EVALUATION OF THE RADIOLOGY UNIT AT LEHURUTSHE HOSPITAL IN THE NORTH WEST PROVINCE

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Public Health in the field of Hospital Management

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DECLARATION

I, Sedie Josephine Moloko, declare that this research report is my own work. It is being submitted for the degree of Master Public Health in the field of Hospital Management at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or for any examination at this or any other University.

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March 2011

DEDICATION

This study is dedicated to the memory of my father, Mr Daniel Moloko who passed away in 1991.

My mother Ellen Moloko for her love and sacrifice for me to be what I am today.

My beloved daughter Katlego. You were with me throughout and gave me the opportunity to continue with my studies. Thank you for believing in me and always reminding me how inspirational I am in your life.

ABSTRACT

BACKGROUND: Lehurutshe Hospital is a district hospital situated in rural North West Province of South Africa. The Hospital offers basic radiological services such as X-rays of the chest, abdomen, extremities and skull according to the norms and standards set by the National Department of Health for a level one hospital. According to 2008/2009 data from the Hospital, it is evident that the number of patients requiring radiology services is increasing. However, no systematic study has been done to determine the reasons and effects of this increasing caseload on the Radiology Unit of the Hospital. This study seeks to establish the caseload and the resources utilised for the services rendered by the Radiology Unit in Lehurutshe Hospital with specific focus on the patient profile and material and human resources utilisation.

AIM: To assess the utilization of the Radiology Unit at Lehurutshe Hospital in terms of caseload, profile of patients, and resource utilization from 01 January to 31 December 2009

METHODOLOGY: This was a cross sectional study. The setting was the Radiology Unit of the Lehurutshe Hospital in Zeerust town, Ngaka Modiri Molema District in the North West Province. A retrospective record review was done and information was extracted from the Hospital information system on various variables that are relevant to the functions and resource utilization of the Radiology Unit, including caseload, profile of patients, resource utilization and workload of staff. No primary data was collected.

RESULTS: The study found that more than 5000 patients were seen and radiological examinations were done during this period with a total number of public patients being significantly higher than private patients. Nearly 500 radiological examinations were done per month. The wide variation in the number of examinations done per month was probably due to seasonality, which may affect operational planning and inventory management at the Unit. Almost 50% of the radiological examinations were chest X-rays. Other examinations include X-ray of the upper and lower extremities and ultrasound examination for obstetrics and gynaecology. These examinations were done based on various clinical indications.

A significant number of public patients seen at the Unit were infants, children and teenagers. The private patients were from an older age group. The majority of patient were unemployed and indigent.

The material resources used in the Unit includes X-ray films, chemicals (developers and fixers) and ultrasound gel. The Unit has two radiographer and one radiographer assistant. In addition, a medical doctor read the X-rays as and when necessary. The direct costs incurred at the unit include use of material resources, maintenance of equipments (service contract) and compensation of employees. Total direct cost during the study period was R 650 803.89, most of which were incurred due to compensation of employees and maintenance of radiological equipments. Patient to staff ratio at the unit was quiet low and it shows there is spare capacity at the Unit, which could easily be used for income generation by the provision of services to private patients.

CONCLUSION: This is probably the first study conducted at a radiology unit of a district hospital in South Africa. This study documented important information, which was not published before.

ACKNOWLEDGEMENT

Firstly thanks to the Almighty God for being with me all the times.

I would like to express my sincere gratitude to my supervisor, Dr. Debashis Basu for his support through hard times, his guidance and support throughout my studies.

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GLOSSARY OF TERMS

District Hospital: a level one hospital offering primary health care services.

Hysterosalpingography (uterosalpingography): an X-ray examination of a woman's uterus and fallopian tubes that uses a special form of X-ray called fluoroscopy and contrast material.

Intravenous pyelogram (IVP): an X-ray examination of the kidneys, ureters and urinary bladder that uses iodinated contrast material injected into veins.

Radiologists: medical specialists who, after completing their medical degrees, specialize for another four years in the interpreting of X-rays and scans. Radiologists work in collaboration with referring doctors and specialists, providing advice, and are always available to discuss the results of diagnostic tests and examinations with their patients.

Radiographers: individuals who assist radiologists by operating the equipment and taking the X-rays or images. An important part of their job is to explain the procedure to the patient and ensure that the equipment is used optimally. Radiographers qualify through formal training of up to four years and may go on to work exclusively in a specialist field of radiology.

Rural hospital: A hospital situated within the rural communities, having no municipal infrastructure (waste removal and bulk water supply).

Ultrasound imaging (ultrasound scanning or sonography): involves exposing part of the body to high-frequency sound waves to produce pictures of the inside of the body. Ultrasound examinations do not use ionising radiation (as used in X-rays). Because ultrasound images are captured in real-time, they can show the structure and movement of the body's internal organs, as well as blood flowing through blood vessels.

X-ray (radiograph): a non-invasive medical test that helps physicians diagnose and treat medical conditions. Imaging with X-rays involves exposing a part of the body to a small dose of ionising radiation to produce pictures of the inside of the body. X-rays are the oldest and most frequently used form of medical imaging.

X-ray of bone: an image of any bone in the body, including the hand, wrist, arm, foot, ankle, knee, leg or spine.

X-ray of chest: the most commonly performed diagnostic X-ray examination. A chest X-ray makes images of the heart, lungs, airways, blood vessels and the bones of the spine and chest.

X-ray special examination: includes Hysterosalpingogram and Intravenous pyelogram

LIST OF ABBREVIATIONS

BRS	Basic Radiological System
CEO	Chief Executive Officer
CHC	Community Health Centre
CT	Computerised Axial Tomography
DHS	District Health System
DHIS	District Health Information System
GP	General Practitioner
HOD	Head of the Department
IQR	Inter-quartile range
LDH	Lehurutshe Hospital
MRI	Magnetic Resonance Imaging
PAHO	Pan American Health Organization
PHC	Primary health care
PSG	Patient Safety Group
SD	Standard deviation
WHO	World Health Organization

CHAPTER 1
INTRODUCTION

The purpose of this study was to assess the utilisation of the radiology unit at a district hospital in the North West Province. This introductory chapter covers the background to the study, statement of the problem, its aims and objectives and an outline of subsequent chapters.

1.1 BACKGROUND

The World Health Organization (WHO) suggested the following criteria for a district hospital (Table 1.1) (World Health Organization 1987).

Table 1.1 Criteria of district hospitals

It forms an essential component of a Health District.
It provides certain level 1 hospital services that cannot usually be delivered at a primary health care (PHC) clinic or community health centre (CHC).
It has the following clinical departments: emergency care, medicine, surgery, obstetrics, paediatrics, psychology, social, outpatient and radiology services
Provides 24-hours service and has more than 30 beds.
Provides in-service training and support to PHC services and facilities in the district.
Ensures the maintenance of good clinical standards in the district.
Provides comprehensive (protective, preventative, curative and rehabilitative) care and is an integral part of the district health programme.
Staffed by generalist doctors who receive support from secondary and tertiary hospitals.
Should render primary level services to the local surrounding population, such as immunization, growth monitoring and Sexually Transmitted Infections, treatment through a separate PHC centre or Out Patient Department (OPD), within the grounds of the hospital.
Has the capacity to interact within the community and with other sectors.

District hospitals in South Africa offer level one care. They play an intermediary role between Primary Health Care (PHC) clinics and Community Health Centres (CHC) which are predominantly run by nurses and, regional hospitals which are predominantly run by specialists and doctors respectively (Department of Health, 2002). Level one care is more of a generalist hospital service accessible to patients daily on a 24 hour basis. It includes diagnostic, treatment, care, counselling and rehabilitation services in the following clinical disciplines namely; Family medicine, Internal Medicine, Obstetrics, Psychiatry, Eye care, Rehabilitation, Surgical, Paediatrics and Geriatric services. In addition, they are expected to provide basic laboratory and radiological services according to the norms and standards set by the National Department of Health for level one hospital (Department of Health, 2002).

1.2 STATEMENT OF THE PROBLEM

Lehurutshe Hospital is a district hospital situated in the North West Province in South Africa. The Radiology Unit of the Hospital provides a valuable service for patients in this area and is one of the important cost drivers for this Hospital. The Hospital statistics showed that the number of patients seen in the Radiology Unit was increasing over the past few years along with a significant increase in the number of patients attending the Hospital.

Although there is a perception of over expenditure in the Hospital and, more specifically, in the Radiology Unit, no systematic study has been done to quantify this problem. It is important to know this information for better planning of the Radiology services of the Hospital.

1.3 RESEARCH QUESTION

How does the Radiology Unit at Lehurutshe Hospital function in terms of caseload, profile of patients, and resource utilization?

1.4 STUDY OBJECTIVES

1.4.1 BROAD OBJECTIVE

To assess utilisation of Radiology Unit at Lehurutshe Hospital in terms of caseload, profile of patients, and resource utilisation for a one-year study period (1 January 2009 –31 Dec 2009)

1.4.2 SPECIFIC OBJECTIVES

1. To determine the caseload of patients attending the Radiology Unit during the study period
2. To describe the profiles of patients attending the Radiology Unit during the study period
3. To determine the resource utilisation in the Radiology Unit during the study period, in terms of (a) material resources (b) human resources and (c) financial resources
4. To determine the monthly workload of health professionals working in the Radiology unit (staff to patient ratio) during the study period

1.5 SUBSEQUENT CHAPTERS

The background to the research has been discussed and objectives defined in this first chapter. Brief outline of following chapters are described below.

Chapter Two: Literature Review

The purpose of the literature review is to explain and discuss concepts related to radiology services at district hospitals in South Africa and elsewhere.

Chapter Three: Research Methodology

The chapter describes the research methodology, study design, setting and scope and data management techniques used in this study.

Chapter Four: Presentation of Results

This chapter deals with an analysis of the findings of the study relating to its aims and objectives.

Chapter Five: Discussion

The findings from the review of the literature are integrated in this chapter with the results obtained from the analysis in order to address the aims and objectives of the study.

Chapter Six: Conclusions and Recommendations

This constitutes the final chapter of the report and draws conclusions from the research related to the aims of the study, makes recommendations and suggests areas for future research in the field of radiological services in district hospitals in South Africa.

CHAPTER 2
LITERATURE REVIEW

In this chapter, relevant reports into radiological services in district hospitals and various factors that might influence the utilisation of this service are discussed. In addition to published literature, information from various unpublished sources was also reviewed.

2.1 RADIOLOGICAL SERVICES

Radiology is a part of medical sciences that specialises in the diagnosis of diseases by obtaining and interpreting medical images. Medical images are obtained in a variety of ways such as the use of X-rays or radioactive substances, sound waves (ultrasound), and body's natural magnetism (MRI). Results may be combined with other examinations and tests to help decide on the most appropriate treatment (RSSA, 2009).

Radiological services refers to services offering diagnostic and interventional radiology services that include X-rays, Nuclear Medicines, Computerised Axial Tomography (CAT) Scan, Magnetic Resonance Imaging (MRI), and Ultrasound. A district hospital is expected to offer basic diagnostic and therapeutic services such as X-rays. According to the norms and standards set by the National Department of Health, these examinations should include the chest, upper and lower extremities, and the skull (Department of Health, 2002).

2.1.1 RADIOLOGICAL SERVICES AROUND THE WORLD

Access to diagnostic radiology and other imaging equipment is a major problem in most developing countries. A significant portion of the world’s population cannot access the benefit of diagnostic radiology (Leggat, 1997). The use of radiological services varied substantially among countries as well as within the countries, particularly for specialised examinations such as CT and MRI examinations, which may be due to differences in accessibility.

Geographical variation in use of radiology has been documented in the United States of America (Rao, Parker, Levin, et al. 2001), Norway (Olsson, Piene, Staf, et al. 1999) and Switzerland (Aroua, Bize, Buchillier-Decka, et al. 1998); This variation can be attributed to accessibility, available economic resources, health care policies, referral systems, and reimbursement policies (Lysdahl and Børretzen, 2007).

For the past 20 years, the WHO has been supporting the development of basic radiology services at district hospitals. These services should provide good quality images, and be easy to use and to maintain (WHO, 2009). In the 1980s, the WHO developed a concept of diagnostic radiology that has been named as the Basic Radiological System (BRS). It is a simplified version of a standard radiographic unit designed by the WHO and the Pan American Health Organization (PAHO). The design of the BRS includes the requirement that it should be able to perform routine radiographic examinations with a minimum of operator training. It should be simple to use and capable of producing excellent radiographs, covering 80% of the radiological examinations required in any hospital or clinic. (Samuel and Palmer, 1985; Viamonte, Martinez, Hanson, et al., 1990; WHO, 2009). The BRS is primarily intended to be used in communities deprived of radio-diagnostic services. The BRS concept comprises of X-ray equipment, as well as equipment for film processing and viewing of X-ray films. It also includes manuals for radiographic and darkroom techniques and, film interpretations. The BRS is aimed at providing the following (WHO, 2009):

- Better radiographic coverage of the entire population
- An adequate radiographic system capable of performing at least 80% of all radiographic examinations required at the district hospital level;
- Radiographic equipment which can be operated by personnel who have had shorter training than fully qualified medical radiology technicians (MRT); and
- Better radio-diagnostic facilities to physicians working in less accessible places of the health care system.

Since then, the system has been further improved and is now called the WHIS-RAD (WHO, 2009).

The WHO expected that the BRS would result in better diagnosis and prognosis of diseases; improved therapeutic decisions and consequent management of patient care; reduced cost to patient, community and government due to the shortened period of disability and bed occupancy, and the reduced need for patient transportation; and lowered radiation dosage per examination (DeCorato, Kagetsu and Ablow, 1995; WHO, 2009). However, the provision of radiological services in developing countries particularly in rural areas still remains a challenge as there is always a scarcity of qualified radiologists and radiographers in these areas. In these situations, use of tele-radiology equipment could provide an alternative for off-site interpretation of radiologic films (DeCorato, et al., 1995).

2.1.2 RADIOLOGICAL SERVICES IN AFRICA

There is insufficient information regarding the radiological services done in Africa. There is a general perception about poor radiological services in the continent. A study conducted in Uganda showed that a significant number of patients were referred to far away hospitals for basic radiological assessments. However, these patients often did not go due to poor economic conditions. This resulted in inappropriate diagnosis, and increased mortality and morbidity (Mayanja, 2005). This study showed the importance of basic radiological services at district hospitals.

2.1.3 RADIOLOGICAL SERVICES IN SOUTH AFRICA

South Africa is faced with a huge challenge of shortage of human resources in radiology especially radiographers. This has a poor impact on the quality of radiological services in this country. At present, there are approximately 500 radiologists and more than 500 radiographers in South Africa (HPCSA, 2009). In addition to challenges associated with human resources, radiology services

in South Africa are also affected by the lack of proper equipment. Some of the factors impacting on resource utilization are poor maintenance of equipment and demotivated staff due to increase workload and low incentives (Cullinan, 2006)

2.2 RESOURCE UTILISATION FOR RADIOLOGICAL SERVICES

Radiology is one of the resource intensive services in terms of human and financial resources. The quality of radiological services is often affected by the shortage of equipment, busier days, longer hours and recruitment difficulties. However, there is a continuous increase in the utilization of imaging services all over the world. One of the major factors driving the demand is new technologies and an aging population (Forster and Kennedy, 2004). Some of the challenges faced by radiological departments include (Cullinan, 2006):

- Lack of skills
- Shortage of radiologists in the hospitals and
- Risk of patients acquiring infections in the hospitals

In order to address these challenges, in-house training, as well as outreach services to the surrounding hospitals is essential.

2.2.1 CASELOAD

The increase in utilisation of radiological services is mainly due to an increased case load. However, availability of newer technologies and increasing dependence of physicians on imaging services has aggravated the situation (WHO, 2009).

The increase in the number of patients seen in the radiology department and lack of radiation standards resulted in increasing hazards to staff members and patients, due to increased exposure to radiation (Cullinan, 2006). This is often due to the failure of staff to comply with safety precautions and guidelines.

The situation in the hospital under study is that the caseload in the radiological

services is increasing monthly. The majority of patients are referred from clinics. Most of the radiological examinations are chest X-rays and X-rays for extremities. A significant number of chest X-rays are done for pulmonary tuberculosis. This might be due to the increased number of patients with HIV/ AIDS.

2.2.2 RESOURCE UTILIZATION FOR RADIOLOGY

Due to limited resources, rural hospitals like LDH have few radiographers and radiographer assistants and no radiologists. It is not easy to fill vacant posts due to budgetary constraints and the lack of radiology health professionals in South Africa. This has resulted in increased workload among existing radiology staff, which often leads to poor quality services, such as poor imaging resulting in patients being inappropriately diagnosed. The implication of shortage of radiology services causes increased use of locum tenets. This affects resources utilization as professionals absent themselves from work (Forster and Kennedy, 2004). The Mpumalanga Provincial Department of Health has attempted to address the HR challenges through in-house training and provision of outreach services (Mpumalanga, 2003).

Because of the costs involved, many radiology services in developing countries (such as Latin America, Caribbean, and Africa) are inappropriately equipped, inadequately staffed, insufficiently maintained and operated without consideration for the health risks to staff and patients posed by ionising radiation. This resulted in missed diagnoses, waste of supplies such as film and processing chemicals, inoperable equipment, and increased cancer risk for the patients examined (WHO, 2001).

Although availability of adequate financial resources and their optimal usage are crucial to effective functioning of any health services, radiology services in district hospitals do not get a fair allocation of financial resources. Generally, the hospital budget is allocated for all medical equipment and there is usually no separate budget for radiological equipment. All services are allocated a certain percentage of their budget from an equitable share. The amount

allocated does not always accommodate all needs to render quality radiological services, which impacted the delivery of services.

Unfortunately, no study has been conducted to document the utilisation of resources at radiology units in public hospitals in South Africa. This study is expected to contribute towards this deficiency in knowledge.

CHAPTER 3
METHODOLOGY

The methodology for this study was selected on the basis of its aims and objectives. In this chapter the following were discussed: setting, scope, and study design and research tools.

3.1 STUDY DESIGN

This was a cross-sectional study based on a retrospective record review.

3.2 STUDY SETTING AND STUDY SCOPE

The study setting was the Radiology Unit within the Lehurutshe Hospital in the Ngaka Modiri Molema Municipality in the North West Province.

Ngaka Modiri Molema District Municipality

The Ngaka Modiri Molema District Municipality (DC38) is situated centrally within the North West Province. The principal towns in the region include Mafikeng, Mmabatho, Zeerust and Lichtenberg. It consists of five local municipalities, namely Ditsobotla, Mafikeng, Ramotshere Moilwa, Ratlou and Tswaing. The population (719 017) is mainly Black Africans (719 017), and the majority are females (378 434). There is a high level of illiteracy (78%, 156 693) and unemployment (15%, 105 721); very few have access to medical aid and therefore use public health facilities. The district is mainly rural but most of the areas are electrified. Means of communication is through use of cell phone (Municipal Demarcation Board, 2009).

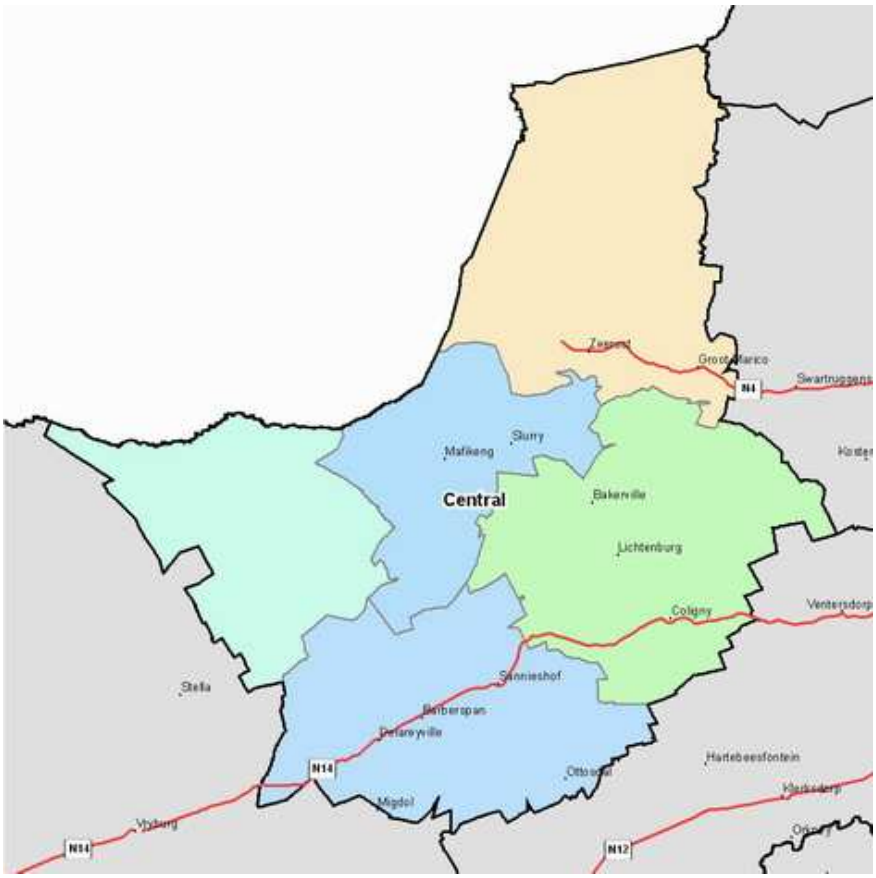

Figure 3.1 Ngaka Modiri Molema Health District

Lehurutshe Hospital

Lehurutshe Hospital (LDH) is a district hospital situated in Ngaka Modiri Molema District Municipal area in Ramotshere Moilwa Sub district. It is 60 kilometres from Mafikeng town. Lehurutshe Hospital and Zeerust Hospital are managed as a complex. The two hospitals are 17 kilometres apart.

The Lehurutshe Hospital has 105 in-patient beds. The Hospital supports PHC in the sub-district and patients are referred from community health centres, clinics (19 fixed and 5 mobile) and private practitioners for level 1 (generalist) services to in-patients and outpatients in the LDH. In some circumstances, PHC services are rendered where there is no alternative source of this care available within a reasonable distance.

The Hospital offers basic radiological services (such as X-ray of chest, abdomen, extremities, and skull) according to the norms and standards set by the National Department of Health for level one hospital (Department of Health, 2002). There are certain radiological services [such as complex radiological examinations (Barium meal, intravenous pyelography, and hystero-salpingography), CT and MRI scans] that are not available at the LDH. Patients requiring these services are referred to the Mafikeng/Bophelong Hospital Complex or the Klerksdorp/Tshepong Hospital Complex.

This Hospital has one mobile X-ray unit, one fixed X-ray unit and two ultrasound machines, all of which require regular servicing. In addition, consumables are regularly required for the X-ray machines. The Radiology Unit employs two radiographers and one radiography assistant. The Hospital has no radiologist. One of the five medical doctors (general practitioners) employed by the Hospital interprets the radiological findings as and when necessary and, if necessary, refer patients to the radiologists working in the regional hospital complexes.

3.3 STUDY PERIOD

The study period was one year from 01 January 2009 - 31 Dec 2009.

3.4 STUDY POPULATION AND SAMPLING

The study population comprised all the patients who had radiological examinations done during the study period at the LDH. The entire study population was included in the study. Therefore, no sampling was done.

3.5 MEASUREMENT AND DATA SOURCES

3.5.1 DATA COLLECTION

Data was extracted from the Hospital Information system, patients' records as

well as from Hospital financial records (Table 3.1). Besides the Hospital Information System, the Radiology Unit also keeps manual records of radiological examinations done in the Unit. This Unit maintains records of consumables used and this was used to determine the amount of consumables used per month. The Unit also maintains records of maintenance of radiology equipments and cost of maintenance. No new equipment was purchased during the study period. Therefore, no capital cost for equipment was included. The staff duty roster from the Unit was used to determine the number of staff worked during the study period. The Hospital Finance Department was able to provide information related to unit cost of the consumables, maintenance cost and compensation of various categories of employees.

Table 3.1 Data source

Objectives	Data source
1 and 2	Hospital Information System and patients' records, Radiology Unit records.
3	Radiology Unit records, Hospital financial records for consumables, maintenance costs for equipments, goods and services
4	Radiology Unit records for staff per category; number per shift for the week

3.5.2 STUDY INSTRUMENT

The data used for this study were extracted from the Hospital Information System to MS Excel based tools designed for this study (Appendix B).

3.5.3 VARIABLES

Variables used in this study are listed below.

- Caseload
- Patients' profile: Socio-demographic and clinical profiles
- Resource utilisation: Material resources, Human resources and Financial resources
- Work-load:

Resource utilization

Resource utilization was calculated based on following formulas:

(a) Material resources

There are mainly two types of consumables used in the Radiology Unit: X-ray films and chemicals. In addition, ultrasound gel was used for ultrasound. There are also maintenance costs of radiological equipment. Material resource utilisation was calculated based on the information collected from the records of the Radiology Unit and Finance department:

- Quantity of material resources used for each item per month = Q
- Unit cost for each item = U
- Cost of material resources used for each item per month: = $Q \times U_c$
- Total cost of material resources used per month:

  $[Q_x \times U_{cx}] + [Q_{ch} \times U_{cch}] + [Q_{cj} \times U_{cj}]$
- Total cost of material resources used during study period

$$\sum_{MR}^{12} = [Q_x \times U_{cx}] + [Q_{ch} \times U_{cch}] + [Q_{cj} \times U_{cj}] + U_{MC}$$

where Q_x = quantity of X-ray films used per month

Q_{ch} = quantity of chemicals used per month

Q_{cj} = quantity of ultrasound jelly used per month

U_{cx} = unit cost of X-ray films

U_{cch} = unit cost of chemicals

U_{cj} = unit cost of ultrasound jelly

U_{MC} = maintenance cost of radiological equipments

(b) Human resources

There are three categories of staff working in the Radiology Unit: Medical doctor, Radiographer and Radiographer assistant. Since the medical doctor was only employed on a part-time basis and was only involved in the reading of the x-rays, his salary was not calculated while calculating the final cost. Human resource utilisation of each category of staff was calculated based on the information collected from the records of Radiology Unit and Human resource department:

- Number of staff per category: = q
- Compensation of employees = u
- Compensation of employees for each category of staff per month: = $q \times u_c$
- Total cost of human resources used per month: =

$$[q_r \times U_{cr}] + [q_{ra} \times U_{cra}]$$

- Total cost of human resources used during study period

$$\Sigma_{HR} = [q_r \times U_{cr}] + + [q_{ra} \times U_{cra}]$$

where q_r = number of radiographers working per month

q_{ra} = number of radiographer assistant working per month

u_{cr} = compensation of a radiographer per month

U_{cra}= compensation of a radiographer assistant per month

(c) Financial resources

The financial resources used during the study period were calculated based on direct costs associated with Unit (materials and human resources). The calculation was based on following formula

$$FR = \sum_{MR}^{12} + \sum_{HR}^{12} + M$$

FR= Financial cost; MR = Material cost; HR= Human resource cost; M= Maintenance cost per anum

The study will not include any capital cost (such as cost of building and equipments) and indirect cost (such as electricity and water). This information is not easily available and unreliable.

<u>Work-load</u>

Staff to patient ratio was calculated based on the ratio of the number of patient seen during the month to number of staff per category available during the

month.

3.5.4 DATA ANALYSIS

The data from the sources mentioned above was collected in the MS Excel based spreadsheets (Appendix B). Then data was then cleaned by looking at missing entry or any error. After that, new variables (such as staff to patient ratio) were created. Subsequently, data was exported to NCSS software for analysis (NCSS, 2007).

3.5.5 STATISTICAL TESTS

The following descriptive statistics were reported:

- Continuous variables with normal distributions (such as age): mean and standard deviation
- Other continuous variables (not normally distributed): median and inter-quartile range, and
- Nominal and ordinal variables (such as ethnicity): proportions.

The statistical significance was calculated at the 95% confidence level.

3.6 PILOT STUDY

No pilot study was done as the data to be used for this study is routinely collected.

3.7 ETHICAL CONSIDERATIONS

No primary data collection was done for this study. No intervention was done as a part of this study. The Chief Executive Officer of the Lehurutshe Hospital had given permission to conduct this study (Appendix A). The project was also approved by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand (Appendix A). Confidentiality and anonymity was maintained at all times in the processes of collection, capturing, and reporting of the information.

CHAPTER 4
RESULTS

The results obtained from the analysis of data were described in this chapter.

4.1 STUDY POPULATION

The study population comprised of all the patients who had radiological examinations done during the study period at the LDH. The entire study population (n=5137) was included in the study. Their records were extracted from the Hospital information system. In case of missing records, attempts were made to collect information from the Radiology unit register and patient records. In spite of all the efforts, records of 12 patients (0.2%) were found to be incomplete and they were excluded from the study. Therefore, the final study population was 5125.

4.2 CASELOAD OF PATIENTS IN RADIOLOGY UNIT

4.2.1 NUMBER OF PATIENTS SEEN AT THE RADIOLOGY UNIT

The caseload of patients seen at the Radiology unit of LH is listed in the Table 4.1 (Figure 4.1)

Table 4.1 Caseload of patients seen at the Radiology Unit

Month	Total	Public	Private
Jan	370	370	0
Feb	420	420	0
Mar	467	467	0
Apr	450	449	1
May	531	433	98
Jun	424	399	25
Jul	539	539	0
Aug	429	428	1
Sep	389	370	19
Oct	408	408	0
Nov	406	406	0
Dec	292	292	0
Total	**5125**	**4981**	**144**

The average number of patients who were seen at the Unit per month was 472 (± 58) with a range from 292 to 539. The lowest number of patients was seen during the month of December, which is usually the quietest month of the year.

The average numbers of public and private patients seen per month were 415 and 12 respectively.

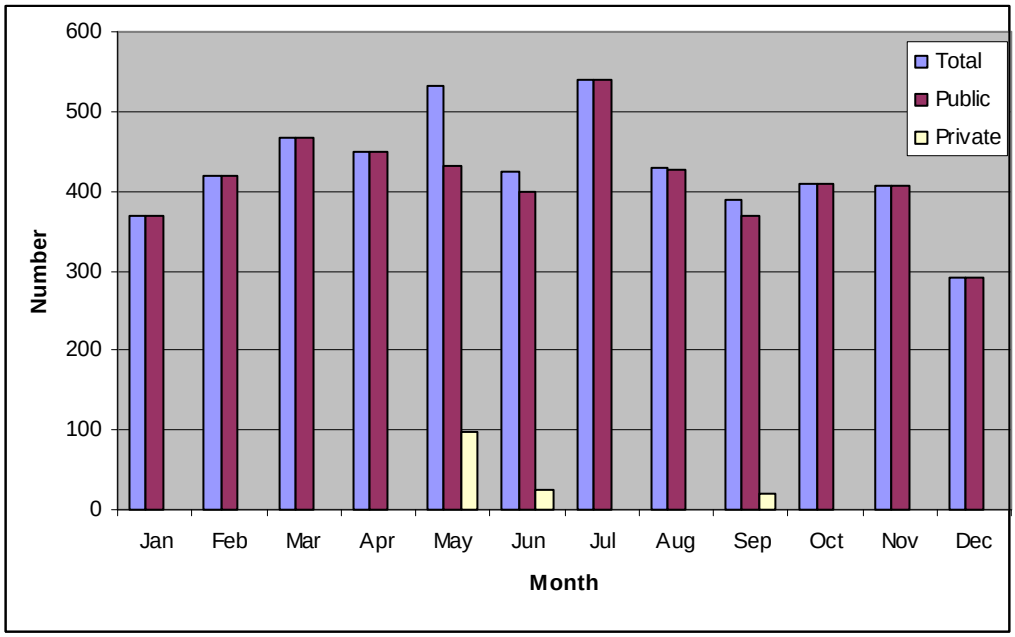

Figure 4.1 Number of patients seen at the Radiology Unit

4.2.2 NUMBER OF RADIOLOGICAL EXAMINATIONS DONE

The number of Radiological examinations done during this period is listed in Table 4.2 (Figure 4.2)

Table 4.2 Radiological examinations done during this period

Month	Total	Hospital	Private
Jan	392	392	0
Feb	460	460	0
Mar	492	492	0
Apr	493	492	1
May	577	479	98
Jun	455	430	25
Jul	539	539	0
Aug	504	503	1
Sep	425	406	19
Oct	461	461	0
Nov	548	548	0
Dec	354	354	0
Total	**5700**	**5556**	**144**

The average number of radiological examinations done per month was 463 (± 69) with a range from 354 to 577. The lowest number of radiological examination done during this period was in the month of December, which is usually quietest month of the year.

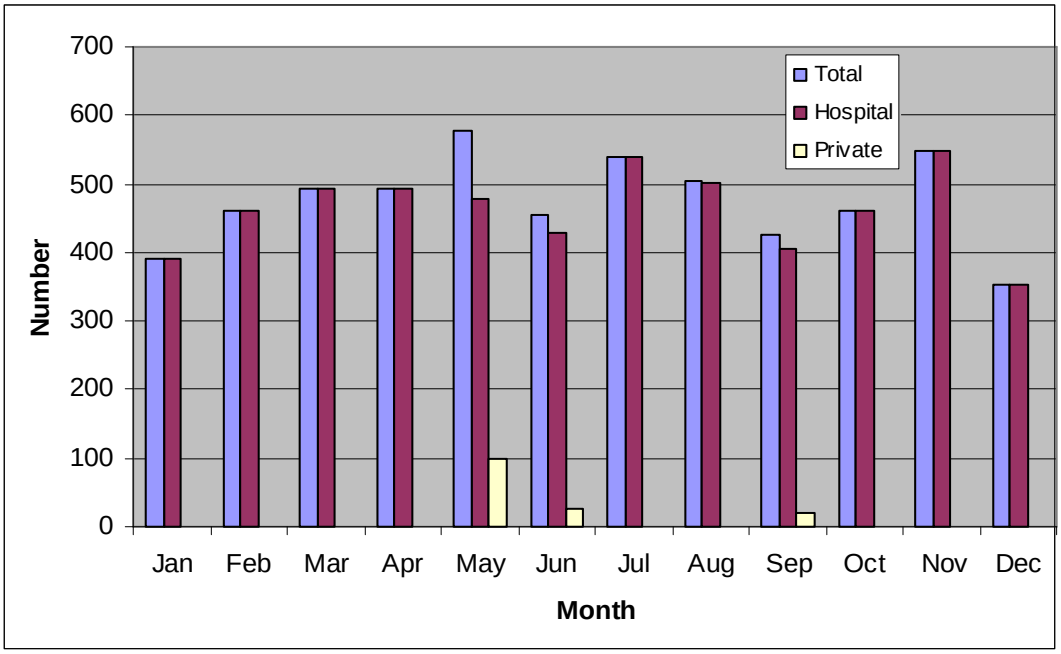

Figure 4.2 Radiological examinations performed during this period

The average number of radiological examinations done for public and private patients seen per month was 466 and 12 respectively. There was an average of one radiological examination per patient.

4.3 TYPES OF RADIOLOGICAL EXAMINATIONS

The number of examination for different categories is listed in Table 4.3 (Figure 4.3). Approximately half of them were chest X-rays. Others include X-ray of extremities and ultrasound.

Table 4.3 Type of radiological examinations done during this period

	Total n (%)	Public	Private
Chest	2570 (45.1%)	2426	144
Chest for TB	276 (4.8%)	276	0
Upper and lower extremities	1489 (26.1%)	1489	0
Pelvis and spine	326 (5.7%)	326	0
Skull and mandible	248 (4.4%)	248	0
Abdomen	165 (2.9%)	165	0
Mobile	22 (0.4%)	22	0
Ultrasound	604 (10.6%)	604	0
Total	**5700**	**5556**	**144**

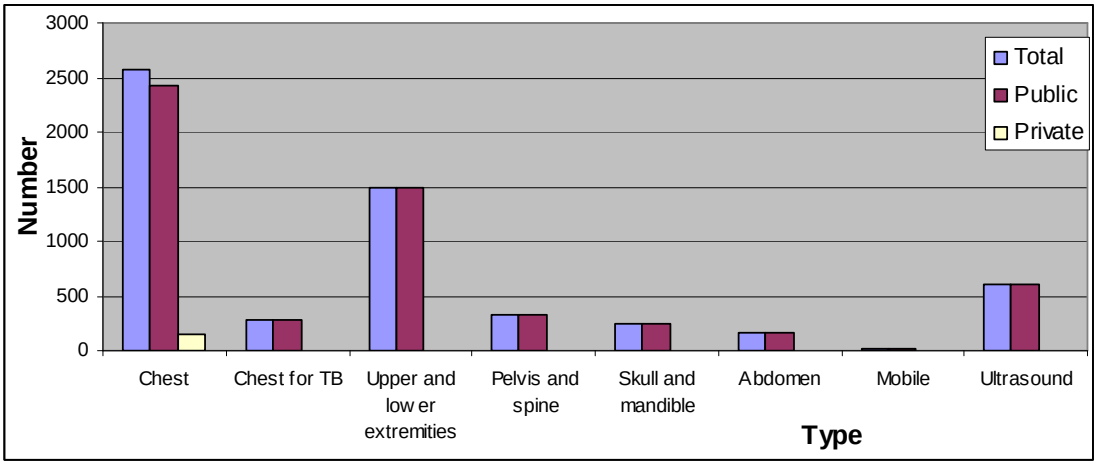

Figure 4.3 Type of radiological examinations performed during this period

4.3.1 RADIOLOGICAL EXAMINATIONS FOR CHEST

The number of chest X-rays done during this period is listed in Table 4.4. The mean number of chest X-rays done during this period was 214 (± 52).

Table 4.4 Chest X-rays done during this period

Month	Total	Public	Private
Jan	130	130	0
Feb	155	155	0
Mar	214	214	0
Apr	240	239	1
May	312	214	98
Jun	211	186	25
Jul	253	253	0
Aug	257	256	1
Sep	227	208	19
Oct	226	226	0
Nov	205	205	0
Dec	140	140	0
Total	**2570**	**2426**	**144**

The mean number of chest X-rays done for public and private patients per month was 202 and 12 respectively.

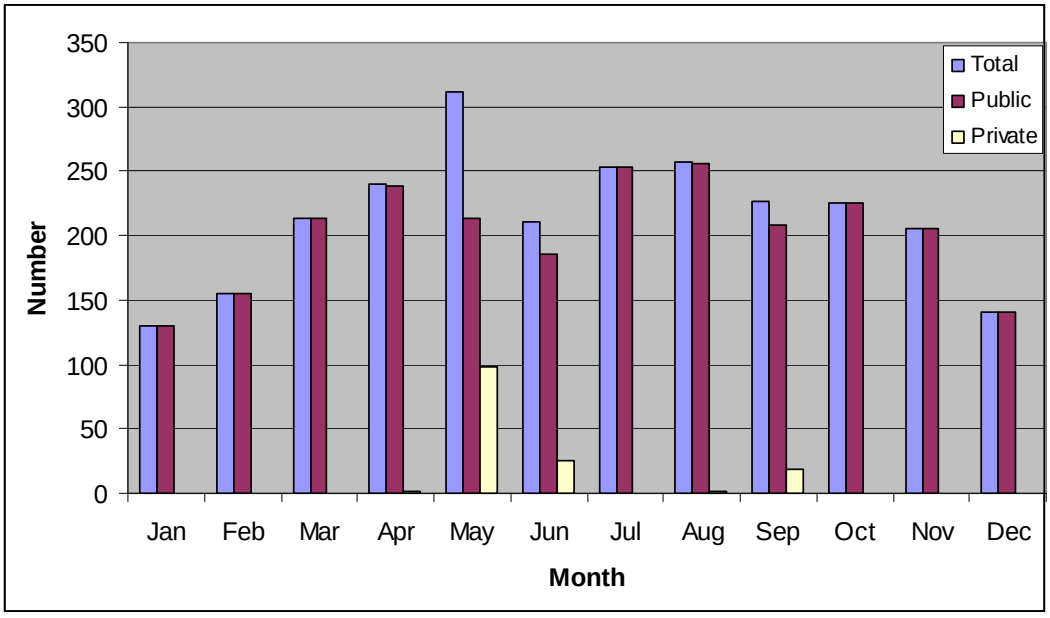

Figure 4.4 Chest X-rays performed during this period

Indication for chest X-rays are listed in Table 4.5.

Table 4.5 Indications for chest X-rays

Systems	Indications
Respiratory	Asthma
	Bronchitis
	Pneumonia
	Lung cancer
	Lung abscess
	Upper respiratory tract infection
Cardio-vascular	Angina
	Cardiomegaly
	Cardiac failure
	Myocardial infarction
	Pericarditis
	Hypertension
Trauma	Chest injury
	Rib fracture
	Intercostal drain
Others	HIV
	Lymphadenitis
	Malnutrition

4.3.2 RADIOLOGICAL EXAMINATIONS (CHEST) DONE FOR PULMONARY TUBERCULOSIS

The number of chest X-rays done for pulmonary tuberculosis during this period is listed in Table 4.6 (Figure 4.5).

Table 4.6 Chest X-ray for pulmonary tuberculosis

Month	Total	Public	Private
Jan	19	19	0
Feb	32	32	0
Mar	29	29	0
Apr	27	27	0
May	25	25	0
Jun	26	26	0
Jul	25	25	0
Aug	32	32	0
Sep	14	14	0
Oct	23	23	0
Nov	15	15	0
Dec	9	9	0
Total	**276**	**276**	**0**

The mean number of chest X-rays done per month for tuberculosis was 23 (± 7). All chest x–rays done for pulmonary tuberculosis were for public patients.

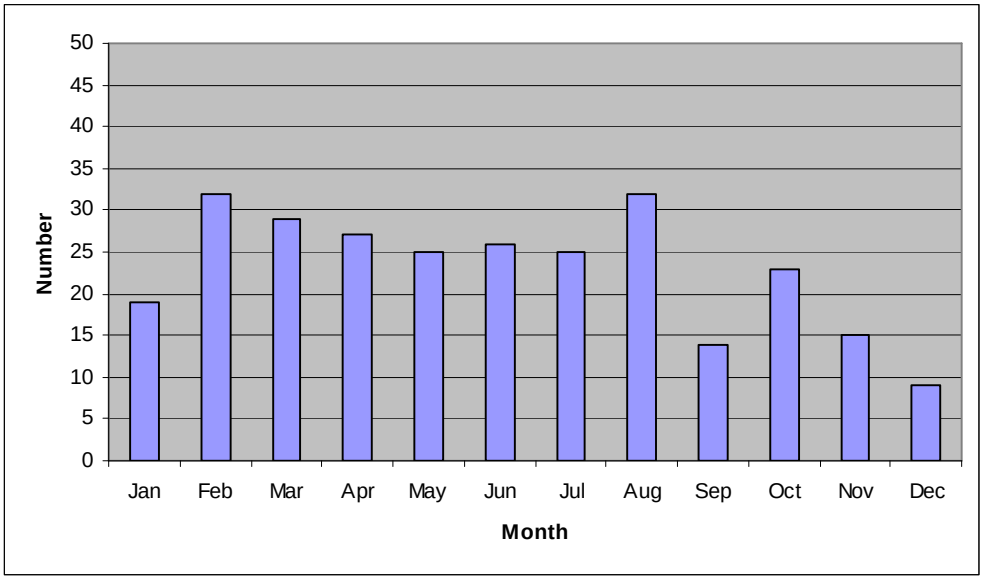

Figure 4.5 Chest X-ray for pulmonary tuberculosis

4.3.3 RADIOLOGICAL EXAMINATIONS DONE FOR UPPER AND LOWER EXTREMITIES

The number of X-rays done for upper and lower extremities during this period is listed in Table 4.7 (Figure 4.6).

Table 4.7 X-ray of upper and lower extremities

Month	Total	Public	Private
Jan	115	115	0
Feb	139	139	0
Mar	115	115	0
Apr	116	116	0
May	117	117	0
Jun	107	107	0
Jul	133	133	0
Aug	104	104	0
Sep	80	80	0
Oct	118	118	0
Nov	205	205	0
Dec	140	140	0
Total	**1489**	**1489**	**0**

The mean number of X-rays done per month for upper and lower extremities was 124 (± 30). These X-rays were done only for public patients.

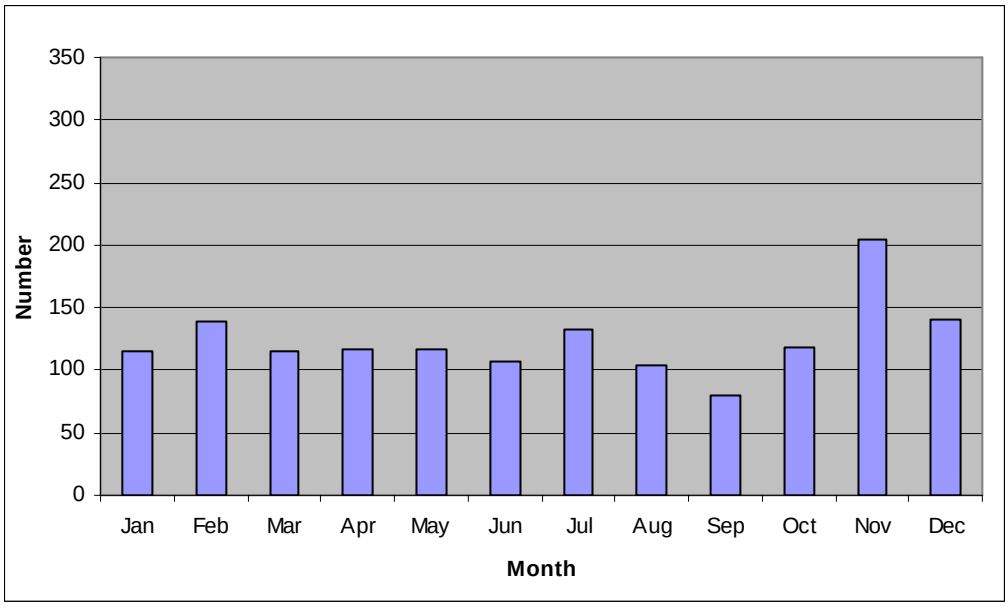

Figure 4.6 X-ray of upper and lower extremities

Indications for X-rays done for upper and lower extremities are listed in Table 4.8.

Table 4.8 Indications for upper and lower extremities X-rays

Systems	**Indications**
Upper extremities	Clavicle fracture
	Shoulder dislocation
	Shoulder fracture
	Arm fracture
	Elbow fracture
	Forearm fracture
	Wrist fracture
	Hand and finger fracture
Lower extremities	Femur fracture
	Knee and patellar fracture
	Leg fracture
	Ankle fracture
	Foot and toes fracture
	Pott's fracture
	Joint derangement internal
Others	Osteoarthritis
	Sprain
	Torn ligaments and muscles

4.3.4 RADIOLOGICAL EXAMINATIONS DONE FOR PELVIS AND SPINE

The number of X-rays done for pelvis and spine during this period is listed in Table 4.9 (Figure 4.7).

Table 4.9 X-ray of pelvis and spine

Month	Total	Hospital	Private
Jan	21	21	0
Feb	42	42	0
Mar	30	30	0
Apr	18	18	0
May	24	24	0
Jun	29	29	0
Jul	36	36	0
Aug	22	22	0
Sep	23	23	0
Oct	18	18	0
Nov	32	32	0
Dec	31	31	0
Total	**326**	**326**	**0**

The mean number of X-rays done per month for pelvis and spine was 27 (± 7). These X-rays were done only for public patients.

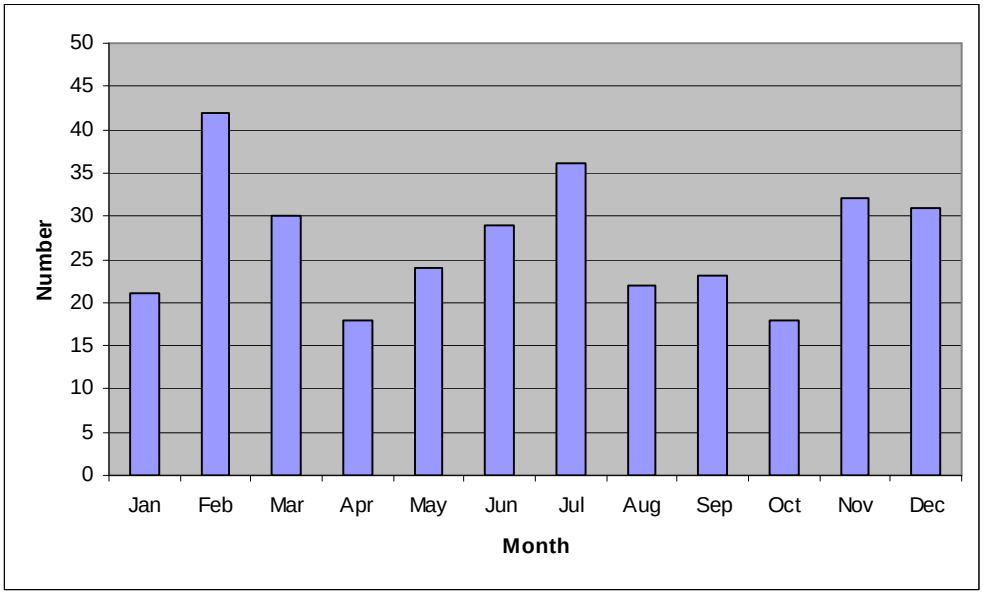

Figure 4.7 X-ray of pelvis and spine

Indications for X-rays done for pelvis and spine are listed in Table 4.10.

Table 4.10 Indications for pelvis and spine X-rays

Systems	Indications
Pelvis	Pelvis fracture
	Hip dislocation
	Tumour and metastasis
Spine	Backache
	Spine fracture

4.3.5 X-RAY FOR SKULL, MANDIBLE AND SINUSES

The number of X-rays done for skull, mandible and sinuses during this period is listed in Table 4.11 (Figure 4.8).

Table 4.11 X-rays of skull, mandible and sinuses

Month	Total	Hospital	Private
Jan	19	19	0
Feb	13	13	0
Mar	23	23	0
Apr	19	19	0
May	24	24	0
Jun	18	18	0
Jul	23	23	0
Aug	24	24	0
Sep	18	18	0
Oct	20	20	0
Nov	16	16	0
Dec	31	31	0
Total	**248**	**248**	**0**

The mean number of X-rays done per month for pelvis and spine was 21 (± 5). These X-rays were done only for public patients.

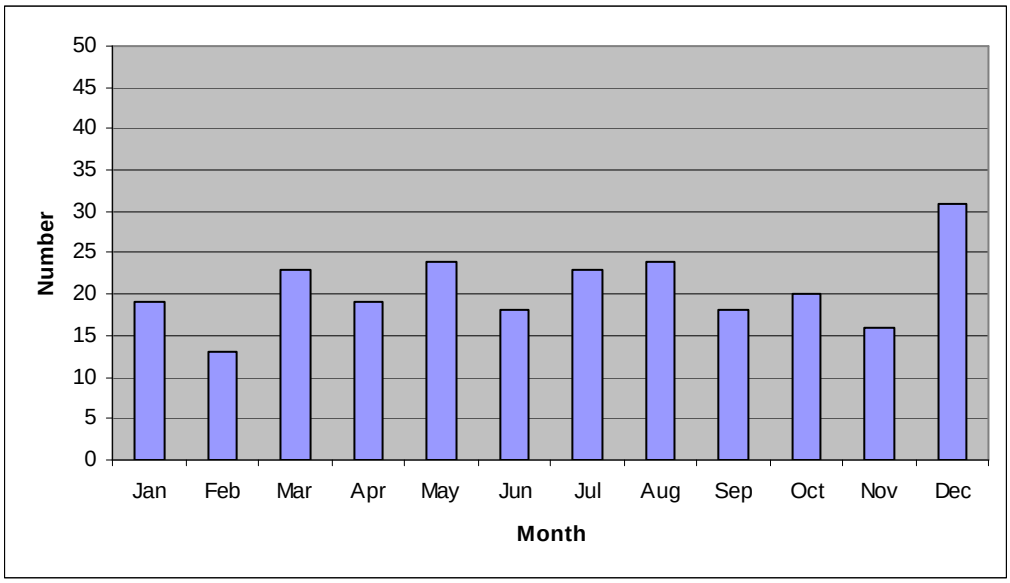

Figure 4.8 X-rays of skull, mandible and sinuses

Indications for X-rays done for skull, mandible and sinuses are listed in Table 4.12.

Table 4.12 Indications for X-rays done for skull, mandible and sinuses

Systems	Indications
Skull	Cervical neck fracture
	Skull fracture
	Space occupying lesion
	Headache
Mandible	Mandible fracture
	Mandible dislocation
	Mastoiditis
	Periodontitis
	Otitis media
Sinuses	Maxillary sinusitis

4.3.6. RADIOLOGICAL EXAMINATIONS OF ABDOMEN

The number of abdominal X-rays performed during this period is listed in Table 4.13 (Figure 4.9).

Table 4.13 X-ray of abdomen

Month	Total	Public	Private
Jan	13	13	0
Feb	14	14	0
Mar	17	17	0
Apr	16	16	0
May	15	15	0
Jun	11	11	0
Jul	13	13	0
Aug	15	15	0
Sep	14	14	0
Oct	17	17	0
Nov	20	20	0
Dec	0	0	0
Total	**165**	**165**	**0**

The mean number of X-rays done per month for abdomen was 14 (± 5).

These X-rays were done only for public patients.

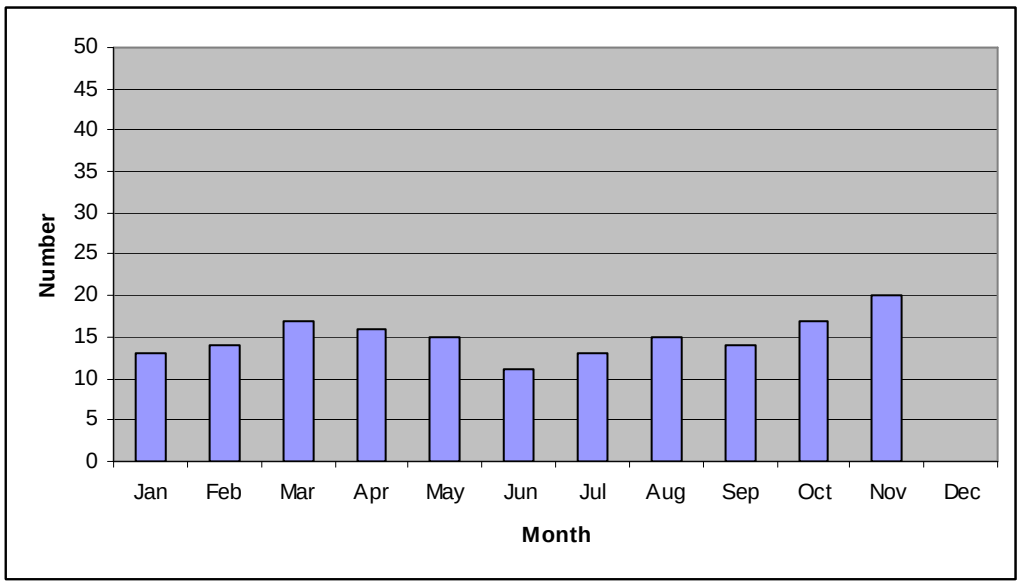

Figure 4.9 X-ray of abdomen

Indications for abdominal X-rays are listed in Table 4.14.

Table 4.14 Indications for abdominal X-rays

Systems	Indications
Digestive	Appendicitis acute
	Pancreatitis acute
	Dyspepsia
Hepatic	Hepatomegaly
	Liver cirrhosis
	Liver rupture
Renal	Cystitis
	Bladder injury
	Renal Failure
	Food poisoning
Others	Abdominal hernia
	Malnutrition

4.3.6 MOBILE X-RAYS

The number of mobile X-rays done during this period is listed in Table 4.15 (Figure 4.10).

Table 4.15 Mobile X-rays

Month	Total	Hospital	Private
Jan	1	1	0
Feb	2	2	0
Mar	0	0	0
Apr	3	3	0
May	2	2	0
Jun	0	0	0
Jul	5	5	0
Aug	6	6	0
Sep	1	1	0
Oct	0	0	0
Nov	2	2	0
Dec	0	0	0
Total	**22**	**22**	**0**

The mean number of X-rays done per month for abdomen was 2 (± 2). These X-rays were done only for public patients.

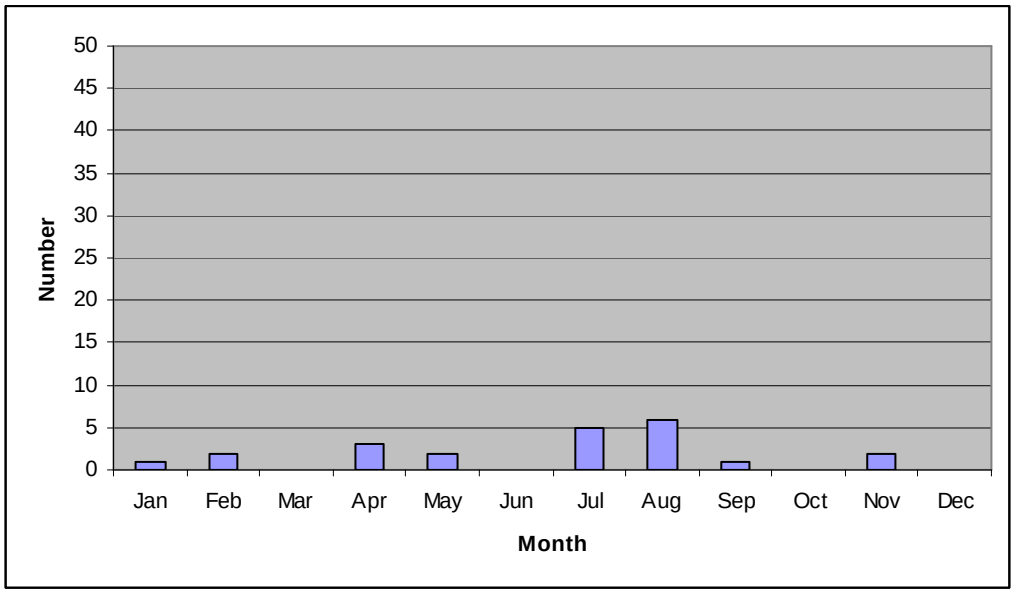

Figure 4.10 Mobile X-rays

4.3.7 ULTRASOUND EXAMINATION

The number of ultrasound examination done during this period is listed in Table 4.16 (Figure 4.11).

Table 4.16 Ultrasound examination

Month	Total	Hospital	Private
Jan	74	74	0
Feb	63	63	0
Mar	64	64	0
Apr	54	54	0
May	58	58	0
Jun	53	53	0
Jul	51	51	0
Aug	44	44	0
Sep	48	48	0
Oct	39	39	0
Nov	53	53	0
Dec	3	3	0
Total	**604**	**604**	**0**

The mean number of ultrasound examination done per month was 50 (± 18). These ultrasound examinations were performed only for public patients.

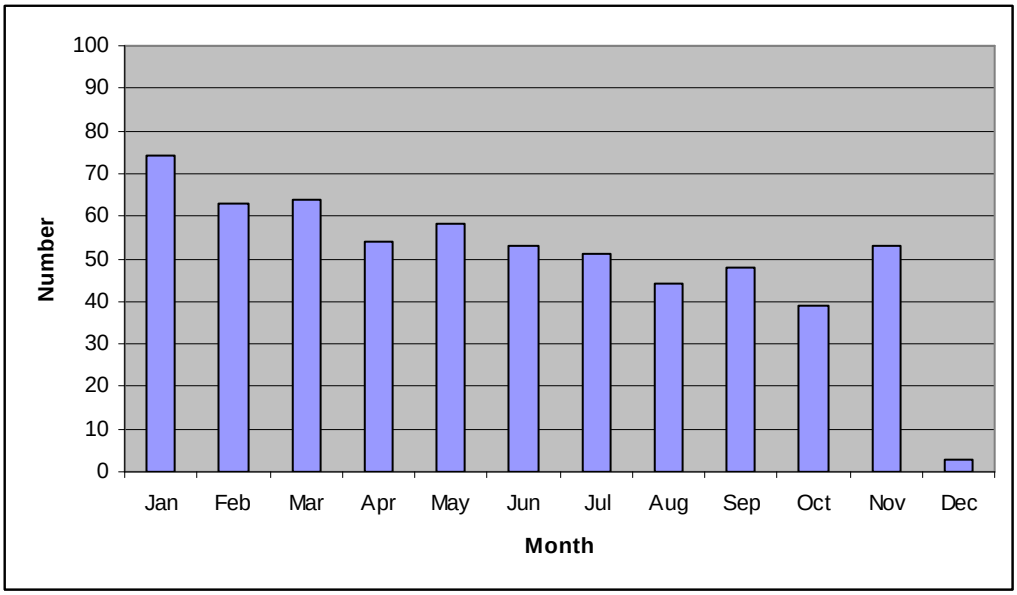

Figure 4.11 Ultrasound examination

Indications for ultrasound examinations are listed in Table 4.17.

Table 4.17 Indications for ultrasound examinations

Systems	**Indications**
Obstetrics	Pregnancy confirmation
	First trimester scan
	Second trimester scan
	Third trimester scan
	Multiple pregnancy
	Fetal viability
	Fetal abnormality (hydrocephalus, polyhydramnios)
Gynaecology	Miscarriage
	Menorrhagia
	Uterine fibroids

4.4 PROFILE OF PATIENTS

4.4.1 AGE

The age of patients is described in Table 4.18 (Figure 4.12). As the age is not normally distributed, non-parametric tests were done to describe and to analyse the data.

Table 4.18 Age distribution (in years)

	Total (n=5125)	Public (n=4981)	Private (n= 144)
Median (IQR)	29 (20-45)	29 (20-45)	27 (19-35)
Range	0.07 to 89	0.07 to 89	7 to 59

The private patients were significantly older than the public patients (Mann Whitney's U test, $p < 0.05$).

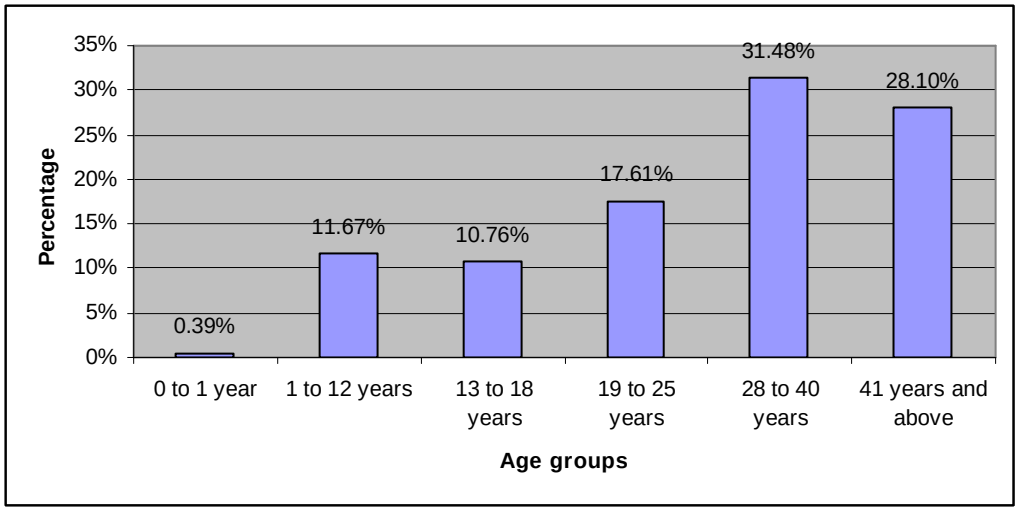

Figure 4.12 Age distribution

4.4.2 ETHNICITY

All the patients seen during this period were black, which is demography of the catchment population.

4.4.3 EMPLOYMENT STATUS

The employment status of the patients is listed in Table 4.19.

Table 4.19 Employment status of patients

Employment status	**N (%)**
Formally Employed	33 (0.6%)
Informally Employed	63 (1.2%)
Unemployed	5029 (98.1%)
Total	**5125**

Most of the patients were unemployed. Therefore, only few patients were paying for their radiological examinations.

4.4.4 MEDICAL AID STATUS

Twenty one patients had medical aid (n=29, 0.4%), which was a very small proportion of the total number of patients.

4.4.5 HOSPITAL CLASSIFICATION

The Hospital classification of patients is listed in Table 4.20. Most of the patients are classified as H1who are also known as ‘non-paying or free’ patients.

Table 4.20 Employment status of subjects

Employment status	N (%)
H1	4916 (95.8%)
H2	162 (3.1%)
Private	47 (1.0%)
Total	**5125**

4.4.6 IN-PATIENT AND OUT-PATIENT STATUS

The distribution of patients in terms of Inpatient/ Outpatient status is described in Table 4.21. No private patient was admitted during this period, who had undergone a radiological examination.

Table 4.21 Inpatient/ out-patient status

	Total	Public	Private
Inpatient	543 (10.9%)	543 (10.8%)	0
Out-patient	4582 (89.1%)	4438 (89.2%)	144
Total	5125 (100%)	4981 (100%)	144 (100%)

4.5 RESOURCE UTILIZATION

4.5.1 MATERIAL RESOURCES

4.5.1.1 Quantity of X-ray films used per month

The quantity of X-ray films used per month is listed in Table 4.22

Table 4.22 Monthly uses of X-ray films

Months	**Total**	**X-RAY FILMS**						
		18/24 cm	**18/43 cm**	**24/30 cm**	**30/40 cm**	**35/35 cm**	**35/43 cm**	**30/60 cm**
Jan	366	31	35	117	46	55	82	0
Feb	467	31	54	142	64	64	112	0
march	539	33	35	207	42	86	136	0
April	472	27	44	131	53	103	114	0
May	580	11	53	157	50	64	245	0
June	431	17	33	113	48	87	133	0
July	532	29	49	149	64	28	213	0
Aug	450	15	52	127	44	69	143	0
Sep	385	8	37	102	41	64	133	0
Oct	437	15	47	148	46	1	180	0
Nov	450	27	56	108	61	5	193	0
Dec	402	25	84	126	61	0	106	0
Total	**5511**	**269**	**579**	**1627**	**620**	**626**	**1790**	**0**

4.5.1.2 Quantity of chemicals used per month

The quantity of chemicals used per month is listed in Table 4.23.

Table 4.23 Monthly uses of chemicals

Months	Items used	
	Developer	Fixer
Jan	10	5
Feb	5	0
March	10	0
April	10	10
May	5	5
June	5	5
July	10	5
Aug	10	10
Sep	15	5
Oct	5	10
Nov	10	5
Dec	10	5
TOTAL	**105**	**65**

One hundred and six bottles (250 ml/ bottle) of Ultrasound jelly was used during this period

4.5.2 HUMAN RESOURCES

The number of staff employed at the Radiology Unit during this period is listed in Table 4.24.

Table 4.24 Human resources used during the period

Category of staff	Position
Medical doctor	Medical officer
Radiographer	Chief radiographer
	Senior radiographer
Radiographer assistant.	Darkroom attendant

4.5.3 FINANCIAL RESOURCES

There were two direct costs associated with the Radiology Unit: Material resources, Maintenance and Human resources. For calculation of financial resources, indirect costs were not calculated (such as electricity, water).

4.5.3.1 MATERIAL RESOURCES

Direct costs associated with material resources used during this period are listed in Table 4.25.

Table 4.25 Costs of material resources used during the period

Items	Quantity	Cost per unit	Total cots
Films			
18/24 cm	269	R 1.40	R 376.60
18/43 cm	579	R 2.71	R 1,569.09
24/30 cm	1627	R 2.40	R 3,904.80
30/40 cm	620	R 4.00	R 2,480.00
35/35 cm	626	R 4.10	R 2,566.60
35/43 cm	1790	R 5.00	R 8,950.00
Sub-total	**5511**		**R 19,847.09**
Chemicals			
Developers (litre)	105	R 85.50	R 8977.50
Fixers (litre)	65	R 85.50	R 5557.50
Ultrasound jelly			
Ultrasound jelly (250 ml/ bottle)	106	R 4.00	R 424.00
Sub-total			**R 14, 959.00**
TOTAL			**R 34,806.09**

4.5.3.2 MAINTENANCE

Maintenance cost for servicing the radiological equipments was based on a service contract. The total cost was R 253 189.80

4.5.4 HUMAN RESOURCES

Direct costs associated with human resources used during this period are listed in Table 4.26.

Table 4.26 Costs of human resources used during the period

Employees	Number employed	Salary notch	Total cots
Chief radiographer	1	R 174,489.00	R 174,489.00
Senior Radiographer	1	R 136,383.00	R 136,383.00
Radiographer assistant.	1	R 51,936.00	R 51,936.00
TOTAL			**R 362.808.00**

4.5.5 TOTAL DIRECT COSTS

Total direct cost for the Unit is listed in Table 4.27.

Table 4.27 Total direct costs

Category	Total cots
Material resources	R 34,806.09
Maintenance	R 253,189.80
Human resources (Compensation of employees)	R 362,808.00
TOTAL	**R 650,803.89**

The average direct cost per month for the unit is R 54,233.66. The average cost per patient was: R 126.99

4.6 WORK LOAD

Work-load per category of staff is described in Table 4.28. The work load per day was calculated based on 365 days as the unit operates seven days a week.

Table 4.28 Work-load in the unit

Category of staff	Number of staff per category	Number of patients	Patient to staff ratio per anum	Patient to staff ratio per day
Medical doctor	1	5125	5125	14
Radiographer	2	5125	2562.5	7
Radiographer assistant.	1	5125	5125	14

CHAPTER 5
DISCUSSION

In this chapter, the results obtained from the analysis of the data were discussed and compared with those from other published studies.

5.1 INTRODUCTION

This study was done in order to assess utilization of Radiology Unit at Lehurutshe Hospital in the North West Province. No studies have been conducted at the level of a district hospital to look at the utilization of radiological services. Very little literature could be obtained that addresses the same topic, as those that were obtained was on studies that were mostly done at tertiary level in developed countries. Even fewer could be found for the African continent.

5.2 CASELOAD OF PATIENTS

More than 5000 patients were seen at the Unit during the study period, the total number public patients being significantly higher than private patients. The highest and lowest numbers of patients were seen during the months of July (n=539) and December (n=292). December is usually the quietest month of a year due to holidays. All the private patients seen during this period came for chest X-rays.

The total number of radiological examinations during this period was 5700. The average number of patients seen per month was 463 with a range from 354 to 577. The lowest number of X-rays was done in the month of December, which is usually quietest month during the year. The wide variation was probably due to seasonality, which may affect operational planning and inventory management at the Unit.

5.3 RADIOLOGICAL EXAMINATIONS

The Unit offers basic radiological services proposed by WHO for a district hospital (WHO, 2009). The Hospital only offers basic radiological examination and did not provide special X-rays (such as barium meal, IVP and HSG), which could easily be offered with existing equipment. Studies in the past suggested that offering basic radiological services could result in better management of patients based on radiological evidence, reduced cost to hospitals as well as patients (due to reduced length of stay) and reduced turn-around time (reduced referral to other facilities) (DeCorato, Kagetsu and Ablow, 1995; WHO, 2009). It was not possible to do special radiological examinations due to the absence of a trained medical doctor. The provision of basic radiological training to one of the medical doctors might improve the situation. The Hospital refers patients for other radiological investigations such as MRI and CT scan to the nearby regional and/ or tertiary hospitals. There was no systematic information available about the efficiency of this referral system (such as turn-around time) and its impact on the functioning of the Hospital. The Hospital does not have a tele-radiology facility and should explore the possibility of using it in the future.

The study found that the majority of the examinations done at the Unit were chest X-rays, which was also offered to private clients. The indications for examinations were for respiratory as well as cardiovascular diseases. Trauma was also one of the indications for chest X-rays. Almost 5% of the X-rays were done for pulmonary TB. It was not clear if these X-rays were done as an adjuvant to sputum microscopy. It would be interesting to explore some of the indications for chest X-rays such as hypertension and HIV.

About a quarter of the X-rays were done for upper and lower extremities. Almost all of these X-rays were done for injury or trauma (such as dislocation, fracture). Other indications included osteoarthritis. Interestingly, some of the other indications included torn ligaments and muscles. It was not clear how X-rays would assist in the diagnoses of these conditions.

Less than 5% of the examinations were done for pelvis and spine. The indications for these examinations include fracture and malignancy. Backache was also one of the indications. It was not obvious, if both lateral and posterior-anterior views were taken for these examinations.

About 2.5% of the X-rays were done for skull, mandible and sinuses. Trauma and malignancy were the main indications for these types of X-rays. Dental disorders and infection of the sinuses also constituted other indications.

Approximately 2% examinations were done for abdomen. This might be due to lack of surgical skills among the medical doctors working at the Hospital during the study period. Acute surgical conditions and malignancies constitute the main indications for abdominal X-rays.

Only a few mobile X-rays were done during this period. There was no record for indications and sites of examinations of these X-rays. Therefore, it would be difficult to develop an understanding of the usefulness of this component.

Ultrasound examination was done for more than 5% of cases. They were done mainly for obstetrics reasons and few others were done for gynaecological indications. It was not clear, if ultrasound examination was routinely done for all pregnant women seen at this Hospital. In addition, it was unclear why ultrasound examinations were not done for other conditions (such as disorders of hepato-billiary and renal systems).

5.4 PROFILES OF PATIENTS

5.4.1 AGE

The study shows that X-rays are done for infants to the elderly population. A significant number of patients are young (infant, child and teenagers). However, it was not clear if the Unit is equipped to manage different age groups particularly the younger population.

5.4.2 ETHNICITY

All patients seen are Blacks and this was attributed to the catchment population served by the Hospital (Municipal Demarcation Board, 2009).

5.4.3 SOCIO-ECONOMIC STATUS

The Hospital rendered services to the indigent population, who are learners, pensioners and the unemployed. Therefore, it was not surprising that the majority of them were unemployed, had no medical aid and classified as H_1. However, some of the employed patients were probably not willing to pay.

Few private patients used the Unit. This implies that there is a possibility of utilisation of this facility as a revenue generation unit for the Hospital.

5.5 RESOURCE UTILIZATION IN THE RADIOLOGY UNIT

5.5.1 MATERIAL RESOURCES

The implication of shortage of radiology services impacts on resource utilization as professionals may not be competent to optimise efficient use of resources (Forster and Kennedy, 2004). This study found that the material resources used in the Unit included X-ray films and chemicals (developers and fixers) and ultrasound gel. The average number of films used per examination was 1.05, implying probably wastage of 5%. However, it might be possible that two films were used to take two different views (lateral and anterior-posterior) during examinations. There was no set standard found for comparing wastage. Similarly, this study recorded the use of chemicals (developer and fixer) and ultrasound gel, which could be used in the future for bench-marking.

5.5.2 HUMAN RESOURCES

Lack of available trained health professionals has a serious negative impact on radiological services (Forster and Kennedy, 2004). The Unit at this Hospital was staffed with one chief radiographer, one senior radiographer and one radiographer assistant. There was no radiologist working at the Hospital. There were five medical doctors working at the Hospital during this period. One of them read the films as and when necessary. It might be beneficial for the Hospital to train this doctor in basic radiological skills through continuous professional development. In addition, the Hospital should also explore the possibility of introducing tele-radiology.

5.5.3 FINANCIAL RESOURCES

The study showed that two types of X-ray films were mainly used during this period: 24/30 cm and 35/43 cm which are the most expensive compared to others and the least used type during this period was 18/24 cm which was the cheapest. This would require further investigations. The chemical used mainly was the developer as compared to fixer.

The Hospital had a maintenance cost to service the radiological equipments which was negotiated at the Provincial level. No detailed information about the contract was available at the Unit. However, the researcher was informed the equipments were serviced on an annual basis.

The study showed that there was good control of resources in the Hospital. The Hospital kept all the records, which were readily available.

The total direct cost for the Unit during the study period was R 650 803.89. The monthly average cost was R 54 233.66. The average cost per patient was R 126.99

This is probably the first study in South Africa, which provides an estimate of the cost of a radiology unit and the average cost per patient at a district hospital in South Africa.

5.6 WORKLOAD OF HEALTH PROFESSIONALS WORKING IN THE RADIOLOGY UNIT

The numbers of full-time staff employed at the Unit were able to provide a 24 hour radiology service. However, the study found on average very few patients (14) were seen per day. It was not clear about the proportion of patients seen during and after working hours as it might have an influence on the work-load (during after-hours, the service is provided on an on-call basis). It is necessary to keep time-sheet to calculate time per patients, which would provide a more realistic estimate. However based on the current work-load, the researcher believes that there is spare capacity at the Unit and the Hospital could explore the possibility of offering these services to the private sector as an income generation scheme for the Hospital.

CHAPTER 6
CONCLUSION AND RECOMMENDATIONS

In this chapter, the results obtained from this study were assessed in relation to the aims and objectives of the study, so that appropriate conclusions can be drawn. The limitations of the study were listed. Based on the findings of the study, appropriate recommendations and suggestions for future research were included.

6.1 CONCLUSIONS RELATED TO THE AIMS OF THE STUDY

This was a cross-sectional study that looked at broad issues pertaining to the subject of resource utilization at a Radiology Unit of a district hospital (Lehurutshe Hospital) in a rural district in the North West Province.

6.1.1 CASELOAD OF PATIENTS ATTENDING THE RADIOLOGY UNIT

The study found that more than 5000 patients were seen during the one year study period. Significantly, more public patients were seen in comparison to private patients, which are expected at a public hospital like LDH. All the private patients seen during this period came for chest X-rays.

The total number of radiological examinations during this period was 5700. Nearly 500 radiological examinations were done per month. The wide variations in the number of examinations done per month were probably due to seasonality, which may affect operational planning and inventory management at the Unit.

Almost 50% of the radiological examinations were chest X-rays. Others include X-ray of upper and lower extremities and ultrasound examinations for obstetrics and gynaecology. It is interesting that no ultrasound was done for other diagnoses. These examinations were done based on various clinical indications.

6.1.2 PROFILES OF PATIENTS ATTENDING THE RADIOLOGY UNIT

A significant number of public patients seen at the Unit were infants, children and teenagers. The private patients were from an older age group. All the patients seen at the Unit are black. The majority of them were unemployed, and indigent. Therefore, the Unit had very little scope to generate revenue from public patients.

6.1.3 RESOURCE UTILIZATION IN THE RADIOLOGY UNIT

The material resources used in the Unit includes X-ray films, chemicals (developers and fixers) and ultrasound gel. The Unit employed two radiographers and one radiographer assistant during the study period. In addition, a medical doctor read the X-rays films as and when necessary.

The direct cost incurred at the unit was R 650 803.89 (average monthly cost R 54 233.66) and cost per patient was R 126.99. The majority of the expenditure was for compensation of employees and maintenance.

6.1.4 WORKLOAD OF HEALTH PROFESSIONALS WORKING IN THE RADIOLOGY UNIT

Patient to staff ratio at the unit was quiet low and it shows there is spare capacity at the Unit which could easily be used for income generation by provision of service to private patients.

6.2 LIMITATIONS OF THE STUDY

This study may have the following limitations:

1. The main limitation for this study was missing and incomplete records within the Hospital Information system. When a record was found to be missing in the Electronic database, the researcher searched the Radiology Unit records and patients' files to find these information. In spite of all the efforts, records of 12 (0.2%) patients could not be

found and they were excluded. Due to small number, the researcher believes that they had little effect on the results of this study.

2. The Unit did keep records of materials used for individual patients. It did not keep records of time spent per patients. Therefore, it was not possible to calculate resource utilization at individual levels.
3. The Unit only kept records for indications for radiological examinations. It did not keep records of final radiological and clinical diagnoses. Therefore, it was not possible to do a comparative analysis between the initial indication and final diagnosis to determine appropriateness of the examinations.
4. The small sample size for the private patients was also a limitation to the analysis and interpretation of the data.

6.3 RECOMMENDATIONS

The recommendations made below were based on the findings from this study as well as from the Radiology unit staff. The analysis of the data also revealed some areas that should be further evaluated and recommendations were made based on the results of this study. Recommendations for further or more in depth research were also highlighted.

6.3.1 FOLLOW UP

Information from this study will firstly be utilised within the Lehurutshe Hospital for the future management of the Radiology Unit. Departmental policy determines that institutions are to be run on a cost-center basis and this study should assist in the allocation of resources to Radiology Unit and establishment of a Cost centre at the Unit.

Information will also be made available to the North West Provincial Department of Health, to assist in the management of radiological services, in all district hospitals in the Province and the allocation of budgets to these units.

6.3.2 FURTHER RESEARCH

The following research ideas are proposed for the future:

- A prospective cohort study to determine resources utilised at the individual level. This would assist to develop variance analysis of resource utilisation at the Unit. In addition, indirect cost associated with the Unit should be calculated.
- A comparative study to analyse the association between the initial indication for radiological examinations and final diagnosis to determine the appropriateness of these examinations.

6.4 SUMMARY AND CONCLUSION

This is probably the first study conducted at a radiology unit of a district hospital in South Africa. This study documented important information which was not published before. The study found that the more than 5000 patients were seen and radiological examinations were done during this period with the total number public patients being significantly higher than private patients. Nearly 500 radiological examinations were done per month. The wide variation in the number of examinations done per month was probably due to seasonality, which may affect operational planning and inventory management at the Unit. Almost 50% of the radiological examinations were chest X-rays. Other examinations include X-ray of upper and lower extremities and ultrasound examination for obstetrics and gynaecology. These examinations were done based on various clinical indications.

A significant number of public patients seen at the Unit were infants, children and teenagers. The private patients were from an older age group. Overall, the majority of the patients were unemployed, and indigent and therefore were not able to pay the required user fees.

The material resources used in the Unit includes X-ray films, chemicals (developers and fixers) and ultrasound gel. The Unit has two radiographer and

one radiographer assistant. In addition, a medical doctor assist by reading X-rays as and when necessary. The direct cost incurred at the unit includes use of material resources, maintenance of equipment (service contract) and compensation of employees. Total direct cost during the study period was R 650 803.89, most of which were incurred due to compensation of employees and maintenance of radiological equipment.

Patient to staff ratio at the unit was quiet low and it shows there is probably spare capacity at the Unit which could easily be used for income generation by provision of an additional service to private patients.

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APPENDICES

APPENDIX A

ETHICS CLEARANCE CERTIFICATE

LETTER FROM POST-GRADUATE COMMITTEE AND

LETTER OF PERMISSION FROM THE HOSPITAL

APPENDIX B
DATA COLLECTION TOOLS