few respondents' answers of certainty in question Q16, above, no respondents disagreed that emergency physicians needed to undergo additional training to keep up with the challenges of reporting on radiographic images (Q17), with 10.3% (n = 4) of the respondents remaining neutral, 43.6% (n = 17) strongly agreeing, and 46.2% (n = 18) agreeing with this point (see Figure 4.23).

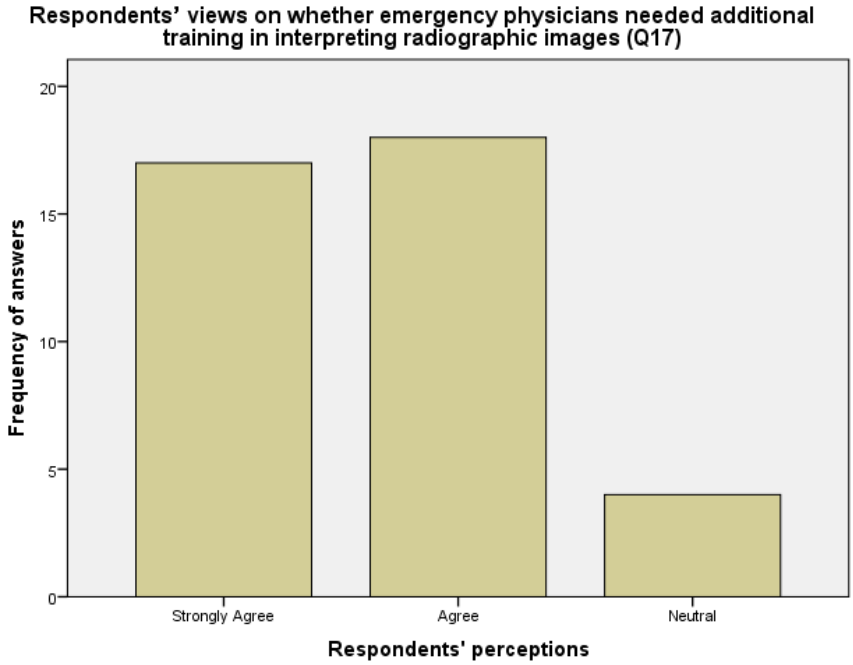

Figure 4.23: Respondents' views on the need for additional training

Possible reasons for the divergences of opinions among the respondents were determined in the inferential statistical analysis portion of the data analysis, as outlined next.

4.3.2 Inferential statistics for objectives three and four

The results of the inferential statistics portions of the data analysis are outlined, next, beginning with the results of the correlation analysis, followed by the chi-square, ANOVA, and tests for reliability, thereafter.

4.3.2.1 Correlations for objectives three and four

The data from the questionnaires of respondents was firstly analysed with a correlation analysis to calculate the non-parametric Spearman's Correlation Coefficient, rho (ρ); in order to quantify the strengths of the linear relationships between the answers that the respondents gave for the different questions, as well as their demographic profiles. As in the case of the hospitals' data, Spearman's coefficient 'ρ' can take on any value between -1 and +1, where a value of -1 represents a perfect negative correlation, and +1 a perfect positive correlation.

There was no statistically significant correlation between the ages of the respondents and whether they felt that the after-hours emergency workload was high (Q1; ρ = -0.191, p = 0.244); or the years of experience working in a hospital and whether the respondents felt that the after-hours emergency workload was high (ρ = -0.105, p = 0.523), as shown in Table 4.2. This indicated that both less- and more-experienced respondents were affected equally by the high workload. Stated differently, as the ages and years' experience of the respondents increased, there was no statistically consistent tendency for the respondents to note that the after-hours emergency workload was higher or lower, and individuals of all different ages and experience levels perceived the workload to be high. Furthermore, there were no statistically significant correlations between age or overall experience in hospitals, and any of the opinions pertaining to radiographic reporting throughout the questionnaire.

Table 4.2: Key results of the correlation analysis to determine Spearman's rho (ρ) for respondents' age, years' experience, and after-hours workload

		Years' experience in a hospital	After-hours emergency workload is high (Q1)
Age	ρ	0.860**	-0.191
	Sig	0.000	0.244
	N	39	39
Years' experience in a hospital	ρ	1	-0.105
	Sig	-	0.523
	N	39	39
**. Correlation is significant at the 0.01 level (2-tailed).			
*. Correlation is significant at the 0.05 level (2-tailed).			

An interesting statistically important correlation that was observed pertaining to experience in the emergency department, though, was that there was a moderate negative correlation between the years of experience working in the emergency department, and the duration of the respondents' training in imaging reporting (Q21); and this result was significant at below a 5% alpha ($\rho = -0.483$, $p = 0.014$) (Table 4.3). This meant that those that had been working for longer in emergency departments tended to have had shorter durations of training in imaging reporting, while those with fewer years' experience in emergency departments tended to have received more training in imaging reporting, as shown in Figure 4.24.

There was a moderate statistically significant negative correlation between whether the respondents had experienced difficulties in interpreting diagnostic images, and whether they felt confident with the after-hours interpretation of radiographic images ($\rho = -0.448$, $p = 0.004$), as shown in Table 4.3. This meant that respondents with fewer difficulties in interpreting diagnostic images were generally more confident with the after-hours interpretation of radiographic images; and this correlation was negative due to the Likert scoring used in this study, which listed agreement (and conversely disagreement) to both questions with the same numerical values.

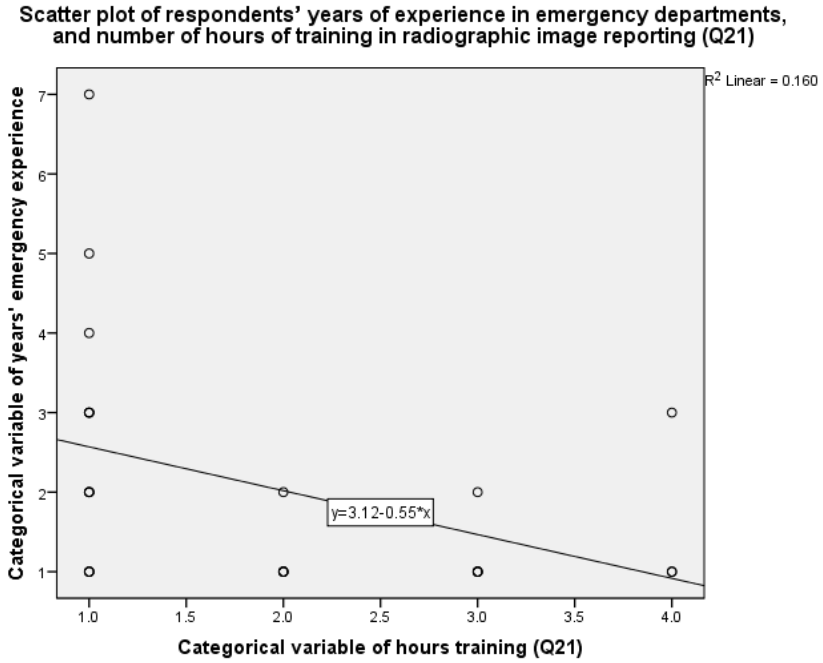

Figure 4.24: Scatter plot between respondents' experience and hours of reporting training

When considering the confidence of the respondents, there was a moderate statistically significant negative correlation between whether the respondents felt confident with the after-hours interpretation of radiographic images and whether their patients, who had been treated at the emergency department, were often asked to return during non-emergency hours for a report by the radiologists ($\rho = -0.503$, $p = 0.001$).

Table 4.3: Correlation analysis to determine Spearman's rho (ρ) for years of experience, confidence with interpretation, confidence in identifying fractures, and whether image interpretation took time

		Difficulties interpreting diagnostic images (Q4)	Chance of pathologies being misdiagnosed (Q8)	Need for additional training (Q9)	Patients asked to return for a report (Q11)	Hours of training in interpretation (Q21)
Years' experience in an emergency department	ρ	0.064	-0.197	-0.030	-0.013	-0.483*
	Sig	0.697	0.229	0.858	0.936	0.014
	N	39	39	39	39	25
Confident with interpretation (Q3)	ρ	-0.448**	-0.114	-0.315	-0.503**	0.195
	Sig	0.004	0.489	0.051	0.001	0.233
	N	39	39	39	39	39
Confident identifying fractures (Q6)	ρ	-0.075	-0.171	-0.548**	0.258	0.090
	Sig	0.652	0.298	0.000	0.113	0.586
	N	39	39	39	39	39
Interpretation takes valuable time (Q7)	ρ	0.211	0.625**	0.372*	-0.217	-0.010
	Sig	0.197	0.000	0.020	0.184	0.951
	N	39	39	39	39	39
**. Correlation is significant at the 0.01 level (2-tailed).						
*. Correlation is significant at the 0.05 level (2-tailed).						

In addition, the same number of respondents who felt less confident identifying fractures on radiographic images (Q6) were more inclined to feel that there was a need for additional training for emergency physicians on the reporting of diagnostic images (Q9) (ρ = -0.548, p = 0.000); while respondents that strongly agreed that the interpretation of images took up valuable patient time (Q7; see Table 4.3) also strongly agreed that there was a chance of pathologies being misdiagnosed during the interpretation of images (Q8) (ρ = 0.625, p = 0.000).

4.3.2.2 Chi-square

A chi-square (χ^2) analysis was performed to allow the researcher to note whether the values in several questionnaire variables varied from their predicted quantities; and thereby determine whether one variable was likely to be affecting the values in the other (Pandis, 2016:898).The primary value of this set of tests was in providing another means of determining whether the demographic profiles of the respondents had any overbearing effect on their preferences to answer a specific way in the questionnaires. Confirming any overbearing effects was determined if the p-value in the chi-square test was below an alpha of 5% ($p < 0.05$), indicating that there was only a 5% (or less) chance that the association had occurred by chance alone.

A sequence of three supporting tests was also performed to verify the chi-square results shown in this section, since the low number of respondents meant that the small sample size typically failed one of the primary assumptions of chi-square analyses. The tests performed included the need to correct for the small sample size. Fisher's Exact Test was therefore performed to verify the chi-square statistic, since Fisher's Exact Test was specifically designed for smaller sample sizes. In addition, the likelihood ratio was calculated to verify the chi-square statistic, and Cramer's V was calculated to provide a measure of effect size, where a V value of 0.00 indicated zero effect, and 1.00 indicated absolute effect.

A key benefit of the chi-square analysis over the correlation analysis was that it could observe statistically significant differences that were not simply linear in nature — thereby highlighting statistically significant differences between specific categories of individuals and their answers, as opposed to just differences between opposing ends of the Likert scale. Chi-square analyses are able to do this by comparing a set of observed data relative to their expected values; and if the observed values are statistically consistently above or below their expected counts — with a corresponding p-value below an alpha of 5% — the observations are judged not to have occurred by chance alone. It was observed, in the chi-square analyses, that the qualification of the respondents was statistically significantly associated with whether the respondents asked patients treated at the emergency department to return during non-emergency hours for a report by a radiologist (Q11) ($\chi^2(20) = 43.900$, $p = 0.009$; LR (20) = 26.109, p = 0.008; Fisher's = 28.443, p = 0.015; Cramer's V = 0.530, p = 0.009); and this was a result that could not be distinguished with the correlation analysis. As shown in Table 4.4 and

Table 4.5, this meant that health professionals with certain qualifications were more inclined than those with other qualifications to ask patients that had been treated at the emergency department to return for a report by a radiologist.

Table 4.4: Results of the chi-square analysis to determine associations between the respondents' qualifications, and whether patients were asked to return for reports (Q11)

	Value	df	Exact significance (2-sided)
Pearson's chi-square	43.900[a]	20	0.009
Likelihood Ratio	26.109	20	0.008
Fisher's Exact Test	28.443		0.015
Cramer's V	0.530	-	0.009
N of Valid Cases	39		
a. 27 cells (90.0%) have expected count less than 5. The minimum expected count is 0.05.			

As depicted in

Table 4.5 fewer-than-expected respondents with an MBCHB and a BSC (n = 2), or an FCS (SA) (n = 1) asked patients to return during office hours, while more-than-expected

respondents with an MBCHB and an M FAM MED (n = 2), or specialist surgeon (n = 1) asked patients to return during office hours. Cramer's V confirmed the effect size of the association, by illustrating that 53% of the outcome of whether a patient was requested to return during non-emergency hours for a radiologist's report, appeared to be associated with the qualification of the respondent.

Table 4.5: Expected versus observed counts during the chi-square analysis between respondents' qualification, and whether patients were asked to return for reports (Q11)

Qualification	Observation	Whether patients treated at the emergency department were often asked to return for a report by the radiologist (Q11).					Total
		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	
MBCHB	Actual Count	5	15	7	4	1	32
	Expected Count	6.6	13.1	5.7	4.9	1.6	32.0
Specialist Surgeon	Actual Count	1	0	0	0	0	1
	Expected Count	0.2	0.4	0.2	0.2	0.1	1.0
MBBS	Actual Count	0	1	0	0	0	1
	Expected Count	0.2	0.4	0.2	0.2	0.1	1.0
MBCHB + M FAM MED	Actual Count	2	0	0	0	0	2
	Expected Count	0.4	0.8	0.4	0.3	0.1	2.0
MBCHB + BSC	Actual Count	0	0	0	2	0	2
	Expected Count	0.4	0.8	0.4	0.3	0.1	2.0
FCS(SA)	Actual Count	0	0	0	0	1	1
	Expected Count	0.2	0.4	0.2	0.2	0.1	1.0
Total	Actual Count	8	16	7	6	2	39
	Expected Count	8.0	16.0	7.0	6.0	2.0	39.0

In other chi-square tests, the total years of experience working in a hospital also appeared to statistically significantly predict whether, during the interpretation of radiographic images, there was a chance of pathologies being misdiagnosed (Q8) ($\chi^2(18) = 34.210$, $p = 0.012$; LR(18) = 23.509, p = 0.172; Fisher's = 27.143, p = 0.040; Cramer's V = 0.541, p = 0.012); whether respondents thought there was a need for additional training for emergency physicians on the reporting of diagnostic radiographic images (Q9) ($\chi^2(18) = 51.082$, $p = 0.013$; LR(18) = 23.691, p = 0.041; Fisher's = 26.503, p = 0.053; Cramer's V = 0.661, p = 0.013); and whether the respondents would typically ask patients treated at the emergency department to return during non-emergency hours for a report by the radiologist (Q11)($\chi^2(24) = 37.429$, $p = 0.040$; LR(24) = 35.643, p = 0.037; Fisher's = 29.995, p = 0.054; Cramer's V = 0.490, p = 0.040). These results are depicted in Table 4.6.

Table 4.6: Results of the chi-square analyses to determine associations between respondents' years of experience working in a hospital, and their questionnaire responses

Test	Chance for pathologies to be misdiagnosed (Q8)			Need for additional training (Q9)			Patients asked to return for a radiologists' report (Q11)		
	Value	df	Exact sig.	Value	df	Exact sig.	Value	Df	Exact sig.
Pearson's χ^2	34.210[a]	18	0.012	51.082[a]	18	0.013	37.429[a]	24	0.040
Likelihood Ratio	23.509	18	0.172	23.691	18	0.041	35.643	24	0.037
Fisher's	27.143		0.040	26.503		0.053	29.955		0.054
Cramer's V	0.541		0.012	0.661		0.013	0.490		0.040

N of valid cases	39			39			39		
a. 35 cells (100.0%) have expected count less than 5. The minimum expected count is .05.									

It is important to state, though, that there was no linear pattern between the respondents' experience levels, and their preferences to answer in a specific way. Thus, while some specific age groups felt similarly on certain questions in the questionnaire, it could not be said that those with fewer years' experience tended to answer a specific way, while those with more experience answered another; but only that certain specific experience categories — for instance 20-25 or 10-15 years' experience — tended to answer with unexpectedly more (or fewer) responses on the Likert scale than other age categories. This explained why this association was not flagged during the correlation analysis, in the previous section.

It was observed that statistically more respondents that had received longer durations of training in radiographic image interpretation and reporting (Q21) felt that emergency physicians were comparable to radiologists for image interpretation (Q16) ($\chi 2(9) = 26.481$, $p = 0.001$; LR (9) = 19.640, $p = 0.038$; Fisher's = 13.146, $p = 0.051$; Cramer's V = 0.594, $p = 0.001$). Conversely, as shown in Table 4.7, respondents that had received shorter durations of training in radiographic image interpretation did not consider their image reporting competencies to be comparable to radiologists; and the effect size of 59.4% (as observed from Cramer's V) was moderate-to-strong on a scale from 0.00 indicating zero effect, to 1.00 indicating absolute effect.

Table 4.7: Results of the chi-square analysis to determine associations between respondents' hours of training in imaging reporting (Q21) and whether emergency physicians felt they were comparable to radiologists for radiographic image interpretation (Q16)

	Value	**df**	**Exact significance (2-sided)**
Pearson's chi-square	26.481[a]	9	0.001
Likelihood Ratio	19.640	9	0.038
Fisher's Exact Test	13.146		0.051
Cramer's V	0.594		0.001
N of Valid Cases	25		
a. 16 cells (100.0%) have expected count less than 5. The minimum expected count is .36.			

The results of Table 4.7, above, were calculated with only 25 valid cases because there were only 25 instances where respondents had provided answers to both their hours of training in imaging reporting (Q21) and whether the emergency physicians felt they were comparable to radiologists for radiographic image interpretation (Q16). For the remaining 14 (invalid) cases, the respondents left either one or both of the answers for these two questions blank — meaning that a chi-square cross tabulation calculation could not be performed between these two questions.

The chi-square analysis was particularly valuable for observing hospital-specific differences. For instance, when considering the hospital's association with respondents, it appeared that there was a highly statistically significant association between which hospitals the respondents were working at, and whether they tended to ask patients treated at the emergency departments to return during non-emergency hours for a report by a radiologist (Q11) ($\chi^2(12) = 27.425$, $p = 0.004$; LR (12) = 34.175, $p = 0.001$; Fisher's = 24.031, $p = 0.001$, Cramer's V = 0.484, $p = 0.004$).

As shown in Table 4.8, 48.4% of the outcome of whether the patients treated at the emergency department were asked to return later for a radiologist's report appeared to be associated with the hospital in which the respondents worked, where more-than-expected respondents at Hospitals A (543 beds) and D (853 beds), and fewer-than-expected respondents at Hospitals B (571 beds) and C(1200 beds) tended to ask patients to return during office hours for a radiologist's report.

Table 4.8: Results of the chi-square analysis to determine associations between respondents' hospital of employ and whether patients were asked to return for radiologists' reports (Q11)

	Value	df	Exact significance (2-sided)
Pearson's chi-square	27.425[a]	12	0.004
Likelihood Ratio	34.175	12	0.001
Fisher's Exact Test	24.031		0.001
Cramer's V	0.484		0.004
N of Valid Cases	39		
a. 19 cells (95.0%) have expected count less than 5. The minimum expected count is 0.26.			

Furthermore, another result that appeared to provide some confirmation to the research questions of this study was that respondents at hospitals where lower mean numbers of examinations were performed per month (<2999 examinations, as ascertained during the first phase of the data analysis), felt statistically more confident identifying pathological conditions on radiographic images, while those at hospitals where health professionals were performing a mean of 4000-or-more examinations per month (see Section 4.2.1), were less confident. This was confirmed with a 43.5% effect size ($\chi^2(8) = 14.789$, $p = 0.040$; LR(8) = 19.059, $p = 0.020$; Fisher's = 13.748, $p = 0.027$; Cramer's V = 0.435, $p = 0.040$), as shown in Table 4.9.

Table 4.9: Results of the chi-square analysis to determine associations between number of examinations performed and whether respondents were confident identifying pathology

	Value	df	Exact significance (2-sided)
Pearson's chi-square	14.789[a]	8	0.040
Likelihood Ratio	19.059	8	0.020
Fisher's Exact Test	13.748		0.027
Cramer's V	0.435		0.040
N of Valid Cases	39		
a. 12 cells (80.0%) have expected count less than 5. The minimum expected count is 0.28.			

A similar, highly statistically significant result was observed where the respondents at hospitals where the health-care professionals performed lower mean numbers of examinations per month (<2999 examinations), tended to ask patients treated at the emergency departments more often than expected to return later for a radiologist's report (Q11), as shown in Table 4.10. Conversely, respondents at hospitals where health-care professionals performed a monthly mean of 4000-or-more examinations, tended to ask patients less-often than expected to return for a radiologist's report.

This was confirmed with a 53.4% effect size (Q11) ($\chi^2(8) = 22.206$, $p = 0.002$; LR (8) = 27.297, $p = 0.001$; Fisher's = 20.724, $p = 0.001$; Cramer's V = 0.534, $p = 0.002$). A similar linearity did not appear to exist between the monthly mean numbers of images reported. Due to the previously-observed associations between hospital, qualification, and the tendency to ask patients to return, though, it is possible that the trends in certain types of qualifications at specific hospitals, as well as the overall numbers of examinations performed may all have come into play in deciding whether to refer patients to a radiologist during office hours.

Table 4.10: Results of the chi-square analysis between numbers of examinations performed and whether patients were asked to return for radiologists' reports (Q11)

	Value	df	Exact significance (2-sided)
Pearson's chi-square	22.206[a]	8	0.002
Likelihood Ratio	27.297	8	0.001
Fisher's Exact Test	20.724		0.001
Cramer's V	0.534		0.002
N of Valid Cases	39		
a. 13 cells (86.7%) have expected count less than 5. The minimum expected count is .56.			

As observed previously, in the correlation analysis, there did not appear to be any linear statistically significant relationships between the mean numbers of examinations performed or reported on, and whether the respondents preferred after-hours examinations to be reported on by a radiologist or radiographer. The vast majority of respondents indicated that they would prefer a radiologist or trained reporting radiographer to report on radiographic images produced after hours (see Q12 and Q15 in the descriptive statistics). There was also no statistically significant tendency for any specific category of respondent to prefer after-hours reporting more (or less) than the other demographic categories of respondents, as all respondents generally preferred a radiologist or trained reporting radiographer to report on their after-hours radiographic images.

4.3.2.3 ANOVA

In the final set of tests for this study, a one-way ANOVA was performed to observe whether any results could be generated pertaining to the demographic profiles of the respondents. The other reason for this test was to determine whether the numbers of examinations performed or reported at the hospitals in this study had any bearing on whether the respondents preferred a radiologist to report on after-hours radiographic images — and thereby capture anything that the previously mentioned correlation and chi-square analyses had missed.

The results of the ANOVA analysis of the respondents' questionnaires simply confirmed the primary finding of the chi-square analysis and correlation analysis. That is, there did not appear to be any demographic preferences, or any linear statistically significant relationships between the mean numbers of examinations created or reported on, and whether the respondents preferred images to be reported on after hours by a radiologist or radiographer trained in radiographic image reporting (as observed in Q12 and Q15 of the questionnaire, respectively). This again emphasised that while the vast majority of respondents preferred a radiologist or radiographer to report on radiographic images produced after hours, there was no statistically significant tendency for the number of examinations performed or images reported at the respective hospitals; or age, experience or qualification of the respondents; or the hospital itself to have any direct bearing on whether the respondents preferred a radiologist or trained reporting radiographer to report on radiographic images produced after hours. The respondents' views, in this respect, were unanimous.

4.3.2.4 Tests for reliability

Cronbach's alpha was calculated to observe the internal consistency of the variables in the questionnaire, and to gauge the reliability of the data. Cronbach's alpha measures internal consistency by observing how directly-associated a dataset is as a group, where a Cronbach's alpha above 0.7 is considered to be acceptable in most social research situations. The alpha coefficients for all dichotomous and ordinal variables from the questionnaire were calculated. The alpha coefficient for the age category, years' experience in a hospital, and years' experience in an emergency department (ordinal variables), was 0.896. This suggested that these three variables — when considered together — had a high internal consistency; or that 89.6% of the variability in a composite score, when combining these three items, could be deemed as a reliable internally consistent variance.

Variables from question Q7 to Q17 of the questionnaire were also analysed together, namely:

- That radiographic image interpretation takes valuable time (Q7);
- That there is a chance for pathologies to be misdiagnosed (Q8);
- That there is a need for emergency physicians to receive more image interpretation and reporting training (Q9);
- That patients are often asked to return for a radiologist's report (Q11);
- That respondents preferred a radiologist to report after hours (Q12);
- That after-hours radiologist reporting would benefit patient flow (Q13);
- That after-hours radiologist reporting would increase productivity (Q14);
- That respondents preferred a radiographer to report after hours (Q15); and
- That emergency physicians need to undergo additional training to keep up with the challenges in interpreting radiographic images (Q17).

The alpha score of these nine variables was slightly lower, at 0.741; however, this still indicated a moderate-to-high internal consistency, such that 74.1% of the variance in a composite score derived by grouping these variables was an internally consistent, reliable variance.

4.4 Conclusion

This study was conducted at four public hospitals in the Durban Metropole. The aim of this study was to determine the emergency physicians' views on whether there was a need for an after-hours diagnostic radiology reporting service in emergency departments at public hospitals, in the Durban Metropole. In analysing the number of radiographic examinations performed after hours, it was observed that between 2383 and 4961 examinations were performed, per month, from October to December of the study period. CXR and extremities constituted the largest proportion of these, while PXR constituted the smallest proportion of examinations performed at each of the four hospitals; while this proportion did not significantly change from month to month for any one of the four hospitals.

In determining the number of radiographic examinations that went unreported, none of the hospitals reported radiology reporting above 1% of its total examinations, with one hospital reporting 0.1% of its total examinations. There was no statistically significant correlation between the overall profile of examinations performed in any one month, and the examinations reported for each of the six radiology categories, while the profile of examinations performed at all four of the hospitals varied considerably to the profile of examinations that were reported on for that month. ANOVA could not confirm, though,

whether there was consistent radiology reporting of specific radiographic categories over others; although, without statistical reliability, it appeared that radiologists reported SXR examinations, on average, the most (0.898% report rate), and PXR examinations the least (0.00% report rate).

Most of the emergency physicians, who participated in this study, seemed to experience difficulties in interpreting radiographic images. They on the other hand, seemed to feel confident in identifying pathological conditions or fractures on radiographic images. Most of the respondents felt that they require more training in image interpretation. The vast majority of respondents claimed they would prefer a radiologist or radiographer to report on after-hours radiographic images, while there was no statistically significant tendency for the number of examinations produced or reported at the respective hospitals; or age, experience or qualification of the respondents; or the hospital itself to have any direct bearing on whether the respondents preferred a radiologist or radiographer to report on the after-hours radiographic images. The views of the respondents, to this effect, were unanimous.

The analyses did, however, confirm parallel forms of reliability, convergent validity, and internal consistency among the data; as well as some pertinent correlations between the respondents' views, and their demographic and career-related backgrounds.

The next chapter will focus on the interpretation and discussion of the statistical results of this study, using descriptive discussions. Furthermore, the limitations and recommendations for future studies will be highlighted.

CHAPTER FIVE
DISCUSSION

5.1 Introduction

The final chapter of the dissertation focuses on the interpretation and discussion of the results that were presented in the previous chapter. The discussion is structured as follows; a) the number of radiographic examinations performed after hours, b) the number of radiographic examinations that went unreported, c) whether emergency physicians in public hospitals within the Durban Metropole felt confident at interpreting radiographic images, and d) whether they preferred an after-hours reporting service or not. This discussion will lead to the presentation of the major findings and conclusion from the study. The chapter also provides the limitations that were experienced, and recommendations for future research. The chapter begins with a discussion of the examination and reporting tendencies at the four selected hospitals.

5.2 The examination and reporting tendencies of the four main hospitals in this study

This section will describe the number of radiographic examinations performed after hours followed by the number of radiographic examinations that went unreported, thereafter.

5.2.1 The number of radiographic examinations performed after hours

The data collected at the four primary hospitals of this study were surveyed over a three-month period: October, November, and December, 2017. The number of examinations that were captured across six different categories of radiographic examinations were recorded, namely for CXR, AXR, spine, extremities, SXR, and PXR; where rib examinations were calculated together with the chest x-ray examinations. Hospital A performed 2659, 2955 and 3529 examinations in October, November and December, respectively, with the number of examinations performed at Hospital A seeming to rise from month-to-month over the three months studied (mean = 3048; SD = 442). Hospital B performed slightly fewer examinations than Hospital A in October (n = 2376), November (n = 2341) and December (n = 2432), and the change in the number of examinations performed at Hospital B over the three months studied was also far lower than Hospital A (mean = 2383; SD = 46).

Hospital C performed the highest total number of examinations each month (October n = 4687; November n = 4866; December n = 4961); though the monthly variation in the number

of examinations performed was quite small (mean = 4838; SD = 139). The reasons for this could be that this hospital was based in a rural area that was known for violence caused by alcohol abuse, stabbings and shootings. This was also in keeping with Nicol et al. (2014:549), who stated that in South Africa, there is a high rate of trauma, with numerous traumatic incidents occurring daily on the road in the form of accidents, at informal settlements (commonly in rural areas), and in bars. Hence, more patients would have been frequenting this hospital due to trauma; while this hospital was also the only public hospital that catered for people from that geographical area. Adeniji and Mabuza (2018:219) also stated that the after-hours patient workloads in emergency departments of South Africa are high, and with hospital C being a 1200-bed hospital, it stands to reason that there would have been more people visiting that hospital after hours.

More examinations were also performed in December, 2017, for each of the four hospitals. Possible reasons, and based on anecdotal evidence for December being the busiest month, are that December is in the festive period — prompting higher traffic volumes, busier roads, and more people being prone to drinking and driving, which results in more motor vehicle accidents. Furthermore, more people are also prone to having spells of violence caused by alcohol abuse during this time. This confirmed by DaGar et al. (2014:165-171).

5.2.2 The number of radiographic examinations that went unreported

The results of this research study have shown that for the study period, at Hospital A, 3-13 examinations (0.23%) were reported on out of a total of 9143 radiographic examinations performed. For Hospital B, 4-7 examinations (0.22%) were reported on out of a total of 7148 radiographic examinations performed. For Hospital C, 2-6 examinations (0.10%) were reported on out of a total of 14514 radiographic examinations performed and for Hospital D, 9-23 examinations (0.62%) were reported on out of a total of 7635 radiographic examinations performed.

At every one of these hospitals, there were about two-to-three radiologists, while these radiologists did not cover the after-hours reporting of radiographic images. According to Gunn et al. (2015:416) radiologists report on a range of specialised studies such as mammography, interventional radiology, fluoroscopy, and, in some cases, ultrasonography [US]. This, in turn, results in limited time for trauma reporting. The radiographic images acquired after hours, which cannot be sufficiently interpreted by the emergency physician, are brought during office hours for a report by the radiologist. The number of radiologists is already limited, and if they also have to cover afterhours reporting, there would be a decrease in the reporting of specialised studies during office hours (Du Plessis and Pitcher, 2015:308).

The total number of examinations that were reported on each month by radiologists at the four hospitals, was far lower than the number of examinations not reported on, constituting only a fraction of the total number of examinations that had been performed. Hospital C performed by-far the most number of examinations of the four hospitals after hours, but reported on the lowest numbers of examinations. Possible reasons that hospital C reported fewer radiographic examinations could be that the workload was too high, or there may have been a shortage of radiologists in that hospital during the day. Currently, there are 976 radiologists registered with the Health Professions Council of South Africa (Daffue, 2017); while Statistics South Africa (2017) estimated that the mid-year population of South Africa for 2017 was 56.52 million. Furthermore, upon obtaining a physical count, it was found that there were only a total of about 25 radiologists practicing in the eThekwini public hospitals, at the time of this study. The estimated population for Durban was at 3,120,282, which made the ratio of the population to radiologists very high (Gqweta, 2012:22).

On the contrary, at Hospital D, which was described, before, to be performing the second lowest number of radiographic examinations out of the hospitals surveyed, the radiologists in fact appeared to be reporting on the most overall examinations of the four hospitals. That is, on average, 0.62% of the total number of examinations that were being performed at Hospital D was being reported on. However, this still represent a very small rate of reporting (<1%). This however was approximately six times as often as in Hospital C, where only 0.1% of the total number of examinations performed was being reported on by the radiologists, each month. It is possible, though, that there could be a degree of artificial inflation of the proportional reporting at Hospital D, due to the smaller number of examinations that were performed; though additional tests on the number of radiologists in operation at the hospitals would be needed to confirm this which was not done for this research study.

Other possible reasons for hospital D reporting more examinations could have been that the workload was less during the day; and therefore, the radiologists were able to report on more of the examinations performed after hours than hospital C. This hypothesis could be supported by the observation that at hospital D, the least reporting was done in December, when hospitals were the busiest. This would have been exacerbated by a shortage of radiologists, since being the festive season; many radiologists would have been on leave. It is important to note, though, that despite the generally-higher rate of reporting at Hospital D, the radiologists at Hospital D were still only reporting on less than 1% of the total examinations performed after hours — even in their most productive month of examination reporting (October n = 23, or 0.93% of examinations performed). This meant that, essentially, almost all radiographic examinations were left unreported on, and the degree of reporting by radiologists at no single hospital was vastly different compared to the degree of reporting being conducted at the other hospitals. It must be noted that at all four hospitals if patients

are asked to come back during normal working hours for a diagnostic report on the examinations produced it is at the discretion of the emergency physician.

From the above findings, it can be seen that since the majority of examinations went unreported, the task to interpret the radiographic examinations produced would have been left to the emergency physicians, and this would conceivably have resulted in a further increase in the physicians' workload. In addition, if the emergency physicians were unsure of their interpretations, the patients would have been asked to come back for a radiologist's report during office hours. However, as noted in the literature, this places undue stress on the patients, such as financial and emotional stress when they are asked to return; meaning that, in such cases, the patients would not be receiving the absolutely best care possible (Van Wyk & Jenkins, 2014:1-6; Nkombua, 2007:14a-14d; Augustyn, 2011:24).

Next, it was observed that the proportional ratio of the different types of examinations performed at each hospital remained nearly unchanged from month to month, since there was a strong correlation between the number of CXR, AXR, spine, extremities, SXR, and PXR examinations performed in one month, compared to the other months at the same hospital. This was in spite of the observation that the means of the different categories of radiographic examinations reported on, appeared to differ considerably; with radiologists reporting SXR examinations, on average, the most (0.898% report rate), and PXR examinations the least (0.00% report rate) out of the different radiographic categories .

It is important to clarify that SXR examinations could have been reported on more due to the amount of trauma that is seen. From the researchers experience SXRs are typically ordered more frequently in cases of trauma. In addition, according to Rull (2019), untrained emergency physicians miss approximately 10% of bony abnormalities on SXRs, which potentially holds more-serious consequences for patients if misdiagnosed. Nonetheless, since the ANOVA result in this study was not statistically significant, it meant that there was too much variability among the data points to confer statistically-reliable consistency for this finding. That is, it indicated that this observation of more SXR reporting and less PXR reporting should instead be interpreted with caution, as it possibly could have occurred due to chance, rather than being a statistically significant anomaly.

5.3 Discussion of the results of the emergency physicians' questionnaire

This section presents a discussion of the results of the questionnaire that was presented to the emergency physicians at the four main hospitals in this study. It begins with the observations pertaining to the demographic profiles of the respondents, next.

5.3.1 The demographic profiles of the respondents

This study analysed the age, gender, experience levels, and education levels of the emergency physicians' sample group. The majority of the respondents fell within the age group of 38-39 years old. The high response rate to the study, from this age group, could be because more physicians within these age groups were employed at government hospitals in KZN, than the other age groups. The ages of the respondents in this study ranged from 25 to over 50 years of age. This is important to note, as it meant that this study provided a wide range of responses from both the newly-qualified and more senior emergency physicians in the profession. The time spent by the physicians working in the emergency department varied from less than five years to more than thirty years.

5.3.2 The confidence of the emergency physicians with interpreting radiographic images

It should be clarified that this study did not explore which part of the body the respondents were confident in identifying pathologies and fractures. However, this study did find that although many respondents were confident in identifying pathologies and fractures on the radiographic images, they were of the opinion that there was a higher chance of pathologies being missed. This can result in mis-management of the patients, and therefore, a poor prognosis for the patient. According to Fabre et al. (2018:361), chest image interpretation is very complicated, even when undertaken by experts; and radiologists even require continuous courses and training in chest reporting, to be able to do so accurately. In a study by Petinaux et al. (2011:18), it was found that emergency physicians missed the diagnoses of 23 pneumothoraces, two pneumomediastina, and 120 cases of pleural effusions.

According to Gatt et al. (2003:214), emergency physicians omit to identify specific radiographic abnormalities; and hence, the authors highlighted the importance of reporting by trained radiologists. Walsh-Kelly et al. (1995:262) found that the interpretation of extremity images by emergency physicians was a problematic area. Ahrberg et al. (2014:10), Ha et al. (2014:492), Donald and Barnard (2012:173), and McLauchlan et al. (1997:295) also found that fractures of the appendicular skeleton were one of the most commonly missed injuries and inaccuracies in reporting that could impact the patient, clinically. This argument in the literature was likely supported in this study by the finding that most of the respondents acknowledged they had experienced difficulties in the interpretation of radiographic images. Contrary to the general feelings of confidence among the physicians, it was found that 74.4% (n = 29) of the respondents either agreed (51.3%, n = 20) or strongly agreed (23.1%, n = 9) that they had experienced difficulties in interpreting diagnostic images. Thus, while one cannot draw conclusions between the findings of this study and that of Walsh-Kelly and

colleagues (1995:262), or Gatt et al. (2003:214), it would appear that there is a need for further empirical research to assess the confidence of emergency physicians and their ability to correctly identify pathologies on radiographic images.

Chung et al. (2004:718) also stated that the reporting of children's skull x-rays was very challenging since the vascular grooves and open sutures could be mistaken for fractures. In this study, it was noted that skull examinations were reported on proportionally higher than any of the other categories of radiographic examination. It was also found that there was no protocol that stated that SXRs had to be reported on, at the target hospitals. The findings of this study are therefore in alignment with the views expressed by Edwards et al. (2011:311), as the respondents expressed the view that the chances of missing pathologies as part of their daily patient management, existed. In addition, the majority of the respondents did not find themselves comparable to a radiologist, regarding the reporting of images. This may indicate that the emergency physicians have a challenge when interpreting SXRs.

Morrison et al. (2009:556) also highlighted that paediatric abdominal images interpreted by paediatric emergency physicians had a low sensitivity and specificity for intussusception. Further analysis on the missing of pathologies by emergency physicians was, however, not assessed in this study; and this may warrant further studies in this regard, as highlighted at the end of the chapter.

5.3.2.1 Links between the respondents' confidence and the number of examinations performed

The majority of respondents agreed (41.0%) or strongly agreed (20.5%) that patients treated at the emergency departments were often asked to return during non-emergency hours for a report by the radiologist. The respondents also stated that a mean of 41.24% of patients' radiographic images required after-hours reporting. This finding underscored the above result on interpretation difficulties, confirming that emergency physicians may, at times, have experienced difficulties in interpreting some of the radiographic images, which required a second opinion by a radiologist.

When linking the respondents' confidence levels, and the number of examinations performed at their hospitals, the study found that physicians in hospitals that performed a lower mean number of examinations per month (<2999) felt consistently more-confident identifying pathological conditions on radiographic images, while those at hospitals performing a mean of ≥4000 examinations per month were less-confident identifying pathological conditions on radiographic images. This further supported the argument that workload could have played a role in the physicians' confidence levels; while a possible reason for a higher workload could

have been because of a lower proportional number of emergency physicians employed relative to the number of patients at the busier hospitals. This was in-keeping with Hoyler et al. (2014:269), who stated that in South Africa, there is a huge shortage of emergency physicians; which are due to an insufficient number of qualifying physicians, as well as physicians leaving the country. Overcrowding in emergency departments due to high patient numbers after hours also brings about inadequacies. That is, it increases the pressure on hospital resources, which consequently leads to the inadequate allocation of these resources, and a subsequent delay in patient care (Bruni et al., 2016:144). Hence, patient workflow is compromised. This is also in-keeping with Gardiner and Zhai (2016:75), who stated that there are many people frequenting the emergency department, after hours.

There was, however, a contradiction in that physicians in hospitals that performed fewer radiographic examinations were more inclined to request patients to return during office hours for a report by the radiologist, as compared to physicians in busier hospitals. This could also have been because the hospitals performing fewer examinations may have had fewer staff to cater to the needs of the patients after hours. This is supported by Adeniji and Mabuza (2018:219) who stated that there are a reduced number of health workers on duty during after hours. Another theory for this contradiction is that they may, perhaps, have had proportionally more radiologists on duty during the day compared to busier hospitals or that the radiologists perform less specialised investigations at these hospitals.

It is therefore possible that a high workload could have played a role in reducing the emergency physicians' confidence in identifying pathological conditions on radiographic images after hours. In addition, even though it is not quite clear what gave rise to this phenomenon, larger hospital having more consultant emergency physicians on duty after hours providing guidance to the more junior emergency physicians, could prompt a lower need for patients to return for radiologists reports during normal working hours.

5.3.3 The training levels of the emergency physicians with interpreting radiographic images

The discussion turns, now, to the training levels of the emergency physicians with interpreting radiographic images, where the training received by the respondents is discussed first, followed thereafter by the training needed by the physicians.

5.3.3.1 Training received by the emergency physicians

Almost all of the respondents (94.9%) admitted to having never attended a radiographic image interpretation course or seminar. This highlighted the fact that the majority of the

emergency physicians within this sample (besides a short module during their undergraduate training), appeared to have had no formal postgraduate training in image interpretation. When considering the perceived number of hours of training, the findings of this study suggested that emergency physicians had received a mean of 299.24 hours of (additional) training in radiographic image interpretation and reporting over the course of their careers.

The modal number of hours of training in radiographic image interpretation and reporting, though, was zero, since 30.8% (n = 12) admitted receiving no training in radiographic diagnostic image interpretation or reporting at any time during the course of their careers; while 35.9% (n = 14) of respondents declined to list any answers for this question. The remaining 13 participants claimed to have received at least some training, with 12.8% (n = 5) having received between one and six hours, 12.8% (n = 5) having received between seven and 792 hours, and 7.7% (n = 3) having received more than 793 hours. It was therefore difficult to measure the true averages of the training that the respondents had received over the course of their careers. It is worth highlighting that a reason that so many respondents declined to answer this question on training could have been due to the respondents not wanting to place themselves, or their managers, in awkward positions.

Owing to the global and national shortage of radiologists, emergency physicians are largely accountable for the reporting of acute trauma radiographic images in the public healthcare sector. Commitment, training and experience is essential to attain adequate accuracy in the reporting of trauma radiographic images (du Plessis & Pitcher, 2015:2).This study found that emergency physicians that had been working for a longer time in the emergency departments tended to have had shorter durations of training in radiographic image reporting, while those with fewer years' experience in the emergency departments tended to have received more training in radiographic image reporting. There was also a negative correlation between the years of experience working in the emergency department, and the duration of the respondents' training in imaging reporting; although this did not expand to cover total years of experience working in a hospital, but only years of experience working in an emergency department. It was found emergency physicians with more experience in the emergency department tended to have less training in image interpretation.

While this was not a very strong correlation, it was nonetheless a statistically significant one. It is, however, possible that these two variables of years' experience in the emergency department and duration of training in imaging reporting, may have been associated by a third, confounding variable that was not measured, such as recent changes in tuition protocols (or otherwise); though age and total experience did not correlate with the duration of training in image interpretation, thereby refuting the tuition hypothesis. A confounding factor related only to emergency department experience, and not to total experience, though,

could have caused this negative correlation, such as an imaging course held only for emergency physicians in recent years, which had not been done in the past. This is supported by Chowa et al. (2017:15), who stated that emergency physicians mostly gain experience in reporting from seminars and in-house tutorials.

It was observed that statistically-more respondents that had received longer durations of training in radiographic image interpretation and reporting felt that their interpretation skills were comparable to radiologists. That is, respondents that felt comparable to radiologists had received more training in the interpretation of images, compared to the respondents that did not feel as comparable to radiologists. This is in-keeping with du Plessis and Pitcher (2015:2), who stated that adequate training is needed for an acceptable level of accuracy in reporting of trauma radiographic images. This finding suggests that the longer the training programme of the emergency physicians, the higher their confidence was. This may also mean that such emergency physicians therefore benefitted from longer training courses; and arguably, that they felt more confident about their image interpretations. This finding may also imply that such emergency physicians were more likely to feel confident in their diagnoses, which would have improved their patients' management and recall.

Next, this study found that the respondents' inclination to ask patients to return for a report during office hours could be linked to the qualifications of the physicians, as well as their lack of training in radiographic image reporting. The emergency physicians may on occasion misinterpret radiographic images (Hlongwane & Pitcher, 2013:638; Aacharya et al., 2011:1-13; Gqweta, 2012:22). As stated by du Plessis and Pitcher (2015:2) misinterpretation could be due to inadequate training. This could be a reason why the patients were asked to return during office hours. However, this is not an aspect that was unique to this study, and according to the literature, training in certain areas are needed which will be discussed in the following section.

5.3.3.2 Training needed by the emergency physicians

The lack of training that had been received by the emergency physicians was appreciated among the respondents, where there was a general consensus over the need for additional training on the reporting of radiographic images. Consequently, about 92% of respondents (59.0% strongly agreed and 33.3% agreed, respectively) perceived that there was a need for further training in the interpretation of radiographic images. That is, most of the respondents agreed that they needed additional training to keep up with the challenges of interpreting radiographic images. This finding was in keeping Edwards et al. (2011:311), who found that there was a need for improved training by physicians in the interpretation of various forms of

specialised images, particularly chest images, and that timely reporting by the radiologists was essential to ensure the correct patient management.

This finding suggests that there is a need for such training courses in the chosen hospitals in the Durban Metropole as well, either in the form of short informal, or longer and more formal training programmes. Even though the type of training programme that the emergency physicians preferred was not assessed in this study, it is safe to conclude that it is imperative for managers of both the radiology and emergency medicine departments of the four hospitals studied, to explore options for such training programmes. It can be argued that such programmes would boost the levels of confidence among the emergency physicians for the interpretation of radiographic images, which would ultimately benefit both the patients' care and management. The next section describes the respondents' noted preferences for an after-hours reporting service.

5.3.4 The need for an after-hours reporting service by a radiographer or radiologist

According to Rajan and Engelbrecht (2018:95), it is extremely stressful working in the emergency sector and those working in the emergency setting experience a high level of burnout. As noted earlier in the chapter, the majority of the respondents agreed that the after-hours emergency workload was high, where only 38.5% of the respondents felt they were able to cope with the workload. Consequently, most physicians (even those who thought that their interpretation skills were comparable to radiologists) felt that the interpretation of images took up valuable time, and that reporting by a radiographer or radiologist would improve patient flow.

In this study, the respondents agreed and strongly agreed, 35.9% and 43.6% respectively, that having a reporting radiographer reporting on radiographic images during after-hours would benefit the patient flow. Conversely, only 10.3% were either neutral, or disagreed; and no respondents strongly disagreed that there would be productivity benefits. This finding has also been keeping with others who find that by having a reporting radiographer after hours; will ease workflow; while this improvement has also been argued to be cost-effective (Buskov et al., 2013:55; Hardy et al., 2013:23; Piper et al., 2005:27). Echoing this sentiment, 38.5% of the respondents in this study agreed, and 56.4% strongly agreed that having a radiologist reporting after hours would increase productivity, with regards to patient flow and service delivery.

The respondents all generally preferred a radiologist or radiographer trained in reporting to report on their after-hours radiographic images. This was irrespective of the number of examinations performed or reported at the hospitals in this study. This had no direct bearing on whether the respondents preferred a radiologist or radiographer, to report on the after-

hours radiographic images. The central view expressed by emergency physicians were that they preferred a report to be produced. This has also further strengthened the argument that an after-hours reporting service, based on the views of the respondents, would be justified.

5.4 Major findings from the study

According to du Plessis and Pitcher (2015:2), the emergency physicians are the ones that provide an initial interpretation of the radiographic images they request; and therefore, the accuracy of the interpretation of the images has a significant impact on patient management. From this study, it could be seen that by far the most examinations went unreported after hours; and the majority of the respondents agreed that they needed additional training to keep up with the challenges of interpreting images. The majority of respondents also did not find themselves comparable to a radiologist when it came to the reporting of images.

The majority of respondents within this study acknowledged that there was a chance of misdiagnosis when interpreting radiographic images; and this in turn, would have had a negative impact on the patients' management. The respondents consequently stated that they would prefer the interpretation of images to be done by a radiologist or by a trained reporting radiographer after hours. Stated simply, the respondents felt that they had a high workload, and that they needed support in order to improve the interpretation, both by an improvement of their skills through training in the interpretation and reporting of radiographic images, and by having the reporting of images done by a radiologist or reporting radiographer after hours.

The finding of a high workload, after-hours, has been supported in the literature (Adeniji & Mabuza, 2018:219), where South African emergency centres are confirmed to be burdened with patients, daily, and there is a pressure on the services provided by these centres. Trauma is the leading cause of death in South Africa, where 28 per 10,000 people die as a result of road accidents (Dulandas & Brysiewicz, 2018:84). Therefore, it is important for the radiology and emergency departments of hospitals to work together to provide the best diagnostic care for patients (Solheim et al., 2018:69). In view of the high workload of emergency physicians, and the claims of the respondents in this study, it is therefore prudent that an after-hours reporting service be considered for the hospitals that form part of this research study.

5.5 Limitations

The following limitations were evident in this research study. This study had a small sample size, which negated the generalisation of the findings to the larger population of emergency

physicians. In addition, this study had a poor response rate — despite the survey being distributed among a large number of emergency physicians within the chosen hospitals of the Durban Metropole. A second limitation was the data collection period used for the number of radiographic examinations performed; where only three months. The data collection period would have been better if it have been extended to a year, in order to allow for a more true presentation of the number of examinations performed and subsequent reporting of examinations. However, due to time and financial constraints, the data collection period could not be extended for this study. A third limitation was that open-ended questions were not asked to determine the views of the emergency physicians.

5.6 Recommendations

Due to the limitations of this study, it is recommended that further, similar, larger studies be performed in future, to include more hospitals (and therefore more emergency physicians), while also covering an extended data collection period. It is also recommended that future studies include the level of confidence of emergency physicians, and the accuracy of their radiographic image interpretation; as well as the patho-anatomical areas in which the emergency physicians are shown to be more- or less- accurate. This would facilitate determining the areas in which skills development is required.

This study did not explore reasons for the low rate of reporting of radiographic examinations by radiologists. It is recommended that future studies explore this observation.

It is recommended that emergency physicians be given support in terms of training in the interpretation of radiographic images. This support could take on the form of the hospitals' management supporting the emergency physicians' professional development; by making courses readily available for further training; by allowing physicians to attend seminars; and by radiologists offering in-house tutorials to the physicians. It is also recommended that an after-hours reporting service be made available to facilitate patient throughput, and to ease the burden placed on emergency physicians.

5.7 Conclusions from the study

The results of this study indicated that there is a need for after-hours radiographic reporting at the chosen research hospitals; and consequently, it is recommended that the heads of department of the emergency and radiology departments should take note of the findings of this dissertation in order to find solutions to improve radiographic reporting after-hours. This implies that a policy change may be needed; where benefits to both patients and physicians would be realised through reduced workload for the emergency physicians, and hence

reducing the risk of misdiagnosis. It is further recommended that universities consider offering training to enable radiographers to conduct formal reporting of radiographic images. This could be implemented via the Radiography and Clinical Technology Board of the HPCSA who must finalise the process and amend the regulations.

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APPENDICES

Appendix A: Questionnaire submitted to the respondents

This questionnaire is aimed at determining the emergency physicians' views on the interpretation of images after hours. The questionnaire consists of two sections.

Section A requires you to complete your demographic data and section B requires you to indicate your level of agreement by placing a tick using a ✓ 5 point descriptive Likert scale (Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree). If you have any queries, please free to contact the principal investigator.

Section A: Demographic information

Age:	
Gender:	
Highest Qualification level:	
Years of experience working in a hospital:	
Years of experience working in the emergency department:	
Name of Hospital working at:	

Section B: Questions

Questions	Please place a tick ✓ in the appropriate box				
1. Do you feel that the after-hours emergency workload is high	(1) Strongly Agree	(2) Agree	(3) Neutral	(4) Disagree	(5) Strongly Disagree
2. Are you able to cope with the workload in the emergency department after hours	(1) Strongly Agree	(2) Agree	(3) Neutral	(4) Disagree	(5) Strongly Disagree

3. Do you feel confident with the interpretation of radiographic images after hours	1 Strongly Agree	2 Agree	3 Neutral	4 Disagree	5 Strongly Disagree
4. I have experienced difficulties in interpreting diagnostic images	1 Strongly Agree	2 Agree	3 Neutral	4 Disagree	5 Strongly Disagree
5. I feel confident identifying pathological conditions on radiographic images	1 Strongly Agree	2 Agree	3 Neutral	4 Disagree	5 Strongly Disagree
6. I feel confident identifying fractures on radiographic images	1 Strongly Agree	2 Agree	3 Neutral	4 Disagree	5 Strongly Disagree
7. The interpretation of images take up valuable patient time	1 Strongly Agree	2 Agree	3 Neutral	4 Disagree	5 Strongly Disagree
8. During the interpretation of images there is a chance of pathologies being misdiagnosed?	1 Strongly Agree	2 Agree	3 Neutral	4 Disagree	5 Strongly Disagree

9. I feel there is a need for additional training for emergency physicians on the reporting of diagnostic images	1 Strongly Agree	2 Agree	3 Neutral	4 Disagree	5 Strongly Disagree
10. I am in a position to teach colleagues on the interpretation of diagnostic images	1 Strongly Agree	2 Agree	3 Neutral	4 Disagree	5 Strongly Disagree
11. Are patients treated at the emergency department often asked to return during non-emergency hours for a report by the radiologist.	1 Strongly Agree	2 Agree	3 Neutral	4 Disagree	5 Strongly Disagree
12. Would you prefer a radiologist to report on radiographic images produced after hours	1 Strongly Agree	2 Agree	3 Neutral	4 Disagree	5 Strongly Disagree
13. I think that by having a radiographer reporting on images after hours, there would be a benefit in patient flow.	1 Strongly Agree	2 Agree	3 Neutral	4 Disagree	5 Strongly Disagree
14. I think by having a radiologist reporting after hours there would be greater productivity with patient flow and service delivery	1 Strongly Agree	2 Agree	3 Neutral	4 Disagree	5 Strongly Disagree

15. I would be content for images to be reported on after-hours by a radiographer trained in imaging reporting	① Strongly Agree	② Agree	③ Neutral	④ Disagree	⑤ Strongly Disagree
16. I feel that emergency physicians are comparable to radiologists in terms of interpretation of images	① Strongly Agree	② Agree	③ Neutral	④ Disagree	⑤ Strongly Disagree
17. I feel that emergency physicians need to undergo additional training to keep up with the challenges in interpreting of images.	① Strongly Agree	② Agree	③ Neutral	④ Disagree	⑤ Strongly Disagree
18. How many patients approximately do you attend to during a quiet after-hours shift	_____				
19. How many patients approximately do you attend to on an after-hours busy shift	_____				
20. What proportion (%) of patients' radiographic images requires after-hours reporting	_____				
21. What was the duration of your training in imaging reporting					

interpretation	
22. Have you have ever attended an image interpretation course	Circle correct answer Yes No Not Sure
23. How long ago did you attend a seminar or course on image interpretation	Circle correct answer <3 months never >3months

Pleased drop off completed questionnaires in the sealed box placed in the HOD of the Emergency department's office.

Thank you for your participation.

Appendix B: Approval letter from the Chief Executive Officer at Pilot Hospital

health
Department:
Health
PROVINCE OF KWAZULU-NATAL

DIRECTORATE:

Reference : Research Protocol
Enquiries
Telephone

E Mail:

Date: 3rd JULY 2018

Ms. S. Chetty

Dear Ms. Chetty

RE: THE DETERMINATION OF THE NEED FOR AFTER-HOURS DIAGNOSTIC RADIOLOGICAL REPORTING IN EMERGENCY DEPARTMENTS.

I have pleasure informing you that permission has been granted to you to conduct the above study.

Kindly take note of the following information before you continue:-

1. Please adhere to all the policies, procedures, protocols and guidelines of the Department of Health with regards to this research.
2. This research will only commence once this office has received confirmation from the Provincial Health Research Committee in the Kwazulu Natal Department of Health.
3. Kindly ensure that this office is informed before you commence your research.
4. The hospital will not provide any resources for this research.
5. You will be expected to provide feedback once your research is complete to the Chief Executive Officer.

Yours faithfully

MEDICAL MANAGER

Appendix C: Approval letter from the Chief Executive Officer at Hospital A

health
Department:
Health
PROVINCE OF KWAZULU-NATAL

DIRECTORATE:

[redacted]

ENQUIRI [redacted]

11 JUNE 2018

Ms S. Chetty
Cape Peninsula
University of Technology

Dear Madam

RE: PERMISSION TO CONDUCT RESEARCH: THE DETERMINATION OF THE NEED FOR AFTER-HOURS DIAGNOSTIC RADIOLOGICAL REPORTING IN EMERGENCY DEPARTMENTS

Permission is granted to conduct the study at this institution.

Please note the following:

1. Please ensure that you adhere to all the policies, procedures protocols and guidelines of the Institution with regards to this research.
2. Please ensure this office is informed before you commence your research and your University's Ethics approval must be attached.
3. You will be expected to provide feedback on your findings to this institution.
4. You will be liaising with : [redacted] er

Yours faithfully

[redacted]

CHIEF EXECUTIVE OFFICER

[redacted]

Appendix D: Approval letter from the Chief Executive Officer at Hospital B

health
Department:
Health
PROVINCE OF KWAZULU-NATAL

[redacted]

Reference: *9/2/3/R*

Date: 23rd July 2018

Principal Investigator:
- **Ms S Chetty**

PERMISSION TO CONDUCT RESEARCH AT [redacted]: "THE DETERMINATION OF THE NEED FOR AFTER HOURS DIAGNOSTIC RADIOLOGICAL REPORTING IN EMERGENCY DEPARTMENTS"

I have pleasure in informing you that permission has been granted to you by [redacted] Hospital Management to conduct the above research.

Please note the following:

1. Please ensure that you adhere to all the policies, procedures, protocols and guidelines of the Department of Health with regards to this research.
2. This research will only commence once this office has received confirmation from the Provincial Health Research Committee in the KZN Department of Health.
3. Please ensure this office is informed before you commence your research.
4. [redacted] will not provide any resources for this research.
5. You will be expected to provide feedback on your findings to [redacted].

[redacted]
HOSPITAL MANAGER
[redacted]

Fighting Disease, Fighting Poverty, Giving Hope

Appendix E: Approval letter from the Chief Executive Officer at Hospital C

health
Department:
Health
PROVINCE OF KWAZULU-NATAL

[redacted]

Enquiry: [redacted]
Ref No: 30/RESH/2018
Date: 25/06/2018

TO: Ms Seshree Chetty

RE: LETTER OF SUPPORT TO CONDUCT RESEARCH AT [redacted]

Dear researcher;

I have pleasure to inform you that [redacted] has considered your application to conduct research on **"The determination of the need for after-hours diagnostic radiological reporting in emergency departments"** in our institution.

Please note the following:

1. Please ensure that you adhere to all the policies, procedures, protocols and guidelines of the Department of Health with regards to this research.
2. This research will only commence once this office has received confirmation from the Provincial Health Research Committee in the KZN Department of Health.
3. Please ensure this office is informed before you commence your research.
4. The institution will not provide any resources for this research.
5. You will be expected to provide feedback on you finding to the institution.

Should the following requirements be fulfilled, a Permission/ Approval letter will follow.

- Full research protocol, including questionnaires and consent forms if applicable.
- Ethical approval from a recognized Ethic committee in South Africa

Thank you.

[redacted]
Senior Medical Manager & specialist in Family Medicine
MBBS, DO(SA), PGDip in HIV (Natal), M.Med.Fam.Med (natal), PhD

[redacted]

Fighting Disease, Fighting Poverty, Giving Hope

Appendix F: Approval letter from the Chief Executive Officer at Hospital D

health
Department:
Health
PROVINCE OF KWAZULU-NATAL

[redacted]

Research Programming

12 June 2018

Ms. S. Chetty
Cape Peninsula University of Technology
P.O. BOX 1906
Bellville

Dear Ms. Chetty

Protocol: "The determination of the need for after-hours diagnostic radiological reporting in emergency departments"

Permission to conduct research at [redacted] Hospital is provisionally granted, pending approval by the Provincial Health Research Committee, KZN Department of Health.

Kindly note the following:-

- The research will only commence once confirmation from the Provincial Health Research Committee in the KZN Department of Health has been received.
- Signing of an indemnity form at Room 8, CEO Complex before commencement with your study.
- [redacted] Hospital received full acknowledgment in the study on all Publications and reports and also kindly present a copy of the publication or report on completion.

The Management of [redacted] Hospital reserves the right to terminate the permission for the study should circumstances so dictate.

Yours faithfully

SUPPORTED/~~NOT SUPPORTED~~

12/06/2018
DATE

[redacted]

Cape Peninsula University of Technology

Appendix G: Respondent information sheet

Title: "The determination of the need for after-hours diagnostic radiological reporting in emergency departments."

Letter of information and consent

Brief introduction and purpose of the study:

The purpose of this research is to investigate your views on the reporting of radiographic images, after hours. This study will determine whether you feel confident and content to adequately report on images, or if an after-hours diagnostic reporting service in your opinion, should be introduced by the radiology department or not.

Outline of the procedure:

I am a fully registered Master of Science Degree student in Radiography at the Cape Peninsula University of Technology. As a course requirement, I am expected to conduct a study as per the above title. I need your assistance in completing the attached questionnaire. You will be given a questionnaire to complete. Participation will be voluntarily. You will not be obliged to participate. You can withdraw from the study at any time. You will not be offered any gifts or favours for completing the questionnaire. The questionnaire can be filled at your own time. There will be a sealed box in which you can place the completed questionnaire at whatever time you so wish. Once the questionnaire is completed, you need to place it in the closed box which can be found in the emergency physicians' manager's room. I humbly request that the questionnaires be completed within one week.

This questionnaire will consist of two sections: Section A will cover demographic information, and Section B will focus on aspects pertaining to this study. The data obtained will be treated as highly confidential. You do not need to add your name to the questionnaire. For this reason, completion of the questionnaire will be anonymous. Your name and that of your hospital site will therefore not be revealed during the data analysis or reporting of the results. Codes will be assigned to each respondent and research site during the data collection phase, in order to maintain anonymity and confidentiality.

Privacy will be maintained by not recording or revealing your identity. Your demographic detail, including the names of the hospitals will also be coded and be kept confidential. Only I, the researcher, will have access to that information as it could lead to identifying the respondents or research sites.

Risks or discomforts to the subject:

There should be no risks to you. The duration for completion of the questionnaire is approximately 15 minutes. You will be requested to provide consent to complete the questionnaire. This process will maintain confidentiality. Access to the completed questionnaires will be controlled and will be kept in a secured lockable cupboard at home. Only the researcher and supervisors will have access to the locked-up data.

Benefits:

This study may add to the body of knowledge with regards to the need for an after-hours reporting service at the four hospitals identified. The study will also inform whether emergency physicians feel they have the confidence and willingness to interpret radiographic images or not within the research sites selected. This may inform whether there is a need for an after-hours reporting service or not. The outcome of this study will thus inform whether such a service will be required or not.

The HODs' of each emergency department and radiography department, as well as the CEOs' of each hospital will be informed of the outcome of the research in their hospital once the data have been analysed. As a respondent, you will then have access to the results.

Should you have any questions related to the content of this letter or the research project, please feel free to contact me or my supervisors at the numbers below.

Seshree Chetty (Principal investigator)

Cell: 083 483 7472

Email: sesh246@gmail.com

Supervisor: Mr A Speelman

Cell: 0822007117

Email: speelmana@cput.ac.za

Chairperson of Research Ethics Committee: Dr N. Naidoo

Contact number: 021 959 8408/6534

Co-supervisor: Mrs D Venter

Cell: 0720262237

Email: venterd@cput.ac.za

Statement of agreement to participate in the study:

I,…….…….…… full name, have read this document in its entirety and understand its contents. Where I have had any questions or queries, these have been adequately explained to me by **Miss S Chetty**. Furthermore, I fully understand that I may withdraw from this study at any stage without any adverse consequences.

My signature below serves as proof that I have consented to partake in this study.

Subject's name (print) ……...

Subject's Signature:……

Date:……

Appendix H: Ethics clearance letter from CPUT

Cape Peninsula
University of Technology

HEALTH AND WELLNESS SCIENCES RESEARCH ETHICS COMMITTEE (HW-REC)
Registration Number NHREC: REC- 230408-014

P.O. Box 1906 • Bellville 7535 South Africa
Symphony Road Bellville 7535
Tel: +27 21 959 6917
Email: sethn@cput.ac.za

6 May 2019
REC Approval Reference No:
CPUT/HW-REC 2018/H9

Dear Ms Seshree Chetty

Re: APPLICATION TO THE HW-REC FOR ETHICS CLEARANCE

Approval was granted by the Health and Wellness Sciences-REC to Ms Chetty for ethical clearance on 29 March 2018. This approval is for research activities related to student research in the Department of Medical Imagining and Therapeutic Sciences at this Institution.

TITLE: **The determination of the need for after-hours diagnostic radiological reporting in emergency departments.**

Supervisor: Mr A Speelman and Mrs D Venter

Comment:

Approval will not extend beyond 7 May 2020. An extension should be applied for 6 weeks before this expiry date should data collection and use/analysis of data, information and/or samples for this study continue beyond this date.

The investigator(s) should understand the ethical conditions under which they are authorized to carry out this study and they should be compliant to these conditions. It is required that the investigator(s) complete an **annual progress report** that should be submitted to the HWS-REC in December of that particular year, for the HWS-REC to be kept informed of the progress and of any problems you may have encountered.

Kind Regards

Dr. Navindhra Naidoo
Chairperson – Research Ethics Committee
Faculty of Health and Wellness Sciences

Appendix I: Ethics approval letter from the Department of Health (DOH)

health
Department:
Health
PROVINCE OF KWAZULU-NATAL

Physical Address: 330 Langalibalele Street Pietermaritzburg
Postal Address: Private Bag X9051
Tel: 033 395 2805/ 3189/ 3123 Fax: 033 394 3782
Email:
www.kznhealth.gov.za

DIRECTORATE:
Health Research & Knowledge Management

HRKM Ref: 233/18
NHRD Ref: KZ_201806_014

Date: 4 July 2018
Dear Ms S. Chetty
CPUT

Approval of research

1. The research proposal titled **'The determination of the need for after-hours diagnostic radiological reporting in emergency departments'** was reviewed by the KwaZulu-Natal Department of Health.

   The proposal is hereby **approved** for research to be undertaken at [redacted]

2. You are requested to take note of the following:
   a. Make the necessary arrangement with the identified facility before commencing with your research project.
   b. Provide an interim progress report and final report (electronic and hard copies) when your research is complete.

3. Your final report must be posted to **HEALTH RESEARCH AND KNOWLEDGE MANAGEMENT, 10-102, PRIVATE BAG X9051, PIETERMARITZBURG, 3200** and e-mail an electronic copy to hrkm@kznhealth.gov.za

For any additional information please contact Mr X. Xaba on 033-395 2805.

Yours Sincerely

Dr E Lutge
Chairperson, Health Research Committee
Date: 04/07/18

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Appendix J: Data collection sheet. The number of radiographic examinations acquired after hours versus the examinations not reported on

*

“Done”- refers to the number of examinations completed.

“Report on”- refers to the number of examinations reported on

“Not report on”-refers to the number of examinations not reported on

Date in 2017		Total images			CXR			AXR			Spines			Extremities			SXR			PXR		
	Hosp.	Done	Report on	Not Report on	Done	Report on	Not Report on	Done	Report on	Not Report on	Done	Report on	Not Report on	Done	Report on	Not Report on	Done	Report on	Not Report on	Done	Report on	Not Report on
Oct	A	2659	5	2654	1103	3	1100	216	0	216	160	0	160	755	0	755	289	2	287	136	0	136
	B	2376	4	2372	909	2	907	271	0	271	142	0	142	758	2	756	208	0	208	88	0	88
	C	4687	2	4685	1503	2	1501	160	0	160	200	0	200	2370	0	2370	352	0	352	102	0	102
	D	2485	23	2462	988	3	985	201	2	199	217	0	217	849	10	839	140	8	132	90	0	90
Nov	A	2955	13	2942	1116	5	1111	266	0	266	275	1	274	825	1	824	319	6	313	154	0	154
	B	2341	5	2336	888	2	886	265	0	265	128	0	128	750	2	748	218	1	217	92	0	92
	C	4866	6	4860	1509	3	1506	183	1	182	218	0	218	2470	0	2470	379	2	377	107	0	107
	D	1956	15	1941	1104	3	1101	150	0	150	213	2	211	245	8	237	173	2	171	71	0	71
Dec	A	3529	3	3526	1162	3	1159	326	0	326	300	0	300	1177	0	1177	449	0	449	115	0	115
	B	2432	7	2425	868	3	865	279	0	279	155	2	153	786	2	784	249	0	249	95	0	95
	C	4961	6	4955	1501	4	1497	159	0	159	208	0	208	2413	0	2413	582	2	580	98	0	98
	D	3194	9	3185	988	4	984	120	3	117	83	2	81	1540	0	1540	400	0	400	63	0	63

Appendix K: Data collection sheet for questionnaire data

Age	Gend.	Qual.	Exp in hospital	Exp in emg dept	Hosp.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23
43	F	MBCHB	18	18	A	1	2	2	3	2	1	3	1	2	3	2	2	1	1	1	2	2	40-50	70-80	60-70%	tuts	no	never
27	F	MBCHB	4	4	A	1	3	4	1	3	3	2	1	1	3	1	1	3	1	3	3	1	30	45	50%	TUTS	no	never
32	F	MBCHB	7	4	A	5	5	5	1	4	2	2	1	1	4	1	1	1	1	1	4	2	30	60-80	50%	tuts	no	never
66	M	MBCHB	20	15	A	1	4	2	4	2	2	4	2	1	2	5	1	1	1	1	5	1	70	120	50%	nil	no	never
36	M	MBCHB	5	2	A	1	3	3	2	2	2	2	1	1	2	2	2	2	2	2	3	2	60	100	50%	uni	no	never
60	M	MBCHB/ I	37	30	A	1	2	1	4	1	1	1	1	4	1	1	1	1	1	1	4	2	130	200	80%	nil	no	never
27	F	MBCHB	4	1	A	1	4	4	2	3	2	1	2	1	3	1	2	2	2	2	4	2	60	120	20%	1day	no	never
44	F	MBCHB/M	20	20	A	1	3	4	1	2	3	2	1	1	4	1	1	1	1	1	3	2	40	70	50%	uni	no	never
39	F	MBCHB	5	2	A	1	2	3	3	2	1	3	2	3	2	2	3	2	2	2	3	3	50	120	50%	160hrs	no	never
42	M	MBCHB	15	6	A	2	3	1	2	4	2	1	1	1	4	2	2	2	2	2	4	2	30-40	60	30%	nil	no	never
44	M	SPECIALIS	20	20	A	1	3	4	1	5	1	1	1	1	5	1	1	1	1	1	5	3	100	100	70%	nil	no	never
29	M	MBCHB	6	4	B	2	2	2	1	2	1	3	1	1	2	2	1	3	1	1	5	1	10	25	10%	1 week	no	never
44	M	MBCHB	13	13	B	2	4	1	5	1	1	4	2	2	2	4	2	2	2	3	2	2	20	40	10%	18Years	no	never
36	M	MBCHB	4	2	B	1	4	3	2	4	2	1	1	1	4	2	1	2	1	1	4	1	15	40	40%	uni	no	never
32	M	MBCHB,B	3	1	B	1	4	2	4	1	1	4	2	2	2	4	4	1	1	1	4	2	15-20	40	20-35%	2 months	yes	>3months
43	F	MBCHB	18	15	B	1	3	3	2	2	2	2	1	1	4	2	1	2	2	2	3	1		25	30%	uni	no	never
37	F	MBCHB	5	3	C	2	2	3	2	3	2	1	1	1	4	4	2	1	2	2	5	1	40	80	20%	1 year	no	never
38	M	mbchb	5	2	C	2	1	3	2	2	1	4	2	2	3	1	1	1	1	1	4	1	30	50	40%	1month	no	never
55	M	mbchb	15	12	C	1	4	3	2	3	2	4	2	1	2	1	2	2	1	3	4	2	20	30	40%	nil	no	never
36	F	mbchb	10	9	C	2	3	3	2	2	1	3	1	2	5	4	1	1	1	1	3	3	15-30	40-50	90%	uni	no	never
38	F	mbchb	14	14	C	2	2	3	2	3	2	4	4	1	4	4	2	2	1	2	4	2	20-30	30-60	50%	uni	no	never
58	M	mbbs	28	4	C	1	5	3	1	2	2	3	3	1	2	2	2	2	3	3	2	1	30	60	50%	4yrs	no	never
28	F	mbchb	5	4	C	2	2	2	3	2	2	4	1	1	3	3	2	1	1	1	2	1	20	80-100	50%	4yrs	no	never
31	F	mbchb/b	1.5	1.5	C	2	2	3	1	3	1	4	2	2	3	4	2	4	2	3	4	2	10	20	5-10%	2days	no	never
34	F	mbchb	10	6	C	2	2	2	2	2	2	4	2	2	4	3	2	2	2	2	3	3	20	40	20%	nil	no	never
33	M	mbchb	7	3	C	1	4	4	4	2	2	2	2	1	2	2	1	1	1	1	3	1	20-30	40-60	>70%	3days	no	never
43	M	mbchb	9	7	C	1	3	2	3	2	1	4	3	2	2	3	2	4	2	3	4	1	50	100	70%	nil	yes	>3months
51	M	fcs(sa)	20	10	C	2	2	1	2	3	2	1	1	1	3	5	1	1	1	1	5	1	15-20	>40	1-5%	nil	no	never
39	M	mbchb	13	4	C	1	4	2	2	2	2	3	2	1	3	3	4	4	4	3	5	1	20	40-50	10%	nil	no	never
38	M	mbchb	14	10	D	1	3	3	1	1	1	3	2	2	2	3	3	3	2	2	3	2	30	60	10%	nil	no	never
36	F	mbchb	12	8	D	2	3	3	2	2	2	2	2	3	2	2	2	2	2	4	2	2	30	40	60%	uni	no	never
28	M	mbchb	4	2	D	2	2	3	2	2	2	2	2	2	3	2	2	2	2	2	4	2	40	50	50%	uni	no	never
42	M	mbchb	15	10	D	2	2	2	2	2	2	2	1	1	3	2	1	2	2	2	4	1	30	50	50%	uni	no	never
46	F	mbchb	20	8	D	2	4	4	2	2	2	2	1	1	4	2	1	1	1	2	3	1	35	50	50%	1year	no	never
32	M	mbchb	8	4	D	1	2	4	2	2	4	2	1	1	3	2	1	1	1	2	4	1	35	50	60%	uni	no	never
38	F	mbchb	9	6	D	2	2	4	2	2	2	1	1	1	2	2	1	1	1	1	5	1	40	60	50%	uni	no	never
42	F	mbchb	13	4	D	1	3	2	2	2	2	4	2	2	3	3	1	1	1	2	3	2	40-50	50-80	80%	nil	no	never
30	M	mbchb	7	4	D	1	3	3	1	1	1	3	2	2	2	3	3	3	2	2	3	2	30	50	<5%	nil	no	never
42	M	mbchb	14	5	D	2	2	3	4	4	5	3	2	2	2	2	2	4	1	2	4	2	50	100	5%	5days	no	never

Appendix L: Statistician letter of support

Royaa Creative Solutions
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Date: 30th Jan, 2019

R.E: Confirmation of Data Analysis Assistance for Ms Seshree Chetty

To whom it may concern,

This is to certify that Ms Seshree Chetty received assistance from Royaa Creative Solutions, for the analysis of the data for her Master's thesis entitled: "THE DETERMINATION OF THE NEED FOR AFTER-HOURS DIAGNOSTIC RADIOLOGICAL REPORTING IN EMERGENCY DEPARTMENTS".

Yours sincerely,

Mr Jeremy. R. Sayer
Data Analysis Project Manager for Ms Seshree Chetty