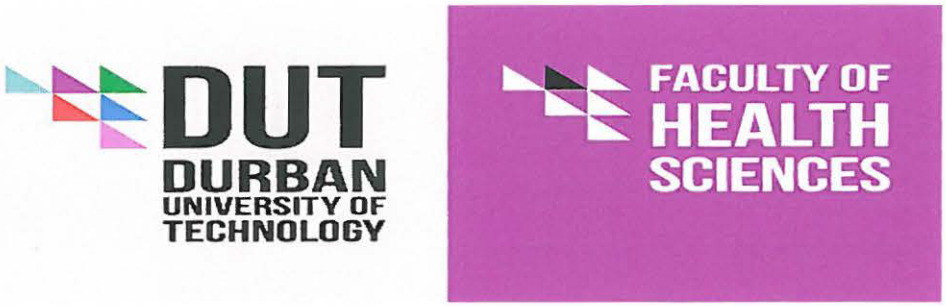

DEPARTMENT OF RADIOGRAPHY

Knowledge, Skills and Perceptions of Diagnostic Radiographers In Image Interpretation of Chest Diseases in eThekwini Public Hospitals.

NTOKOZO GQWETA

APRIL 2014

Knowledge, Skills and Perceptions of Diagnostic Radiographers In Image Interpretation of Chest Diseases in eThekwini.

BY

NTOKOZO GQWETA

A DISSERTATION submitted in fulfilment of the requirements of the Master's Degree in Technology.

To the:

Department of Radiography: Faculty of Health Sciences

Durban University of Technology

2013

DECLARATION:

Except for the quotations specifically indicated in the text and such help as I have acknowledged, this dissertation is wholly my own work, and has not been submitted for any qualification at any other institution.

Ntokozo Gqweta **Date**

I, the undersigned supervisor approve of the submission of this dissertation

---

Mrs. S. Naidoo. Degree of Master of Applied Sciences (MRT) **Date**

I, the undersigned co-supervisor approve of the submission of this dissertation

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Dr. F. Peer. Doctorate in Technology: Radiography (DUT) **Date**

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ABSTRACT

Escalating current healthcare needs coupled with the dire shortage of radiologists created a climate in countries abroad to extend the role of the radiographer (Williams 2006). The South African radiography profession demonstrates similar if not worse challenges within the radiology services (Gqweta 2012). The human resource needs in the healthcare sector creates a gap in the provision of radiology services (Brandt *et al* 2007). Often under these circumstances radiographers are asked by emergency department's personnel to comment on radiographic appearances (Hardy and Snaith 2007). Radiographers do provide opinions in order to facilitate patient management (Gqweta 2012). Since the chest x-ray is the most commonly performed x-ray examination in x-ray departments (Manning, Leach and Bunting, 2000), it is assumed that most requests for an opinion may be directed for the clarification of this x-ray examination. Therefore radiographers need to have an in-depth understanding of the knowledge and skills related to the identification of patterns on chest images. The aim of the study was to establish and describe the current chest image interpretation skills, knowledge and perceptions of diagnostic radiographers in eThekwini Health District of KwaZulu-Natal (KZN) with regard to image interpretation.

METHOD:

A quantitative study using a descriptive design with a qualitative aspect using an interpretive design was employed. A simple random sample of hospitals within the eThekwini health district that have x-ray departments was drawn. All diagnostic radiographers that met the inclusion criteria from within these hospitals were invited to partake in the study and all were registered with the Health Profession Council of South Africa (HPCSA). A questionnaire was utilised to collect data on the perceptions and knowledge of diagnostic radiographers on radiographic appearances. A reporting template was provided for the respondents to report on ten (10) chest images and to standardise responses. Accuracy, specificity and sensitivity measurements were utilised to determine the image interpretation knowledge and skills of radiographers without formal training on image interpretation. The SPSS (Statistical Package for the Social Sciences) version 21 was utilised for the raw data capture and analysis.

RESULTS

Forty two (42) radiographers participated in the study. Almost half (46%) of the respondents were chief radiographers and twenty four point four percent (24.4%) of the respondents were senior radiographers. X-ray department managers and community service radiographers each had twelve (12%) percent representation. The majority of the respondents frequently performed chest x-rays. Furthermore they regularly observe Pulmonary Tuberculosis (PTB) abnormal patterns more than those of pneumonia and lung cancer on chest radiographs. The respondents indicated that there is a need for them to extend their roles to include

image interpretation. This will ensure that radiographers are responsive to current health care needs perpetuated by the absence of radiologists and the ever rapidly increasing population. The majority of the respondents were able to identify abnormal appearances on the radiographs (high sensitivity). However there was a proportional decrease on the identification and recognition of the normal appearances (specificity). There was no respondent that obtained a mark of eighty (80%) on the image interpretation knowledge assessment section.

CONCLUSION

Radiographers are able to identify abnormal patterns on chest images. However they are unable to adequately exclude an abnormality (low specificity). Furthermore they lack the ability to adequately describe abnormal radiographic/radiological appearances. The image interpretation knowledge base of radiographers is limited and specific. Therefore there is a need for an intensive education and training for prospective reporting radiographers.

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ABREVIATIONS

KZN-	KwaZulu-Natal
HPCSA-	Health Professions Council of South Africa
SPSS-	Statistical Package for the Social Sciences
PTB-	Pulmonary Tuberculosis
CA-	Cancer
CT-	Computed Tomography
MRI-	Magnetic Resonance Imaging
UK-	United Kingdom
EU-	Excretory-Urogram
SAQA-	South African Qualification Authority
DUT-	Durban University of Technology
FP-	False Positive
TP-	True Positive
FN-	False Negative
TN-	True Negative
PA-	Posterior Anterior
BTECH-	Baccalereus Technology
XDR-	Extreme Drug Resistant
DoH-	Department of Health.
COAD-	Chronic Obstructive Airways Disease

DEFINITITON OF TERMS

Image interpretation: Image interpretation is a process of extracting qualitative and quantitative data on the image about the shape, location, structure, function, quality, relationship of and between objects using human knowledge and experience (Malila 1974).

Medical image interpretation-	The formulation of an opinion based on image characteristics to assist in the diagnosis and management of a particular clinical problem (Freeman 2006).
Role extension-	Post qualification acquisition of skills, responsibilities and resultant associated additional professional accountability (Hardy 2002).
Radiography role extension-	A fundamental change to the current professional practice of radiographers (Williams, 2006).

CHAPTER 1

BACKGROUND TO THE STUDY

1.1. Introduction

The South African healthcare system is plagued by human resource shortages especially those that are in the specialist fields including radiology (Brandt, et al, 2007). Overwhelmingly enough this situation is exacerbated by a high patient to doctor/radiologist ratio in Africa and in particular South Africa (Kawooya 2007). There are approximately 863 radiologists registered with the Health Profession Council of South Africa (HPCSA) (Daffue, IT specialists at HPCSA on 15 February 2013) and the population of South Africa is estimated to be a little over 50 million (Lehohla, 2012). Therefore the resultant radiologist to patient ratio is one radiologist to 57, 937 thousands patients.

In the KwaZulu-Natal (KZN) province, there are approximately 111 HPCSA registered radiologists (An email correspondence from Ms Daffue, HPCSA IT specialist received 15 February 2013). The population in this province is estimated to be just over 10 million people (Lehohla 2012). Consequently the radiologist to patient ratio in this province is 1 radiologist to 90,090 thousand patients. Ratios in the public and private health sector may differ with the public sector demonstrating a much bleaker situation (Mochifefe 2005). The migration of these specialists from non-specialist work such as reporting of plain films into more specialised modalities such as Computed Tomography (CT), Magnetic Resonance Imaging (MRI) and angiographic studies only exacerbate the situation (Freeman 2006). As a result the clinical radiology departments are experiencing major service delivery constraints (Williams 2006). The effects of these constraints include increased workload for radiologists, longer working hours and longer waiting times for patients (Prime, Patterson and Henderson 1999; Williams 2009).

Accordingly the constraints and the high demand for healthcare services in South Africa, necessitates that the healthcare system be adaptive and fluid (Gqweta 2012). South African radiology service practitioners need to have roles which are flexible and responsive to current healthcare needs. A model similar to that utilised by the United Kingdom (UK) is necessary for South Africa if the radiography profession is to effectively respond to the existing healthcare needs (Williams 2006). The UK initiated a model called Role Extension in which radiographers adopted duties that were previously only within the authority of the radiologist (Hardy and Snaith 2009). Role

extension was initiated in an effort to respond to healthcare demands for radiology services. The process was research driven leading to policy changes and the extension of the scope of the UK radiographer. Some of the roles that were eventually within the radiographers' scope were report writing, performance of Barium enemas, and injection of contrast media during excretory-urograms (EU's) (Williams 2006).

Reporting of plain films could be the initial domain to be adopted and adapted to suit the level of expertise of South African (SA) radiographers. Additionally extending the role of the South African radiographer may result in service delivery effects similar to those experienced by the UK healthcare community (Gqweta 2012). These effects may include but are not limited to reduced patient waiting times, prompt production of reports and utilisation of radiographer's expertise (Freeman 2006). Therefore a similar model can benefit the SA healthcare sector. However such changes or extensions in any profession need to be evidence based through thorough research, planning and implementation (Field and Snaith 2013). The introduction of radiography role extension can possibly relieve some of the work related pressures experienced by the radiologists in SA and elsewhere in Africa (Kawooya 2007) and assist with the prompt service delivery as has been noted in the UK (Field and Snaith 2013). This study was then designed to determine the perceptions of radiographers, evaluate their knowledge and skills based expertise relating to radiography role extension with special reference to the identification of common chest pathologies.

The underlying theme was to identify and report on the current issues in radiography that may predominantly advocate for role extension. The overarching theme was to study the skills and knowledge of SA radiographers in the interpretation of chest images. Furthermore the focus was on actions and changes that may bring about change in the radiography profession which may benefit the patients' wellbeing and boost the healthcare of the SA population. Thus it was important to design a study that included the reporting of chest x-rays as they are the most frequently performed examinations in x-ray departments (Manning, Leach and Bunting 2000; Gqweta 2012). Furthermore radiographers are often asked to provide opinions on the radiographic appearances of chest images by emergency department personnel (Hardy and Snaith 2009).

It is anticipated that this research study will form the basis for radiography role extension in SA and thus positively impact on future radiology service delivery. Additionally the results of the present study may be used to inform the planning and

implementation of further training, if necessary, for radiographers to perform within extended roles. The study also hopes to inform the radiographers' scope of practice which will need to be officially changed to include any role changes, especially reporting.

1.2. MOTIVATION AND SINIFICANCE

The shortage of radiologists especially within the public healthcare sector has negative consequences for patients requiring immediate comprehensive care (Brandt *et al* 2007). The current study aims to yield vital information on the current status of radiographers within the radiology services in SA. Consequently it is anticipated that these results will inform a move towards positive changes and outcomes for the radiography profession and radiological services. The development of the role of the UK radiographer to include image interpretation has demonstrated positive outcomes for both the patients and the practitioners (radiologists and radiographers) (Williams 2006).

It therefore stands to reason to investigate the knowledge and skills based expertise of eThekwini Health District of KwaZulu Natal (KZN) diagnostic radiographers in identifying disease pattern changes on chest radiographs. This will ensure validation or disconfirmation of current opinions volunteered by radiographers and may be used as a basis for training and education purposes.

1.3. AIMS AND OBJECTIVES OF THE STUDY

Aim :

The purpose of this study is to explore the knowledge, skills and perceptions of diagnostic radiographers on image interpretation of chest diseases.

Objectives:

- To determine the knowledge of radiographers in identifying disease patterns on chest radiographs.
- To examine the skills of radiographers in identifying disease pattern changes on chest radiographs.
- To establish the perceptions of radiographers towards reporting of chest images.

1.4. DELIMITATIONS

Although there are numerous diseases that affect the chest, this study will focus on the manifestation of only three chest diseases; pulmonary tuberculosis, lung cancer and pneumonia. Literature has illustrated that these are the diseases that prevalent in South Africa (Oostewyk 2005; Bortz 1994). Only diagnostic radiographers registered with the HPCSA and working within the public health sector will be included.

1.5. ASSUMPTIONS

It is assumed that the information provided by the respondents during the data collection process is a true reflection of what they feel and their true capabilities.

1.6. OUTLINE OF CHAPTERS

Chapter one:
This chapter will be an introduction, providing the reasons for the research along with the overview of what the reader may expect to find in subsequent chapters.

Chapter two:
This chapter will consist of the literature review and will critically evaluate current knowledge pertinent to the study.

Chapter three:
This chapter will present the research methodology including the decisions about the research paradigm, design, methods and strategies utilised.

Chapter four:
This chapter will consist of the presentation of the results of the study.

Chapter five:
This chapter will consist of the discussion of the results.

Chapter six

This chapter discusses the conclusions and recommendations of the study and will highlight the achievements and shortcomings of the study.

References:
This section will include detailed references cited throughout the document.

Appendices:

All the material relating to the study including the permission letter, information letter, questionnaire, reporting template and the recruitment sheet will be included within this section.

CHAPTER TWO

REVIEW OF THE RELATED LITERATURE

2.1. INTRODUCTION

This chapter provides a review of literature related to image interpretation of chest diseases by radiographers. It is therefore important to begin this discussion by exploring the impact of radiologist shortages on the role of radiographers. This information will provide a sense of the current status within the South African radiology services. Furthermore it will provide an indication of areas that require close inspection where role extension can initially be focused. The current study focused on a subset of role extension, that is, image interpretation. Therefore a discussion of literature on image interpretation by radiographers is crucial to provide a foundation to the discussion. Accordingly the literature will include radiography image interpretation developments in countries abroad and possible areas of need and change in South Africa. In countries abroad the need for, and the utilisation of, radiographers as image interpreters has been driven by healthcare needs.

A similar profile is observable in South Africa where the scourge of chest diseases is responsible for a big percentage of deaths in the society (Lehohla 2012). Thus the literature includes the exploration of a few prevalent chest diseases in the Southern African regions (USAID 2010), the focus being SA and KZN. Therefore a discussion of chest diseases is not complete without a discussion on the diagnostic technique, with special reference to the chest radiograph. The chest radiograph is discussed in light of its utility in the diagnosis of many chest related abnormalities in the clinical environment. A discussion of this diagnostic tool is not complete without a thorough description of how to utilise it. Therefore the literature includes the actual process of interpreting a radiographic image, whilst utilising appropriate terminology.

Similarly to the above an exploration of role extension with special reference to image interpretation is not complete without the discussion of the radiographers' and the radiologists' views and opinions. Therefore the literature also includes the opinions of both the radiographers and radiologists on radiographers being tasked with more roles that have clinical decision making powers. The above exploration is made in light of the radiography role extension experiences in countries abroad. In closing, the process of change observed internationally with regard to radiography role extension is reviewed. This process includes the researching, conceptualisation, planning, implementation and evaluation of radiography role extension.

2.2. The effects of the scarcity or unavailability of radiologists on the role of radiographers.

South Africa is constantly disadvantaged by a deficiency of resources, mainly in rural areas. Furthermore the lack of resources is sometimes in the form of adequately qualified personnel (human resources) rather than funds and equipment (Brandt *et al* 2007). In clinical radiography this lack of resources is demonstrated through the shortage of radiologists in rural areas and during after hour duties in district and tertiary hospitals (Smith, *et al* 2008; Brandt *et al* 2007). Statistical records from the HPCSA reveal that there are approximately 863 radiologists registered in 2013. When this record is compared to the South African population of approximately fifty million, it yields a doctor to patient ration of 1 radiologist to 57, 937 patients (Lehohla 2012; email from Daffue, Information Technologist at HPCSA received 15 February 2013). This ratio is in stark contrast to some countries abroad such as Australia which have 65 radiologists per million patients. This practitioner to population ratio culminates in 1 radiologist per 15, 384 patients per year (Smith & Baird 2007). Within the African countries, particularly South Africa, a higher patient to doctor ratio led to many x-ray facilities operating without the aid of an onsite radiologist. Furthermore in these facilities the radiographer's opinion on radiographic appearances is often required by referring doctors and other allied health workers (Kawooya 2007, Gqweta, 2012). It is therefore important to conduct a study that will assess the knowledge and skills of radiographers in interpreting images in order to assess the validity of their opinions.

In countries abroad, the national shortage of radiologists and the continuing rise in the level of actions undertaken offered a climate that inspired the development of radiographers (Brealy *et al* 2005). The scope of radiographers was extended to include some practices that were predominantly within the scope of radiologists (Williams 2006). Reporting of plain films was the first avenue to be adopted, as it was attracting the least attention after the new modalities of CT, MRI and intervention radiology became top priority for radiologists (MacKay 2006). Radiographers in private and in public practice accepted role extension as a positive framework and process for adequate professional development (Toh, Reed and Robinson 2007). Radiography role extension is an addition of skills and responsibilities that extend beyond the statutory responsibilities and competencies of the current profession (Hardy and Snaith 2009). Thus the present study aimed at ascertaining the current image interpretation (pattern recognition) abilities of South African radiographers for purposes of possible future professional development.

Pattern recognition is defined as being able to recognize normal anatomy and physiological appearances on an image and those variations of appearances, which may indicate pathology (Corr 2001). Internationally image interpretation by radiographers was initially introduced as the first step to meet the increasing clinical demands of deficient radiology services (Paterson *et al* 2004). The role of this practice was to provide a climate for improving service delivery within radiological departments, this approach has been met with success in countries abroad like the UK (Radovanovic and Armfield 2005). A similar developmental approach for a South African radiography profession may be of benefit to the local and national healthcare provision. However it is important to also note that the introduction of image interpretation by radiographers has also been confronted with some impediments (Piper and Paterson 2009; Hughes *et al* 1996). These turbulent occasions may have gave rise to further probing and perhaps solidified the foundation for the success of the radiography profession developmental process. The red dot system is the case in point. The red dot system was introduced as the first step in image interpretation. The red dot system is a process whereby a radiographer applies a red dot on a radiographic image that demonstrates signs of abnormality (Okeji, Udoh and Unwuru 2012; Hardy and Culpan 2005; Hughes *et al* 1996).

2.3. Image interpretation by radiographers

The purpose of the red dot system was to make the referring doctor aware of the possibility of abnormal findings on an x-ray image (Robinson 1998; Hargreaves and Mackay 2003). Experts concurred that applying or withholding a red dot on a radiograph constitutes a clinical decision by the radiographer (Hardy and Culpan 2007; Piper and Paterson 2009). However the red dot system is voluntary and therefore an absence of the dot does not necessarily mean normality. Furthermore the red dot indicates that there is an abnormality, but it does not allow the radiographer to describe it and specify its location. The referring doctor has to play 'hunt the abnormality' (Hardy and Culpan 2007). Consequently the ambiguous nature of this practice has been questioned in different studies. Subsequently the structure of the red dot system has been amended to eliminate the evident shortfalls of the previous structure (Piper and Paterson 2009).

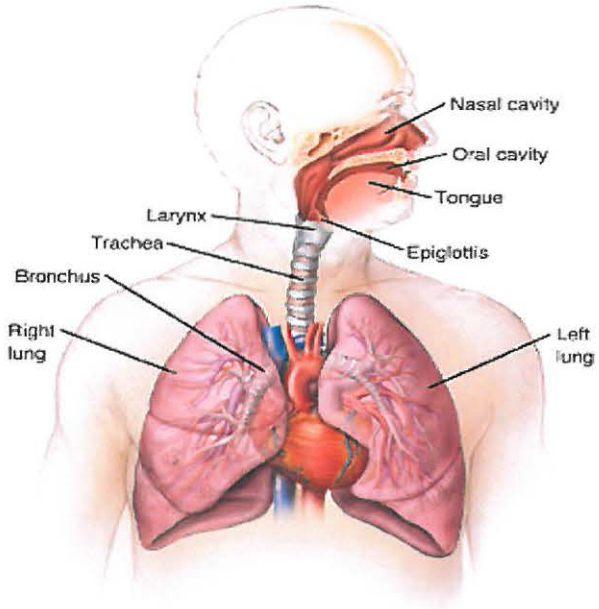
The subsequent amendment resulted in adequate and effective utilisation of the radiographers' skills and knowledge which resulted in radiographers experiencing higher levels of job satisfaction (Radovanovic and Armfield 2005; Smith and Baird, 2007). Furthermore it provided a space for the radiologists to be involved in more

highly specialised procedures (Smith and Baird 2007). These positive outcomes were truly realised after radiographers in the UK were mandated to identify, describe the abnormality and to specify its location (Hardy, Spencer and Snaith 2008). Furthermore patients had access to a wider variety of diagnostic modalities with a reduction in waiting times. However, this practice sets out a clear obligation on the part of the radiographer to undertake the appropriate education and training (Piper and Paterson 2009). According to the author's knowledge, there is no baseline data available on the knowledge and skills of the South African radiographers with regard to image interpretation. Consequently there is no sufficient evidence that promotes the need for South African radiographers to embark on education and training in order to interpret images. Therefore there is a need for the current study to provide this data to set the stage for future professional development of radiographers. This is especially relevant for chest x-ray examinations.

2.4. The basic anatomy and physiology of the lungs.

A thorough understanding and comprehension of the anatomy and physiology of the chest is important for imaging purposes (Kawooya 2007). It is equally important to understand that this knowledge cannot be accumulated only via theoretical teaching; it requires practical experience in many normal chest x-ray images to obtain the ability to differentiate normal from abnormal radiographic appearances (Delrue *et al* 2011). Therefore a brief review of the chest anatomy and physiology is relevant in a study of image interpretation. The chest comprises of two lungs, the left and the right. Furthermore it has a heart and twelve pairs of ribs on either side encapsulating the lungs and heart. The function of the ribcage is to protect the vulnerable internal organs mentioned above (Totora and Grabowski 2003). The lungs are divided into lobes by fissures. The right lung has three lobes, the upper, middle and lower lobes with two fissures separating the lobes (Bontrager and Lampignano 2010). Whereas the left lung has two lobes, the upper and the lower lobe with one fissure (Armstrong and Wastie 1992). The trachea is a windpipe that is positioned in alignment with the spine and branches into the left and right main bronchus at the level of the fifth (5^{th}) thoracic vertebrae (Totora and Grabowski 2003). The bronchi further branch into bronchioles which end at the alveoli, a sac like structure where gaseous exchange occurs (Bontrager and Lampignano 2010). A depiction of the description presented above is seen in Figure: 2.1.

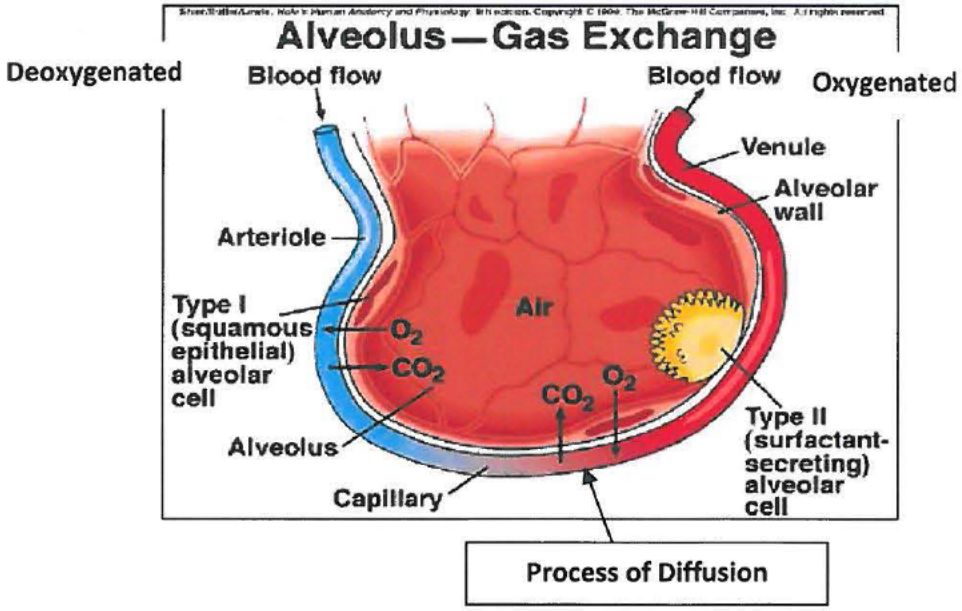
Figure: 2.1. **The chest anatomy (the lungs).**



(Yale School of Medicine 2013)

The significance of a thorough understanding of the normal physiology of the lungs is hinged on the need to demonstrate understanding, comprehension and an ability to be sensitive to a disruption of normal lung function. Respiration is a term used to describe the process of gaseous exchange between the outside environment and the lungs (Totora and Grabowski 1996). Air enters the body via the nostrils and then moves into the trachea, bronchi and bronchioles and into the alveoli. Gaseous exchange occurs in the alveoli through the process of diffusion (Bontrager and Lampignano 2010). The gases from the environment that is high in oxygen will diffuse through the alveoli membrane to the bloodstream with low oxygen content (Figure: 2.2. Gaseous exchange in the alveolus). Knowledge of anatomy and physiology of the lungs and surrounding structures is necessary for the interpretation of chest radiographs.

Figure: 2.2. **Gaseous exchange in the alveolus.**



(Tamarkin 2011)

2.5. Reporting: The Chest Radiograph.

The chest x-ray is the most frequently requested imaging examination in medical practice setup. Furthermore this examination is used as a basis for the management of many diseases (Manning, Leach and Bunting 2000; Nayak and Lindsay 2004). Thus immediate reporting of chest radiographs has major benefits for the patient's outcome (Sonnex *et al*, 2001). The benefits of radiographers interpreting images may include but are not limited to; a reduction in the number of unreported plain films; especially chest x-rays (Rudd 2003). It is thus imperative that reports of these x-rays be compiled timeously in order to inform patient management (Mochifefe 2005). However reporting on chest x-rays is a challenging task especially for individuals not trained in the speciality of interpreting x-rays (Freeman 2006; Sonnex *et al* 2001). This necessitates for specialised training to be implemented to minimise the variations observed especially amongst experienced and inexperienced interpreters (Brealy and Scally 2007). Hardy, Spencer and Snaith (2008) concurs the importance to acknowledge the value of plain chest x-rays to direct treatment is limited by the variable ability of the interpreters.

The significance of the current study lies in the fact that the chest x-ray images are used as tools in a systematic approach to evaluate findings that may suggest the presence of different chest diseases such as tuberculosis which are rampant in the South African context (Umzinyathi District Municipality 2009). Furthermore chest x-rays are utilised in the monitoring of progress during and after treatment of these chest diseases (Heo *et al* 2009). In alignment with the above literature the aim of the

current research study is to explore the knowledge, skills and perceptions of diagnostic radiographers on image interpretation of chest diseases.

2.6. Prevalent lung diseases in South Africa.

There is a high burden of tuberculosis epidemic in South Africa the rate of this disease are double those observed in different developing countries. When compared to the USA and other Western Europe Countiries the rate is 60 times higher (United State Agency for International Development (USAID) 2010). In a study of death notification forms conducted between 1997 and 2003, *tuberculosis* and *pneumonia* emerged among the leading causes of death amongst South Africans (*Oosterwyk 2005). It is thus imperative to* include these diseases in the study to explore the knowledge, skills and perceptions of diagnostic radiographers on image interpretation of chest diseases. Baseline data needs to be collected, studied and documented, so that it can be used as evidence based data in the facilitation, planning and implementation of radiography role extension in South Africa.

2.6.1. The basic pathophysiology of PTB, Ca Lung and Pneumonia

It is relevant to discuss a brief overview of the pathophysiology of the disease in order to understand their presentations on the image. The paragraphs below illustrate the pathophysiology of each of the diseases e.g. PTB, Ca Lung and Pneumonia. An understanding of the pathophysiology may be important in the image interpretation process. Therefore anatomy, physiology and pathophysiology are paramount in the image interpretation process (Kawooya 2007).

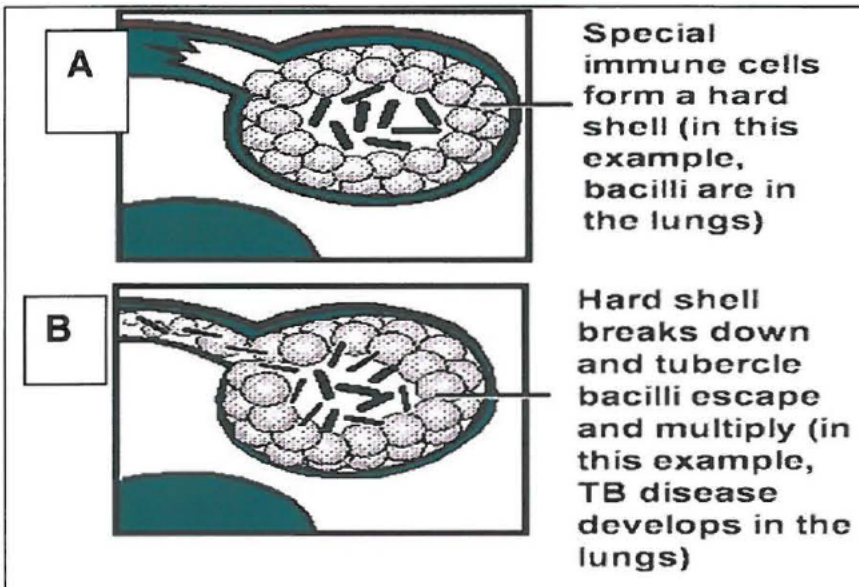
2.6.1.1. Pulmonary Tuberculosis (PTB).

Pulmonary Tuberculosis (PTB) results from mycobacterium tuberculosis that causes infection and inflammation (Weller and Wells 1990). An infection will occurs if a person inhales droplet nuclei containing tubercle bacillus that travels and reaches the alveoli of the lungs (Reid and Roberts 2005). During the early days and weeks of infection, the TB bacilli multiplies in the lungs; a small number enters the blood stream, reaching other sites of the body and may lead to miliary TB (Kowalczyk and Mace 2009). The body's defences start to recognise the bacteria at 2 to 10 weeks and sends in defence mechanisms (East African Community Health 2013). It is at this time that the tubercle bacilli are ingested by alveolar macrophages; a huge amount of these bacilli will be destroyed or inhibited during this process (Schluger 2005). Further immune responses are in the form of lymphocytes which will cause

the accumulation of more phagocytes around the tubercle bacillus (Yu-zhong *et al* 2011). The phagocytes will then transform into epithelioid cells and Langhans' giant cells with surrounding infiltration by lymphocytes to form typical tubercles and localize the lesion (Schluger 2005)

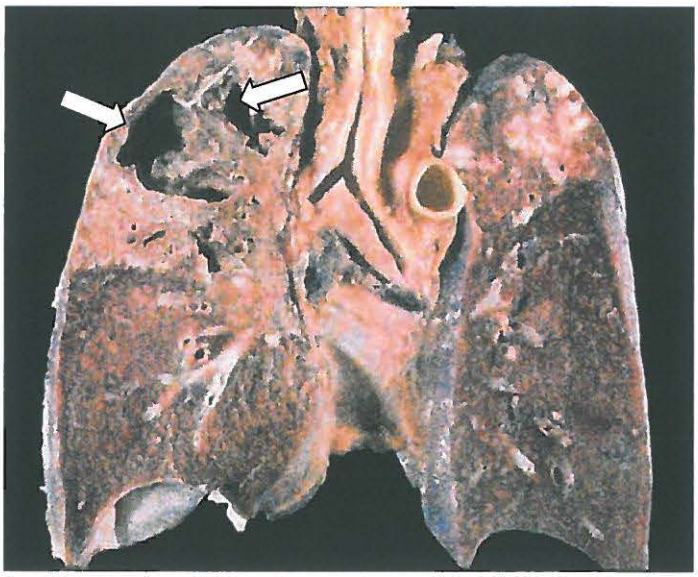
The macrophage cells may eventually die and become liquid within the tubercle and this will result in poor oxygen supply and build-up of acid environment within the bacilli leading to bacterial inactivation and in some cases death (Yu-zhong *et al* 2011) (Figure: 2.3a image A). However when the immune system is compromised it cannot keep the tubercle bacilli under control and the bacilli begin to break out of the tubercle and multiply rapidly resulting in active TB (Desrosiers 2002; East African Community Health 2013) (Figure: 2.3a image B). Therefore it can be deduced, from the above, that the affected alveolus will have a reduced surface area for oxygen intake and may have an increased fluid content. Furthermore the area destroyed by the bacteria develops a fibrous tissue resulting in decreased elasticity and thus a poor breathing mechanism (Totora and Grabowski 2003) .This may ultimately result in a radiographic image with areas of increased density (opacification) depicting scaring in an area of healed tissue (Kowalczyk and Mace 2009). In addition pulmonary tuberculosis may be demonstrated as areas of consolidation, Ghon focus, pleural effusion, cavities and there may be a mycetoma (Figure: 2.3.b) (Bortz 1994). These patterns may also include undefined shadowing within the lung parenchyma (Figure: 2.3c).

Figure: 2.3a. **TB Bacili (demonstrated as dark strands) in the alveolus.**



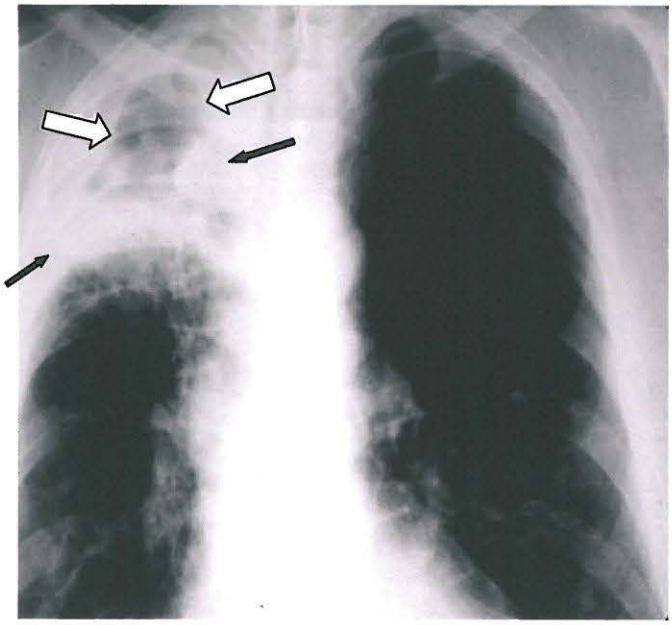
(East African Community Health 2013).

Figure: 2.3b. **Photograph of human lungs showing secondary tuberculosis with cavities in the right upper lobe (see arrows).**



(Hunter *et al* 2006)

Figure: 2.3c. **PA chest x-ray depicting tuberculosis patterns.**



(Black arrows show area of consolidation and white arrows show a cavity in the right upper zone.)

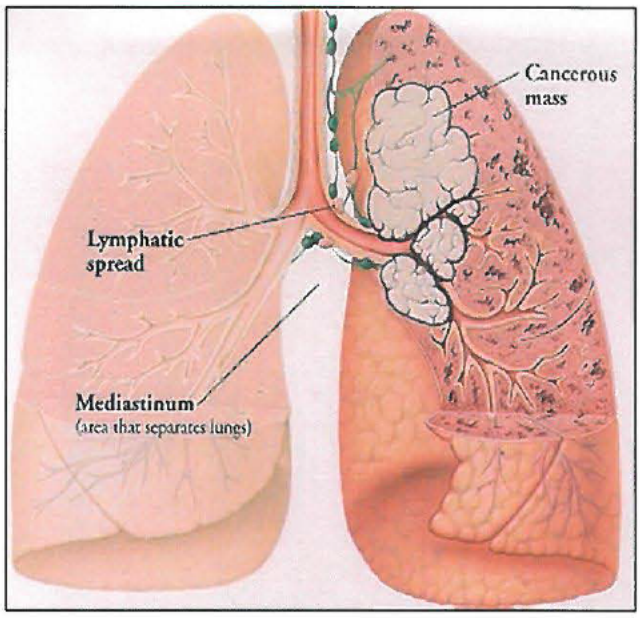
(Leischner n.d.)

2.6.1.2. Cancer of the lung.

A brief discussion of the lung cancer pathogenesis is described below. A tumour may develop in the lung as a result of an inciting agent such as nicotine from tobacco products (Miller 2005; Gqweta 2010). However other predisposing and precipitating factors may be involved in the development of a cancer. The development of most cancers follows a similar profile characterised by abnormal rapid development of cells (American Cancer Society 2012). In this description the reference made is to the development of a bronchogenic carcinoma. The inciting agent causes the epithelial and squamous cells within a part of the bronchial tree, usually the main bronchi, to replicate uncontrollably (Stevens and Lowe 2000; Kowalczyk and Mace 2009).

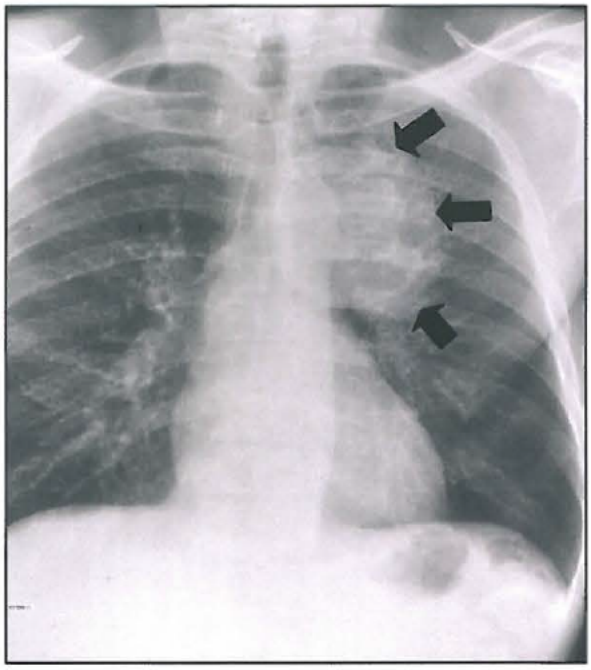
The cancerous cells may develop intra or extraluminally to a bronchial branch. Consequently they may cause an occlusion of the affected bronchus and this may result in the collapse of the part of the lung supplied by the bronchus or bronchiole (Figure: 2.4.) (Voigt n.d.;Gqweta 2010). Radiographically, lung cancer patterns may include but are not limited to, atelectasis, volume loss and tracheal deviation towards the affected area. Solitary nodules of sizes not bigger than three centimetres may be depicted (Corne and Pointon 2007). Well defined homogenous areas of increased density may be present and represent primary location (Figure 2,4b). A secondary spread may be indicated by nodules of varying sizes throughout the lung field (Adam *et al* 2008).

Figure: 2.4a. **Cancer in the left upper zone of the lung.**



(Birch 2012)

Figure: 2.4b. **PA Chest x-ray depicting a mass on the left upper zone (arrows).**

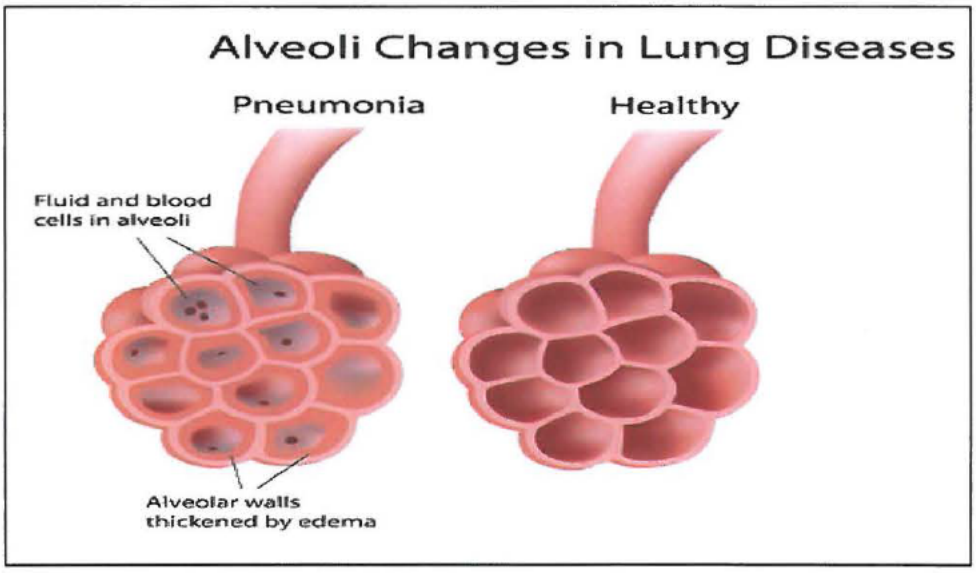


(Mountain, Libshitz & Hermes 1999)

2.6.1.3. Pneumonia.

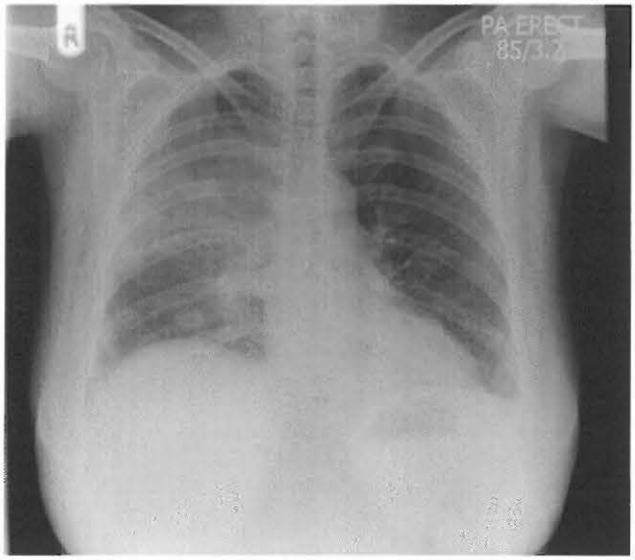
In pneumonia the bacterial organisms gain entry into the distal air spaces rather than colonising the bronchi. Furthermore rapid spread through alveoli spaces causes acute inflammatory exudates (Armstrong and Wastie 1992; Stevens and Lowe 2000). The overproduction of mucus and other fluids may lead to difficulty in breathing and inhibits gaseous exchange in the lungs (Figure 2.5a), (Totora and Grabowski 2003; Kowalczyk and Mace 2009).

Figure: 2.5a. **Alveoli changes in lung disease.**



(Yeoman 2013)

Figure: 2.5b. **PA chest image depicting pneumonia patterns.**



(Jones 2011)

The basic pathophysiology of the abnormality will allow the image interpreting radiographer to have an understanding of the disease mechanism. Furthermore it will allow him/her to understand and comprehend the resultant radiographic image patterns. When depicted on radiographic images, pneumonia patterns may sometimes be similar in profile to those of pulmonary tuberculosis. However; a salient distinguishing sign is consolidation with air bronchograms, an obscured cardiac silhouette, cavitations and may or may not have pleural effusion (Figure: 2.5b) (Corr 2001).

2.7. The utilisation of related radiographic terminology

It is important for a report to have a clear radiographic description of an abnormality present (Ridley 2002). A clear radiographic description of an abnormality is possible through the utilisation of appropriate radiological/radiographic terminology in the description of abnormal appearances. A radiological report's effectiveness may be increased by the appropriate usage of the correct terminology. Therefore a written report must utilise accurate terminology in order to describe the radiographic findings on an image (Berlin 2000; Delrue *et al* 2011). Furthermore as cited in Berlin (2000) by Spira (1996) a long description of appearances without a sensible conclusion has no merits and is may often be perceived as an attempt cover the interpreter's inadequacies rendering the referring physician confused. It is therefore important that appropriate terminology is used in the description of abnormal findings on radiographs.

Broadly classified, a number of abnormal patterns may be recognized on chest radiography. These patterns may include: Air-space opacity or consolidation, often referred to as air-space disease , interstitial opacity , nodules or masses , thoracic lymphadenopathy , pulmonary cysts or cavities and pleural space abnormalities (Curry International Tuberculosis Centre 2011). Furthermore the appropriate radiological diagnosis may result in an improved prognosis. Consequently there is a need for radiographers to be conversant with the correct radiographic and reporting terminology in order to compile relevant reports.

2.8. The image interpretation process (report writing)

It is necessary for any image interpreter to follow a prescribed process in compiling reports. The radiological report should consist of these major areas; the clinical referral, radiographic technique, findings, conclusion and the advice (European Society of Radiology 2011). The report is a permanent record of the practitioner's essential radiological observations and impressions. Furthermore it is an integral component of the patient's permanent health record. In addition, this report is almost always included in correspondence to insurance companies (Taylor 1990). The report is basically the predominant method of communication from the radiologist to the referring doctor (Ridley 2002). A report is an important bridge between the diagnosis and treatment of a patient's illness (Berlin 2000). It is therefore imperative that the radiological report be accurate and reflects as close as possible the findings as depicted on the image.

2.8.1. The sequence of reporting

According to Taylor (1990) and Machiori *et al (*1999) the standard radiology report is organized according to the following structure:

1. Preliminary information- the medico-legal information of the patient and diagnostic quality of the image.
2. Radiological findings - a systematic and descriptive section on the abnormal findings. This section may have the following information.
   2.1. Status – distinguish whether appearances are normal or abnormal.
   2.2. Description – Provide a clear descriptive account of the abnormality.
   2.2. Localization - identify the location of the abnormality
   2.3. Categorization - categorise the abnormality in terms of significance or insignificance
   (Robinson 1998)
3. Impressions- point by point of most important radiological findings.

4. Recommendations (optional) - suggestion of further investigative modalities.
5. Signature

(The American College of Radiology 2010)

Elaborately the process is as follows, when physicians assess the radiographs; their principal concern is to determine the presence of abnormalities on the radiographic image (Machiori 1999). They then describe these abnormal appearances. Furthermore when an abnormality is identified, physicians mentally categorise the findings as either significant or insignificant or as elaborate as infective, arthritide e.t.c. They then assess the probable influence of abnormal findings on the patients' treatment and management plans. Lastly, if probable, clinicians may ascertain the specific pathologic conditions present (eg, fracture, Paget's disease, haemangioma). Kawooya (2007) and Nightingale (2004) in Piper and Paterson (2009) explains that the reporter needs to be able to observe, analyse, interpret and write a report on radiological findings. The image interpretation stages described above are also relevant and imperative to be utilised by radiographers that are involved in image interpretation. Thus the current research study employed some of these steps in assessing the radiographers' ability to interpret chest images.

2.8.2. The Analysis of the reporting sequence

STAGE 1: Observation

Observations require an ability to recognise and distinguish between normal and abnormal radiographic patterns (Robinson 1998). Therefore it is imperative that the reporter be familiar with normal radiographic patterns in order to discern abnormality. Equally important is the knowledge of the characteristics of image quality e.g. density, contrast, noise, positioning (Kawooya 2007). Knowledge of image characteristics will minimise the chances of an incorrect report resulting from an un-diagnostic image. Therefore the reporter needs to observe and record characteristics of image quality as well.

STAGE 2: Analysis

Analysis requires the practitioner to piece together the various patterns to derive at a postulation of a pathological diagnosis e.g. "homogenous shadow + air bronchogram + silhouette disruption = lobar pneumonia. This stage requires knowledge of anatomy, physiology and pathology (Kawooya 2007). This is a stage where the individual reporter will have to describe the abnormal features visualised (Piper and Paterson 2009). The interpreter will then suggest the disease whose patterns are prominent and may provide a differential diagnosis based on this analysis.

STAGE 3: Interpretation

Interpretation encompasses communicating the pathological findings acquired during the analysis stage, the epidemiology, the clinical features and other information including lab results, and then theorizing a probable cause. *An example*: - lobar pneumonia, plus cough and chest pain for one week, almost certainly caused by a streptococcal pneumonia virus if occurring in a young man. A large rounded mass, with spiculated margins in a chronic 50 year old male smoker may be indicative of a bronchogenic carcinoma (Kawooya 2007). This stage requires thorough medical knowledge as a result it may be an area of difficulty for the radiographer unless specific and intense training is provided.

STAGE 4: Report writing

Report writing includes writing down the observations, and findings at the analysis and interpretation stages in a systematic and clear manner as a means of communicating to the referring physician (RANZCR 2010). It is important to note that despite their limited training in image interpretation, radiographers play a vitally important (but understated) role in assisting with diagnosis through identifying and communicating abnormal findings to the referring physician (Smith and Baird 2007). Therefore Kawooya (2007) postulates that the four stage report writing pattern may be achieved by radiographers through training. The author further explains how self-directed learning, peer learning and mentoring as well as formal training and education form a vital part of this training. The radiographers' report is undoubtedly a requirement in many healthcare institutions in South Africa if current healthcare needs are to be addressed (Gqweta 2012). The four stage image interpretation model above is necessary for effective reporting. The radiolgraphic/radiological reports should entail a concise description of the relevant radiographic findings. These findings must be interpreted in the context of the clinical history and clinical condition of the patient (Paterson *et al* 2004).

2.9. Perceptions about radiographers interpreting radiographic images.

2.9.1. The radiographers' perceptions.

A study by Toh, Reed and Robinson (2007) performed in Australia revealed that the majority of radiographers are in favour extended roles. Conversely radiographers related role extension to an improved job satisfaction and professional development. However some research studies have reported that radiographers may feel

threatened or experience a sense of increased anxiety associated with the new roles. Furthermore some radiographers explained that it is not their job to report on radiographic images. Additionally they expect to be remunerated in alignment with the new responsibilities imposed by new roles (Radovanovic & Armfield 2005).

Despite the fact that most countries abroad have conducted research studies on radiography role extension, the findings may not be relevant for a South African context (Williams 2006). Therefore there is a need to know the perceptions of our local radiographers on role extension and image interpretation. The radiographer's perception could impact on their attitude towards further education and training. Hence the purpose of this study is to explore the knowledge, skills and perceptions of diagnostic radiographers on image interpretation of chest diseases.

2.9.2. The radiologists' perceptions.

Some radiologists are concerned that the public might confuse the professions of radiography and radiology subsequently demeaning their status (Chapman 1997). Other radiologists are experiencing feelings of threat by the idea of advancing radiographers into areas previously only within their domain (Radovanovic and Armfield 2005). Moreover the radiologists do not have complete conviction of the ability of the radiographer to accurately report on trauma radiographs (Forsyth and Robertson 2007). The radiologist misgivings can be mitigated through a provision of a well-defined, task specific image interpretation model for radiographers (Donovan and Manning 2006; Hughes *et al* 1996). Even though there are reservations from radiologists with regards to allowing radiographers to perform image interpretation, some research studies have demonstrated a positive feedback (Friedrich-Nel and Bartholomew 2009). Some radiologists support the inclusion of reporting emergency and trauma radiographs into the scope of the South African radiographer. Moreover they are willing to offer academic and clinical support to radiographers interpreting images (Williams, 2009).

2.10. International experiences of reporting radiographers.

The South African healthcare sector especially the radiological services can benefit from employing a similar model of radiography development as used in the UK. The model of radiography development in the UK created healthcare professionals that are multi-skilled and able to operate under different roles (Hardy 2002). The usage of a similar model may ensure that current challenges experienced within the South African healthcare system, especially in radiological services, are mitigated and

possibly eliminated. Similar to the UK, South Africa is experiencing challenges that include the absence of radiologists and the lack of time available for the necessary education and training of radiographers, and the increased patient to radiologist ratio (Freeman 2003; Williams 2006 & Kawooya 2007).

2.10.1. Changes in International health care provision.

International research findings advocates for an increase clinical utility of the radiographers' report (Radovanovic and Armfield 2005). Additionally the quality of radiographs improves proportionally because both technical and diagnostic criteria are considered during image assessment (Paterson *et al* 2004). This will result in an improvement to the quality of clinical patient management as reports assist referring clinicians to provide appropriate treatment (Williams 2009). Moreover there will be a reduction in the number of patients discharged with undiagnosed fractures and urgent cases can be accelerated (Toh, Reed and Robinson 2007). Resource allocation, personnel motivation may be improved, while enhancing career development, if a legitimate system of delegation is utilised (Smith and Baird 2007).

2.10.2. The processes of change in the radiography profession.

The process of radiography role change must be research driven and evidenced based (Friedrich-Nel and Bartholomew 2009; Brealy and Scally 2008). The research on radiography development should be driven by healthcare needs with possible ways of addressing them (Gqweta 2012). Therefore a conceptual framework of the structure of change is necessary. This framework should be evidence based, flexible and be used as a guide to the planning of role extension (Smith and Baird 2007). Before the implementation phase it is necessary to amend and or change the healthcare legislation that governs professional acts of radiographers (Brealy and Scally 2008). This amendment or change of the Health ACT should complement the prospective roles of radiographers suggested in the research and conceptualisation phases (Cowling 2008). An amendment of the legislation will enable the development of regulated new radiographers' roles. Additionally these roles may be task specific in order to enable stringent control processes (Donovan and Manning 2006). Furthermore a new curriculum may need to be developed to complement the new roles.

The new training and education courses may be offered at both undergraduate and post graduate levels. Therefore the radiographer must agree to accept a new role and be specifically and sufficiently trained for it (Paterson *et al* 2004). Furthermore

the course for new roles, e.g. reporting, should be conducted to inculcate academic, practical and clinical skills. Furthermore these authors Paterson *et al* (2004) explain that workloads should not be excessive but should include the entire scope of general clinical cases. Currently in South Africa there are some research based evidence for radiography role extension (Williams 2009; Williams 2006; Brandt *et al* 2007; Gqweta 2012; Munro *et al* 2012). These research studies exhibit that there is a need for South African radiography personnel to extend their roles in order to respond to current healthcare needs. Evidence overseas suggest that if carefully planned, implemented and evaluated, role extension can improve and maintain or the quality of patient care (Smith and Baird 2007).

Chapter Summary

The role of the radiographer has radically changed in countries abroad in response to the healthcare needs (Williams 2006). The change has brought with it many advantages for the patient, the personnel as well as the entire healthcare system (Gqweta 2012). The South African healthcare system may benefit from the implementation of radiography role extension. Image interpretation by radiographers should begin with chest image interpretation as these are frequently requested and performed examination within x-ray departments (Kowalczyk and Mace 2009). The shortage of radiologists has had a adverse influence on the delivery of service within the South African health care system, in that many radiological examinations are not reported on time, resulting in delayed patient management (Williams 2006; Brandt et al 2007; Kawooya 2007; Gqweta 2012). The introduction of radiography role extension especially, image interpretation, will alleviate some of the negative effects of the absence of the radiologists in many clinical settings. However the reporting radiographer should have a thorough knowledge of anatomy, physiology and pathophysiology (Delrue *et al* 2006). Effective change and response to current health care needs may be achieved through research and involvement of relevant stakeholders. It is undeniable that the processes to be followed needs to be informed by research (Williams 2009). Currently there is a need for scrutinising image interpretation models that are being utilised and are functional internationally in order to find the best suited model for the South African healthcare system.

CHAPTER THREE

METHODOLOGY

3.1. Introduction

This chapter describes the research design and methodology that was employed to perform this study. It indicates the selection of the research participants, the ethical considerations, type of data collected, the data collection procedure and the statistical methods employed.

3.2. Permission to perform the study

Permission to perform the study at the eThekwini Health District was requested from the Chairperson: Health Research Committee: KZN Department of Health (Appendix A) and approval granted (Appendix H).

3.3. Invitation to participate

Recruitment fliers (Appendix E) were printed in English and displayed for the attention of the individuals who would meet the requirements of the inclusion criteria. These invitations were displayed on notice boards of all the selected hospitals' x-ray departments for the attention of diagnostic radiographers.

3.4. Participants' letter of information and informed consent.

The research participants that responded positively to the invitation were provided with a letter of information and consent form that explained the significance of the study, the procedure and the confidentiality clause (Appendix C). Subsequent to reading the information sheet, the participants were then required to sign the consent form (Appendix C) to acknowledge voluntary participation and understanding of the contents of the information sheet.

3.5. Selection of the research population

The research participants were all diagnostic radiographers that responded to the invitation and who met the inclusion criteria. They all were registered with the HPCSA. These respondents were selected according to the following criteria.

3.5.1. Inclusion Criteria.

- Diagnostic radiographers currently practicing in a public clinical environment in the eThekwini Health District of KZN.
- They must be currently registered with the HPCSA.

- This population will include community service radiographers as well as radiographers with +-40 years of practicing experience.

3.5.2. Exclusion Criteria.

- All Ultrasound, radiotherapy, nuclear medicine, supplementary radiographers, students and unemployed radiographers will be excluded from the study, as the focus is on the image interpretation knowledge and skills of the diagnostic radiographer.
- Diagnostic radiographers working in private practice were excluded from the study. The study focused on the skills in public sector where there is a dire shortage of specialists.

3.6. Ethical considerations.

The study was conducted following the guidelines of the Durban University of Technology's ethical consideration for the conduct of research in the Faculty of Health Sciences' policy document (Section C: ethics clearance form) (Appendix G). Approval for permission was also obtained from the Department of Health (Appendix A). The researcher was always present at all the research sites to maintain an appropriate level of confidentiality at all times. All data was securely locked up in the office of the researcher and only accessed by the researcher. No names and personal information that could be used to identify participants were obtained. Participants were made aware that they could withdraw from the study at any point if they wanted to and no coercion was utilised to encourage participation.

3.7. Pilot study

The data collection tool(s) were piloted to a group of diagnostic radiographers that works in the eThekwini Health District of KZN, in order to ensure its accuracy, appropriateness and relevance. They were encouraged to identify areas that were unclear on the questionnaire and the reporting template. Necessary amendments were made to the data collection tools following this process and prior to their usage in the main study.

3.8. Sampling method.

There are approximately 130 diagnostic radiographers employed in 14 public health institutions in eThekwini according to an email correspondence from Mrs Lindiwe Ndlela a Director of Recruitment Department of Health KZN. Seven (7) of these institutions were randomly selected as a sample using the simple random sampling

method (Appendix F). All diagnostic radiographers meeting the inclusion criteria from the seven (7) selected institutions were invited to participate in the study. It was anticipated that this will equate to a sample size of approximately 40-50% of the total population of radiographers in the public health sector in the eThekwini Health District. It was further anticipated that a high response rate (>80%) would be attained as a result of using the data collection process outlined in 3.9 below.

3.9. Study design and data collection.

The research study employed the quantitative and a qualitative research approaches. Within the qualitative approach an interpretive design was utilised. A cross sectional design was used with the quantitative approach. According to Adams and Smith (2003) the qualitative approach is used to examine the meanings, perceptions, experiences and understandings of those involved in the phenomenon researched. The significance of this approach for this study rests in the need to empathically understand the situations within the South African radiography profession. Conversely cross-sectional surveys are studies conducted in order to determining the frequency of a particular characteristic in a defined population at a particular point in time (Hopkins, 2000a). This design was used in this study to demonstrate the current level of knowledge and skill that the diagnostic radiographers possessed in interpreting chest images. Therefore questionnaires and chest images in conjunction with reporting templates were used as data collection tools. These were quantitative and qualitative designs that provided a combination of qualitative and quantitative data.

3.9.1. Primary data collected.

- Personal and demographic data of the research participants
- Results from the questionnaire pertaining to the radiographers' knowledge of chest disease patterns (Appendix B)
- Results from the skills test related to the interpretation of the disease patterns on the chest x-rays (Appendix D - reporting template)
- Results pertaining to the radiographer's perceptions towards reporting of chest images (Appendix B)

3.9.2. Data collection process.

The researcher presented himself to the research sites (public hospitals) within the eThekwini Health District for data collection. The researcher was available in order to

answer any queries pertaining to interpretation of the information letter (Appendix C), the questionnaire (Appendix B), and the reporting template (Appendix D) and to facilitate the research process.

- The procedure:

  The questionnaire (Appendix B) was distributed to the participating radiographers to complete prior to image interpretation.

  The questionnaire was designed to assess image interpretation knowledge and to gain information on the radiographers' perceptions on image interpretation as an extended role in radiography.

  Thirty (30) minutes was the allocated time limit to complete the questionnaire.

  On completion of the questionnaire, ten (10) Posterior Anterior (PA) digitised chest images were projected onto a white screen for radiographers to interpret using a standardised form (Appendix D).

  A maximum time of 60 minutes was allowed to interpret all ten (10) images.

  Reference Standard: two radiologists with combined experience of 60 years in imaging were utilised to provide reference reports.

- Data Collection Tools

  Data was collected using a laptop, a whiteboard, a projector, a reporting template, ten (10) posterior anterior (PA) chest images and a questionnaire. The same laptop, whiteboard, the projector and the reporting template were utilised throughout the data collection phase in order to ensure consistency and reliability.

- The Image Interpretation Session.

  A room was reserved at each sampled hospital for data collection. This room was systematically prepared in order to optimise the viewing conditions. It was ensured that the respondents were seated within two metres from the screen on which the images were projected. On an average, five (5) respondents were accommodated per session of approximately 1 hour. The size of the projected images was made to be equal to the size of the 35cm X 35cm x-ray film. Each image was displayed for a maximum of five minutes to provide sufficient time for respondents to identify an abnormality (if any) and describe its appearances. The clinical history relating to each image was not provided in order to eliminate any possible advantage that the reference may have considering their medical background.

- The reporting template

  Each respondent was provided with a reporting template in order to standardise the responses received. The reporting template required a respondent to (i) state whether the image was normal or abnormal (ii) describe the abnormality (if any) (iii) state the location of the abnormality (if any) and then (iv) state the most probable disease(s) depicted by observed patterns.

- The reference standard

  Two radiologists were consulted to provide the reference reports. One had a clinical experience of 40 years whilst the other had 20 years of experience. These radiologists reported on the same ten (10) PA chest images that were used by the respondents. They were also provided with the same standardised reporting templates to use. Where the two radiologists disagreed on a particular report, a third radiologist (with 40 years of experience) was consulted. In an event whereby the third (3^{rd}) radiologist was in disagreement with the previous two (2) radiologists, the image concerned was disregarded and not utilised for the analysis of results. Image PA 03 was eliminated and not used for the analysis due to discordance of the radiologists' reports. Therefore the analysis was carried out using only nine (9) images. The radiographers' responses were judged against those of the radiologists.

- The chest image bank

Ten (10) Posterior Anterior (PA) chest images were extracted from a bank of images used for teaching purposes in the undergraduate classes. Six (6) of these images had abnormal patterns depicting three disease processes, which included pulmonary tuberculosis, lung cancer and pneumonia. Four (4) of these images were normal.

3.9.3. Validity and Reliability

Validity represents how well a variable measures what it is supposed to (Hopkins 2000a) .Validity was ensured through the use of peer reviewed articles and published books to gain content. Experts in the field of image interpretation were consulted to ensure that the images and content were relevant for the type of research to be conducted.

Reliability refers to the repeatability or reproducibility of a measure or variable (Hopkins 2000b). Reliability was ensured through the utilisation of a standard protocol (reporting template) to obtain the information from the respondents regarding the image appearances. Each respondent was seated about the same distance (1 metre) from the projected images. They all utilised the same data collection sheet and same set of images as well as the computer, and the projection board. The image size was equal to 35 x 43 cm to ensure that it correspond to the hardcopy chest images used for reporting.

3.10. Data analysis.

The images that were correctly reported on as either normal or abnormal by the respondents (radiographers) were allocated a point. Therefore each respondent had a maximum of ten points. All the respondents' points were tallied and an overall accuracy, sensitivity and specificity were calculated using the formulation seen on table 3.1 and 3.2.

Table 3.1: Required data to calculate accuracy, specificity and sensitivity

Term	**Description**
False Positive (FP)	An incorrect record of presence of abnormality
True Positive (TP)	A correct record of presence of abnormality
True Negative (TN)	A correct record of an absence of abnormality
False Negative (FN)	An incorrect record of absence of abnormality

(Piper and Paterson 2009; 43)

Table 3.2: **Calculating accuracy, sensitivity and specificity.**

	Case Status		
Test Results	**Disease Present**	**Disease Absent**	**Total**
Positive test	A (True Positive)	B (False Positive)	A+B
Negative test	C(False Negative)	D(True Negative)	C+D
Results	A+C	B+D	A+B+C+D

(Bohay 2000:641)

The formulation below utilised by Bohay (2000) in his study was utilised. The following formulas were utilised to calculate the overall accuracy, sensitivity and specificity.

- **ACCURACY=** A+D/ A+B+C+D,
- **SENSITIVITY=** A/ A+C
- **SPECIFICITY =** D/ B+D

The SPSS (Statistical Package for the Social Sciences) version 21 was used for raw data capture and analysis. All the raw data were assessed for normality, as this is a prerequisite for using inferential statistics. The assumptions of normality were assessed using histograms and box plots. Descriptive statistics (demographic data) was explained giving an account of the demographic layout of the observations of the study. A frequency distribution was used to display the frequency of occurrence of each result. Mean and median values were used as measures of central tendency. A statistician Mr. Deepak Singh was consulted in the compilation of the questionnaire and data analysis phase in order to compile, present and describe data numerically.

3. 10.1. Statistic and Thematic analysis to meet objectives of the study.

Section 3.10.1.1, 3.10.1.2 and 3.1.0.1.3 describe the process of data analysis followed. Each objective was analysed separately to provide clarity on the results.

3.10.1.1. Objective 1: To determine the knowledge of radiographers in identifying disease patterns on chest radiographs.

This objective was addressed using the following method. The number of correct responses were summed up and divided by the total number of questions in section B of the questionnaire; they were multiplied by 100 to create a percentage score. A minimum of 80 % was expected from the respondents in order to indicate an adequate level of knowledge. A score of eighty (80%) percent was deemed an adequate achievement for the study. The choice of the 80% mark was based on the fact that the schooling and university systems deem this as an excellent level of performance and thus achievement (Victorian University of Wellington 2007; Kwantlen Polytechnic University 2011). The mean, standard deviation and range of knowledge scores were presented for the sample as a whole, as well as a frequency table showing the percentage of respondents who scored 80% or above.

3.10.1.2. Objective 2: To examine the skills of radiographers in identifying disease pattern changes on chest radiographs.

This objective was addressed by having two radiologists reporting on the nine (9) digitised chest images using the reporting template (Appendix D). The radiologist's reports were used as a reference standard by which the radiographers' reports were judged. Accuracy, Sensitivity and Specificity measures were determined by obtaining data on the true positives and true negatives as well as false positives and false negatives. Appropriate formulas were applied in order to highlight the participants' level of skill in chest interpretation (see Table 3.1 and 3.2). The data from the template, where respondents had to describe the appearances, was transcribed and latter compared to the radiologists report. The aim was to check for alignment and or consistency of the respondents' reports to the reference standard.

3.10.1.3. Objective 3: To establish the perceptions of radiographers towards reporting of chest images.

The descriptive part of this objective was answered using frequency tabulation as well as thematic presentations of the perceptions that radiographers had about reporting chest images. The data will be transcribed verbatim and emergent themes will be categorised in order to systematically present the perceptions of the respondents on the subject of image interpretation. This will ensure that the objective to identify the radiographers' opinions on radiography role extension with special reference to image interpretation is met.

3.11. Chapter summary.

This chapter highlighted the research methodology that was utilised in the current study. It indicated and explained all the relevant and necessary ethical considerations that were followed as well as gaining permission to perform the study. Appendices A-F are the permissions that were obtained as well as the tools used to collect the data. The data collection method, the selection of the research participants and the statistical analysis are also explained.

CHAPTER FOUR

RESULTS

4.1. INTRODUCTION.

This chapter focuses on the results of the study using descriptive and inferential statistics. Data are presented in the form of frequencies, mean, median and themes. The chapter is presented in four sections, that is, the respondents' demographic data. The further three (3) areas are organised according to the research objectives in alignment with the respondents' knowledge, skills and perceptions. The demographic section is presented in order to allow us to discern the current radiography profile within eThekwini Health District provincial hospitals. The results pertaining to pattern recognition knowledge provide a view of the current knowledge profile. It reflects the knowledge of radiographers on the image appearances of PTB, lung cancer and pneumonia. The skills results reflect the competence of the radiographers in identifying and describing radiographic patterns of PTB, cancer and pneumonia. All the respondents' reports were analysed and then compared to the radiologists' reference reports. The chapter then goes on to present the perceptions of the respondents on radiography role extension with special reference to image interpretation. This section reflects the respondents' views and opinions about the current and anticipated situation in the radiography profession. A chapter summary is presented.

4.2. DEMOGRAPHIC DATA:

Fourty two (42) respondents returned the questionnaires and interpreted the images. Thus the resultant return rate was sixty six percent (66%). One of the questionnaires was incorrectly completed and was excluded from the statistical analysis therefore the analysis was performed on 41 respondents. Of the 41 respondents, 33 were females and 8 were males. Gender and age distribution are presented in Table 4.1.1. On closer inspection of the table the following patterns are observed. Within the age group of 20 - 29 years eighty five percent (85%) of the respondents were females and fifteen percent (15%) were males. Females in this age group constituted approximately fourty one point five percent (41,5%) of all the females in the study . The age group between 20 and 29 years constituted approximately fifty one point five percent (51,5%) of the entire sample of female respondents. This group of female respondents constituted fourty one point five percent (41.5%) of the entire sample of respondents. The above statistics may be reflecting the gender demographics which are biased towards females within the radiography profession.

TABLE 4.1.1: GENDER AND AGE DESTRIBUTION.

			Gender		Total
			Female	Male	
Age Groups (years)	20 - 29	Count	17	3	20
		% within Age Groups	85.0%	15.0%	100.0%
		% within Gender	51.5%	37.5%	48.8%
		% of Total	41.5%	7.3%	48.8%
	30 - 39	Count	10	2	12
		% within Age Groups	83.3%	16.7%	100.0%
		% within Gender	30.3%	25.0%	29.3%
		% of Total	24.4%	4.9%	29.3%
	40 - 49	Count	3	2	5
		% within Age Groups	60.0%	40.0%	100.0%
		% within Gender	9.1%	25.0%	12.2%
		% of Total	7.3%	4.9%	12.2%
	50 - 59	Count	1	1	2
		% within Age Groups	50.0%	50.0%	100.0%
		% within Gender	3.0%	12.5%	4.9%
		% of Total	2.4%	2.4%	4.9%
	60 - 69	Count	2	0	2
		% within Age Groups	100.0%	0.0%	100.0%
		% within Gender	6.1%	0.0%	4.9%
		% of Total	4.9%	0.0%	4.9%
Total		Count	33	8	41
		% within Age Groups	80.5%	19.5%	100.0%
		% within Gender	100.0%	100.0%	100.0%
		% of Total	80.5%	19.5%	100.0%

Table 4.1.2 presents data on the qualifications of the respondents. Fifty six point one percent (56.1%) of the respondents possessed a 3-year National Diploma in Diagnostic Radiography as their highest qualification. Meanwhile thirty one point seven percent (31.7%) of the respondents possessed a B. Tech Degree in Diagnostic Radiography as their highest qualification. Seven point three percent (7.3%) of respondents had a 2-year National Diploma and four point nine percent (4.9%) of the respondents had a 3-year Degree in Diagnostic Radiography. The majority (78%) of the respondents had graduated from Durban University of

Technology (DUT). Only about seven point three percent (7.3%) were trained in hospital based institutions.

Table 4.1.2: Qualifications and Institutions.

			Highest qualification				Total
			Two Year National Diploma	Three Year National Diploma	Three Year Degree	B. Tech Degree	
Institution where the highest qualification was obtained	Addington Hospital	Count	1	0	0	0	1
		% of Total	2.4%	0.0%	0.0%	0.0%	2.4%
	Baragwanath Hospital	Count	1	0	0	0	1
		% of Total	2.4%	0.0%	0.0%	0.0%	2.4%
	DUT	Count	0	20	1	11	32
		% of Total	0.0%	48.8%	2.4%	26.8%	78.0%
	King Edward	Count	1	0	0	0	1
		% of Total	2.4%	0.0%	0.0%	0.0%	2.4%
	Medunsa University	Count	0	0	1	0	1
		% of Total	0.0%	0.0%	2.4%	0.0%	2.4%
	Natal Technikon	Count	0	1	0	0	1
		% of Total	0.0%	2.4%	0.0%	0.0%	2.4%
	PE Technikon	Count	0	1	0	0	1
		% of Total	0.0%	2.4%	0.0%	0.0%	2.4%
	Tshwane University of Technology	Count	0	0	0	1	1
		% of Total	0.0%	0.0%	0.0%	2.4%	2.4%
	University of Johannesburg	Count	0	0	0	1	1
		% of Total	0.0%	0.0%	0.0%	2.4%	2.4%
	Wits Technikon	Count	0	1	0	0	1
		% of Total	0.0%	2.4%	0.0%	0.0%	2.4%
Total		Count	3	23	2	13	41
		% of Total	7.3%	56.1%	4.9%	31.7%	100.0%

Figure 4.1.3 displays data on the respondents' first radiography qualification. This figure demonstrates the actual years since each respondent's first qualification. There is an exponential decrease in the number of qualified radiographers with time. Consequently there is only fifteen percent (15%) of the respondents qualified for as long as twenty (20) to fourty (40) years from the date of the study. These individuals

constitute the group with the most experience. Fifty six point one percent (56.1%) of the respondents had been qualified for less than ten years. This group constituted the majority of the current respondents.

Figure 4.1.3: Number of years since obtaining the first radiography qualification.

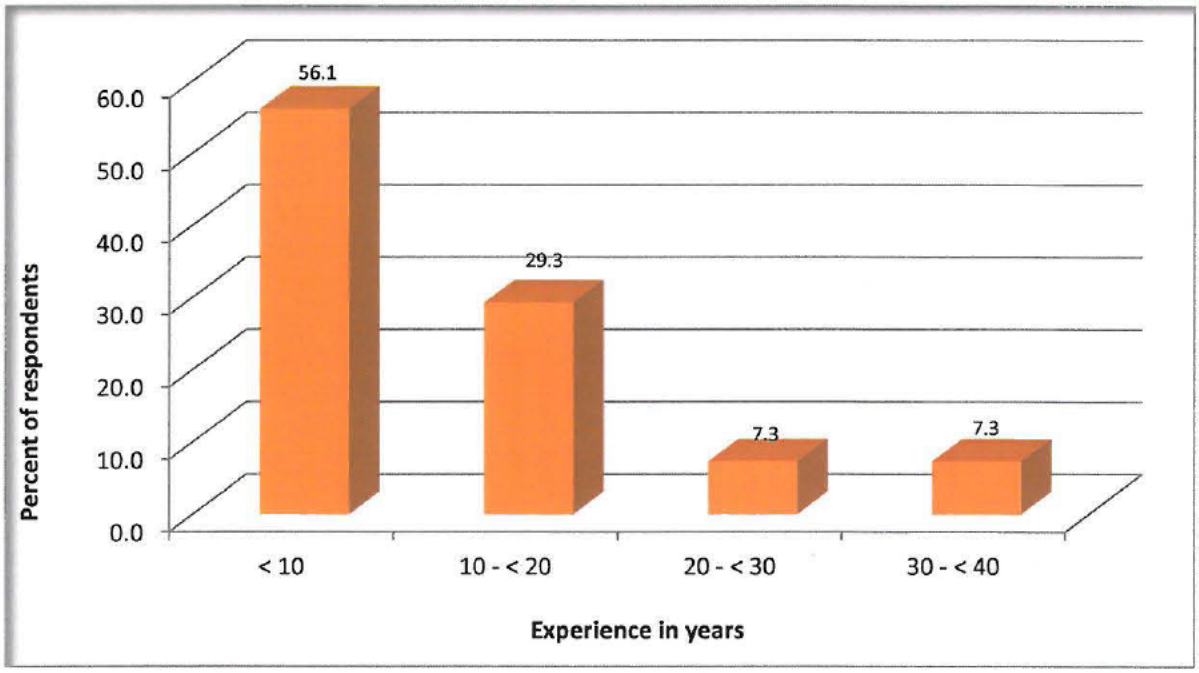
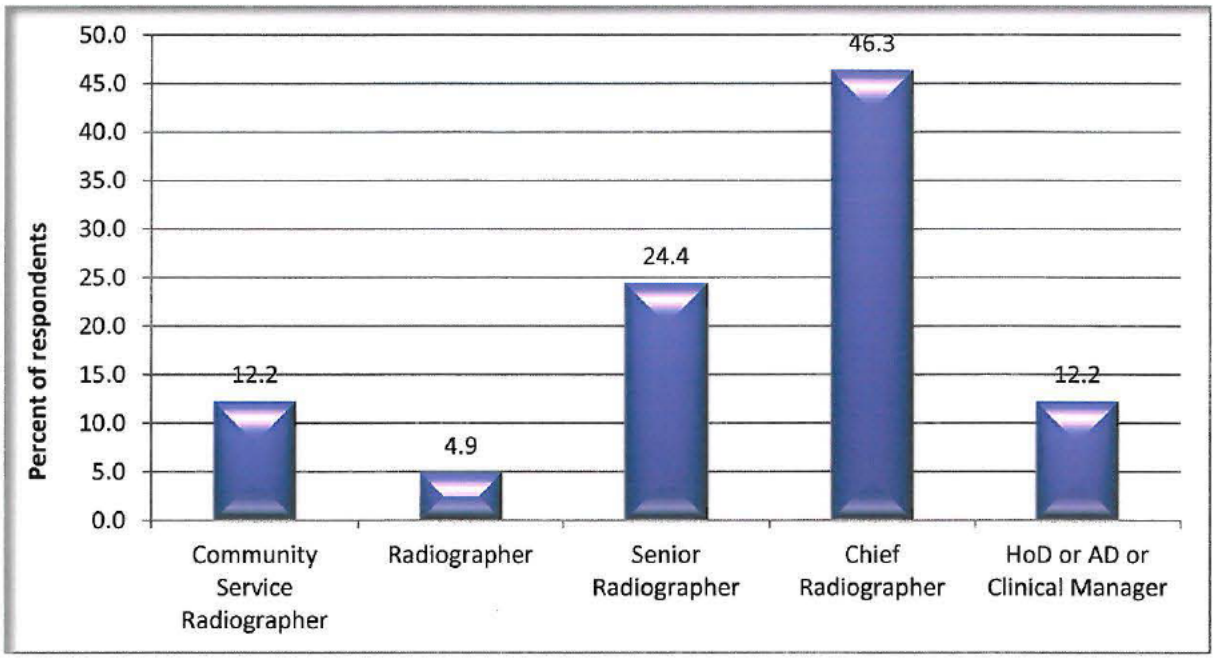


Figure 4.1.4 demonstrates data on the current ranks held by the respondents within the radiography clinical environment. Fourty six percent (46%) of the respondents were chief radiographers. Whereas twenty four point four percent (24,4%) of respondents were senior radiographers and only twelve percent (12%) represented community service radiographers. Outside the clinical roles, managers formed twelve percent (12%) of the sample.

Figure 4.1.4: Ranks of the respondents.



Sixty five point nine percent (65.9%) of the respondents were working at District Hospitals, twenty four percent (24%) were at a Regional level and a further nine point eight percent (9.8 %) worked at a Tertiary Hospital (see Figure 4.1.5). This demonstrates the distribution of hospitals within the eThekwini Health district. Figure 4.1.5. Illustrates the types of hospitals where the respondents were employed at. This may also provide an indication of the types of clinical settings (departments) where radiographers are mostly stationed.

Figure 4.1.5: Types of hospitals that employed the respondents.

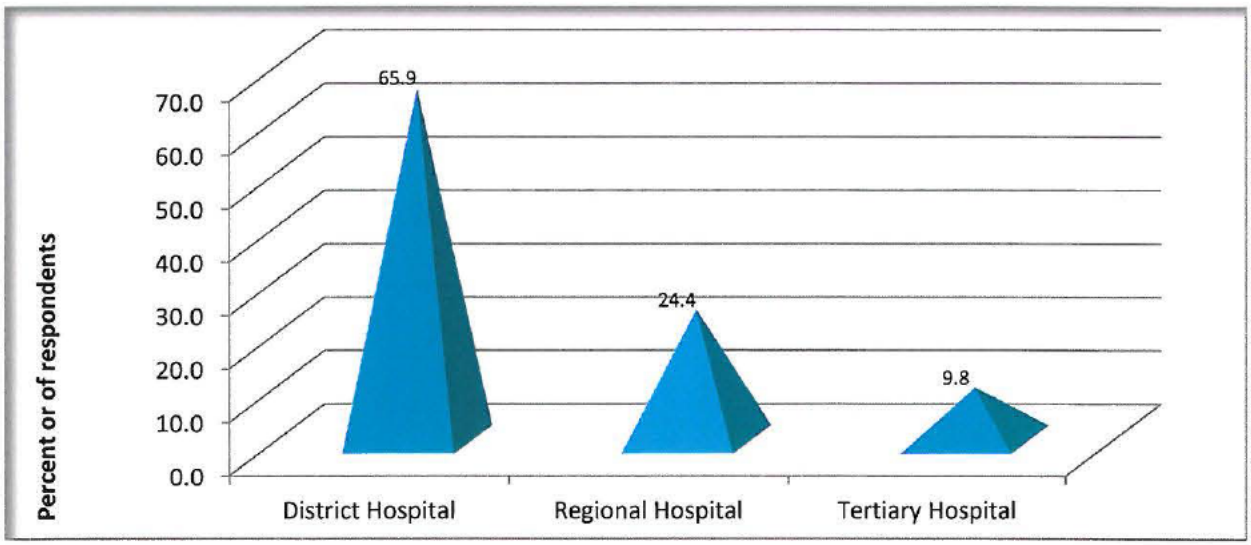


Table: 4.1.3. Demonstrates that seventy point seven percent (70,7%) of the respondents were mostly working within the general radiography departments. This

reflects the level of hospitals where the respondents were employed. All other speciality departments were reflected to a much lesser extent (see Table 4.1.3.)

Table 4.1.3: The respondents were predominantly stationed in the following workstations (departments).

	Frequency	Percent
General	29	70.7
Trauma and Emergency	3	7.3
Ward Radiography	3	7.3
MRI	1	2.4
CT	2	4.9
Mammography	1	2.4
Other Specify	2	4.9
Total	41	100.0

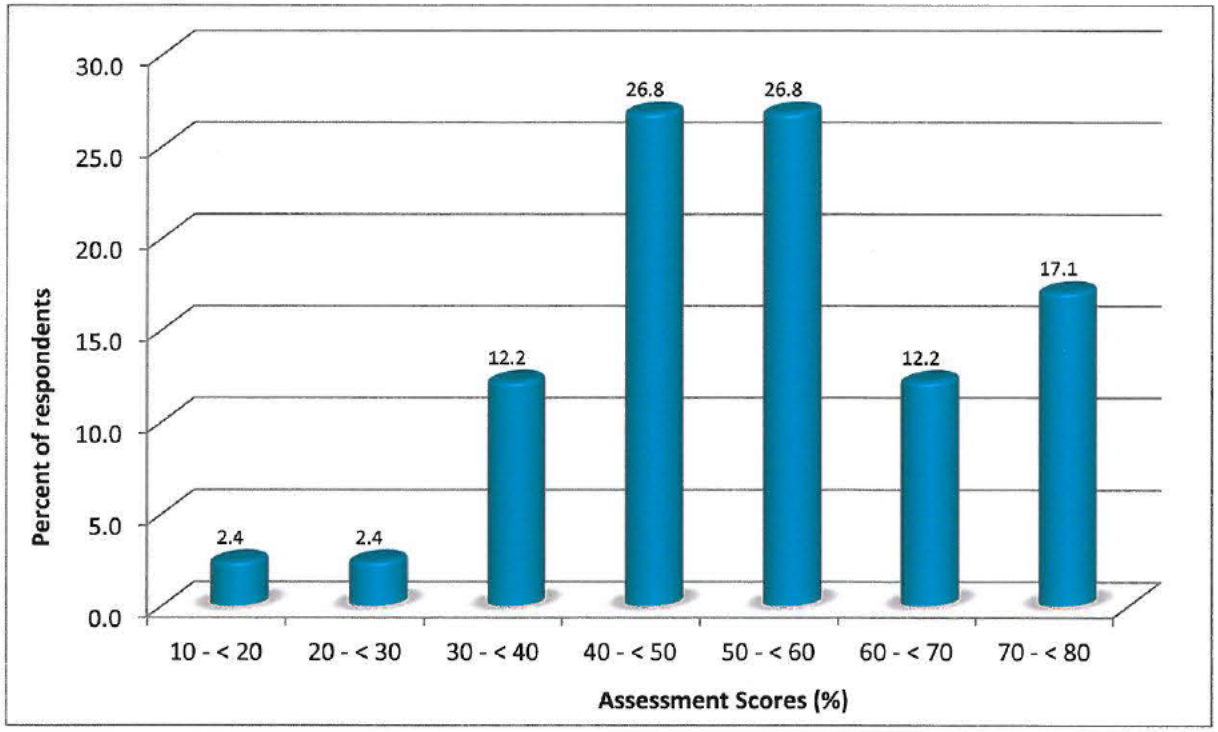
4.3. PATTERN RECOGNITION KNOWLEDGE SCORES.

This section presents the results that are addressing the first objective.

Objective 1: To determine the knowledge of radiographers in identifying disease patterns on chest radiographs.

This is an analysis presentation of the pattern recognition knowledge scores extrapolated from the assessment section of the data collection tool (questionnaire). Figure 4.2.1. Demonstrates that approximately fifty six point one percent (56,1%) of the respondents obtained a score above fifty percent (50%) for the assessment. A closer inspection demonstrates that smaller percentages of respondents received scores above sixty (60) and seventy percent (70%) marks (see Figure 4.2.1.). These results may indicate an inadequate level of pattern recognition knowledge from the respondents.

Figure 4.2.1: Pattern Recognition Knowledge Scores (%).



4.4. PATTERN RECOGNITION SKILLS.

This section addresses the second objective.

Objective 2: To examine the skills of radiographers in identifying disease pattern changes on chest radiographs.

4.4.1. Demonstrated skills.

Ten (10) PA chest x-rays were projected to demonstrate the level of skill possessed by the respondents with regard to the following variables. Respondents needed to demonstrate their ability to identify the abnormality (if any), indicate its location and suggest a differential diagnosis (patterns suggestive of). The respondents' interpretations were compared to those of the two radiologists consulted to provide reference reports. Results to this comparison are presented in table 4.3.1 below.

Table 4.3.1: Image Interpretation.

		Is the image normal or abnormal?				Location of the abnormality			Differential diagnosis		
		correctly normal	incorrectly normal	correctly abnormal	incorrectly abnormal	correctly identified location	incorrectly identified	not stated	differential	differential	non stated
Abnormal IMAGE PA 01	Frequency		3	38			41			38	3
	Percent		7.3	92.7			100.0			92.7	7.3
Bronchospasm IMAGE PA 02	Frequency		29	12		3	11	27	1	8	32
	Percent		70.7	29.3		7.3	26.8	65.9	2.4	19.5	78.0
Normal IMAGE PA 04	Frequency	31			10		9	32		9	32
	Percent	75.6			24.4		22.0	78.0		22.0	78.0
Pulmonary Tuberculosis IMAGE PA 05	Frequency			41		41			29	8	4
	Percent			100.0		100.0			70.7	19.5	9.8
Normal IMAGE PA 06	Frequency	20			21		20	21		16	25
	Percent	48.8			51.2		48.8	51.2		39.0	61.0
Bony Metastasis (Ca) IMAGE PA 07	Frequency			41		29	10	2	16	21	4
	Percent			100.0		70.7	24.4	4.9	39.0	51.2	9.8
Lobar Pneumonia IMAGE PA 08	Frequency			41		36	5		19	15	7
	Percent			100.0		87.8	12.2		46.3	36.6	17.1
Solitary Nodule (Ca) IMAGE PA 09	Frequency			41		39	2		23	12	6
	Percent			100.0		95.1	4.9		56.1	29.3	14.6
Normal IMAGE PA 10	Frequency	27			14		13	28		12	29
	Percent	65.9			34.1		31.7	68.3		29.3	70.7

4.4.1.1. **Image Analysis.**

Below are the results of the respondents on each image in the study. Thus the sensitivity (ability to detect an abnormality) and specificity (ability to exclude an abnormality from an image) results are presented. The respondents' interpretations were compared to those of the two radiologists consulted to provide reference

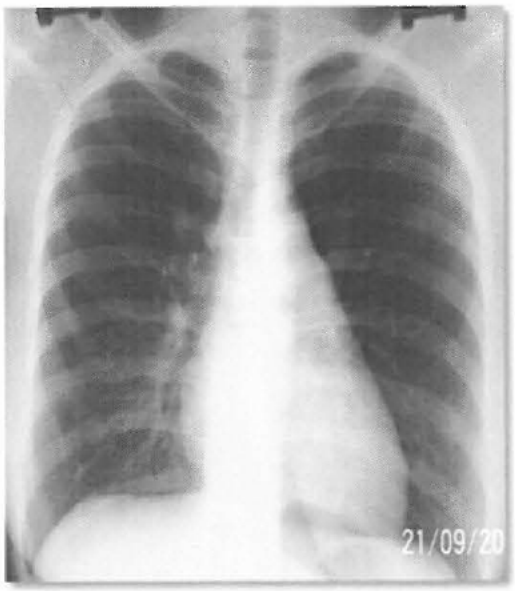
reports. The majority of the respondents were able to detect the presence of an abnormality in cancer, PTB and pneumonia cases. However there were differences in the identification of the location and the naming of the probably causal disease.

Figure: 4.3.1.1. (a). PA Chest Image 01: Normal.

REFERENCE REPORT: *Hyperinflated lungs. Blunting of the right costophrenic angle. Prominent bronchovasular markings, lower zones bilaterally. Findings characteristic of Chronic Obstructive Airways Disease (COAD) with right pleural effusion.*

Figure: 4.3.1.1. (a) depicts image **PA 01** which was reported by the radiologists as being abnormal. Ninety two point seven percent (92.7%) of the respondents reported the image as being abnormal in accordance with the reference standard. Thus the radiographers' sensitivity was particularly high for this particular image.

Figure: 4.3.1.1.(b). PA Chest Image 02: Bronchospasm.

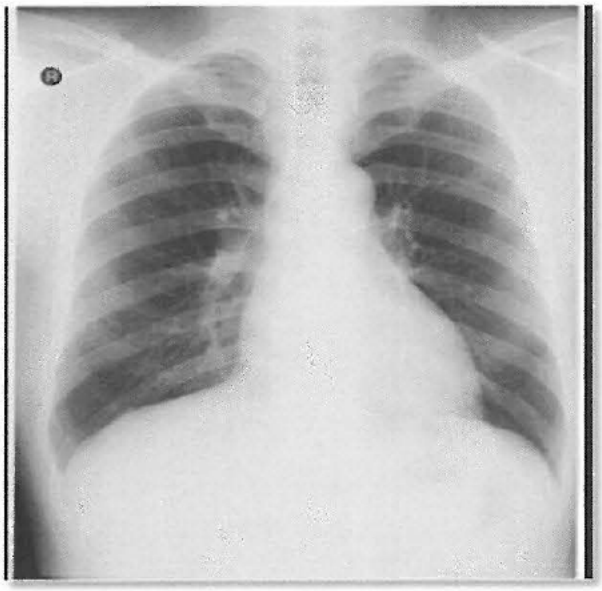


REFERENCE REPORT: *Chest rotated due to technique. No consolidation. Overinflation of both upper zones suggest bronchospasm. Bronchitis or allergic condition not excluded.*

Figure: 4.3.1.1. (b) depicts image **PA 02** which was reported by the reference standard as abnormal. Seventy one percent (71%) of the respondents reported this

image as normal. Twenty nine percent (29%) of the respondents identified the image as being abnormal. This demonstrated low sensitivity from the respondents.

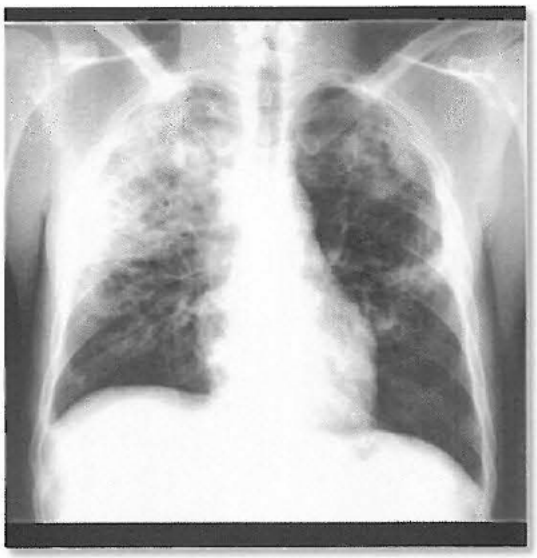
Figure: 4.3.1.1(d). PA Chest Image 04: Normal.



REFERENCE REPORT: No heart or lung lesion seen.

Figure: 4.3.1.1. (d) depicts image PA 04. Seventy six percent (76 %) of the respondents correctly identified image PA 04 as normal. Twenty four percent (24%) of the respondents incorrectly interpreted the image as abnormal. Again this demonstrated low specificity similar to that observed in figure 4.3.1.1. (a) Demonstrating normal appearances.

Figure: 4.3.1.1.(e) PA Chest Image: Pulmonary Tuberculosis.

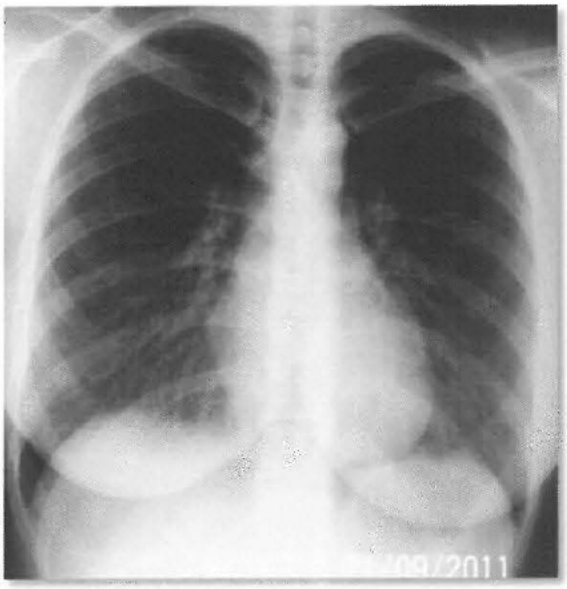


REFERENCE REPORT: There is bilateral upper lobe consolidation with cavitation. The consolidation in the right upper lobe is accompanied by pleural thickening and multiple cavities. There is also consolidating disease in both midzones. Possible adenopathy of right hilum. Patterns suggest: bilateral adenoid pulmonary tuberculosis with cavitation, suspect immune compromise.

Figure: 4.3.1.1. (e) depicts image PA 05. All the respondents correctly identified image PA 05 as depicting abnormal patterns. Furthermore all respondents correctly identified the location. Thus the specificity was increased for patterns of PTB

however, only seventy percent (70%) of the respondents correctly record the differential diagnosis as PTB. This trend is also invariable consistent with the respondents' reported ability to identify and describe pulmonary tuberculosis patterns (see figure 4.4.3. B). Respondents demonstrated a one hundred percent (100%) accuracy level in identifying these abnormal patterns on chest.

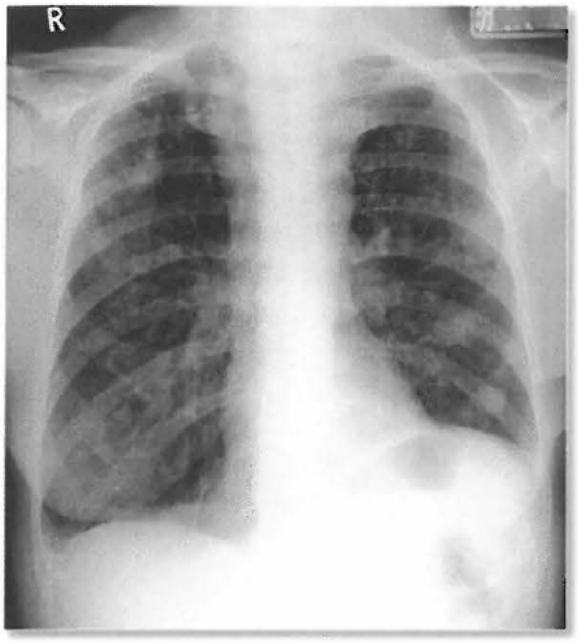
Figure: 4.3.1.1.(F). PA Chest Image 06: Normal.



REFERENCE REPORT: No heart or lung lesion visualised.

Figure: 4.3.1.1.(F) depicts image PA 06. There was a close distribution of those respondents that identified the image as being normal and those that recorded it as being abnormal. Fourty eight point eight percent (48.8%) of the respondents reported the image as normal. Whereas fifty one point two percent (51,2%) of the respondents believed that the image was abnormal. Additionally this image demonstrated the low sensitivity observed for previous normal images (PA 01, PA 04).

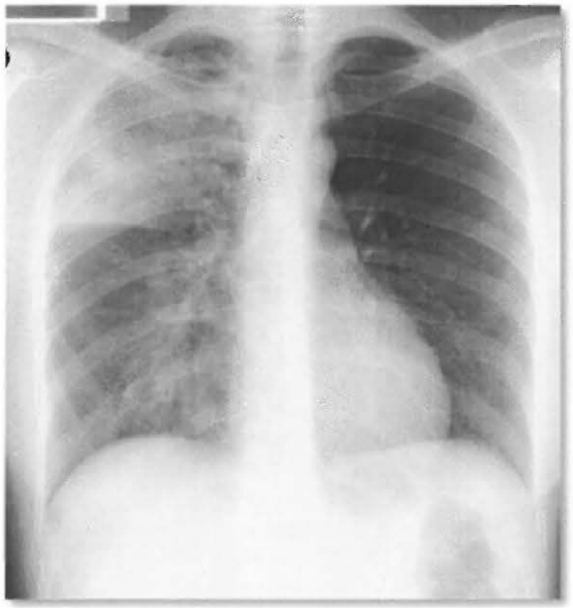
Figure: 4.3.1.1.(G) PA Chest Image 07: Lung Metastasis.



REFERENCE REPORT: Left breast not identified. Nodularity throughout both lungs of varying sizes. Also increased shadowing on both mid and lower zones. Suspect lung metastasis and probably superimposed bronchus infection. Left diaphragm elevation. Patterns suggest: suspect lung metastasis from cancer left breast or colon or genitor-urinary tract.

Figure: 4.3.1.1. (G) depicts image PA 07. All the respondents identified image PA 07 as being abnormal. However only seventy percent (70%) of the respondents correctly identified the location and only thirty nine percent (39%) correctly identified the differential diagnosis as metastasis.

Figure: 4.3.1.1.(H). PA Chest Image 08: Pneumonia.

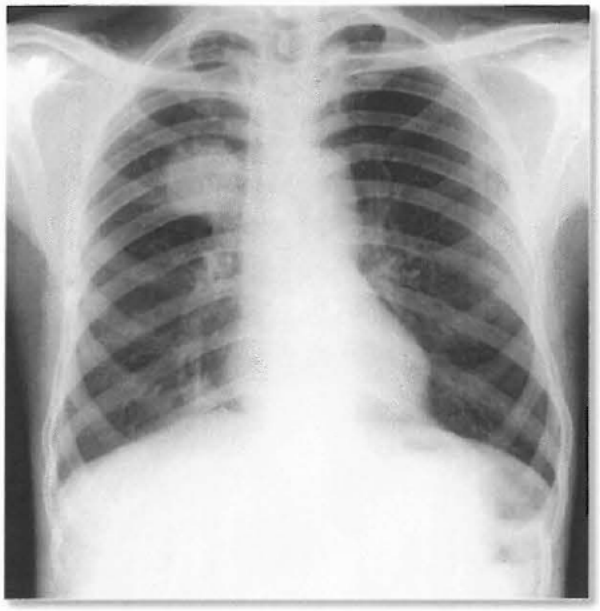


REFERENCE REPORT: There is a right upper lobe pneumonia. No volume loss, the trachea is central. The left lung is clear. There is increased shadowing in the right lower zone in keeping with bronchutus condition, this may relate to pus aspiration. Double pathology streptococcal pneumonia with underlying TB not excluded. Streptococcas and klebsiella pneumonia.

Figure: 4.3.1.1. (H) depicts image PA 08. All the respondents correctly identified the image as having abnormal patterns. Eighty seven point eight percent (87,8%) of the respondents identified the correct location and fourty six point three percent (46,3 %) percent correctly identified the differential diagnosis as pneumonia. The results

recorded are consistent with the self-reported ability to identify pneumonia patterns (see figure 4.4.3.A).

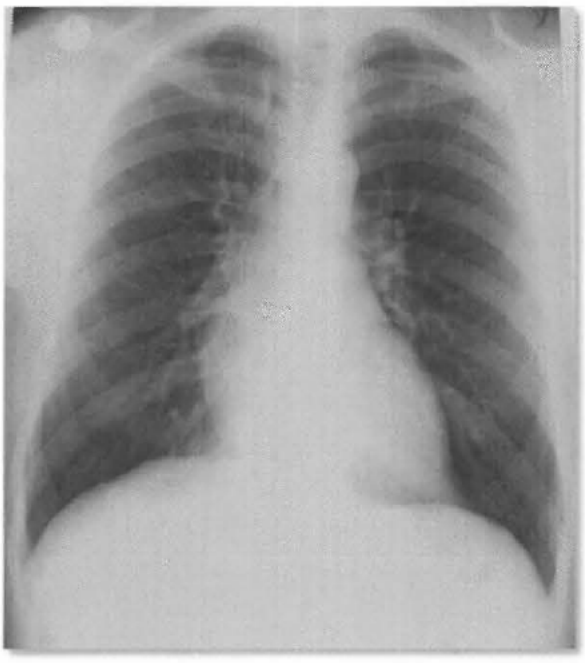
Figure 4.3.1.1.(I) PA Chest Image 09: Solitary Nodule Cancer.



REFERENCE REPORT: Left lung clear. There is a 2cm lesion in the right upper zone with ill defined margins. The remainder of the right lung is clear no adenopathy seen. Differential 1) bronchial carcinoma ? smoking background 2) bronchial adenoma ?coronoid syndrome, haematoma or hydrated cyst not favoured. Bronchial carcinoma.

Figure: 4.3.1.1. (I) depicts image PA 09. All the respondents correctly identified image PA 09 as being abnormal. Of that only eight seven point eight percent (87.8 %) correctly identified the location. Whereas fifty six percent (56 %) correctly identified the differential diagnosis as patterns of cancer. Again the trend here demonstrated the self reported ability to identify an abnormality however an inability to describe it (see figure 4.4.3 A & B).

Figure 4.3.1.1.(J). PA Chest Image 10: Normal.



REFERENCE REPORT: No heart or lung lesion visualised.

Figure 4.3.1.1. (J) depicts image PA 10. Sixty five point nine percent (65.9%) of the respondents correctly identified the image as normal. Thirty four point one percent (34,1%) percent of the respondents incorrectly identified the image as being abnormal. The trend on normal x-rays identified as being abnormal is identifiable throughout this set of images (see figure 4.3.1.1 (A) & (D) & (F).

4.4.1.2. The reporting template.

Data from the descriptive section (where respondents had to describe abnormal findings) of the reporting template was transcribed and latter analysed. The analysed data was then examined to identify any themes that may provide an insight into the knowledge and skill of the respondents. Themes were identified and subjected to further analysis and examination for alignment with the radiologist report. The resultant analysis revealed that even though the respondents were able to identify abnormal appearances, they were not able to adequately describe these findings. The reporting template had four Sections, **SECTION 1** respondents had to (i) identify whether image is normal or abnormal, **SECTION 2** (ii) describe the abnormality, **SECTION 3** (iii) state the location of the abnormality and **SECTION 4** (iv) state the disease which the patterns are suggestive of. The description provided did not align with that of the radiologists or provide a clear radiographic description of the abnormality. Table 4.3.1.2 demonstrates the themes that emerged from the descriptive section of the reporting template analysis.

Table: 4.3.1.2. Emergent themes (from the reporting template).

- Partial (incomplete) descriptions
- Absence of descriptions
- Use of appropriate radiological terms
- Vague descriptions
- Inaccurate descriptions

4.4.2. Analysis of themes.

4.4.2.1. Partial (incomplete) description.

There is a need for a comprehensive and complete description of abnormal findings if an accurate diagnosis is to be formulated. However, most of the respondents provided descriptions that were restricted and incomplete. The descriptions were selective and favouring gross (obvious) abnormal patterns with less or no attention

towards subtle abnormal changes. Consequently, some subtle abnormal patterns which could have been significant were not described at all. Correspondingly the resultant descriptions were incomplete, inconclusive and did not reflect the severity of the abnormality. For example ***Respondent 28*** noted that image PA 08 presented with 'fluid levels over the middle lobe and no further explanation or descriptions of this observation were formulated. ***Respondent 19*** reported this image as 'fluid level in right lung'. The examples above and other similar interpretations were elementary in approach and restricted in scope.

4.4.2.2. Absence of descriptions.

In cases where an abnormality is identified on radiographic images, it is imperative that the description is comprehensive in order to formulate and record an informed opinion about its nature, severity and significance. However, even though some respondents in the current study were able to indicate the presence of an abnormality, they were unable to provide a description thereof. Respondents were provided with ample time to write the descriptions of their findings but they did not attempt the section. The absence of a description was noted even for abnormalities that were gross and appeared elementary in presentation and therefore presumably easy to describe.

4.4.2.3. The use of appropriate radiological terms.

It is imperative that the appropriate descriptive radiological terminology be used in order to describe abnormal and normal radiographic appearances. However the results reflect that the respondents were unable to utilise the correct radiological terminology to describe these findings. Furthermore most respondents utilised inappropriate terminology to describe findings and this rendered their reports irrelevant. The usage of these inappropriate terms led to construction of reports/descriptions that were not adequately linked to the radiographic appearances with the possible causal disease process. For example ***Respondent 31*** reported image PA 05 appearances as *'the whole right lung no appearance'*. The above description requires further analysis of the abnormality in order to demonstrate the nature, severity and possible significance of the abnormality. As a result the reports provided were vague and sometimes inaccurate. Notwithstanding the above its important to note that some respondents did utilise the terms opacification, consolidation and density in some of their reports.

4.4.2.4. Vague descriptions.

A clear description of an abnormality does lead to the correct formulation of a diagnosis. However several abnormal findings were vaguely described and due to these equivocal reports the true nature of the abnormality could not be formulated. For example ***Respondent 30*** on describing image 3 appearances wrote 'Trachea deviation, opacification, heart deviation to right'. ***Respondent 32*** described appearances on image 5 as 'nodules present, patchy appearances'. Image 8 was described by ***respondent 28*** as 'mottled appearance on both lungs'. Whereas ***respondents 13*** when reporting findings on image 3 noted that the 'entire right lung is affected. No lung fields can be seen.' These descriptions were unclear and not specific to and the nature of the abnormality could not be formulated. Furthermore it was impossible to compile a list of possible differential diagnosis. Therefore the specified descriptions were redundant and irrelevant.

4.4.2.5. Inaccurate descriptions.

Accurate reporting is dependent on the knowledge of anatomy, physiology and pathology (Kawooya 2007) as well as the imaging modality used. Furthermore it is reliant on the usage of appropriate radiological terminology. An analysis of the respondents' reports revealed inaccuracies in the descriptions provided. The descriptions provided were not indicative of abnormalities present on images. Thus incorrect possible causes for appearances were formulated. These descriptive inaccuracies led to an incorrect diagnosis. For example ***respondent 25*** noted the following on image PA 08 'on the right middle lobe the horizontal fissure is calcified and pulled upwards, on the left side the apical area shows area filled with air suggestive of pneumothorax' . Similarly ***respondent 12*** reported image 07 findings as 'left lower lobe is elevated air under the diaphragm'. These are examples of misdiagnosis as they depict a condition not present on the radiographic image.

4.4.3. Specificity, sensitivity, accuracy and differential diagnosis.

The following results are those that reflect the overall accuracy, sensitivity and specificity for the entire sample of the images. True positives [TP] and true negatives [TN] refer to those cases which the respondents correctly identified an abnormality and normality respectively. False positive [FP] and false negatives [FN] refers to a record of a normal image as being abnormal and an abnormal image recorded as normal respectively.

4.4.3.1. Specificity.

Specificity is an ability of the respondents to correctly identify a normal radiograph (Hardy and Culpan 2007). Specificity is calculated using the following formula; TN/TN+FN (see Table 3.2). The resultant specificity was found to be seventy one percent (71%). The overall percentage of specificity demonstrated in this study was very low. The specificity score achieved in this current study was lower than the 90–95% specificity benchmark levels used in radiographer reporting studies (MacKay 2006).

4.4.3.2. Sensitivity.

Sensitivity is an ability of the respondent to correctly identify an abnormal radiograph (Hardy and Cuplan 2007). Sensitivity is calculated using the following formula, TP/TP+FP (see table 3.2). The overall percentage of sensitivity of the radiographers in the study was recorded at eighty three percent (83%). Therefore the respondents in the current study were able to correctly identify 83% of the abnormal cases. The sensitivity of radiographers in this study demonstrates an alignment with the respondents' perceived ability to identify abnormal patterns on chest x-rays (see figure 4.4.3.A). The sensitivity scores achieved in the current study are however below the 90–95% sensitivity benchmark used in radiographer reporting studies (MacKay 2006).

4.4.3.3. Accuracy.

For the purpose of this study accuracy will be defined as the overall number of correctly identified cases as being either normal or abnormal. The following formula was utilised. TP+ TN/ TN +TP+FN +FP (see Table 3.2). The resultant accuracy of the respondents was recorded at seventy nine percent (79%). This means that in 79% of the cases the radiographers in the study were able to correctly state whether an image was normal or abnormal. Therefore in about twenty seven percent (27 %) of cases they were unable to correctly identify images as being normal or abnormal.

4.4.3 4. The differential diagnosis.

The differential diagnoses or the responsible disease process for abnormalities presented was accurately identified by respondents in fifty five percent (55%) of cases. This finding is aligned with the respondents' perceived ability to describe pattern changes on images as well as their knowledge scores (see figure 4.4.3B and 4.2.1). Fourty eighty percent (48%) of the respondents were able to correctly identify

cancer as a differential diagnosis. PTB was correctly stated as a differential diagnosis by seventy one percent (71%) of the respondents. Fourty six percent (46%) of the respondents stated pneumonia as a differential diagnosis. This is an interesting trend considering that the majority of the respondents reported that the were able to describe PTB patterns better than cancer patterns (see figure 4.4.3. B).

4.5. PERCEPTIONS OF RADIOGRAPHERS ON ROLE EXTENSION.

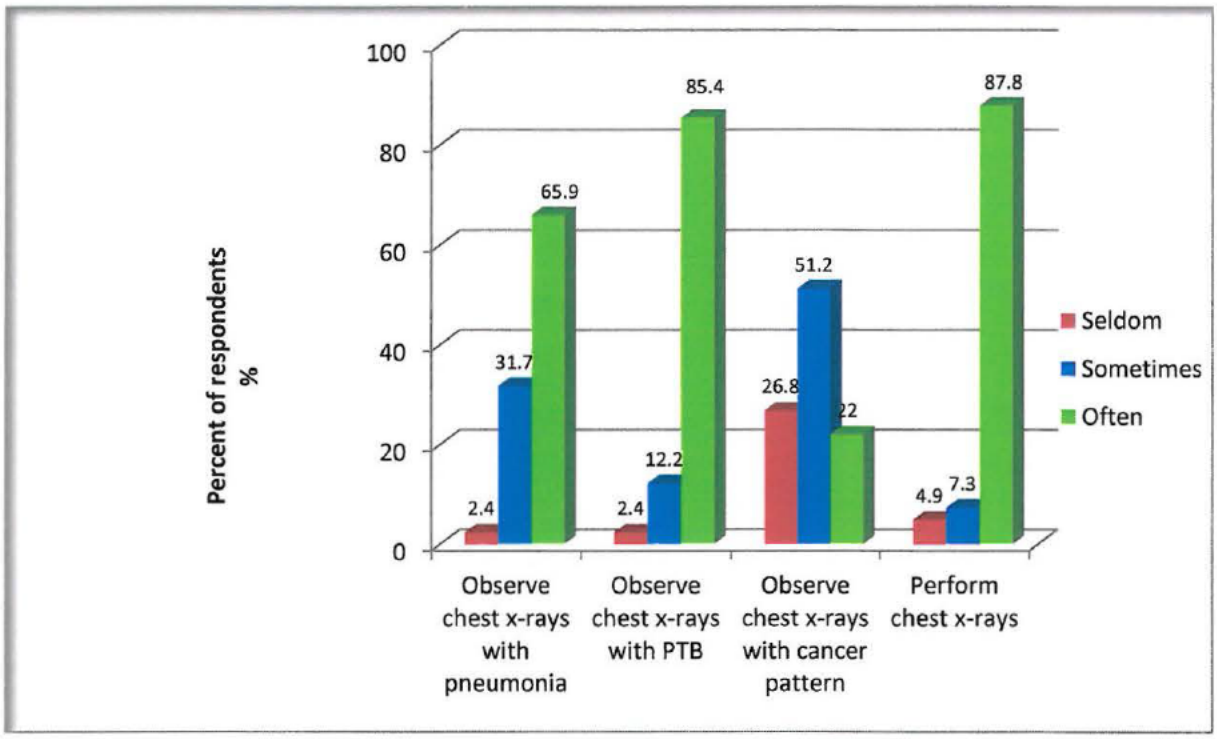
This section addresses the 3rd objective.

Objective 3: To establish the perceptions of radiographers towards reporting of chest images.

4.5.1. Perceived abilities to interpret chest images.

The figures and tables below present data on the responses of the respondents pertaining to role extension. Questions were asked to determine the extent of exposure the respondents have on chest x-rays as well as certain disease patterns. The eighty seven point eight percent (87, 8%) of the respondents indicated that they routinely perform chest x-rays. Eight five point four percent (85, 4%) of the respondents indicated that they often observe chest x-ray with PTB patterns. Whereas only sixty five point nine percent (65,9%) of the respondents reported they frequently observe patterns of pneumonia on chest images. Twenty two percent (22%) of the respondents reported that they often observe patterns of cancer on chest images (see figure 4.4.1). These observational trends may be reflective of disease demographics of the region. KZN has a high prevalence of PTB (UMzinyathi Health District 2009).

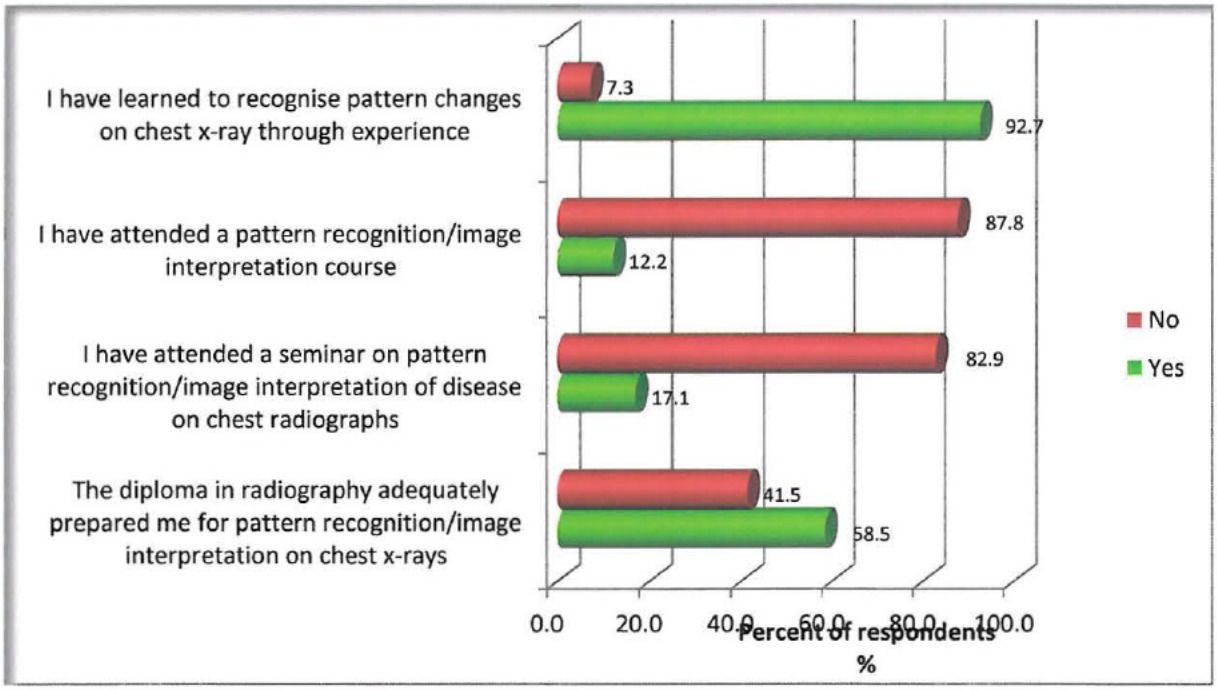
Figure 4.4.1: Prevalence of certain chest disease as seen on chest radiographs.



It is interesting to note that cancer patterns are reported to be observed far less than the other two infective diseases. This may have some implications on the identification proficiency of this disease by radiographers.

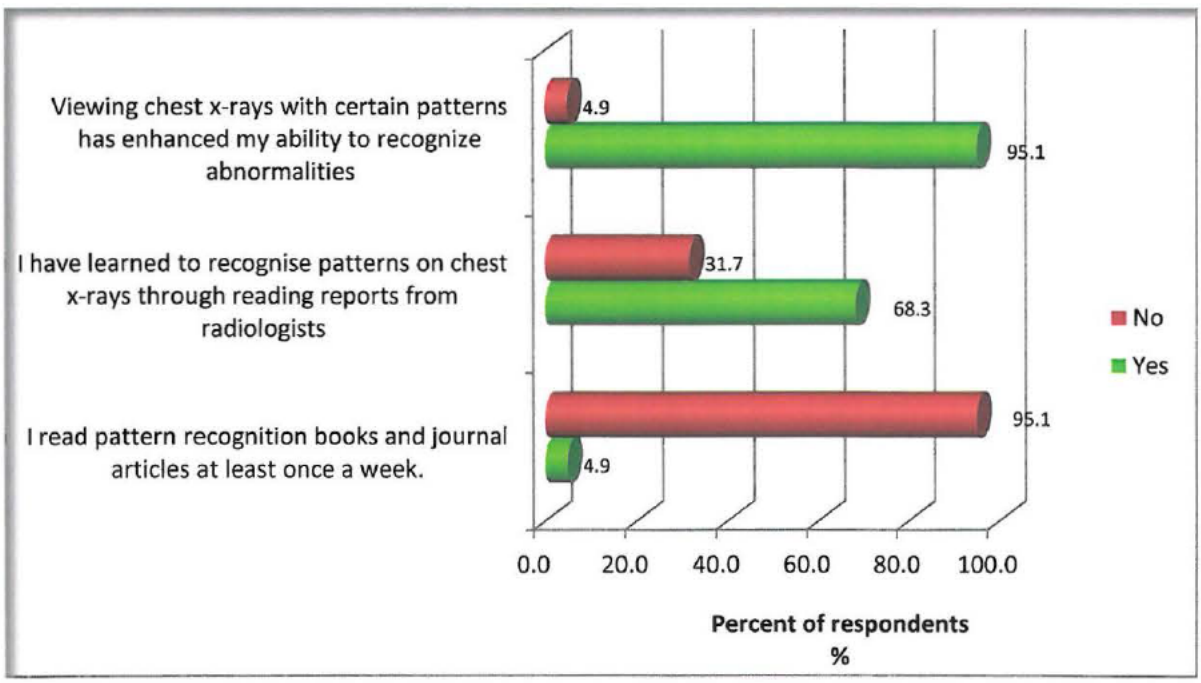
The figures below indicate the opinion of the respondents on their ability to recognise abnormal patterns on chest image (x-rays). Figures 4.4.2.(a) and 4.4.2.(b) present the prevalence of the responses on a particular question item. A high percentage of respondents (92.7%) indicated that they have learnt to recognise patterns through experience. See Figures: 4.4.2 (a).

Figures 4.4.2 (a). Approaches to acquiring pattern recognition skills.



Fifty eight point five percent (58.5%) of the respondents indicated that the National Diploma in Radiography contributed to their knowledge and skill to recognise abnormal patterns on chest images. There seems to be a lack of seminars and short courses on pattern recognition of radiographic images. Eighty seven point eight percent (87.8%) of the respondents contended that they have never attended any courses on image interpretation. Additionally about eighty two point nine percent (82.9%) of the respondents indicated that they have never attended a seminar where image interpretation was discussed.

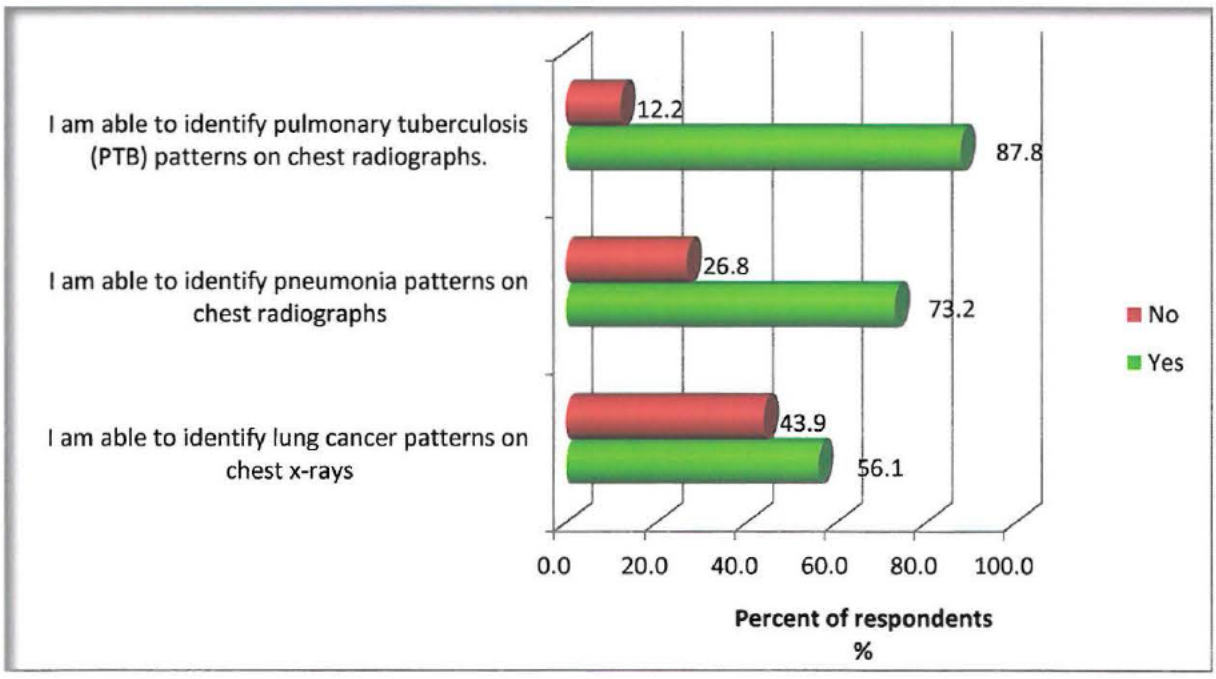
Figures 4.4.2.(b): Approaches of acquiring pattern recognition skills.



The majority (95%) of the respondents indicated that clinical exposure to certain disease patterns enhanced their ability to recognise abnormalities on chest radiographs. Parallel to this sixty eight percent (68%) of the respondents reported that they read image interpretation reports from radiologists to enhance their chest abnormality detection skills. However, only four point nine percent (4.9 %) of the respondents reported that they read image interpretation literature to enhance their knowledge and skills. This trend may be demonstrating priority patterns of radiographers.

Respondents were then asked questions that required them to indicate their abilities in identifying and describing patterns on chest images depicting three disease processes. These diseases were cancer, pneumonia and pulmonary tuberculosis. **Figure 4.4.3.(A):** and **4.4.3.(B**) present their responses with regard to their ability to identify and describe respectively the above diseases on chest x-rays.

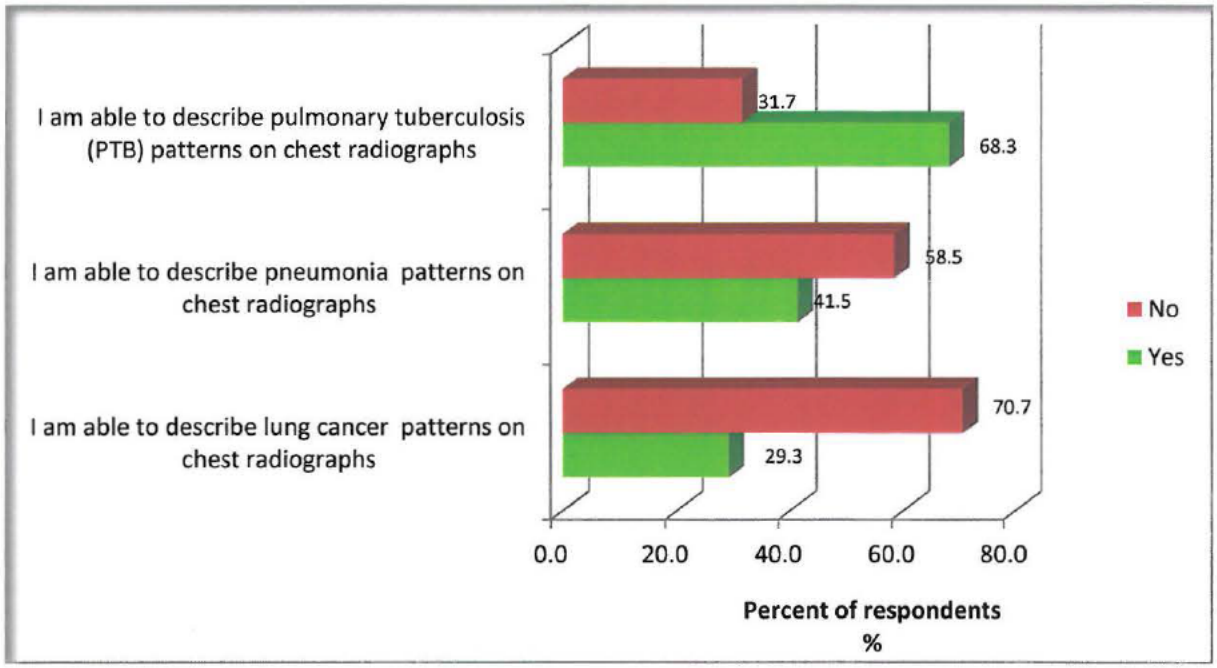
Figure 4.4.3 (A): Perceived ability to identify PTB, Lung cancer and Pneumonia patterns on chest radiographs.



Eighty seven point eight percent (87.8%) of the respondents indicated that they are able to identify pulmonary tuberculosis patterns on chest x-rays. Approximately seventy three percent (73%) and fifty six percent (56%) of the respondents indicated that they can identify pneumonia and cancer patterns respectively. The trends observed above are aligned with the respondents' clinical exposure to certain diseases (see figure 4.4.1). There is a parallel alignment between how often a particular disease pattern is observed e.g. PTB, and the respondents' perceived

ability to identify it on an x-ray. The respondents' perceived ability to describe abnormal patterns for PTB, lung cancer and pneumonia is depicted below.

Figure: 4.4.3 (B): Perceived ability to describe PTB, lung cancer and Pneumonia patterns on chest radiographs.



Seventy point seven percent (70.7%) of the respondents reported that they were unable to confidently describe cancer patterns on chest images. About fifty eight point five percent (58.5%) of the respondents indicated that they were unable to describe patterns of pneumonia on chest images. However this trend was inverted for the description of PTB. Sixty eight point three percent (68,3%) of the respondents indicated that they were able to describe PTB patterns on chest x-rays. There seems to be no link between the frequency of clinical exposure to certain disease patterns and the perceived ability to describe them. There also appears to be no connection between the ability to identify a particular disease pattern and the ability to describe it (see figure 4.4.3 A & B). This observation demonstrates that frequent clinical exposure alone is not enough for a radiographer to acquire the ability to describe patterns on x-rays.

4.5.2. The need for radiography role extension.

The figures and tables below indicate the perceptions of the respondents with regards to the various questions on aspects which indicate the need for radiography role extension into image interpretation. Furthermore they reflect the themes that emerged in the analysis of the qualitative data. Table 4.4.4 reflects the responses of the respondents on a cross-tabulation of the question "Have you ever been asked by

a medical officer or nurse or any other practitioner to comment on the appearances of an x-ray?" and "Did you comment on the said radiographic appearances?"

Table 4.4.4: Respondents that were asked for an opinion on radiographic appearances.

			Have you ever been asked by a medical officer or nurse or any other practitioner to comment on the appearance of an x-ray?		Total
			Yes	**No**	
Did you comment on the said radiographic appearances?	Yes	Count	26	0	26
		% of Total	63.4%	0.0%	63.4%
	No	Count	8	7	15
		% of Total	19.5%	17.1%	36.6%
Total		Count	34	7	41
		% of Total	82.9%	17.1%	100.0%

Eighty two point nine percent (82,9%) of the respondents indicated that they had been asked to comment on the appearance of an x-ray by either a medical officer, nurse or any other health care professional. Of these sixty three point four percent (63.4%) of the respondents indicated that they did in fact comment on the x-ray appearances. The most prevalent reason for radiographers to provide an opinion on radiographic appearances was to assist the medical officer and by extension ensure the wellbeing of the patient. The respondents which refused to provide an opinion on radiographic appearances explained that providing a diagnostic was not in their scope of practise. ***Respondent 18*** explained through her statement that she '*...have been advised since being a student to never comment on films to avoid legal issues'*. For most respondents the concern for the patients' wellbeing outweighed the perceived legal restrictions placed on them with regard to availing an opinion. However the reported reason for commenting on radiographic appearances was to assist fellow practitioners, doctors, nurses and other allied health care professionals. Consequently ninety seven point six percent (97.6%) of the respondents believed that their roles should be extended to include image interpretation if they are to be of further service to the patient and their colleagues. See Table: 4.4.5. and 4.4.6

Table: 4.4.5: The need to extend the role of the radiographer.

	Frequency	Percent
Yes	40	97.6
No	1	2.4
Total	41	100.0

The qualitative data demonstrated in the table below provides a list of themes that emerged as reasons for the need to extend the role of the radiographer (see table 4.4.6). These themes are organised according to questions through which they emanated.

Table 4.4.6: Emergent themes from the qualitative data.

Emergent Themes (On the Qualitative data) radiographer opinions.
30. Why did you comment? 1. Assist fellow practitioner (collegiality and service delivery by implication)
31. Is there a need for role extension **1.** Absence of radiologists 2. Improving Service Delivery 3. Radiography professional development 4. Inexperienced interpreters (doctors and nurses)
32. Areas where role extension need priority 1. Frequently requested examinations 2. Examinations frequently depicting pathological patterns
33. Type of education 1. Orientation to Professional development. 2. Orientation to Acquisition of necessary skills (authentic learning)
34. Medico-legal implications of image interpretation 1. Legal implications 2. Medical implications 3. Accountability
35. How to mitigate medico-legal issues. 1. Intensive accredited education and training. 2. Ongoing audits and collaboration 3. Medico-legal cover.

One of the major reasons that drive the need for role extension was indicated by respondents as the shortage and in some instances the absence of radiologists.

There was also a need to improve service delivery and to develop the profession of radiography. Moreover the need was driven by the usage within clinical settings of inexperienced image interpreters. Additional discussions on role extension revealed that the implementation needs to respond to current healthcare needs are within the radiology departments. Moreover the respondents indicated that the education and training for the new roles should be tailored to respond to the needs of the consumers, radiographers. An analysis of these themes is outlined below.

4.5.2.1. Absence of radiologists.

This is said to be one of the most pervasive themes that emerged in the study. The respondents indicated that the absence of the radiologists was one of the major reasons to extend their roles, especially within the KZN province. ***Respondent 23*** stated that there is a '*shortage of radiologists in KZN*'. Consequently, many institutions have x-ray facilities without the presence of a radiologist. Furthermore the few institutions that have radiologists during the day shift, do not have these specialists for after hour duties. Consequently junior doctors are being trusted with the task of decision making on many aspects of patient management. ***Respondent 15*** explained that '*Often radiologists are not available after hours and junior doctors are usually the first to consult with the patient*'. It is in this regard that the respondents felt that radiographers would be helpful to extend their role into image interpretation in order to facilitate patient management. These respondents emphasised the importance of their roles should their scope be extended.

4.5.2.2. Improving Service Delivery.

Improving service delivery emerged as one of the important foundations of role extension for radiographers. The respondents felt that with their role extended they would be making clinical decisions and a subsequent impact to the advantage of the patients. They also felt that currently their role is integral to the wellbeing and management of the patient but with the extended roles measurable impacts can be made. ***Respondent 6*** explained that *"It will cut down the waiting time of patients that either have gross pathology or pathology present."* ***Respondent 36*** also added that '*Interpretation of images is necessary to fast track patients that require urgent medical attention*'. The current health needs warrant that radiographers be responsive and be accountable for the development of their profession in order to fully respond to current healthcare needs. Beyond service delivery improvements the respondents reported that the extension of the role will also positively impact on their professional development.

4.5.2.3. Radiography professional development.

Williams (2006) noted that the role of radiographers in South Africa has not developed and thus still viewed only as a technical job. This has major implications to the practitioners in radiography. Even though the radiography profession forms an integral part of the healthcare team, radiographers as practitioners have always been viewed as technical operators with no practitioner clinical impact (Gqweta 2012). ***Respondent 36*** pointed out that even though the role of the radiography profession has always been integral to the decisions made, role extension will *'enlighten/empower the profession of radiography.'* Radiography is a rapidly changing profession in terms of technology; however such change has not been occurring with the practitioners. Role extension will ensure professional development in terms of practitioner impact within the clinical environment. Further analysis of the response revealed that role extension is a requirement driven mainly by the absence of radiologists and the subsequent presence of inexperienced interpreters.

4.5.2.4. Inexperienced interpreters (doctors and nurses).

Radiographers have always been of assistance to other health care practitioners that require help with image appearances, however this practice has always been informal and between the professionals. The respondents in this study expressed that role extension will ensure patient management is fast tracked through assisting junior medical doctors, especially after hours. ***Respondent 15*** explained that *'radiographers should be able to comment on image appearances to assist early start to treatment'*. The theme demonstrates a sense of responsibility towards the patient through an action of collegiality.

4.5.3. Areas for initial role extension and types of education.

The following section demonstrates the respondents' responses with regard to the areas where radiographers can extend their roles to. Ninety seven point six percent (97,6%) of the respondents indicated that the chest x-ray image is one area where a radiographer can initially extend their roles to. The reason for prioritising the chest is two-fold. The first reason being that chest x-ray images are the most frequently requested and performed x-ray examinations, as observed by the respondents. Secondly the respondents reported that they have observed many disease processes on chest x-ray images. Thus two themes emerged from this analysis: theme 1: frequently requested examinations and theme 2: examinations frequently depicting pathological features. The analysis of these themes follows:

4.5.3.1. *Frequently* requested examinations.

The respondents in this study indicated that image interpretation for radiographers should begin with examinations that are frequently requested and performed. In addition they felt since these examinations are frequently performed it would be wise to respond to the need. The chest x-rays emerged as the most frequently requested and performed x-ray examination in x-ray departments. The respondents explained that the frequency of these chest examinations is justified. This is because many medical protocols, treatment and monitoring requires a chest x-ray as either the basis for diagnosis, monitoring during and follow up after treatment. ***Respondent 40*** purported that *'everything begins with the chest. For example if patient is going to theatre or things like that they will always ask for a chest x-ray. It is the most important and the most difficult'.* The respondents also indicated that in order to make a relevant contribution towards patient management they will have to respond to this demand. ***Respondent 12*** explained that '*CXR are most commonly performed after hours and during day. It's vital that we can see changes in the chest.*'' The provision of health care is based on the principle of prevention, however where this has failed it uses the protocol of effective and adequate reaction that will have a positive clinical impact. The current respondents indicated that they will be responding to the need of current health care needs through radiography role extension into image interpretation.

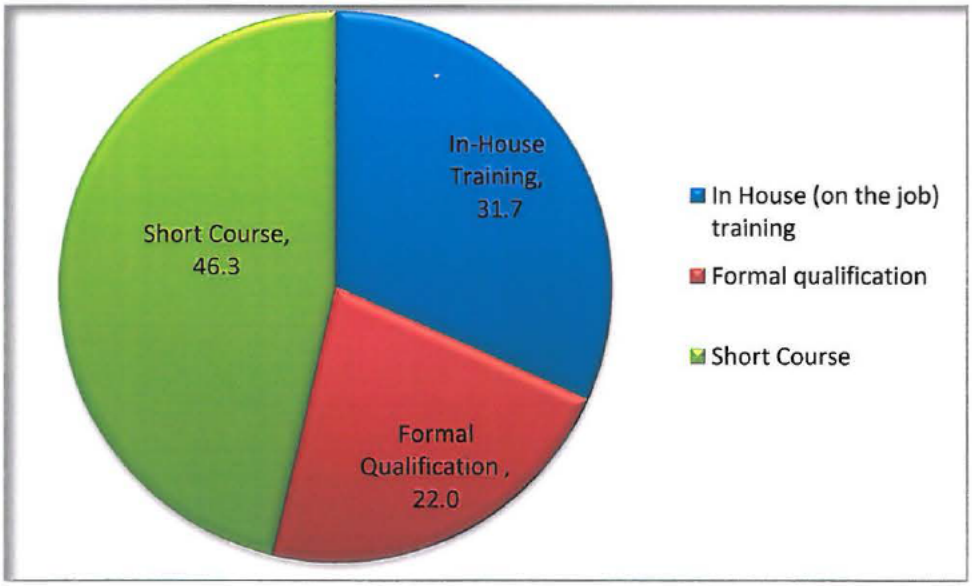
4.5.3.2. Examinations frequently depicting pathological patterns.

The majority of the respondents explained that priority, in terms of radiography image interpretation, should be provided to the areas where the majority of pathological patterns are observed. This theme is aligned with the one above. Consequently the chest x-ray was the area that the respondents have frequently observed abnormalities in. The increase in the disease patterns demonstrated within the chest x-ray could be said to result from regional environmental factors. ***Respondent 17*** explained that he '*chose CXR because majority of patients we x-ray have chest pathology.*' ***Respondent 28*** reiterated that radiographers should be allowed to interpret chest x-rays *'because of the prevalence of HIV and TB in KZN'.* Therefore the relevance of the radiographers' role is directly proportional to addressing the current health care needs.

4.5.4. Preferred types of education and training.

Respondents recognised that there is a need for training and education in order to effectively perform within the extended roles. However there were differences with regard to the duration and structure of such training. Fourty six point three percent (46.3%) of the respondents indicated that they prefer short courses. And the rest were split between in-house training, thirty one point seven percent (31.7%) and post graduate diplomas or degrees twenty two percent (22%) (see Figure 4.4.6).

Figure 4.4.6: Preferred education and training strategy for role extension.



The analysis of the qualitative data pertaining to training and education revealed the following themes: orientation to professional development and orientation to skills development.

4.5.4.1. Orientation to Professional development.

Most respondents understood that as part of professional development and recognition it would be important to embark on a formal qualification for image interpretation. They explained that any other form of education will not provide sufficient in depth theoretical and practical knowledge that will enable them to be independent practitioners in the area of image interpretation. ***Respondent 15*** explained that *'a recognised qualification will also mean greater recognition of oneself.'* ***Respondent 39*** reiterated that a *'formal qualification is always better as it is more credible'.* These respondents explained that with a formal post graduate diploma or degree there will be enough time to ensure that all possible pathological patterns of particular areas are discussed in-depth. Furthermore they emphasised the importance of increasing the standing of the profession through this type of

education. The formal qualification was therefore seen as being aligned with professional development and recognition. It also meant recognition by those within and outside the profession increasing the professional standing within the clinical environment.

4.5.4.2. Orientation to skills development.

Time constraints and family responsibilities were reasons that most respondents opted for a shorter learning period. These respondents indicated that they still need to earn a salary whilst they are studying in order to simultaneously attend to personal and family responsibilities. They explained that formal post graduate qualifications e.g post graduate diplomas and degrees would leave little or no time for them to fulfil their family responsibilities. Consequently these respondents chose to engage in short term studies as opposed to long term studies. ***Respondent 25*** felt that a *'long diploma or degree course might need you to be a full time participant in academic study .You might not be allowed to earn a full salary.'* Therefore ***respondent 29*** proposed that a *'3-6 months course is enough to acquire image interpretation skills if conducted on a module basis, without demanding far much time from people'*. One of the outcomes of this theme was that the learning gained though short courses and in-house training programmes be relevant and made authentic through immediate application. ***Respondent 9*** alluded to this and explained that *'when people learn as they do, the practical approach allows for deeper understanding'.* These individuals explained that the current radiography curriculum has provided them with the basics in image interpretation and that it would not be necessary to embark on long term education and training. The aim of these individuals was to acquire the necessary skills and practice within defined medico-legal confines.

4.5.5. The implications of radiography role extension.

The role of the radiographer expands parallel with the increasing potential for medico-legal implications (Williams 2006). In alignment with the above statement, the respondents in the study understood that legal implications may rise with increasing responsibility. **Respondent 36** explained that *'whenever image interpretation is present there will be litigations; it is your report that doctors base their management on together with their clinical findings, of course.'* Following the same vein of reasoning **Respondent 3** explained that *'anything which is patient related has medical implications. If you get to interpret the chest image wrongly the patient might be given the wrong' medication'.* These respondents were of the opinion that there might be increased litigation instituted against radiographers

personally for misinterpretations. The implications are far reaching and can extend to the particular practitioner being removed from the HPCSA register as not complying with the minimum standards of care stipulated by the council. As a consequence, these respondents voiced that institutions should have a medico-legal cover for reporting radiographers. In the UK the Trust of the National Health System will take responsibility for vicarious liability with the understanding that all conditions have been met and agreed upon. However in South Africa malpractice insurance is available to public sector employed radiographers who are personally responsible for payment of annual fees (Williams 2006).

Consequently with role extension into image interpretation radiographers will be held liable for their actions. An incorrect diagnosis arising from incorrect interpretation by a radiographer not adequately trained and not having the necessary skills to practice within a particular area may lead to a disciplinary action. Thus measures should be instituted in order to prevent law suites resulting from malpractice or negligence. The current study revealed the following themes.

4.5.6. Addressing the implications.

4.5.6.1. Intensive accredited education and training.

Intensive accredited education and training was one of the ways that the respondents indicated may mitigate the medico-legal implications. The respondents also explained that a stringent training process will minimise the possibility of misdiagnosis/ misinterpretations by radiographers. ***Respondent 30*** explained that '*image interpretation must be accredited training comprehensive to ensure accurately enough to prevent false diagnosis'*. Ongoing training to refine the skills of reporting radiographers was recommended; ***respondent 3*** suggested that '*we can send radiographers for another course until they are confident in what they have to do'.* Prime, Paterson and Henderson (1999) concluded that there is evidence that radiographers have the potential to report, provided that there is sufficient, organised training to competently perform in the extended role.

4.5.6.2. On-going audits and collaboration with the radiologists.

One of the suggested ways to mitigate medico-legal implication was ongoing audits of radiographers and collaboration with the radiologists. Most of the respondents concur that there should be random audits by radiologists where at certain intervals random radiographers' reports are re-interpreted by radiologists. This will ensure that

the radiographers are kept at optimum performance levels all the time. Thus where a decrease in standard is identified remedial action can be effected immediately. A similar comment from a study by Brandt *et al* (2007) was made that this practice (report writing) needs input from senior radiology staff to guarantee quality control, minimise litigation and maintain a proficient level of competency. It is within this vein of thought that **respondent 6** explained that there in a need to *"have the radiologist do checks on random reports before handing them to the patient."* Image interpretation by radiographers will need the collaboration between radiographers and the medical team. This will ensure consistence and adequate care provided to the patients. Previous studies have noted that in the absence of suitable training and audit, the quality of services provided to the accident and emergency (A&E) departments could significantly be reduced (Hardy and Culpan 2007).

4.6. Chapter Summary

Fifty six percent (56%) of the respondents in this study were within their first ten (10) years of working life. Most of these respondents have ascended their ranks into the chief radiographer post. A majority (56%) of the respondents had only their three (3) year diplomas and only about 31% had BTech degrees. It is interesting to note that the highest qualification that these respondents had was a BTech degree. A relationship is demonstrated between the self-reported abilities of radiographers to interpret images and the actual performances on the skills and knowledge tests. The majority of the respondents reported having an ability to identify abnormalities but few reported to be able to accurately describe these abnormalities. The results from the skills section revealed that the respondents lacked the ability to describe certain patterns as well as link these patterns to certain diseases. Sixty percent (60%) of the respondents were able to score above 50% for the knowledge section. These scores are significant for the study as none of the respondents scored 80% or more which was set as a level that demonstrates adequate knowledge. The perceptions of the respondents on role extension are positive and support the concept. These respondents feel that there is a need to extend their role in order to respond to current radiological needs. However respondents do feel that there is a need for the amendment of the current legislative and provision for appropriate further training and education. They understood that the extended roles will not increase their skills and knowledge but will develop their profession.

CHAPTER FIVE

5.1. Introduction.

This section discusses the results of the study. It elaborates and explores the trends that are emergent on the research results which may assist in answering the aim of the study. The discussion includes a view into the current situation within the South African radiography profession in order to provide context into proposed career developments. The interaction between the role of the radiographer, the chest x-ray and the current health needs of radiology services is explored. The potential of a reporting radiographer within the clinical setting is scrutinized. The discussion further explores the current image interpretation skills possessed by radiographers. Furthermore it explores the strategies that are employed by radiographers to acquire image interpretation skills. Future education and training needs and strategies are discussed. The need for role extension especially into image interpretation is contextualised through the discussion of prevalent diseases within South Africa. The role of the chest x-ray is explored in relation to the diagnosis of these diseases. In addition factors that influence the need for the change of the role of the radiographers are explored. A summary of the chapter is provided.

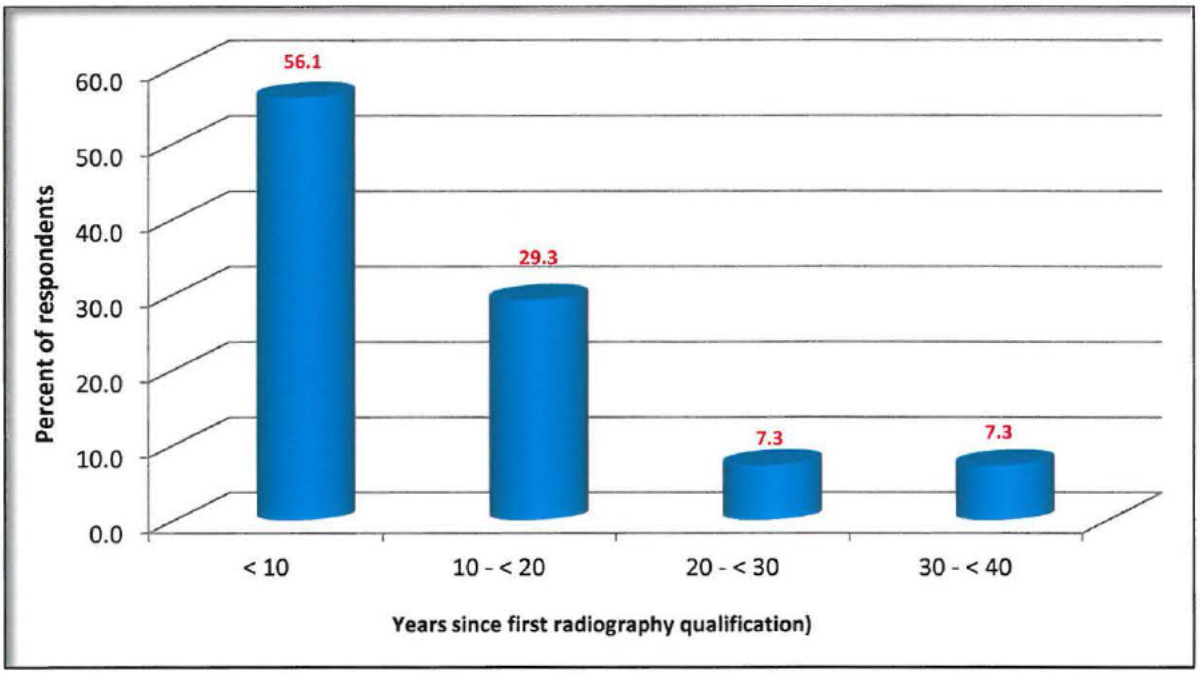
5.2. Currently in the South African radiography profession.

The results of the current study provide valuable information about the subject of image interpretation by radiographers. The concept of image interpretation is a subset of role extension therefore the current data is vital for, and can be utilised in, radiography professional development strategies. The radiography profession elsewhere and in South African is undergoing continuous and rapid technological development (Brandt et al 2007). However there is diminutive progress in professional development and transformation that is aligned with current healthcare needs. Furthermore the development of the radiography profession is slow in South Africa and not in keeping with the health care needs (Gqweta 2012). The personnel profile of the profession is reflective of this slow change.

Eighty point five percent (80.5%) of the respondents were females and only nineteen point five percent (19.5%) were males. Gender and age distribution are presented on Table 4.1.1. These gender demographics were noted and are similar to those of a previous study (Gqweta 2012). Fourty eight point eight percent (48.8%) of the respondents were within the age group between twenty (20) and thirty (30) years. Of this group only fifteen percent (15%) were males. These demographics may be

demonstrating the profile of the majority of the working age group within the radiography profession. The age demographics are also aligned with the respondents' work experience where fifty six percent (56%) of respondents received their first qualification in the past ten years (figure 5.1). This group constitutes the majority of the respondents.

Figure 5.1: **Experience: First Qualification.**



The analysis of the data revealed specific trends that may be indicative the need for additional skills to the role of a radiographer. The majority of the respondents (56%) possessed 3 year diploma qualifications. Approximately one third (31,7%) of the respondents possessed Baccalaureate in Technology (B.Tech) radiography degrees. There appeared to be a lack of motivation to obtain higher qualifications. This may be due to current unclear or non-existent career pathways in the South African radiography profession. Almost half (46%) of the respondents are chief radiographers. The chief radiography rank is the highest rank of progression in clinical radiography (Society of Radiographers of South Africa (SORSA) 2009). Beyond this rank there is no clinical position except a managerial position which may not suite the ability and interest of the entire workforce. Moreover the managerial positions are competitive, few and may require a vast amount of experience to execute effectively. In the current study the managerial ranks were represented by only twelve point two (12.2%) percent of the respondents.

There is an indication that within ten (10) years of obtaining the first qualification, an individual radiographer would have worked their way up into the chief radiographer rank. This has serious implications for the radiography profession and practitioners. These implications may include a decrease in radiographer morale in the working environment and lack of inspiration to improve one's qualification. The decrease in morale may arise from the performance of routine day to day radiography tasks with no novelty (Gqweta 2012). This may indirectly lead to poor service delivery, a reduction in the interest from prospective practitioners and a negative impact on current retention strategies. A career path has been proposed by the Society of Radiographers of South Africa (SORSA) through the Occupational Dispensation Document (SORSA, 2009). However there have not been any structural changes within the department of health that are aligned with this proposal. The majority of individuals in the chief radiographer rank are approximately 30 years of age. Accordingly, these individuals still have approximately 30 years to work on the same clinical rank if they have no aspirations of becoming managers.

The South African radiography profession has no clinical rank higher than that of a chief radiographer (SORSA 2009). A national diploma qualification with adequate experience is sufficient for an individual to function up to the level of a chief radiographer rank. As a result of the lack of incentives for radiographers to improve their qualification beyond a national diploma, there is poor motivation to acquire higher qualifications (Gqweta 2012). Radiography role extension in particular towards chest image interpretation, can offer a platform for new career roles. These roles may in turn encourage further education and training of individuals who are to practice them proficiently and professionally. Conversely all the anticipated changes may be advocated for by the researching of the current situation within the radiography profession.

5.3. The radiographer, the chest x-ray and current healthcare needs.

The interplay between the radiographer, the chest radiograph and current healthcare needs provide justification for a debate on changes of the current professional acts of South African radiographers. The role of the chest radiograph is imperative and relevant in the management of patients (Delrue *et al* 2011). The role of the radiographer in the production of a diagnostic chest radiograph that will allow for subsequent proper diagnosis is unparalleled. Furthermore the prevalence of the requests and performance of chest x-ray examinations within radiology departments sets the framework for development of the radiography profession. Eighty seven point eight percent (87, 8%) of the respondents indicated that they routinely

performed chest x-ray examinations. A previous study by the author also reported a similar trend (Gqweta 2012).

Chest x-rays are utilised as diagnostic tools in the management and diagnosis of patients (Malnick *et al* 2010). Thus the radiographer's knowledge and skills on the production of high quality and diagnostic radiographic images of this area is crucial. Furthermore the radiographer's knowledge and skills should also include the ability to distinguish between an abnormal from a normal chest radiographic pattern. Therefore radiographers need to constantly update their knowledge about common occurring diseases of the region. Eighty five point four percent (85, 4%) of the respondents reported that they mostly observe chest x-rays with PTB patterns. Approximately sixty five point nine percent (65, 9%) of the respondents reported to observe pneumonia patterns on chest x-rays and only twenty two percent (22%) of the respondents reported to frequently observing lung cancer patterns. These observational trends reflect the prevalence of the occurring disease within the region. The province of KZN experiences a high prevalence of PTB infections mostly as a result of HIV and AIDS (Lehohla 2012).

Pulmonary Tuberculosis claimed many lives in the year 2004 when an outbreak of a strong strand of Xtreme Drug Resistant (XDR) tuberculosis was discovered in Msinga a vast rural area within the KZN province (uMzinyathi District Management 2009). Consequently the XDR and the MDR (Multiple Drug Resistant) strands of PTB have since been discovered in other areas of the KZN province (Master 2011). Therefore the observational patterns reported by the respondents are consistent with the prevalent disease occurring in this province. According to these observational trends pneumonia is the second most and lung cancer the least prevalent chest disease (Oostewyk 1999; Lehohla 2012). As a consequence of the shortage of radiologists within the South African health system, radiographers are often called upon to comment on image appearance (Gqweta 2012). Accordingly, radiographers need to have thorough knowledge and skill to identify these disease patterns on chest radiographic images. This will ensure that they provide an informed opinion on chest radiographic images when required by referring practitioners. Currently the South African Health Act provides guidelines for radiographers to communicate the results of the examination of which they have performed to the referring practitioner (Republic of South Africa; Government Gazette 29079 2006). The majority of the respondents in the current study indicated that they exercise the above right. However in order for the radiography profession to fully engage the existing health

care needs in radiography, the extended roles will need to be formally mandated, regulated and implemented.

5.4. Radiographers interpreting the radiographic image.

Fifty eight point five percent (58.5%) of the respondents indicated that their diploma in the radiography qualification was instrumental in them acquiring their knowledge and skills to recognise abnormal patterns on chest x-rays. However there seems to be a lack of practical application of these skills. The current study demonstrates this lack of application in two ways. Firstly, the image interpretation knowledge scores obtained by respondents demonstrated an inadequate level of knowledge. All of the respondents in the current study obtained less than 80% on the image interpretation knowledge test. A score of eighty (80%) percent was deemed an adequate achievement for the study. The choice of the 80% mark was based on the fact that the schooling and university systems deem this as an excellent level of performance and thus achievement (Victorian University of Wellington 2007; Kwantlen Polytechnic University 2011). It does however reflect that about 20% of the related data is either not understood or adequately utilised. This may have some implication for the clinical setting; however it is unrealistic to set the expectancy achievement at 100%. Since no data on radiography image interpretation knowledge scores was found, it was appropriate to institute the excellent level as deemed in academia. This score was however, lower than scores of ninety percent (90 %) to ninety five percent (95%) utilised for sensitivity and specificity in image interpretation studies (Mackay 2006). Therefore an achievement level that is lower than the set eighty percent (80%) indicated an inadequate level of image interpretation knowledge in selected abnormal chest patterns. Secondly the respondents demonstrated a lack of skill in describing the specific radiographic features related to pulmonary tuberculosis, pneumonia and cancer during image interpretation. In alignment with a previous study (Gqweta 2012) these observations demonstrate that the knowledge imparted during undergraduate radiography studies is inadequate for comprehensive application within the clinical setting.

5.5. The current strategies to develop image interpretation skills.

The results of the current study demonstrate that there is a need for a dedicated image interpretation course that will address the current health care needs and the skills deficiencies. Presently there is a deficiency in the presentation of image interpretation educational opportunities such as seminars and short courses which are dedicated to image interpretation for radiographers in some of the provinces.

Eighty seven point eight percent (87.8%) of the respondents indicated that they have never attended any courses on image interpretation. A further eighty two point nine percent (82, 9%) of the respondents reported that they have never attended any seminars that taught or discussed chest x-ray interpretation. It is unclear whether these courses and seminars are offered and respondents don't attend or they are not offered at all. Whatever the case may be, this trend may be indicative of the lack of initiatives by radiographers to enhance their knowledge, skills and professional status. Currently the role of the radiographer is still viewed only as a technical support with no professionally attached clinical contribution to the patient management process (Williams, 2006).

Equally surprising is the lack of self-directed learning towards acquiring adequate image interpretation skills. Ninety five percent (95%) of the respondents indicated that they do not read any image interpretation literature. However they indicated that a constant exposure to a clinical setting with certain disease patterns on chest x-rays enhances their ability to recognise abnormalities .Five percent (5%) of the respondents reported that they actually do read literature on image interpretation. Whereas a sixty eight percent (68%) of the respondents reported that they read image interpretation reports from radiologists to enhance their chest abnormality detection skills. It is of interest to note that these forms of learning are practical in nature and infused within the radiographers' day to day duties.

The current methods of obtaining image interpretation knowledge and skills are informal and not mandatory. The responsibility is therefore on the interested radiographer to pursue further knowledge in this area. Consequently there may be complacency in acquiring the skills and knowledge pertaining to image interpretation. The lack of career pathways coupled with the absence of image interpretation accredited training programs for radiographers may be at the heart of this complacency. It is however, necessary to note that a thorough knowledge of specific abnormal radiographic patterns is pivotal, if radiographers are to have a positive impact on the clinical management of patients. Furthermore image interpretation requires that an individual have sufficient knowledge of terminology used to describe patterns on radiographs. Equally important is the knowledge of patterns that are suggestive of certain diseases (Piper and Paterson 2009; RANZCR 2010). This is imperative in directing or guiding, with clinical history, the management and thus positive clinical outcome of patients (Kawooya 2007).

5.6. Image interpretation: currently in the South African radiography profession.

Most undergraduate diagnostic radiography programmes in the UK comprise of a basic level of training in image interpretation. However, there is diminutive evidence to support that this education is satisfactory to be competent in reporting trauma radiographic images (Hardy and Culpan 2007). The South African radiography curricular also includes some basic image interpretation material within the undergraduate courses (Gqweta 2012). However this basic image interpretation skill is mostly utilised by radiographers in the clinical environment as a tool to judge and comment on the diagnostic quality of an image. Furthermore they use this knowledge as a decision premise on the need for additional views.

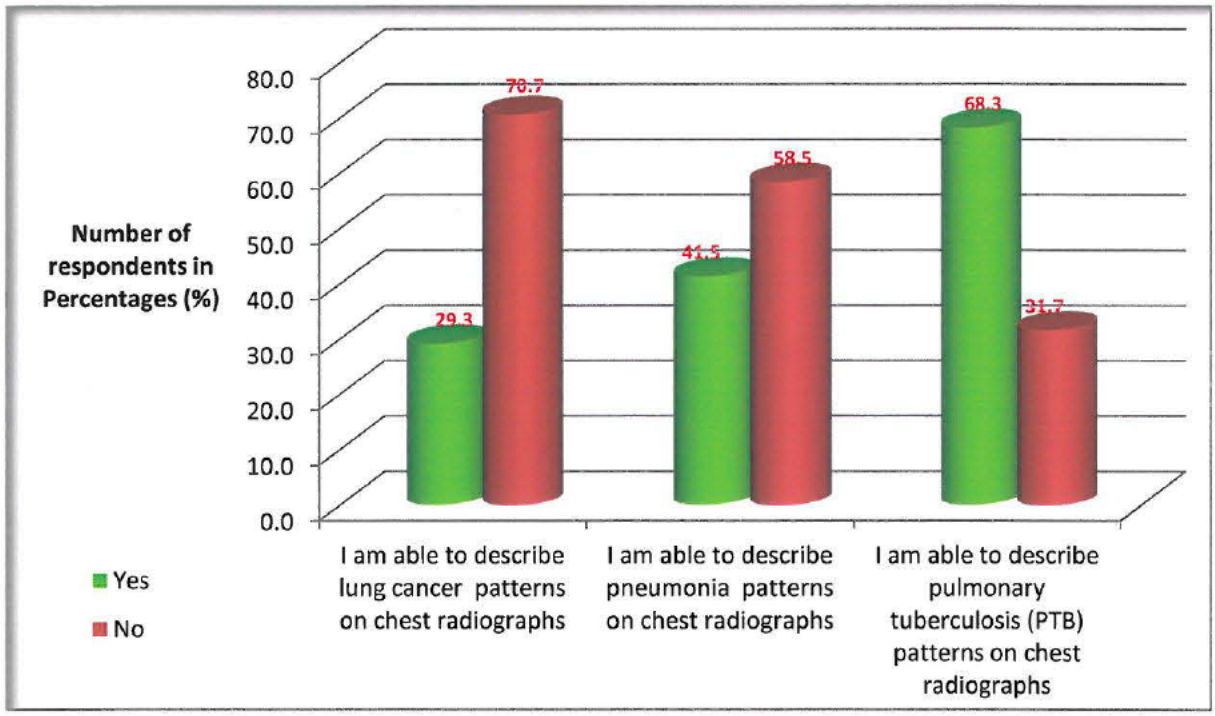
The current results demonstrate that image interpretation skills of radiographers without intensive formal training is inadequate to influence or direct patient management. The ability to identify an abnormality may not be enough, on its own, to influence patient management without further description and analysis of the abnormality (Kawooya 2007). A chest x-ray reported as depicting abnormal patterns does not adequately assist a medical officer who is looking for possible causes for the patient's signs and symptoms. Thus as a result of the shortage of radiologists as reported in many studies (Gqweta 2012; Williams 2009; Brandt *et al* 2007; Williams 2006) radiographers may need to acquire the necessary skills and knowledge to describe and identify the location of an abnormality. This may lead to a compilation of most likely causal diseases (differential diagnosis). However the involvement of radiographers to this level may need additional training and the amendment of their scope of practice to include the new roles.

5.7. Image interpretation: Implications for future education and training.

Image interpretation is based on the thorough description of the patterns observed. When an abnormality is thoroughly described, its patterns may be checked against patho-physiology of different diseases (Delrue *et al* 2011). Consequently this result in the selection and compilation of differential diagnosis with the most likely positioned at the top of the list. The current study revealed a discrepancy between the respondent's perceived ability to describe an abnormality and their actual capability. The respondents in the current study reported that they are able to describe the appearance of PTB, pneumonia and cancer (see Figure 5.2). However these respondents were unable to obtain a satisfactory mark on an assessment aimed at evaluating their ability to describe patterns pertaining to chest diseases.

Furthermore they were unable to adequately describe the appearances as seen on images that represented these diseases. Consequently they were unable to provide radiological descriptions that were directive towards causal disease. However these respondents were able to identify the abnormality and in certain instances identify the responsible disease for such an abnormality.

Figure 5.2: **perceived ability to describe PTB, Cancer and Pneumonia patterns.**



During image interpretation phase of the current study, respondents used minimum directive descriptions of PTB. In most instances these respondents did not use the correct image interpretation terms to describe the abnormalities. Consequently these descriptions were non-directive in terms of which disease the patterns may be presenting. There seemed to be an inadequate usage of the correct image interpretation terminology. The inadequate usage may be stemming from non-formal engagement of radiographers with image interpretation in clinical settings (Gqweta 2012). It is important to note that the pivotal point of image interpretation is in the description of the abnormality which leads to analysis and diagnosis (Piper and Paterson 2009).

There is a need for the reporting radiographer to understand the patho-physiology of certain diseases (Kawooya 2007). Accordingly knowledge of the pathophysiology of these diseases (e.g. PTB, Cancer or pneumonia) will enable the reporting radiographer to know what patterns to expect on the radiograph. However, understanding the pathophysiology comes second to basic knowledge of normal

anatomy and physiology (Delrue *et al* 2011). Consequently effective image interpretation is based on the thorough knowledge of the normal anatomy and physiology of the area under examination. Thus the curriculum for the training and education of the reporting radiographer will have to include modules on anatomy, physiology and pathology. Only through a thorough knowledge of the normality will radiographers be able to distinguish abnormality and thus effectively respond to the South African healthcare needs, specifically radiological services. The current study demonstrates the lack of, and the need for a multi skilled individual within the radiography clinical setting to caution the impact of radiological personnel shortages. The need for a radiographer with such knowledge and skill is evident especially within the primary healthcare (PHC) system, rural areas and during after hour duties (Gqweta 2012; Brandt *et al* 2007).

A study by Piper and Paterson (2009) on the ability of radiographers to report on trauma radiographs followed a three phase framework. This framework included an identification of the abnormality, analysis and recording of the findings. The current study also utilised this system because the inclusion of stage three (interpretation) requires thorough medical knowledge and access to patient files (Kawooya 2007). The bank of images utilised for the study were images used for training purposes therefore there were no additional patient information. However, Kawooya (2007) suggests that if radiographers are to be trained to do reporting, it would have to be all the way. Thus they will have to be able to engage with stage three as well. Evidently, there is a need for a radiographer to completely and effectively engage with image interpretation in order to inform crucial clinical decisions. However the current study demonstrates that there is an absence of skill from radiographers to fulfil this role. It is therefore evident that only through intensive education and training, will radiographers be part of the clinical decision making processes. The respondents in the current study had image interpretation accuracy, sensitivity and specificity that had the potential to be improved for effective utilisation into the clinical setting. A comparison of these results with previous studies for pre training reporting is presented in Table 5.3. The comparison provides average percentages of sensitivity, specificity and accuracy of the abnormality detection ability of radiographers without further image interpretation training.

Table: 5.3: Sensitivity, Specificity and Accuracy of radiographers *(without formal specific image interpretation education and training)*.

STUDY	SENSITIVITY (%)	SPECIFICITY (%)	ACCURACY (%)
Hargreaves & Mackay, (2003).	76.2	96.4	89.9
MacKay (2006)	72.1	50.1	Not mentioned
Brandt *et al* (2007) Average	91.9	87	89.5
Gqweta (Current study)	83	71	79

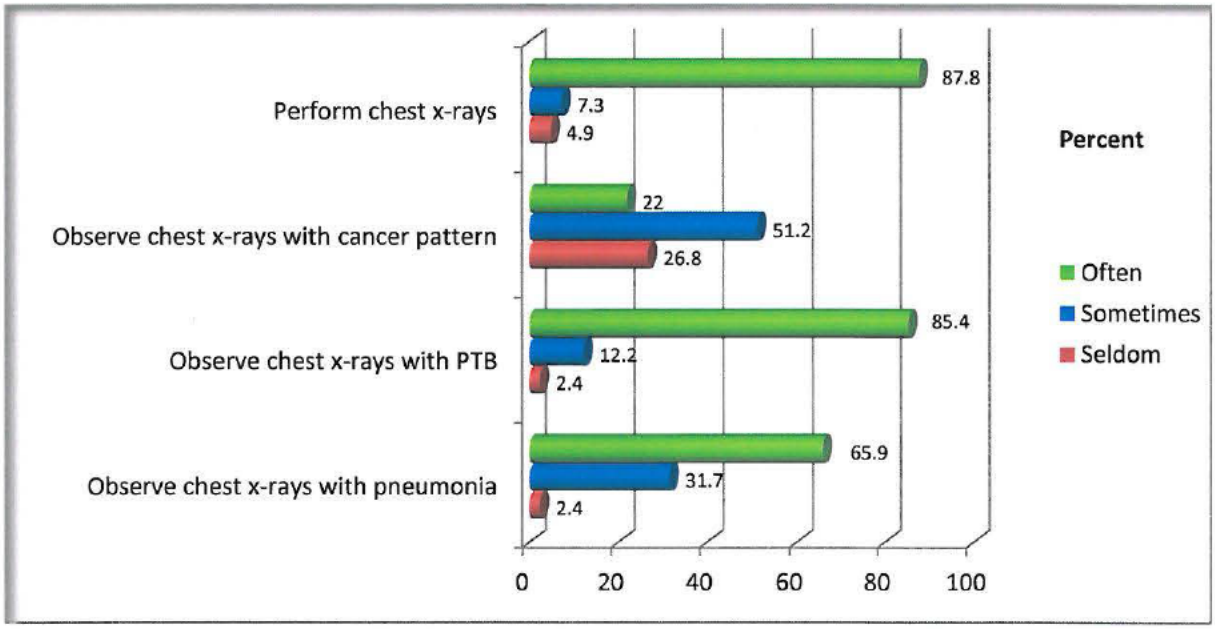
The respondents in the current study compared well with respondents in previous studies with regard to pre training image interpretation skills. However it was noted that the specificity of the current study was lower than these former studies. Interestingly enough there is a trend of decreasing sensitivity and specificity when the commenting section of the interpretation is considered (Hargreaves and MacKay 2003). This trend also manifests in this current study. The current study required respondents to describe the abnormality and comment on the findings (suggest what disease these patterns depict). The transcribed data on the descriptive section of the reporting template revealed a lack of knowledge and skill in describing the abnormalities. This section of the reporting is what constitutes radiographer comment, which is imperative to guide and influence management of the patient (Kawooya 2007).

Radiographer commenting is defined by Hardy and Culpan (2007) as that act where radiographers would indicate an abnormality on the radiographic image, and describe its location and appearances. However it is imperative to note that, the quality of images projected onto a screen using power point is inferior in quality to those that are printed or viewed on computer screens (Hardy and Culpan 2007). Albeit this, the current study provides some important points that can be utilised by the radiography profession in debating, planning and implementation of image interpretation by radiographers. The development of the radiography profession will be relevant if it is contextualised and deals with current needs within the South African radiology environment. It will be relevant if it addresses current issues like the scourge of diseases in South Africa.

5.8. Pulmonary tuberculosis, pneumonia and lung cancer.

PTB, lung cancer and pneumonia are the leading causes of deaths in South Africa (Bradshaw *et al* 2006). Consequently they were included in the study as they are prevalent diseases in the KZN province (Lehohla 2012). As such it is essential that radiographers are able to identify these patterns of these diseases on chest x-rays. The ability of the radiographer to identify the presence of the abnormality and to link it to a particular disease was parallel to reported clinical exposure to certain diseases. Eighty five point four percent (85, 4%) of the respondents have reported to have observed PTB patterns more than pneumonia and cancer patterns (see figure 5.3). The more a disease was reported to have been observed the higher the likelihood of its patterns being correctly identified on the chest radiograph. The discussion below explores the ability of the respondents on the identification of these diseases.

Figure 5.3: Patterns of disease observations.



5.8.1. Pulmonary Tuberculosis (PTB).

Tuberculosis is an infectious disease caused by a micro-organism. A bacilli called *Mycobacterium tuberculosis* enters the body via inhalation into the lungs (Weller and Wells 1990; Reid and Roberts 2005). The spread of these micro-organisms is via blood, the lymphatics, airways and direct extension of organs (Kowalczyk and Mace 2009). Furthermore pulmonary tuberculosis is the most infectious and the most common form of the disease, occurring in over 80% of cases (Department of Health 2000; Department of Health 2004). Consequently the majority of respondents in the

current study reported the prevalence of PTB observations within their clinical environment. The majority of the respondents were able to identify pulmonary tuberculosis patterns especially the secondary type. All the respondents were able to identify the following image (5.4.) as being abnormal and the abnormality was identified as PTB.

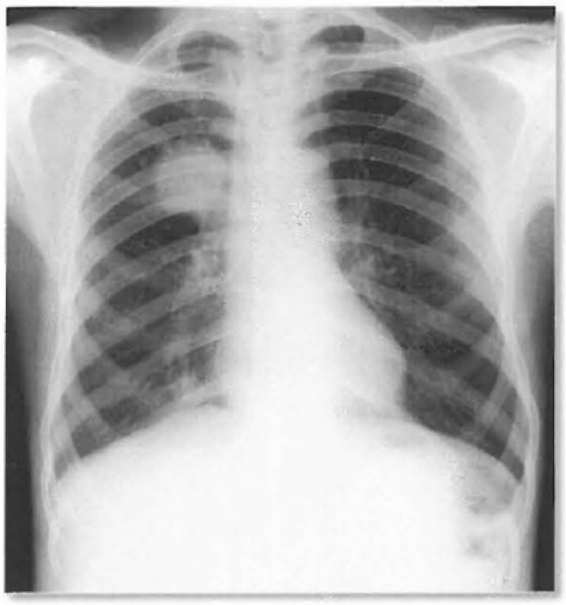
Figure: 5.4: Chest Image: **Pulmonary Tuberculosis.**

REFERENCE REPORT: There is bilateral upper lobe consolidation with cavitation. The consolidation in the right upper lobe is accompanied by pleural thickening and multiple cavities. There is also consolidating disease in both midzones. Possible adenopathy of right hilum. Patterns suggest: bilateral adenoid pulmonary tuberculosis with cavitation suspect immune compromise.

5.8.2. Lung Cancer.

The cancers of the respiratory and the digestive systems are the leading causes of cancer deaths in South Africa amongst other cancers (Norman, Mqogi and Sitas 2012). Lung cancer was recorded as the leading cause of deaths amongst males when compared to other cancers in a study of South African disease burden (Bradshaw *et al* 2006). Respondents in the current study were able to observe that there is an abnormality in the image below (see Figure 5.5.). They however demonstrated different degrees of abilities in distinguishing what disease the abnormality depicted. This difference was noted for different presentations of the same disease. Image PA 09 demonstrates a solitary nodule (see Figure 5.5.).

Figure: 5.5.: Chest Image: **Solitary Nodule.**



REFERENCE REPORT: Left lung clear. There is a 2cm lesion in the right upper zone with ill defined margins. The remainder of the right lung is clear no adenopathy seen. Differential 1) bronchial carcinoma ? smoking background 2) bronchial adenoma ?coronoid syndrome, haematoma or hydrated cyst not favoured. Bronchial carcinoma.

The appearance of a clearly defined nodule that is solitary was a cue for fifty six percent (56%) of the respondents to identify the abnormality in the image as a pattern of cancer/tumour. However in the absence of a clear defining appearance and in the presence of a confluent sign only two percent (2%) of the respondents were able to identify the radiographic appearances on the image as depicting patterns of cancer (see figure 5.6.). These respondents' reports were aligned with those of the radiologists.

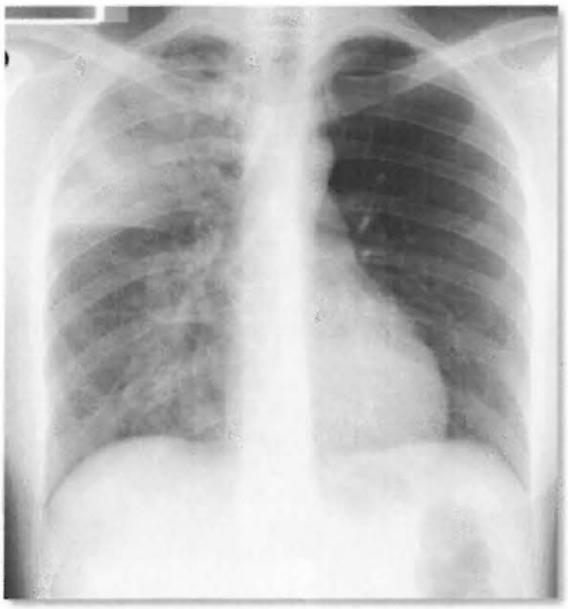
5.8.3. Pneumonia:

Pneumonia is an acute infection of the lung parenchyma distal to the terminal bronchiole, it is mainly bacterial, and associated with clinical and/or radiological evidence of consolidation of a part or parts of one or both lungs (Feldman *et al* 2007). Furthermore this disease remains a cause of significant morbidity and mortality throughout the world (Stevens and Lowe 2000). Mortality is reduced by early initiation of antibiotics because the causative organism(s) is vulnerable to the medicine, and delayed or inappropriate initial therapy may lead to adverse outcomes (Feldman *et al* 2007; Kowalczyk and Mace 2009).

The role of radiography in the initial diagnosis process of patients and the subsequent monitoring through imaging is of importance in the patient management process. Thus the involvement of radiographers in the initial image interpretation is also important and can lead to possible early detection of diseases. Furthermore it may lead to better utilisation of human resources in a sector that is constantly understaffed (Brandt *et al* 2007). Ninety percent (90%) of respondents in the current

study were able to identify the presence of an abnormality. However, only fourty six percent (46%) of the respondents were able to state that these patterns were those depicting pneumonia see image below (Figure 5.6). Again these findings are aligned with the reported observations of diseases observed within KZN radiography departments.

Figure: 5.6: Chest Image: Lobar Pneumonia.

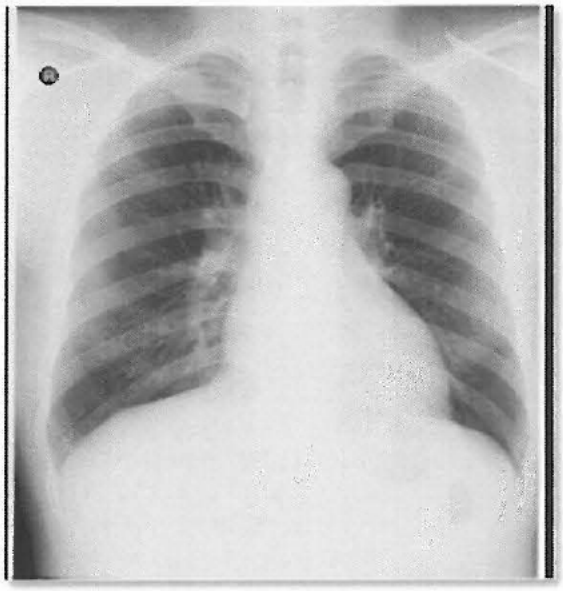


REFERENCE REPORT: There is a right upper lobe pneumonia. No volume loss the trachea is central. The left lung is clear. There is increased shadowing in the right lower zone in keeping with bronchutus condition, this may relate to pus aspiration. Double pathology streptococcal pneumonia with underlying TB not excluded. Streptococcas and klebsiella pneumonia.

5.8.4. Normal chest radiographic appearances.

Fifty two percent (52%) of the respondents identified normal radiographic appearances as abnormal. Again this depended on the image being viewed. There were four (4) normal images on the batch of images used for the research study. In all four images the respondents were divided in half or almost in half. Fourty eight percent (48%) indicating the image as normal while fifty two percent (52%) said it was abnormal see image below (Figure 5.7.). This has serious implications for the clinical environment. Further investigations may be required to confirm or disconfirm a false positive radiographer's report. This may result in cost for the patient, the department, the hospital and the national health system. Furthermore it can contribute to the psychosocial stresses of the patient. It is imperative that radiographers familiarise themselves with the normal, anomaly and the normal variants in order to optimally engage in image interpretation.

Figure: 5.7: Chest Image: Normal Chest Radiograph.



REFERENCE REPORT: No heart or lung lesion visualised.

5.9. The role of chest radiographs in the monitoring of diseases.

In pulmonary tuberculosis chest radiographs are utilised in three phases when the sputum results are positive, when the sputum results are negative and during and at the end of PTB treatment course (Department of Health 2000). When sputum results are positive chest radiographs may be requested. The aim of the chest radiograph is to demonstrate, confirm or exclude PTB. Furthermore it also allows for the demonstration of possible suspected complications, reasons for frequent or severe haemoptysis, and other lung diseases (Catanzano and Curtis 2008). However when the sputum results are negative chest radiographs may be used if PTB is still clinically suspected despite negative smears, in order to make a decision regarding diagnosis and treatment. The department of health (2000) further stipulates that during and at the end of PTB treatment chest radiographs are recommended. Chest radiographs are significant especially if there are any specific clinical reason or if progress during treatment is unsatisfactory.

Feldman *et al. (*2007) explains that a chest radiographic image is desirable for all patients with pneumonia. Accordingly Feldman stipulates the uses of a chest radiograph in pneumonia cases as to confirm, assess the extent of the disease, to indicate the presence of underlying disorders. However the significance of the chest x-ray results is dependent on the level of proficiency and experience of the interpreter (Manning, *et al* 2006). However it is necessary to recognise that, generally, the radiologist's report is only part of the algorithm that leads ultimately to the patient's management (Feldman *et al* 2007). Thus these reports may have or

may not have an impact on the resultant outcomes and management of the patients on their own they need to be utilised in light of other diagnostic information (Smith and Baird 2007). Thus the role of the radiographs and the radiographer in a clinical environment is invaluable. Radiographers are currently involved informally in image interpretation through the provision of opinions on radiographic appearances (Gqweta 2012).

5.10. Factors influencing the change of the South African radiographers' role.

Radiography role extension is the assumption of duties, by radiographers, which were previously only within the domain of radiologist (Williams 2006). Research results from countries abroad and within the country have demonstrated numerous evidence that advocate for radiography role extension (Brandt *et al* 2007; Williams 2009; Gqweta 2012). The current study demonstrates the fundamental driver of the need for transformation in radiology/radiography as hinged on the limited number of, and in some cases, the absence of radiologists. The limitation of radiologists in clinical setting is contrasted by major population increases (Kawooya 2007; Lehohla 2011). Additionally dramatic healthcare needs and rapid technological developments especially within radiology have led to many radiologist pursuing more specialised endeavours (Freeman 2006; Williams 2009). This has led to a shortage of radiologists within conventional departments for reporting of studies. Consequently the shortage of radiologists is always at the centre of the discussions about radiography role extension (Brandt *et al* 2007; Williams 2009; Munro *et al* 2012; Gqweta 2012). Thus the current research results reflect that the shortage of radiologists is amongst other factors that drives the need for radiography role extension.

5.10.1. The shortage of radiologists and its consequences.

As a consequence of the shortage of radiologists in many healthcare facilities with x-ray departments operate without the aid of a radiologist (Kawooya 2007). Thus many x-ray examinations are not reported on and in cases where reports are produced it is usually outside the critical period where they would have influenced patient management (Price 2006). Consequently the report does not influence patient clinical outcomes. It is thus evident that other healthcare professionals, such as radiographers; need to adapt their practice in order to respond to the current healthcare needs (Gqweta 2012). In the absence of a radiologist the role of the radiographer is important in flagging the cases that need immediate attention of the attending physician (Brandt *et al* 2007). Therefore patient management can continue

uninterrupted especially during after hour duties in rural areas and primary healthcare centres.

5.10.2. The impact of radiography role extension.

Previous studies have noted that the impact of role extension on the health system is positive and may alleviate some of the consequences caused by the shortage of radiologists (Williams 2006, Brandt *et al* 2007; Williams 2009 and Gqweta 2012). Role extension transformed the healthcare system in the United Kingdom (UK) (Freeman 2006). Radiographers became more involved in making clinical decisions and were no longer used only as auxiliary personnel (Snaith and Hardy 2008). Evidence suggests that the transfer of some reporting tasks from radiologists to radiographers would improve the quality of care provided to the patient (Smith and Baird 2007). Furthermore there is agreement that selectively trained radiographers can actually report on radiographs with accuracy, comparable to radiologists (Piper and Paterson 2009; Hughes et al 1996). Additionally this practice results in various benefits to doctors, radiographers and most importantly patients (Radovanovic and Armfield 2005). The relevance of implementing a similar structural change within the South African radiography profession can only yield the same benefits.

5.10.3. The radiographers' perceptions on role extension.

South African radiographers are willing to re-evaluate their role within the clinical environment in order to respond to current health care needs. Furthermore they recognise that the current scope of practice restricts them from responding to current healthcare needs (Gqweta 2012). However the current respondents recognise that there is a need for further education and training in order to effectively engage within extended roles. They also stated that there is a need for legislative amendments in order to protect radiographers performing within extended roles. Role expansion is linked to responsibility and accountability issues, both from a legal and an ethical point of view (White and MacKay 2002). Thus the radiographers in the current study expressed that there will be a need for medico-legal cover in order for them to effectively perform duties within the new roles.

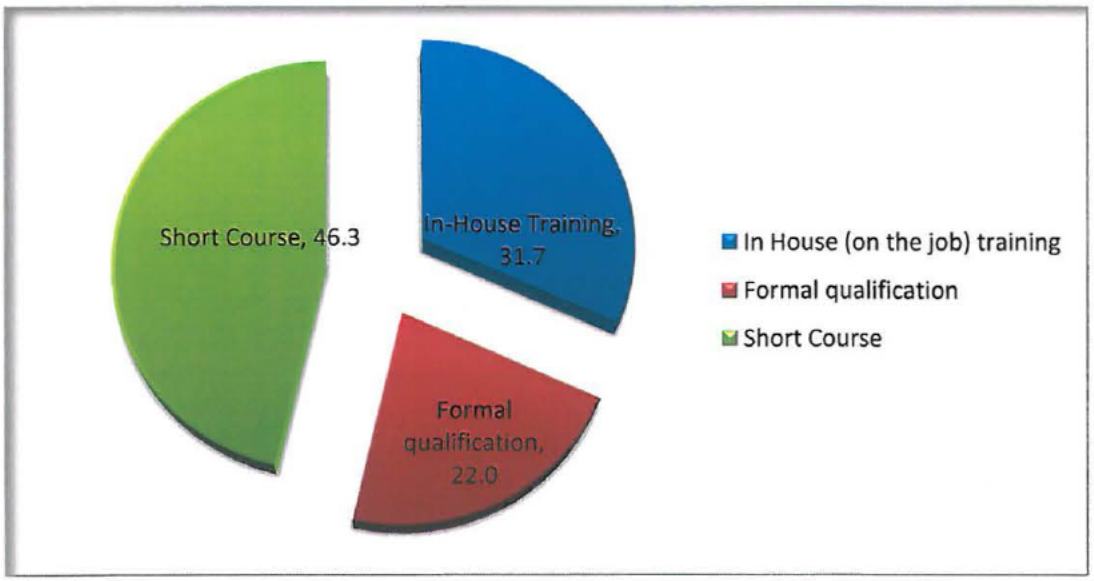
5.10.4. Medico-Legal aspects, Education and Training.

An analysis of the qualitative data in the current study revealed the radiographers' concerns with regard to medico-legal cover should the new roles be incorporated into their scope of practice. ***Respondent 27*** explained *'the radiographers would have to take responsibility for the interpretation she makes and would be legally*

liable' Furthermore ***respondent 28*** felt that there is a need for an '*Insurance to cover*' any medico legal cases made against radiographers. These respondents indicated that increased responsibility will proportionally necessitate higher level of accountability. They therefore understood that with extended role there is an increased likelihood of litigations instituted against reporting radiographers. As a result the respondents indicated that there should be a vicarious responsibility cover by the employer. Vicarious liability describes a situation whereby the delegating or the overseeing individual or entity takes responsibility for the actions of the persons performing the acts (White and McKay 2002). However vicarious liability will be accepted to be in effect if it is proven that the relationship between the defendant and the transgressor is that of employer and employee (Beyer 2006; Tufal n.d.).

These respondents also indicated that if they can obtain adequate and intense training on image interpretation the likelihood of litigation may be reduced. The respondents concurred that an intensive education and training may reduce the likelihood of misinterpretation by reporting radiographers. Thus forty six point three percent (46, 3%) of the respondents opted for short courses and thirty one point seven percent (31, 7%) selected in-house training programs. They felt that these methods of education and training offerings will allow them to effectively and immediately apply the theory to the practice. Those that chose post graduate diplomas and degrees felt that in order for the profession to progress in a recognisable manner this type of learning is necessary. Figure 5.9 below provides a pie chart of the training methods preferred.

Figure 5.9: Preferred Education for Image Interpretation:



The role of education in the extension of the radiographers' role is paramount and should be at the centre of discussion. Twenty two percent (22%) of the current respondents felt that formal qualifications are necessary if the radiography profession is to be effectively developed and be recognised as valuable by those within and outside the profession. For example ***respondent 15*** explained that *'radiographers may not take in-house or on the job training seriously. A recognised qualification will also mean greater recognition of oneself'.* These respondents stated that in-house training programs and short courses may only be responding to current healthcare needs within the radiology services structure and may not be responding to, and contributing towards, formal professional development. Despite the concerns expressed above, the respondents indicated that a short study period may be beneficial in the interim through allowing them time to work while they are studying and thus earn a living. It is thus important to have the education and training for role extension tailored to consider those individuals that are full time employees.

5.11. Chapter summary.

The impact of involving radiographers in image interpretation should not be underestimated. This involvement may have positive implications for the clinical setting specifically and the health care sector in general as it is responsive to current health care needs (Hargreaves and MacKay 2003; MacKay 2006; Brandt *et al* 2007; Gqweta 2012). However such benefits will come by through stringent processes of training and changes within the health act to reflect the new role of radiographers. The engagement of the radiography professionals into clinical decision making may have benefits for both the patients and practitioners. Previous studies have demonstrated that the radiographers' role has always been viewed as technical and thus having no direct professional clinical input into the management of patients (Williams 2006; Gqweta 2012). This may have implications for the morale of the current radiographer. Furthermore this could be partially responsible for the lack of aspiration towards obtaining post graduate studies to masters and doctorate degrees. Radiographers use their knowledge of pattern recognition to make decisions on further views necessary to demonstrate an abnormality (Hargreaves and MacKay 2003). It is therefore interesting to note, as demonstrated in the current study, that radiographers do apply knowledge imparted during undergraduate studies to assist within the clinical setting through provision of opinions where necessary.

The role of the radiographer concerning image interpretation can be specific and limited. This will ensure optimum functioning with most positive results for the

patients and professionals involved. One way to achieve this limiting of the reporting would be through identification of profusely occurring disease in a particular region. Then these individuals may be taught on images that depict these diseases. This will ensure responsiveness of the radiography profession to health care needs of the area. An example of these is the prevalence of PTB in South Africa. Thus the role of the radiographer in the reporting of chest images is significant. However currently there is a need for thorough intensive training, education and support from relevant stakeholders including the radiologists. Different types of education and training courses can be designed to suit the needs of the radiographers. The current study highlights an interest from the respondents for short courses and in-house training programmes.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS.

6.1. Introduction.

This chapter provides a summary of the dissertation. A summary of the significance, the findings and limitations of the research will be provided. Future research areas emanating from current research results will be explored. The conclusion and the recommendations to be made to guide the process of future research studies will follow.

6.2. Significance of the study.

The importance of this study lies in the critical process of developing the radiography profession and is evidenced based on the current health care needs within radiology services. The development of the role of the radiographers can improve radiological services especially in the public health sector. Thus the main aim of the study was to illustrate the need for role extension into image interpretation. At the same time the study aimed at demonstrating the current image interpretation skills of radiographers, to find educational gaps relevant for future roles. This study was conducted as a basis for radiography professional development and is responding to current needs within the radiological services.

6.3. Research findings.

The current respondents demonstrated that there is a need for radiography role extension, especially into image interpretation. Furthermore the results of the knowledge and skills test revealed that there is a skills and knowledge gap with regard to chest image interpretation. Respondents indicated that role extension into image interpretation can be realised through current regulation amendments and intensive education and training.

6.4. Limitations of the study.

The study only included radiographers working within the public health sector. A more comprehensive population that includes private health sector radiographers may be advantageous. The images used were projected using power point slides. These images may not be of the same high quality of printed radiographs or images displayed on reporting screens. This may have an effect on the reported appearance on these images. Furthermore, the data collection process was very long. The

respondents were required to spend at least 1 and half hours participating. This could have an effect on the participation rate as the study was done during working hours.

6.5. Future research.

Future research studies will have to focus on the many aspects of role extension. These aspects may include reporting, training, regulations, perceptions of the current radiographers' role from doctors and other healthcare practitioners.

6.6. Recommendations

Experimental studies need to be conducted with small samples of radiographers but higher variety and number of images. A similar explorative study can be conducted within the private sector to demonstrate any skills deficiencies and any possible difference. Moreover, these studies may reveal similarities and/or differences between image interpretation skills of private and public radiographers.

6.7. Concluding statements.

The role of the radiographer has radically changed in countries abroad in response to the health care needs .The change has brought with it many advantages for the patient, the personnel as well as the health care system at large. The South African healthcare system can only benefit from the implementation of radiography role extension (Williams 2006). Image interpretation by radiographers, with special reference to reporting of chest images, is imperative as these examinations are frequently requested and are used as basis for treatment, follow up and work ups before surgery. The shortage of radiologists has had an adverse influence within the South African radiological services (Gqweta 2012). The introduction of radiography role extension especially, image interpretation, may alleviate some of the negative effects resulting from the absence of the radiologists in many clinical settings. Effective change and response to current health care needs can be achieved through research and involvement of relevant stakeholders. It is undeniable that the processes to be followed needs to be informed by research (Williams 2009). Furthermore there needs to be a closer look at models that are working in countries that have implemented radiography role extension, such as the UK.

Almost two thirds (56%) of the respondents in this study were within their first ten years of working life. Most of these respondents have ascended the ranks into the chief radiographer post. There seems to be a lack of drive to obtain further

qualifications beyond a diploma level. A majority (56%) of the respondents had only their three year diplomas and only about 31% had BTechs. It was interesting to note that the highest qualification obtained by the respondents was a BTech degree. Perhaps a further confirmation to a lack of interest in pursuing post graduate studies into Masters and PhD levels. There could possibly be a number of reasons for the lack of enthusiasm; however a thorough discussion of this point is beyond the scope of this study. A relationship was demonstrated between the self-reported abilities of radiographers to interpret images and the actual performances on the skills and knowledge tests. The majority of the respondents reported having an ability to identify abnormalities but few reported to be able to describe these abnormalities. The results from the skills section revealed that the respondents lacked the ability to describe certain patterns as well as link these patterns to certain diseases. A two thirds (60%) of the respondents were able to score above 50% for the knowledge section. These scores are significant for the study as none of the respondents scored 80% or more, which was set as a level that demonstrates adequate knowledge. The significance of these scores lies in the fact that there is a need for a curricular that will introduce an intensive image interpretation theory to form basis for adequate application of image interpretation skills. Even though sensitivity of the respondents in the current study (88%) measures well with another study for pre training reporting, specificity and accuracy fall short of this comparison (MacKay 2006). The very low specificity (39%) may relate to the fear, from radiographers, of diagnosing an abnormal image as being normal when it is in fact abnormal. It may also be as a result of misinterpretation of the normal variants (Hardy and Culpan 2007). Radiographers are able to identify abnormalities on chest radiographs with PTB, Cancer and Pneumonia patterns. Their sensitivity is higher for PTB patterns. However there is a lack of the ability to describe these patterns which may give rise to an inability to comment about the significance of an abnormality.

The impact of involving radiographers in image interpretation should be made a priority in in order to maximise service delivery in the radiology department. The radiographers' involvement has positive implications for the clinical setting specifically and the health care sector in general, as it is responsive to current healthcare needs (Brandt *et al* 2007; Hargreaves and MacKay 2003; MacKay 2006; Gqweta 2012). However such benefits will come by through stringent processes of training, policy changes and involvement from relevant stakeholders (Gqweta 2012). The engagement of the radiography professionals into clinical decision making may have benefits for both the patients and practitioners. Previous studies have

demonstrated that the radiographers' role has always been viewed as technical (Williams 2006; Gqweta 2012). This may have implications for the moral of the radiographer. Furthermore this could be partially responsible for the lack of interest demonstrated by radiographers towards post graduate studies to PhD level. It is however relevant to note that even though radiographers, do not have formal training in the interpretation, they have great experience in viewing radiographs than other professionals. Furthermore during their basic 3-year diploma training period they get experience in learning to evaluate radiographs for image quality and normality. When radiographers detect an abnormality they decide if further radiographs are necessary (Hargreaves and MacKay 2003). It is therefore interesting to note that radiographers do apply knowledge imparted during undergraduate studies to assist within the clinical setting through provision of opinions where necessary (Gqweta 2012).

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Appendix A

DUT DURBAN UNIVERSITY OF TECHNOLOGY

Permission Letter

Mrs. Dladla, P
District Manager
Name of institution: eThekwini Health District
Date: August 2011
RE: **REQUEST FOR PERMISSION TO: conduct a research study.**

Dear Ms. Dladla, P

I am currently registered as a Masters student in the department of Radiography at the Durban University of Technology. In order to fulfil the criteria for the Masters program, your support and written permission to administer a questionnaire at your institution is sought.

The proposed title of my project is: Knowledge, skills and perceptions of diagnostic radiographers on image interpretation of chest diseases in eThekwini.

I intend selecting approximately 145 participants for this study where some will be randomly selected from public health institutions and others from the private health institutions. The participants will include community service radiographers, senior and chief radiographers. I have randomly selected the proposed sites for the study. These are:

1. Addington Hospital
2. Clairewood Hospital
3. IALCH
4. KEH
5. Mahatma Ghandi Hospital

6. PMH
7. RK Khan

Brief Introduction and Purpose of the Study:

The main aim of this study is: To explore the knowledge, skills and perceptions of diagnostic radiographers on image interpretation of chest diseases.

This is a quantitative study that will need approximately 1 hour 30 minutes from the respondents to complete a questionnaire and to interpret a set of chest radiographs. The questionnaire and image interpretation is intended to elicit information pertaining to image interpretation knowledge and skills of radiographers. The researcher will preferably like to conduct the study during staff lunch times. There will be no cost to the respondents and the health facility.

It is hoped that this study will result in a guideline for the training needs of radiographers on chest image interpretation when role extension is implemented in South Africa. This is an initiative which has improved health service delivery in countries abroad such as the United Kingdom.

The proposal has been reviewed by the Department of Radiography and approved by the Research Committee of the Faculty of Health Sciences, at the Durban University of Technology (DUT). Appropriate ethical approval has been obtained from the DUT .

Yours sincerely

Mr Ntokozo Gqweta
Researcher
BTech Radiography

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Appendix A

Supervisor Details:
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Sample Response

I,..... (Print full name) in my capacity as District or Hospital manager/assistant manager, hereby grant permission for the research study titled: **Knowledge, skills and perceptions of diagnostic radiographers on image interpretation of chest diseases in eThekwini** to be conducted on diagnostic radiographers at..... .....district.

Signature:..... date: .....

Questionnaire

Title of study: Knowledge, skills and perceptions of diagnostic radiographers on image interpretation of chest diseases in eThekwini.

The purpose of this questionnaire: To gather information, from diagnostic radiographers from the eThekwini Health District, on their knowledge, skills, and perceptions of the interpretation of images on chest diseases.

NB: Your cooperation in completing the questionnaire will be of great value to me, and to the radiography profession. This questionnaire is completely confidential and your participation is invaluable to the outcome of the research study. You are encouraged to answer the questionnaire as honestly as possible and to the best of your ability.

SECTION A

BIOGRAPHICAL INFORMATION

QUESTIONNAIRE NUMBER | DUTRSNT |

To indicate your answer in questions 1 to 11 you must place a cross (x) in the appropriately numbered box.

1. **INDICATE** your gender by placing a cross (X) in the appropriate box.

Female	1
Male	2

2. **Please provide your age in the box on the right** = [ ] **years**

3. Qualification (mark with a cross (X) the highest qualification.	
Two year National Diploma: Radiography	1
Three year National Diploma: Radiography	2
Three year Degree: Radiography	3
BTech Degree: Radiography	4
Masters Degree: Radiography	5
Doctorate's Degree: Radiography	6

4. **At which institution did you obtain your highest qualification? (include country)**

_____

5. **How long have you been qualified (pertains to your first qualification)** = [ ] **years.**

6. **Type or level of hospital you working at:**

Community Health Centre(CHC)	District Hospital	Regional Hospital	Tertiary Hospital	Private hospital
1	2	3	4	5

7. **Workstation mostly stationed at.**

General	Trauma and emergency	Ward radiography	MRI	CT	Chest unit	Mammography	Fluoroscopy	Angiography	Other Please state
1	2	3	4	5	6	7	8	9	10

8. **Did you have a break in service**

Yes	1
No	2

If you answered YES to question 8 above STATE the actual years of diagnostic clinical experience in the following question.

9. **Indicate your experience in a diagnostic clinical environment?** [ ] Years and [ ] Months.

10. Indicate your rank

Community service radiographer	1
Radiographer	2
Senior radiographer	3
Chief radiographer	4
HoD or AD or Clinical Manger	5

Pattern recognition is defined as being able to recognize normal anatomy and physiological appearances on an image and those variations of appearances, which may indicate pathology (Corr, 2001).

Place a cross (x) on the appropriately numbered box to indicate you answer.

	In my department	Never	Rarely	Sometimes	Often	Always
12.	I perform chest x-rays.	1	2	3	4	5
13.	I observe chest x-rays with cancer patterns	1	2	3	4	5
14.	I observe chest x-rays with PTB patterns	1	2	3	4	5
15.	I observe chest x-rays with pneumonia patterns	1	2	3	4	5

	The pattern recognition skill	Yes	No
16.	I have learned to recognize pattern changes on chest x-rays through experience.	1	2
17.	I have attended a pattern recognition/image interpretation course	1	2
18.	I attended a seminar on pattern recognition /image interpretation of diseases on chest radiographs.	1	2
19.	The diploma in radiography adequately prepared me for pattern recognition /image interpretation on chest x-rays	1	2
20.	Viewing chest x-rays with certain patterns has enhanced my ability to recognize abnormalities	1	2
21.	I have learned to recognise patterns on chest x-rays through reading reports from radiologists	1	2
22.	I read pattern recognition books and journal articles at least once a week.	1	2
23.	I am able to identify pulmonary tuberculosis (PTB) patterns on chest radiographs.	1	2
24.	I am able to identify pneumonia patterns on chest radiographs.	1	2
25.	I am able to identify lung cancer patterns on chest x-rays.	1	2
26.	I am able to describe pulmonary tuberculosis (PTB) patterns on chest radiographs	1	2
27.	I am able to describe pneumonia patterns on chest radiographs	1	2
28.	I am able to describe lung cancer patterns on chest radiographs	1	2

The perceptions			
	Place a cross (X) in the appropriate box to indicate your answer	Yes	No
29.	Have you ever been asked by a medical officer or nurse or any other practitioner to comment on the appearance of an x-ray		
30.	In respect of the above, did you comment on the said radiographic appearances?		
If , yes to the question above, EXPLAIN why:			
31.	Is there a need for radiographers to extend their role to include image interpretation		
	EXPLAIN your answer above:		

3.2. Rank the anatomical site in order of priority in terms of which areas radiographers must extend their role in terms of image interpretation/reporting. 1 = top priority and 4 least priority.

Chest	
Abdomen	
Appendicular skeletal	
Axial skeletal	
STATE the reason for your number one ranking	

33. Indicate the type of training suitable for image interpretation by radiographers. Place a cross (x) to indicate your answer.

In- House (on the job) training	1
Formal qualification e.g Post Graduate Degree or Diploma	2
Short course	3
EXPLAIN your answer above.	

34. What medico-legal implications would image interpretation present to the participating radiographers?

35. In your opinion how would these be mitigated or eliminated

SECTION B

Place a cross (x) on the appropriately numbered box to indicate your answer.

The following questions pertain to patterns as seen on chest radiographs

36. Lower lobe pleural effusion will be demonstrated on a chest x-ray as;

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An area of increased density	1
An area of increased density with air fluid levels	2
A miniscial shaped area of increased density	3
None of the above	4
I do not know	5

CA

37. Cavitation will be demonstrated on a chest radiograph as an area of;

Translucency within a consolidation with smooth margins	1
Translucency within a consolidation with rough and irregular margins	2
Consolidation within an area of transluceny with smooth margins	3
None of the above	4
I do not know	5

CA

38. Air bronchograms will appear on a chest radiograph as;

Translucent lines enlarged end within an area of consolidation	1
Translucent lines similar to a leafless tree.	2
Dense lines within areas of translucency	3
All of the above	4
I do not know	5

CC

39. A solitary pulmonary nodule will appear on a radiograph as;

Well defined, discreet circular opacity, approximately 3cm or less =	1
Irregular discreet opacity	2
Irregular and large area of opacity	3
An area of opacity with areas of translucencies within it.	4
I do not know	5

CB

40. A collapsed lobe may be characterised by an area of.....on the chest radiograph.

Opacification with volume loss.	1
Opacification with no volume loss	2
Opacification with volume loss and air bronchograms	3
Opacification with a cavity	4
I do not know	5

CB

41. An abscess will be demonstrated on a chest radiograph as an area of:

Cavitation within a consolidation with air fluid levels	1
Air fluid levels within a lobe	2
An area of increased opacification	3
An area of translucency	4
I do not know	5

CA

42. Miliary PTB patterns will be demonstrated on a chest radiograph as;

Multiply nodules of varying sizes	1
Multiply small nodules demonstrated throughout both lungs	2
Multiply large nodules of 3cm and above demonstrated on both lungs	3
Multiply nodules demonstrated on the apices	4
I do not know	5

CA

43. Lung metastases will be demonstrated on a chest radiograph as;

Multiply masses (nodules) of 2cm or less with smooth margins on both lungs	1
Multiply masses (nodules) of 5 cm and larger with irregular margins on both lungs	2
Irregular areas of opacification on one lung	3
Multiply large masses (nodules) at the hilar region	4
I do not know	5

CB

44. The differentiating sign between an apical mass and pleural thickening on a chest radiograph is;

A mass will be characterised by an area of consolidation with destruction of the associated ribs	1
Pleural thickening will be an area of consolidation with no rib destruction	2
Pleural thickening will have an area of translucency and a mass will not	3
Only 1 & 2 are correct	4
I do not know	5

CB

45. Ghon focus will appear on a chest radiograph as an area of;

Large focus of translucency	1
Small focus of opacification with hilar and medistenal adenopathy	2
Consolidation of the lower lobe	3
A large consolidation in apices of the lung	4
I do not know	5

CA

Mark with a cross (X) on the appropriate box next to each of the following statements to indicate your answer.	True	False	
46. Fibrotic patterns on chest x-rays may indicate the presence of healed pulmonary tuberculosis (PTB)	1	2	CA
47. PTB reactivation is indicated by the presence of cavitations and/or pleural effusion	1	2	CA
48. Calcifications may indicate the presence of pneumonia.	1	2	CA
49. A solitary nodule 3cm or smaller may indicate presence of lung cancer	1	2	CB
50. Consolidation with air bronchograms may indicate the presence of PTB	1	2	CC
51. Pleural effusion, ghon focus, apical infiltration, consolidation, calcification and fibrosis are patterns suggestive of pulmonary tuberculosis	1	2	CA
52. Lung Collapse, presence of solitary nodules, consolidation with associate rib destruction, volume loss, multiple masses of varying sizes are patterns that are suggestive of lung cancer	1	2	CB
53. Consolidation with air bronchograms, cavitation, pleural effusion are patterns suggestive of pneumonia	1	2	CC

Indicate what disease on column B **MAY** be demonstrated by patterns on column A. (Place the appropriate letter on the column on the far right hand corner to indicate your response.)

Column A	Column B	Answer	
54. Homogenous patterns involving complete or segment of lung with patent airways	a. Lung cancer		CC
55. Radiographic patterns distributed along the course of the airways with absent bronchograms.	b. Secondary PTB		CC
56. Oedema and inflammatory cellular infiltrate with ground glass appearance.	c. Primary PTB		CA
57. Parenchymal consolidation, lymphadenopathy and pleural effusion.	d. Interstitial pneumonia		CA
58. Airspace consolidation, cavitations, fibrotic changes and focal nodular opacification	e. Bronchopneumonia		CA
59. Decreased lung volume, diffused nodulation, atelactasis and large solitary nodules.	f. Lobar pneumonia		CB

Thank you for your participation in this study. Your input is greatly valued will be treated in confidence.

Yours sincerely

Mr. N. Gqweta

Researcher.

Appendix C

DUT DURBAN UNIVERSITY OF TECHNOLOGY

Letter of Information and Consent

Title of the Research Study:

Knowledge, skills and perceptions of diagnostic radiographers on image interpretation of chest diseases in eThekwini.

Principle Investigator:

Mr. N. Gqweta

Brief Introduction and Purpose of the Study:

The chest x-ray is the most commonly performed x-ray examination in x-ray departments. Conversely this x-ray examination is where radiographers are often asked to comment on especially by personnel from emergency departments.
Therefore the aim of the current research study is to investigate the knowledge; skills based expertise and perceptions of diagnostic radiographers in identifying disease pattern changes on chest radiographs. These will be conducted at the eThekwini Health District of KwaZulu Natal (KZN).

Outline of the Procedures:

You will receive a questionnaire to complete. Once the questionnaire is completed you will receive a reporting template with chest images that you will be required to interpret. The questionnaire will take approximately 30 minutes and the image interpretation session will not take more than 60 minutes.

Risks or Discomforts to the Subject:
There are no major risks associated with this study.

Benefits:
this study will provide baseline data on image interpretation abilities of diagnostic radiographers.

Remuneration:
There will be no remuneration.

Costs of the Study:
There will be no further costs to you.

Confidentiality:

Appendix C

All information that we receive about you will be stored in a restricted environment. There will be no invasion of your privacy. Only the researcher involved will be able to see the information. Your identity will be kept confidential and not associated with the results as codes will be used.

Persons to Contact in the Event of Any Problems or Queries:

Mr. N. Gqweta: Tel: 031 373 2510/2450 –ntokozog@dut.ac.za /Mrs. Naidoo – Tel: 031 3732875/2450 nalenen@dut.ac.za

Statement of Agreement to Participate in the Research Study:

(I,.....subject's full name, ID number....., have read this document in its entirety and understand its contents. Where I have had any questions or queries, these have been explained to me by .....to my satisfaction. Furthermore, I fully understand that I may withdraw from this study at any stage without any adverse consequences and my future health care will not be compromised. I, therefore, voluntarily agree to participate in this study.

Subject's name (print) .....Subject's signature:..... Date:.....

Researcher's name (print): ..... Researcher's signature:.....Date:.....

Witness's Name(print).....Witness's signature.....Date: .....

Appendix D

REPORTING TEMPLATE

Participant Number	
X-ray Number	

- **Place a cross (X) on the appropriately numbered box to indicate your response.**

INDICATE the institution you are currently employed at.	
PRIVATE PRACTICE	1
PROVINCIAL	2

1. INDICATE whether this x-ray is NORMAL or ABNORMAL	
Normal	1
Abnormal	2

2. RATE your confidence level on the above answer.			
Definitely confident	Confident	Not sure	Not confident
1	2	3	4

3. DESCRIBE the ABNORMAL appearance (if any).

4. STATE the LOCATION of the abnormality (if any)

5. RATE your confidence level on answer 3 and 4 above			
Definitely confident	Confident	Not sure	Not confident
1	2	3	4

6. SUGGEST what disease these patterns (if any) may be presenting.

FOR OFFICE USE ONLY:			
1. TN	**2. TP**	**3. FN**	**4. FP**

Adapted research from studies by (Marchiori, *et al 1999,* Piper *et al*, 2005, Manning *et al*, 2006 and Piper & Paterson, 2009)

DUT DURBAN UNIVERSITY OF TECHNOLOGY

Are you interested?

To be a participant in this research study!!

Image Interpretation for Radiographers

Department of Radiography
Faculty Of Health Sciences
Durban University of Technology
P.O.Box 1334
Durban—4000

Purpose of the Research:

Exploring the Knowledge, skills and perceptions of Radiographers.

Who is eligible?

Employed Diagnostic radiographers registered with the HPCSA.

Procedure .

You will be required to complete a questionnaire and interpret chest images.

CONTACT: Mr. N. Gqweta

TEL: 031 373 2510/2450

EMAIL: ntokozog@dut.ac.za

F

DEEPAK SINGH

Registered Scientist

Database and Statistical Analysis

(Pr. Sci. Nat.) (No. 400027/96)

P. O. Box 24002
Hillary
4024

(cell): 083-775-9239
singhd@telkomsa.net

QUOTATION

23 April 2012

Mr N. Gqweta
Department of Radiography
DUT

Sir

Statistical Analysis for M. Tech.

The following services will be rendered to you:

1. Coding of data.
2. Analysis
3. Output in Word format.

Sampling

There are approximately 130 diagnostic radiographers employed in 14 public health institutions in eThekwini. Half of the institutions will be randomly selected as a sample and all diagnostic radiographers meeting inclusion criteria from within the selected institutions will be invited to participate in the study. This will equate to a sample size of approximately 40-50% of the total population of radiographers in the public health sector in eThekwini Health District. It is anticipated that a high response rate (>80%) will be attained using the data collection process outlined in 5.5 below of the proposal.

I have used Statgraphics Centurion to determine the following possible sample sizes for your study based on a population of 130. At a 95% level of confidence with a 10% error rate, the required sample size would be 64.

F

The statistical aspect of the research will encompass the following:

- Descriptive statistics using frequency and cross-tabulation tables and various types of graphs
- Inferential statistics using correlations
- Testing of hypotheses using chi-square tests for nominal data
- Testing of hypotheses using ANOVA (factorial or mixed factorial)

(Additional methods may be used as the need arises.)

The total cost for the project will be three thousand five hundred rand only (R3 500).
If you have any queries, please feel free to contact me.

Sincerely

Deepak Singh

DURBAN UNIVERSITY of TECHNOLOGY

Faculty of Health Sciences

ETHICS CLEARANCE CERTIFICATE

Student Name	Ntokozo Gqweta	**Student No**	20926757
Ethics Reference	FHSEC 018/11	**Date of FRC Approval**	18/7/2011
Qualification	**Masters Degree in Technology: Radiography**		
Research Title:	Knowledge, skills and perceptions of diagnostic radiographers on image interpretation of chest diseases in eThekwini.		

In terms of the ethical considerations for the conduct of research in the Faculty of Health Sciences, Durban University of Technology, this proposal meets with Institutional requirements and confirms the following ethical obligations:

1. The researcher has read and understood the research ethics policy and procedures as endorsed by the Durban University of Technology, has sufficiently answered all questions pertaining to ethics in the DUT 186 and agrees to comply with them.
2. The researcher will report any serious adverse events pertaining to the research to the Faculty of Health Sciences Research Ethics Committee.
3. The researcher will submit any major additions or changes to the research proposal after approval has been granted to the Faculty of Health Sciences Research Committee for consideration.
4. The researcher, with the supervisor and co-researchers will take full responsibility in ensuring that the protocol is adhered to.
5. ***The following section must be completed if the research involves human participants:***

	YES	NO	N/A
❖ Provision has been made to obtain informed consent of the participants	√		
❖ Potential psychological and physical risks have been considered and minimised	√		
❖ Provision has been made to avoid undue intrusion with regard to participants and community	√		
❖ Rights of participants will be safe-guarded in relation to: - Measures for the protection of anonymity and the maintenance of Confidentiality.	√		
- Access to research information and findings.	√		
- Termination of involvement without compromise	√		
- Misleading promises regarding benefits of the research	√		

[redacted]
SIGNATURE OF STUDENT/RESEARCHER — 23/8/2011 DATE

[redacted]
SIGNATURE OF SUPERVISOR/S — 23/8/2011 DATE

[redacted]
SIGNATURE OF HEAD OF DEPARTMENT pp — 30 August 2011 DATE

[redacted]
IGNATURE: CHAIRPERSON OF RESEARCH ETHICS COMMITTEE — 1/9/2011 DATE

H

health

Department:
Health
PROVINCE OF KWAZULU-NATAL

Health Research & Knowledge Management sub-component
10 – 103 Natalia Building, 330 Langalibalele Street
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Pietermaritzburg
3200
Tel.: 033 – 3953189
Fax.: 033 – 394 3782
Email.: hrkm@kznhealth.gov.za
www.kznhealth.gov.za

Reference : HRKM133/11
Enquiries : Mrs G Khumalo
Telephone : 033 – 3953189

06 September 2011

Dear Mr N Gqweta

Subject: Approval of a Research Proposal

1. The research proposal titled **'Knowledge, skills and perceptions of diagnostic radioraphers on image interpretation of chest diseases in eThekwini'** was reviewed by the KwaZulu-Natal Department of Health.

The proposal is hereby **approved** for research to be undertaken at Addington, Clairwood, Inkosi Albert Luthuli Central, King Edward VIII, Mahatma Gandhi, Prince Mshiyeni Memorial and RK Khan Hospitals.

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 Mrs G Khumalo on 033-3953189.

Yours Sincerely

[redacted]

Dr E

Chairperson, Health Research Committee

KwaZulu-Natal Department of Health

Date: 12/09/11