# THE CHARACTERISTICS AND OUTCOMES OF LOWER LIMB AMPUTATIONS AT MOI TEACHING AND REFERRAL HOSPITAL, ELDORET

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**SM/PGORT/04/11**

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**DECLARATION**

This thesis is my original work and to the best of my knowledge, has not been submitted for an award of academic credit in any other University or research institution. No part of this thesis may be reproduced without prior written permission of the author and or Moi University

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**Declaration by Supervisors**

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## DISCLOSURE

The investigator did not receive any outside funding or grants in support for this study. Neither he nor a member of his immediate family received payments or other benefits or commitment or agreement to provide such benefits from a commercial entity.

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## DEDICATION

I dedicate this work to all patients who have lost a limb from any cause and to all those persons and organizations that have dedicated their time and resources in improving healthy orthopedic outcomes.

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## ACRONYMS AND ABBREVIATIONS

AKA- Above Knee Amputation

BKA- Below Knee Amputation

EWA-Early Walking Devices

IPOP-Immediate Post-operative Prosthesis

IREC- Institutional Research and Ethics Committee

KNH-Kenyatta National Hospital

LLA- Lower Limb Amputation

LEA-Lower Extremity Amputation

MESS-Mangled Extremity Severity Score

MRTH-Moi Teaching and Referral Hospital

NIDDM-Non-Insulin Dependent Diabetes Mellitus

PAD-Peripheral Arterial Disease

PVD- Peripheral Vascular Disease

TMA- Transmetartarsal Amputation

SPSS-Statistical Packages For Social Sciences

## OPERATIONAL DEFINITIONS OF VARIABLES AND KEY CONCEPTS

**Amputation-** complete loss in the transverse anatomical plane of any part of the lower limb for any reason as a primary or secondary operation

**Major amputation**- any amputation through or proximal to the ankle joint

**Minor amputation**- any amputation distal to the ankle joint

**Comorbidity:** A concomitant but unrelated pathologic or disease process that indicated the co-existence of two or more disease processes

**Deep Vein Thrombosis:** Formation of one or more thrombi in the deep veins of the lower limbs or pelvis confirmed by Doppler ultrasound.

**Deep surgical infection:** Surgical site infection involving deep tissues (fascia and muscle layers) that occurs within 30 days of surgery if no implant is in place or within a year if an implant is in place.

# ABSTRACT

**BACKGROUND:** Major limb amputation is a big but preventable public health problem. It is associated with profound economic, social and psychological effects on the patient and family especially in developing countries where prosthetic services are poor. Indications include trauma, infections, tumors and peripheral vascular diseases which are modifiable. Limb salvage surgeries are not well developed in our setting. Even in centers with limb revascularization, major amputations are still done. In MTRH, there is paucity of knowledge about the outcome of amputation, discharge destination, prosthesis use, rehabilitation and follow-up of these amputees.

**OBJECTIVE:** To determine the characteristics and outcomes of lower limb amputations among patients presenting to MTRH.

**METHODOLOGY:** This was a descriptive prospective study conducted at MTRH orthopaedics and surgical wards and clinics. Study population were patients who underwent lower limb amputation. Only patients from whom written informed consent was obtained were enrolled. Consecutive sampling was used. Interviewer administered questionnaire was used to collect socio-demographic and clinical findings and outcomes at admission and on discharge. Data obtained was analyzed using SPSS, version 20. Chi-square and t-test were used for comparison of variables.

**RESULTS:** A total of 85 patients participated in the study with age ranging from 3months to 97 years and a mean age of 49.6 (SD 23.8). Males were 56 (65.9%) while females were 29 (34.1%) (male to female ratio of 1.9:1). Forty two (49.4%) of the patients were aged between 40-69 years. Transfemoral amputations constituted 37 (43.5%) while 31 (36.5%) were transtibial amputation. Forty two (51%) amputations were done on the left. Diabetes was the predominant comorbidity in 26 (51%) patients. Vascular etiology constituted 44 (48%) patients while trauma had 20 (23.5%) and tumors 8 (9.4%). Patients with vascular indications were older compared to the rest. Surgical site infection was the main complication in 26 (52%) of the 50 subjects that developed complications. Decision to amputate was made by the consultant surgeon in 62 (73%) patients. Sixty-seven (79%) patients had a discussion on prosthesis use and type with their surgeon but only 6 (7.1%) were reviewed by prosthesis officers. Five patients (5.9%) died.

**CONCLUSION:** Peripheral vascular disease was the prevalent indication for amputation. Transfemoral amputation was the commonest level of amputation done. Diabetes mellitus was the predominant comorbidity and surgical site infection was the commonest complication.

**RECOMMENDATIONS:** Preventive measures be instituted to reduce the burden of vasculopathy and surgical complications. Strengthening of domiciliary prosthesis services should be done.

**LIMITATIONS:** Surgeries were performed by different surgeons with varying levels of experience which could have had an impact on outcomes

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# CHAPTER ONE: INTRODUCTION

## 1.1 Background Information

Amputation is the most ancient of all surgical procedures with a history of over 2500 years, going back to the time of Hippocrates (Obalum and Okeke 2009, Dupras, Williams et al. 2010). Major limb amputation is reported to be a major but preventable public health problem that is associated with profound economic, social and psychological effects on the patient and family especially in developing countries where the prosthetic services are poor (Chalya, Mabula et al. 2012). It involves removal of part or entire extremity. It is generally performed for various indications, which include trauma, peripheral vascular disease, tumors, infections, congenital anomalies or diabetes mellitus with or without peripheral vascular disease. Amputations are lifesaving procedures and improve the function in diseased limb and are not a sign of failure of treatment.

Lower limb amputations (LLA) are permanent, disabling condition which may restrict mobility, activities of daily living and employment (Hazmy, Mahamud et al. 2001, Obalum and Okeke 2009). With or without prosthetic replacement, it carries high morbidity and leads to severe emotional and physical problems. A study in Kenyatta National Hospital (KNH) found peripheral Vascular disease (PVD) as the main indication(Awori and Atinga 2007) while a study in Nigeria found peripheral arterial disease as uncommon(Thanni and Tade 2007). In the USA, about 25,000 to 30,000 amputations are performed annually(Jordan, Marks et al. 2012). Lower limbs are often more involved compared to upper limbs.

## 1.2 Problem Statement

Amputations continue to be done despite advances to reduce and manage the risk factors. Major amputation rate from a systematic review by Dormandy et al 1999 is reported to be about 200-500 per million per year (Dormandy and Rutherford 2000). Major amputations result in significant morbidity and mortality especially in patients with diabetes as comorbidity(Jordan, Marks et al. 2012). Multidisciplinary teams (MDT) are needed in the preoperative care of amputees with adequate access to the relevant healthcare professionals. Ogeng'o et al found that 70% of amputations are preventable among rural Kenya children and adolescents (Ogeng'o, Obimbo et al. 2010). Patients with diabetes are at a higher risk of amputations as a study in Kikuyu hospital showed diabetes vasculopathy as a major cause of amputation (Ogeng'o, Obimbo et al. 2009). Diabetics comprise about 2-5% of the population but constitute 40-45% of all amputations (Dormandy and Rutherford 2000). Limb salvage surgeries are not well developed in our setting and even in centers with limb revascularization, major LLA are still done(Finch, Macdougal et al. 1980). Domiciliary physiotherapy services, occupational therapy services and prosthesis are still out of reach of patients in most hospitals.

## 1.3 Justification of the Study

Major indications of lower limb amputations are preventable (Awori and Atinga 2007, Ogeng'o, Obimbo et al. 2010). Awareness programs can only succeed in implementation if they are guided by information based on the etiologies of amputations(Pecoraro, Reiber et al. 1990). Limb salvage surgeries are not well developed in our setup. LLA continue to be done even in centers with well-developed vascular surgery units. Peripheral Vascular Disease (PVD) in diabetes are increasing, as

depicted in a study in KNH that found a 4.6% prevalence of diabetic foot ulcer (DFU)(Nyamu, Otieno et al. 2003) and a finding that mortality doubles in patients with diabetes. Prosthesis and adequate rehabilitation for patients who have had amputations are expensive (Yinusa and Ugbeye 2003, Sprengers, Lips et al. 2007) and effective rehabilitation services are not well developed in Kenya. Adequate medical therapy and a complete rehabilitation scheme can lead to regaining of function and attainment of social and occupational reinstatement among the amputees depicted by need to have multidisciplinary teams (Larsson, Apelqvist et al. 1995, Aksoy, Gurlek et al. 2004). Characterizations can be used by hospital for planning and improvement delivery of required services.

In our set up, there is paucity of knowledge about the outcome of amputation, discharge destination, prosthesis use, rehabilitation and follow-up of these amputees. This study therefore, seeks to bridge this gap.

### 1.4 Research Questions

What are the characteristics and outcomes of lower limb amputations at Moi Teaching and Referral Hospital?

### 1.5 Objectives

#### 1.5.1 Broad Objective

To determine characteristics and outcomes of lower limbs amputations at MTRH

#### 1.5.2 Specific Objectives

- To describe the socio-demographic characteristics of patients undergoing lower limb amputation at MTRH

- To describe the indications, levels of lower limb amputations at MTRH
- To determine the comorbidities in patients undergoing lower limb amputation at MTRH
- To determine outcomes of lower limb amputations at MTRH

### 1.6 Scope of the study

This was a hospital based study on the characteristics of lower limbs amputations. The site was a tertiary referral hospital which may not be a true reflection of societal lower limb amputation statistic. The study was to be carried out in a restricted time frame to fit in the overall postgraduate program. Since this was a prospective study, projections on patients' attendance to the unit were not affected by factors not foreseen.

# CHAPTER TWO: LITERATURE REVIEW

## 2.1 Introduction

Lower limb amputation (LLA), especially major LLA, is a permanent disabling condition that may restrict mobility, the activities of daily living and employment. Major limb amputation is reported to be a major but preventable public health problem that is associated with profound economic, social and psychological effects on the patient and family especially in developing countries where the prosthetic services are poor.(1995, Chalya, Mabula et al. 2012). A properly performed amputation can not only be lifesaving for the patient, but may often be a better therapeutic alternative than an ill-conceived, futile attempt at a vascular reconstruction doomed to fail for lack of adequate recipient vessels(Gu 2004). Peripheral vascular disease (PVD) with or without diabetes is the major cause of LLA in Western countries.

The association of diabetes with LLA may be attributable to the combined effects of microangiopathy, peripheral neuropathy, infections and personal factors. There is paucity of knowledge about the cause of amputation, discharge destination and follow-up of these amputees.

In the United States of America (USA), 25,000 to 30,000 amputations are done annually. The financial cost of major lower limb amputation to the National Health Service (NHS) had been estimated at between £10 000 and £15 000 per procedure(Vamos, Bottle et al. 2010). The psychological, social and economic impact of lower limb loss is profound to patients and their families.

The responsibility for performing an amputation may even fall on the most junior member of the surgical team. Whatever the reason for performing an extremity amputation, it should not be viewed as a failure of treatment but it must be viewed as an opportunity to reestablish or enhance the patient's functional level and facilitate a return to near-normal locomotion(Beaty , 1995). Amputation can be the treatment of choice for severe trauma, vascular disease, and tumors (Finch, Macdougal et al. 1980, Perkins, De'Ath et al. 2012). Patients and family members must be aware of their options and have realistic expectations of surgical outcomes in order to make informed decisions regarding amputation.

Over the past 10 years advances in surgical and radiological revascularization have expanded the treatment options for critical leg ischemia, but advances have been countered by the increasing global incidence of diabetes(Humphrey, Dowse et al. 1996, Rayman, Krishnan et al. 2004)

Significant global variation exists in the incidence of leg amputation for a variety of etiological reasons (1995). A study in Kenyatta National Hospital (KNH) by Awori et al showed peripheral vascular diseases (PVD) as the prevalent cause(Awori and Atinga 2007). However, Ogeng'o et al assessed the patterns of limb amputations among rural Kenyan children and found trauma to account for 42% (Ogeng'o, Obimbo et al. 2009). There are currently few contemporary data on the overall incidence, mortality rate and impact of diabetes on leg amputation. Locally, a study at KNH showed a prevalence of 4.6% of diabetic foot ulcers (DFU) in patients who had diabetes at a tertiary hospital (Nyamu, Otieno et al. 2003). These data would enable outcomes from new interventions to be assessed, and could guide healthcare delivery and workload planning. However,

there is a group who cannot benefit from preventative health care, that is, newly diagnosed diabetic patients with already established severe complications(Larsson, Apelqvist et al. 1995, Chen, Ho et al. 2006).

Major limb amputation is reported to be a major but preventable public health problem that is associated with profound economic, social and psychological effects on the patient and family especially in developing countries where the prosthetic services are poor.(Chalya, Mabula et al. 2012) A substantial proportion of non-traumatic, lower extremity amputations (LEAs) are thought to be preventable by the provision of appropriate health care. In people with diabetes, for example, reductions in amputation rates of between 44% and 85% have been reported following the provision of improved foot care(1995, Canavan, Unwin et al. 2008)

One of the greatest difficulties for a person undergoing amputation surgery is overcoming the psychological stigma that society associates with the loss of a limb (Fitzpatrick 1999). Persons who have undergone amputations are often viewed as incomplete individuals (Willrich, Pinzur et al. 2005). Following the removal of a diseased limb and the application of an appropriate prosthesis, the patient can resume being an active member of society and maintaining an independent lifestyle.

Although a diseased limb can be removed quite readily resolving the problem of the extremity, the care does not end there. The surgery must be performed well to ensure that the patient is able to wear prosthesis comfortably. Knee joint salvage enhances rehabilitative efforts and decreases the energy expenditure required for ambulation (Chiodo and Stroud 2001).

The patient must learn to walk with prosthesis, apply and remove the prosthesis, care for the prosthesis, monitor the skin and the presence of any pressure points, ambulate on difficult terrain, and use the commode at night. Due to the complexity of these issues, the treatment team should include the surgeon, the primary care physician, a physical therapist, a prosthetist, and a social worker.

**2.2 History of the Procedure**

Amputation surgery is an ancient procedure dating back to prehistoric times (Beaty , Dupras, Williams et al. 2010). Neolithic humans are known to have survived traumatic, ritualistic, and punitive rather than therapeutic amputations. Cave-wall hand imprints have been found that demonstrate the loss of digits. Unearthed mummies have been found buried with cosmetic replacements for amputated extremities.

The earliest literature discussing amputation is the Babylonian code of Hammurabi, inscribed on black stone, from 1700 BC, which can be found in the Louvre (Dupras, Williams et al. 2010). In 385 BC, Plato's *Symposium* mentions therapeutic amputation of the hand and the foot. Hippocrates provided the earliest description of therapeutic amputation in *De Articularis* for vascular gangrene. Hippocrates described amputation at the edge of the ischemic tissue, with the wound left open to allow healing by secondary intent(Beaty).

The main risks described in the early history of amputation surgery were hemorrhage, shock, and sepsis. Before the discovery of anesthesia, the procedure itself was quite difficult. The patient would be held down by a number of assistants and be given alcohol (usually rum). The patient would essentially be awake and aware during the procedure (Sachs, Bojunga et al. 1999, Mavroforou, Koutsias et al. 2007).

## 2.3 Surgical Principles of Amputations

### 2.3.1 Determination of Amputation Level

Determining the appropriate level of amputation requires an understanding of the tradeoffs between increased function with a more distal level of amputation and a decreased complication rate with a more proximal level of amputation. The patient's overall well-being, general medical condition, and rehabilitation all are important factors (Beaty).

Screening tests for nutritional status and immunocompetence should be performed (Pedersen and Pedersen 1992). Medical illness, infection, and major operations all induce a hypermetabolic state. Multiple studies have confirmed that malnourished or immunocompromised patients have markedly increased rates of perioperative complications (Smith 2001). Dickhaut et al. showed an 86% healing rate for Syme amputations performed in patients whose serum albumin level was at least 3.5 g/dl and total lymphocyte count was at least 1500 cells/ml (Dickhaut, DeLee et al. 1984).

If a patient has no ambulatory potential, wound healing with decreased perioperative morbidity should be the chief concern. A transtibial amputation in this setting is not a reasonable option because of the increased risk of wound problems and increased skin problems from knee flexion contractures. A knee disarticulation often provides the best function for these patients. Compared with transfemoral amputation, knee disarticulation provides a longer lever arm with balanced musculature to help with bed mobility and transfers. In addition, muscles are not divided and do not atrophy and contract over the femur as they often do after transfemoral amputation. Finally, better

sitting stability and comfort are provided with a through-knee amputation (Beaty , Waters, Perry et al. 1976).

Determining the most distal level for amputation with a reasonable chance of healing can be challenging (Lantsberg and Goldman 1991, Adler, Boyko et al. 1999, Smith 2001). Preoperatively, clinical assessment of skin color, hair growth, and skin temperature provides valuable initial information. Preoperative arteriograms, although already obtained for vascular surgery consultation, are of little help in determining potential for wound healing. Segmental systolic blood pressures likewise offer little useful information because they are often falsely elevated owing to the noncompliant walls of arteriosclerotic vessels. Measurements of skin perfusion pressures may be of some benefit, however. Some authors have recommended thermography or laser Doppler flowmetry as methods to test skin flap perfusion (Wutschert and Bounameaux 1997). Others recommend determining the tissue uptake of intravenously injected fluorescein or the tissue clearance of intradermally injected xenon-133. Wyss et al found transcutaneous oxygen measurements to be most beneficial (Wyss, Harrington et al. 1988).

### 2.3.2 Technical Aspects

Meticulous attention to detail and gentle handling of soft tissues are important for creating a well-healed and highly functional amputation stump. The tissues often are poorly vascularized or traumatized, and the risk for complications is high (Beaty).

#### 2.3.2.1 Skin and Muscle Flaps

Flaps should be kept thick. Unnecessary dissection should be avoided to prevent further devascularization of already compromised tissues. Covering the end of the stump with a sturdy soft-tissue envelope is crucial. Past studies have determined the best type of flaps for each level of amputation, but atypical flaps are always preferable to amputation at a more proximal level (Jaegers, Arendzen et al. 1995). With modern total-contact prosthetic sockets, the location of the scar rarely is important, but the scar should not be adherent to the underlying bone. An adherent scar makes prosthetic fitting extremely difficult, and this type of scar often breaks down after prolonged prosthetic use. Redundant soft tissues or large “dog ears” also create problems in prosthetic fitting and may prevent maximal function of an otherwise well-constructed stump.

#### 2.3.2.2 Hemostasis

Except in severely ischemic limbs, the use of a tourniquet is highly desirable and makes the amputation easier (Reid, Camp et al. 1983, Kutty and McElwain 2002). The limb may be exsanguinated by wrapping it with an Esmarch bandage before the tourniquet is inflated. In amputations for infections or malignancy, however, expressing blood from the limbs in this manner is inadvisable (Pedowitz, Gershuni et al. 1993). In such instances, inflation of the tourniquet should be preceded by elevation of the limb for 5 minutes.

Major blood vessels should be isolated and individually ligated. Larger vessels should be doubly ligated. The tourniquet should be deflated before closure, and meticulous hemostasis should be obtained. A drain should be used in most cases for 48 to 72 hours (Beaty).

#### 2.3.2.3 Nerves

A neuroma always forms after a nerve has been divided. A neuroma becomes painful if it forms in a position where it would be subjected to repeated trauma. Special techniques have been tried in the hopes of preventing the formation of painful neuromas (Barbera and Albert-Pamplo 1993). These include end-loop anastomosis, perineural closure, Silastic capping, sealing the epineural tube with butyl-cyanoacrylate, ligation, cauterization, and methods to bury the nerve ends in bone or muscle. Most surgeons currently agree that nerves should be isolated, gently pulled distally into the wound, and divided cleanly with a sharp knife so that the cut end retracts well proximal to the level of bone resection. Strong tension on the nerve should be avoided during this maneuver; otherwise, the amputation stump may be painful even after the wound has healed. Crushing also should be avoided. Large nerves, such as the sciatic nerve, often contain relatively large arteries and should be ligated.

#### 2.3.2.4 Bone

Excessive periosteal stripping is contraindicated and may result in the formation of ring sequestra or bony overgrowth. Bony prominences that would not be well padded by soft tissue always should be resected, and the remaining bone should be rasped to form a smooth contour (Lange 1989). This is especially important in locations such as the anterior aspect of the tibia, lateral aspect of the femur, and radial styloid.

### 2.4 Open Amputations

An open amputation is one in which the skin is not closed over the end of the stump. The operation is the first of at least two operations required to construct a satisfactory stump. It always must be followed by secondary closure, reamputation, revision, or

plastic repair. The purpose of this type of amputation is to prevent or eliminate infection so that final closure of the stump may be done without breakdown of the wound. Open amputations are indicated in infections and in severe traumatic wounds with extensive destruction of tissue and gross contamination by foreign material (Hansen 1989, Lange 1989). Appropriate antibiotics are given until the stump is finally healed.

### 2.5 Postoperative Care

Postoperative care of amputations often requires a multidisciplinary team approach (Perkins, De'Ath et al. 2012). In addition to the surgeon, this team may include a physical medicine specialist, a physical therapist, an occupational therapist, a psychologist, and a social worker. An internist often is required to help manage postoperative medical problems. All of the same precautions are followed as for any major orthopedic surgery, including perioperative antibiotics, deep venous thrombosis prophylaxis, and pulmonary hygiene. Pain management includes the brief use of intravenous narcotics followed by oral pain medicine that is tapered as soon as tolerated. Several studies have noted decreased narcotic usage with improved pain management through the use of continuous postoperative perineural infusional anesthesia for several days (Elizaga, Smith et al. 1994).

### 2.6 Complications

#### 2.6.1 Hematoma

Meticulous hemostasis before closure, the use of a drain, and a rigid dressing should minimize the frequency of hematoma formation. A hematoma can delay wound healing and serve as a culture medium for bacterial infection (Beaty).

### 2.6.2 Infection

Infection is considerably more common in amputations for peripheral vascular disease, especially in diabetic patients, than in amputations secondary to trauma or tumor (Humphrey, Dowse et al. 1996, Vaccaro, Lodato et al. 2002). Any deep wound infection should be treated with immediate debridement and irrigation in the operating room and open wound management. Antibiotics should be tailored according to the results of intraoperative cultures (Dunkel, Belaieff et al. 2012, Kono and Muder 2012). Delayed closure may be difficult because of edema and retraction of the flaps.

### 2.6.3 Wound Necrosis

First step in evaluating significant wound necrosis is to reevaluate the preoperative selection of the amputation level. If transcutaneous oxygen studies were not obtained preoperatively, they should be obtained at this point to evaluate wound healing potential (Lantsberg and Goldman 1991). A serum albumin level and a total lymphocyte count should be obtained. Many authors have reported significantly more problems with wound healing in patients with serum albumin levels less than 3.5 g/dl or total lymphocyte counts less than 1500 cells/mL (Pedersen and Pedersen 1992). Nutritional supplementation has been shown to promote wound healing in this setting. Patients who smoke tobacco should quit immediately because smoking severely compromises cutaneous blood flow, lowering tissue oxygen pressure. In a study by Lind et al., the risk of infection and reamputation was 2.5 times higher in smokers than in nonsmokers (Lind, Kramhoft et al. 1991).

### 2.6.4 Contractures

Mild or moderate contractures of the joints of an amputation stump should be prevented by proper positioning of the stump, gentle passive stretching, and having the patient engage in exercises to strengthen the muscles controlling the joint. At the knee, increased ambulation tends to reduce a contracture. In some patients, prosthetic modification may be necessary to adapt to the contracture. Rarely, severe fixed contractures may require treatment by wedging casts or by surgical release of the contracted structures (Beaty , Perkins, De'Ath et al. 2012).

### 2.6.5 Pain

After the immediate postoperative pain has been resolved, some patients continue to feel chronic pain as a result of various causes. The first step in management is to diagnose the cause accurately. Phantom limb pain must be differentiated from residual limb pain, and both must be distinguished from pain arising from a distant site, such as from a herniated lumbar disc (Iacono, Linford et al. 1987).

Residual limb pain often is caused by a poorly fitting prosthesis (Bukowski 2006). The stump should be evaluated for areas of abnormal pressure, especially over bony prominences.

A neuroma always forms after division of a nerve. A painful neuroma occurs when the nerve end is subjected to pressure or repeated irritation. A painful neuroma usually can be prevented by gentle traction on the nerve followed by sharp proximal division, allowing the nerve end to retract deep into the soft tissue. A painful neuroma usually is easily palpable and often has a positive Tinel sign. Treatment initially consists of socket modification. If this fails to relieve symptoms, simple neuroma excision or a more

proximal neurectomy may be required (Barbera and Albert-Pamplo 1993, Wu, Tella et al. 2002).

### 2.6.6 Dermatological Problems

Patients should be instructed to wash their stumps with a mild soap at least once a day. The stump should be thoroughly rinsed and dried before donning the prosthesis. Likewise, the prosthesis should be kept clean and should be thoroughly dried before donning.

Contact dermatitis is common and may be confused with infection (Baptista, Barros et al. 1992). Skin inflammation is associated with intense itching and burning when wearing the socket. The most common cause is failure to rinse detergents from stump socks thoroughly. Other sensitizers include nickel, chromates used in leathers, skin creams, antioxidants in rubber, topical antibiotics, and topical anesthetics (van Ketel 1977). Treatment consists of removal of the irritant, putting on of soaks, application of steroid cream, and warm compression.

Bacterial folliculitis may occur in areas of hairy, oily skin. The problem may be exacerbated by shaving and by poor hygiene. Treatment initially consists of improved hygiene and possibly socket modifications to relieve areas of abnormal pressure. Occasionally, cellulitis develops that requires antibiotic treatment, or an abscess forms that requires incision and drainage (Beaty).

Epidermoid cysts may develop at the socket brim. These frequently occur late and are best treated with socket modification. Excision may be required.

Verrucous hyperplasia refers to a wartlike overgrowth of the skin at the end of the stump (Beaty). It is caused by proximal constriction that prevents the stump from fully sitting in the prosthesis.

Lower limb amputations are the most common (76% to 80%) of all amputations. Dysvascular limbs, resulting from either diabetes mellitus or primary peripheral vascular disease, account for 82% of hospital discharges attributed to amputations; 97% of dysvascular amputations are in the lower extremities. Several studies have shown that despite advances in revascularization techniques, rates of lower extremity amputations remain unchanged(Beaty).

**2.7 Prosthesis Use**

Age and level of amputation seem to determine the success of prosthetic use. Statistics from the Centers for Disease Control have shown that transfemoral amputations occur at a rate of 0.5 per 1000 in diabetic patients younger than 65 years old compared with 4 per 1000 in diabetic patients 75 years old or older. Morbidity is more frequent after transfemoral amputations than after transtibial amputations, and patients with transfemoral amputations are much less likely to use a prosthesis successfully and consistently than are patients with more distal amputations.(Beaty)

**2.8 Levels of Lower Limb Amputation**

The level of amputation is always a difficult decision and has a major impact on the patient's quality of life. It is dependent on functional considerations (e.g., poor prosthetic use after transfemoral amputations of dysvascular limbs), healing consequences (e.g., choosing a procedure that would not require revision or repeat

surgery because of poor healing) and energy expenditure considerations (Gu 2004, Ellington, Bosse et al. 2012).

### 2.8.1 Foot and Ankle Amputations

Amputations around the foot and ankle are becoming increasingly popular. With advances in vascular and perfusion assessment and improvements in foot prostheses and footwear, success with ankle and partial foot amputations, as measured by functional, independent living, seems to be improving. When it is determined that limb salvage is not in a patient's best interest, ablation by amputation or disarticulation should be viewed as a reconstructive procedure rather than a treatment failure (Finch, Macdougal et al. 1980).

Foot amputations include toe disarticulation, metatarsophalangeal disarticulation, transmetartarsal, Lisfranc, Chorpat's and Syme's.

**2.8.1.1 Toe Amputations-** Amputation of a single toe, with few exceptions, causes little disturbance in stance or gait. Amputation of the great toe does not functionally affect standing or walking at a normal pace. Amputation of the second toe frequently is followed by severe hallux valgus because the great toe tends to drift toward the third to fill the gap left by amputation. Amputation of any of the other toes causes little disturbance. Amputation of all toes causes little disturbance in ordinary slow walking, but is disabling during a more rapid gait and when spring and resilience of the foot are required. It interferes with squatting and tiptoeing. Usually, amputation of all toes requires no prosthesis, other than shoe filler. Amputation of more than two rays often is more disabling than a transmetartarsal amputation (Beaty).

Amputation through the metatarsals is disabling in proportion to the level of amputation—the more proximal the level, the greater the disability. The loss of push-off in the absence of a positive fulcrum in the ball of the foot is chiefly responsible for impairment of gait. No prosthesis is required other than shoe filler. Foot amputations proximal to the transmetartarsal level result in considerable gait disturbance because of the loss of support and push-off. Consequently, most amputations of the forefoot and midfoot have been discarded in favor of more functional ones in the hindfoot or at the ankle (Beaty).

**2.8.1.2 Midfoot Amputations-**include Lisfranc amputation at the tarsometatarsal joints, which seldom has been performed because of the equinus deformity that usually develops and is frequently followed by severe equinovarus deformity, and Pirogoff amputation, in which the calcaneus is rotated forward to be fused to the tibia after vertical section through its middle. To prevent equinus deformity after midfoot amputations, one or more dorsiflexors of the ankle must be transferred.

**2.8.1.3 Hindfoot and Ankle Amputations-** these must fulfill the requirements of an end-bearing stump, but also must leave enough space between the end of the stump and the ground for the construction of some type of ankle joint mechanism for the artificial foot. The Syme amputation consists of a bone section at the distal tibia and fibula 0.6 cm proximal to the periphery of the ankle joint and passing through the dome of the ankle centrally. The tough, durable skin of the heel flap provides normal weight bearing skin. The chief objection to this amputation is cosmetic. The prosthesis used must accommodate the flair of the distal tibial metaphysis that is covered with heavy plantar skin and is large and bulky. For this reason, the amputation usually is not recommended for women. The prosthesis used for a classic Syme amputation consists of a molded

plastic socket, with a removable medial window to allow passage of the bulbous end of the stump through its narrow shank, and a solid-ankle, cushioned-heel foot prosthesis (Beaty).

### 2.8.2 Transtibial (Below-Knee) Amputations

The importance of preserving the patient's own knee joint in the successful rehabilitation of a patient with a lower extremity amputation cannot be overemphasized. Transtibial amputations can be divided into three levels-short, standard and long transtibial amputations (Aksoy, Gurlek et al. 2004).

Success of rehabilitation depends on multiple variables, including cognitive status, premorbid functional level, condition of the upper extremities and contralateral lower limb, and coexisting medical and neurological conditions (Lim, Finlayson et al. 2006). Early rehabilitation efforts may be geared toward independence in a wheelchair, stump care education, skin care techniques to avoid decubitus ulcers, care of the contralateral intact lower limb, and preprosthetic general conditioning. Weight bearing on the residual limb usually is delayed until skin healing has progressed(Beaty , Lim, Finlayson et al. 2006).

### 2.8.3 Knee Disarticulation

Disarticulation of the knee results in an excellent end-bearing stump. Newer socket designs and prosthetic knee mechanisms that provide swing phase control have eliminated many of the former complaints concerning this level of amputation. Advantages of knee disarticulation include the large endbearing surfaces of the distal femur covered by skin and other soft tissues that are naturally suited for weight bearing are preserved, a long lever arm controlled by strong muscles is created, and the prosthesis used on the stump is stable (Beaty). Immediate post-operative prosthesis (IPOP) is easier to use with through knee disarticulation.

### 2.8.4 Transfemoral (Above-Knee) Amputation

Above knee amputation (AKA) can be classified as short transfemoral, mid transfemoral, long transfemoral, and supracondylar. It is second in frequency only to transtibial amputation. In this procedure, the patient's knee joint is lost, so it is extremely important for the stump to be as long as possible to provide a strong lever arm for control of the prosthesis(Beaty).

A major obstacle to rehabilitation after transfemoral amputation is the loss of the knee joint, which exponentially increases the energy expenditure for locomotion with a prosthesis(Beaty , Aulivola, Hile et al. 2004).

### 2.8.5 Hip Disarticulation

Hip disarticulation occasionally is indicated after massive trauma, for arterial insufficiency, for infection (e.g., infected subtrochanteric nonunion, necrotizing fasciitis), or for certain congenital limb deficiencies. Most frequently, however, hip disarticulation is necessary for treatment of bone or soft-tissue sarcomas of the femur or thigh that cannot be resected adequately by limb-sparing methods. The inguinal or iliac lymph nodes are not routinely removed with hip disarticulation (Beaty , Bukowski 2006).

# CHAPTER THREE: RESEARCH METHODOLOGY

## 3.1 Location of the study

The study was conducted at the Moi Teaching and Referral Hospital in Eldoret town, Kenya's fifth largest urban center and headquarters of Uasin Gishu County in Western Kenya. It is located 300 km North West of the capital city, Nairobi.

MTRH has a bed capacity of 1000 and is the second largest referral hospital in the country after Kenyatta National Hospital. It has a catchment area with a population of 20 million people covering Western part of Kenya and Eastern part of Uganda.

According to the central statistics of the hospital, MTRH has an average outpatient of 210,000 per year or an average of 600 outpatients per day, with the accidents and emergency department receiving over 10,000 outpatients per year. It also has cumulative 35,000 inpatients per year with the orthopedics department having over 1300 inpatients per year. MTRH was therefore appropriate for this study.

## 3.2 Study Population

### 3.2.1 Inclusion Criteria

The study population included all patients of all ages who underwent lower limb amputation. In patients who underwent revision of amputation, the new level of amputation was recorded as the level.

### 3.2.2 Exclusion Criteria

The study excluded

- Patients treated and amputated elsewhere but followed up in MTRH.
- Patients who were unable to give consent including minors and patients mentally incapacitated or disabled who did not have a parent or legal guardian present.

- Patients who declined to give consent or whose guardians declined to give consent.
- Minors who declined to give assent, irrespective of their guardians consent.

### 3.3 Study Design and Methods

This was a cross sectional prospective study, that began in October 2012 and ended in September 2013. Patients with lower limb amputation, who meet inclusion criteria, were consecutively recruited into the study after giving written informed consent, while in minors, assent was sought and consent from the guardian's/parents obtained. An interviewer administered questionnaire was used to obtain data. The data collected included patients socio-demographic details, clinical data that included indication, level, laterality of amputation, urgency of surgery, comorbidities, complications and rehabilitations with emphasis on prosthesis use and referral to prosthesis officer. The patient progress notes and patients medical records were reviewed to get data on clinical decision maker and documented complications. They were interpreted and summarized into a closed ended interviewer-administered questionnaire. This was done by the principal investigator.

### 3.4 Sampling Technique and Sample Size

The sample size was determined by the use of statistical formula/Fisher's formula (Mugenda and Mugenda 2003).

$$n = \frac{Z^2pq}{d^2}$$

where:

n = desired sample size (if population greater than 10,000)

Z = the standard normal deviate usually which was set at 1.96 which corresponded to 95% confidence level.

p = estimated characteristic of the study population (50% / 0.5 Lim et al had a desired comorbidity of study-diabetes in 49.6%)

q = 1 – p

d = the minimum error / degree of accuracy desired, which was set at 5% or 0.05

Therefore:

$$= \frac{(1.96)^2 \times 0.5 \times 0.5}{(0.05)^2}$$

$$= \frac{0.9604}{0.0025}$$

$$= 384.16$$

$$= 384$$

Since the population was be less than 10,000 the following formula was be used to determine the desired sample size.

$$nf = \frac{n}{1 + \frac{n}{N}}$$

Where:

nf = the desired sample size (N<10,000) i.e. population less than 10,000

n = the desired sample size (384)

N = total population (target) <10,000

According to the hospital records, about 54 cases of lower limb amputation were done in a year at MTRH. In two years, the total number of patients seen (N) = 108

Therefore: $nf = \frac{384}{1 + \frac{384}{108}}$

$= \frac{384}{1 + 3.56}$

$= \frac{384}{4.56}$

$= 84.2$

Desired sample size = 85

**3.5 Sampling techniques**

Consecutive sampling technique was used in which all patients who underwent amputation of the lower limb were recruited into the study until the required sample size was achieved.

### 3.6 Data collection Instruments and Procedures

Upon obtaining written informed consent/assent from the study participants, socio-demographic details and clinical data were obtained and filled in the interviewer administered questionnaire. The patients file notes and progress notes were read and summarized into study variables as indicated below:

### 3.7 Study Variables

**3.7.1 Socio-demographic details-**age, sex, level of education, religion, occupation

**3.7.2 Indication of Amputations**

These were classified as Vascular (Diabetes, Peripheral Vascular Disease) and Non Vascular (Trauma, infections, Burns, Tumors and congenital)

**3.7.3 Levels of Amputations**

The levels of amputations were operationalized as follows;

- Toe disarticulations
- Transmatatarsals amputation (TMA)
- Tarso metartarsal amputation (LisFranc),
- Ankle disarticulation
- Transtibial amputation (Below knee amputation)
- Knee disarticulation
- Transfemoral amputation
- Hip disarticulation

**3.7.4** Laterality of amputation-left, right, bilateral

**3.7.5** Comorbidity-Diabetes, Hypertension,

**3.7.6** Urgency of surgery-Emergency, urgent and elective

**3.7.8** Preoperative antibiotic prophylaxis

**3.7.9** Complications profile

**3.7.10** Rehabilitation-prosthesis use and visit by prosthesis officer

**3.7.11** Outcome-discharge, death

### 3.8 Quality Control

Development of questionnaire and pre-testing of the questionnaire was carried out. Review of data after collection to check for missing data and unclear parts, cleaning of data and counter checks on data entry was done.

### 3.9 Data Management

Data was collected using standardized questionnaire. Data entry and verification was done by creation of variables for data coding and assigning numerical values for quantitative analysis. Parallel data entries were done to compare for correctness. SPSS version 20.0 statistical packages was used to analyze the data.

Presentation of data: The results were illustrated in terms of pie charts, histograms, bar charts, diagrams and figures.

### 3.10 Ethical considerations

The IREC approval was sought and approval granted before starting this investigation. The patients were informed appropriately on the benefits and risks of the study in a language that they fully understood and his/her written consent sought. For those below 18 years of age, consent was sought from the parent or legal guardian. This was voluntary participation and no patient was denied treatment whether s/he gave consent or not. The confidentiality of data was maintained during and after the research. Those who wished to withdraw from the study were free to do so without affecting their medical care. The research was compiled into a thesis which will be submitted in partial fulfilment of the MMed Orthopedics Program.

### 3.11 Study Limitations

The surgeries performed were done by surgeons with varied levels of experiences and training. This could have had an impact on the outcome. This was however, mitigated by all surgeries being supervised by attending/consultant surgeons.

## CHAPTER FOUR: RESULTS

There were 85 patients who underwent amputations of the lower limb. The age of the patients ranged from 3 months to 97 years old, with an average of 49.6 years SD+/-23.8. Majority (65.9%) of the patients were males presenting a ratio of male to female of 1.9:1. Slightly more than half (53.3%) of the patients were self-employed followed by non/dependent at 32%, the least were those who were formally employed. Most of the patients either had primary (33.8%) or secondary (44.6%) level of education. In addition all the patients were Christians.

**Table 1: Socio-demographic characteristics**

| | | Frequency | Percentage |
|---|---|---|---|
| **Age** | Mean | 49.6 | |
| | SD | 23.8 | |
| **Sex** | Male | 56 | 65.9 |
| | Female | 29 | 34.1 |
| **Occupation** | non/dependent | 24 | 32.0 |
| | self employed | 40 | 53.3 |
| | informal/casual | 6 | 8.0 |
| | Formal | 5 | 6.7 |
| **education level** | no formal education | 9 | 13.8 |
| | Primary | 22 | 33.8 |
| | Secondary | 29 | 44.6 |
| | College | 5 | 7.7 |
| **Religion** | Christian | 85 | 100 |

**Table 2: Age Distribution**

| Age banding (years) | Frequency | Percentage |
|---|---|---|
| 0-9 | 2 | 2.4 |
| 10-19 | 10 | 11.8 |
| 20—29 | 7 | 8.2 |
| 30-39 | 7 | 8.2 |
| 40-49 | 15 | 17.6 |
| 50-59 | 13 | 15.3 |
| 60-69 | 14 | 16.5 |
| 70-79 | 7 | 8.2 |
| 80-89 | 6 | 7.1 |
| 90-99 | 4 | 4.7 |
| Total | 85 | 100.0 |

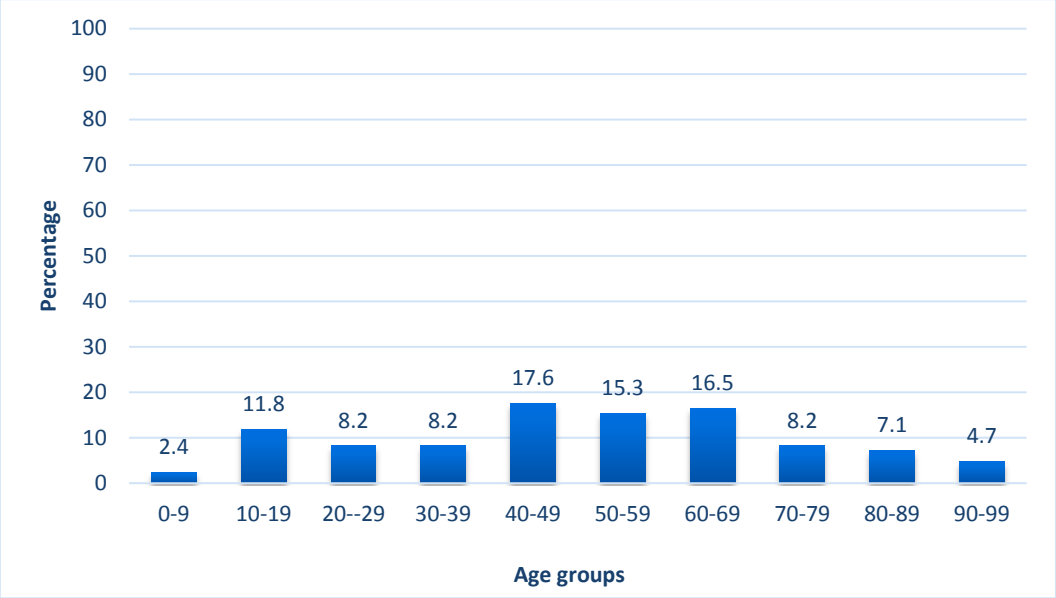


**Figure 1: Bar graph depicting age groups**

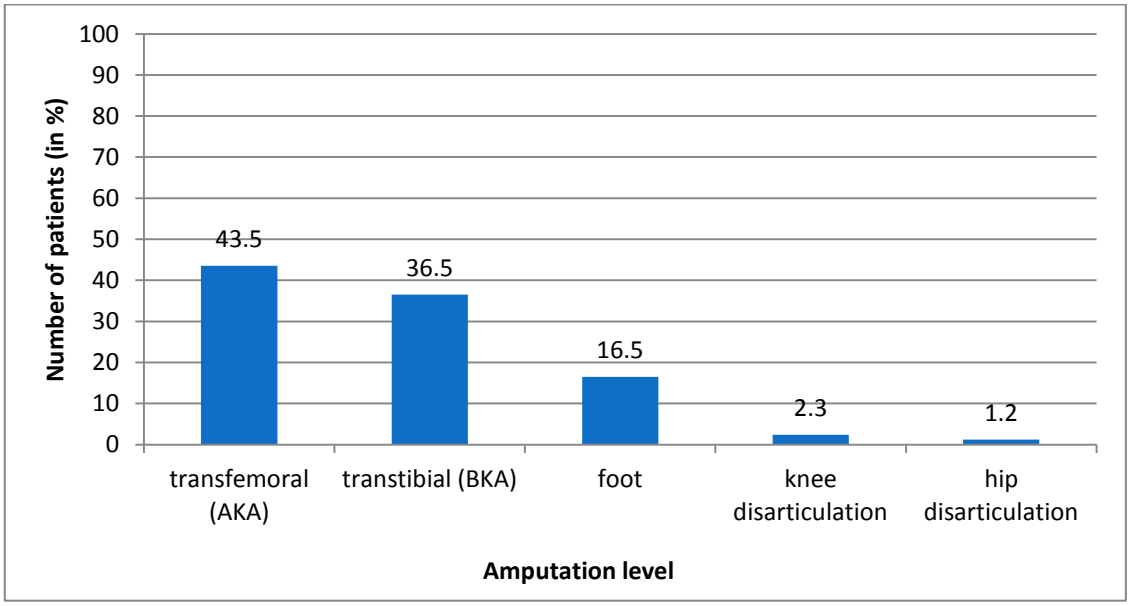


**Figure 2: Level of amputation (n-85)**

Most (43.5%) of the amputations were transfemoral (AKA), followed by transtibial (BKA), hip disarticulation was only done to 1(1.2%) patient. There were 2 cases of bilateral amputation-one AKA and one BKA.

**Table 3: Foot amputation**

| Level of Amputation | Frequency | Percentage |
|---|---|---|
| Metatarsophalangeal disarticulation | 7 | 63.6 |
| Transmetartarsal (TMA) | 2 | 18.2 |
| Toe disarticulation (interphalangeal) | 1 | 9.1 |
| Syme's | 1 | 9.1 |
| Total | 11 | 100 |

The above table shows the level of amputation of those who underwent foot amputation, where majority (63.6%) of the patients were done metatarsophalangeal disarticulation.

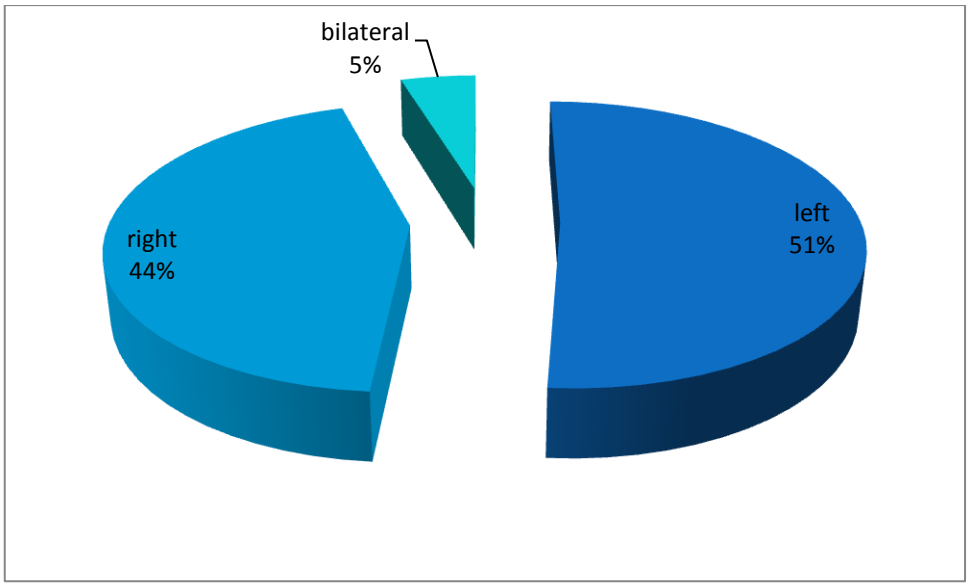


**Figure 3: Laterality of amputation**

Half (51%) of the patients had amputation of the left lower limb, 44% was amputated on the right side while 5% had bilateral amputation.

**Table 4: Comorbidities**

| Comorbidity | Responses | Percent of Cases |
|---|---|---|
| Diabetes Mellitus | 26 | 51.0% |
| Hypertension | 14 | 27.5% |
| Infection | 9 | 17.6% |
| Trauma (other than the involved limb) | 3 | 5.9% |
| Tumors (other than the involved limb) | 3 | 5.9% |
| Coagulopathy | 2 | 3.9% |
| Burns | 1 | 2.0% |
| Renal Failure | 2 | 4.0% |
| Chronic Ulcer | 1 | 2.0% |
| Varicose veins | 1 | 2.0% |
| Atrial Fibrillation | 1 | 2.0% |
| Total | 63 | |

The above table show the comorbidities associated with lower limb amputation, where half (51%) had diabetes, followed by hypertension (27.5%) and Infections (17.6%).

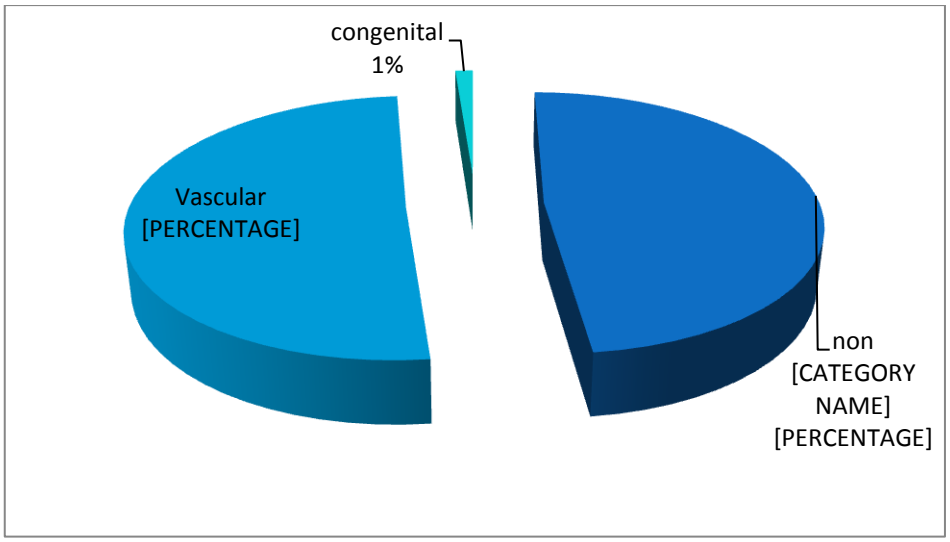


**Figure 4: Amputation indication (n = 85)**

The above figure indicates the indication for the amputation where about half 44(51.7%) was non-vascular and other vascular 40(47.1%) only 1(1.2%) which was congenital.

**Table 5: Specific Vascular Indications**

| | Frequency | Percent |
|---|---|---|
| Diabetes related microangiopathy | 26 | 59.1 |
| Peripheral Vascular Disease | 16 | 36.3 |
| Deep Venous Thrombosis (DVT) | 1 | 2.3 |
| Wet Gangrene from vasculitis | 1 | 2.3 |
| Total | 44 | 100.0 |

Among the vascular indication, diabetes related microangiopathy was the main condition with 26(59.1%), followed by peripheral vascular disease 16(36.3%). Deep

Venous Thrombosis (DVT) and complicated vasculitis each formed 2.3% of the vascular indications.

**Table 6: Abridged Wagner's classification of DM foot**

| | Frequency | Percent |
|---|---|---|
| Gangrene of toes or forefoot | 2 | 7.9 |
| Deep ulcer with osteomyelitis, or abscess | 6 | 23.0 |
| Midfoot or hind foot gangrene | 10 | 38.4 |
| Ulcer extend into tendon, bone, or capsule | 8 | 30.7 |
| Total | 26 | 100.0 |

In the group that had diabetic foot from microangiopathy, Wagner class 4 formed the majority at 10 (38.4%), class 5 was 8 (30.7%), class 3 was 6 (23%) the least was Wagner 2 at 7.9%.

**Table 7: Non-vascular indication**

| | Frequency | Percent |
|---|---|---|
| Trauma | 20 | 48.7 |
| Infection (non-diabetes) | 9 | 21.9 |
| Tumors | 8 | 19.5 |
| Burns | 3 | 7.3 |
| Snake bite | 1 | 2.6 |
| Total | 41 | 100.0 |

The above table shows the specific conditions for those who had non vascular indication where most 20(48.7%) of them were due to trauma followed by non-diabetes related infections 9 (31.9%) and tumors 8 (19.5%). Burns to the extremity accounted for 7.3% while snake bite complications were 2.6%.

**Table 8: Association between Indications and Age**

| | Age | | | |
|---|---|---|---|---|
| **Indication of amputation** | **N** | **Mean** | **Std. Deviation** | **p-value** |
| Vascular | 40 | 60.30 | 17.85 | 0.001 |
| Non vascular | 42 | 37.84 | 22.49 | |

The average age of the patient who had vascular indication for amputation were older ($\bar{X}$ = 60.3 years) as compared to those who had an indication of non-vascular indication ($\bar{X}$ = 37.8 years). The difference in these age means was statistically significant ($p<0.001$).

**Table 9: Amputation complication recorded**

| **Complication** | **Responses** | **Percent of Cases** |
|---|---|---|
| Surgical Site Infection | 26 | 61.9% |
| Stump Failure/Dehiscence | 7 | 16.7% |
| Amputation Revision | 8 | 19.0% |
| Death | 5 | 11.9% |
| Bed Sores | 1 | 2.4% |
| Pathological fracture | 1 | 2.4% |
| Sepsis | 1 | 2.4% |
| Phantom Limb Sensation | 1 | 2.4% |
| Total | 50 | |

Majority (61.9%) of the complication recorded were surgical site infections followed by amputation revision (19%), and stump failure/dehiscence (16.7%).

**Table 10: Association between Indication and patient developing complication(s)**

| | | Did the patient develop complication | | Total |
|---|---|---|---|---|
| | | No | Yes | |
| Indication of amputation | vascular | 19 | 21 | 40 |
| | Non vascular | 22 | 20 | 42 |
| Total | | 41 | 41 | 82 |

The association was not statistically significant (p>0.05)

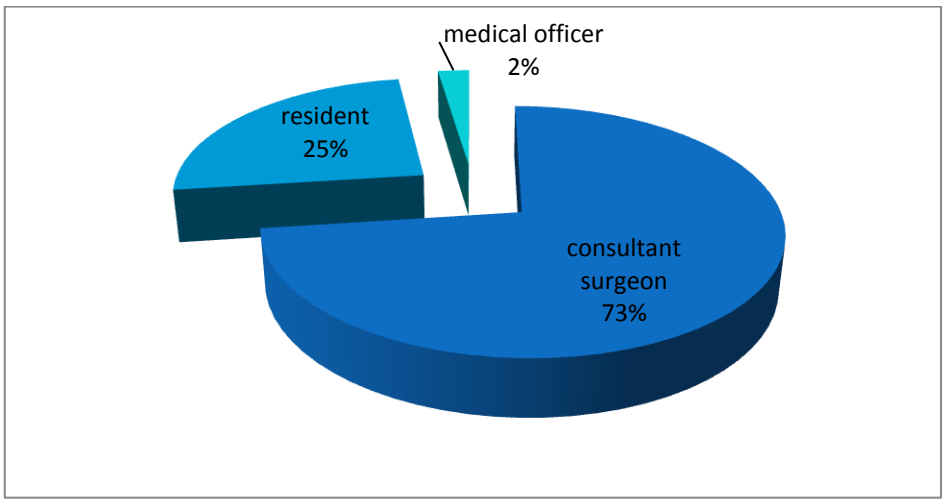


**Figure 5: Clinical Decision Maker**

Decision to amputate was done mostly (73%) by the Consultants Surgeons, Resident Doctors (postgraduate trainees) made 25% of the decisions while only 2% were done by the Medical Officers from the Emergency room/casualty.

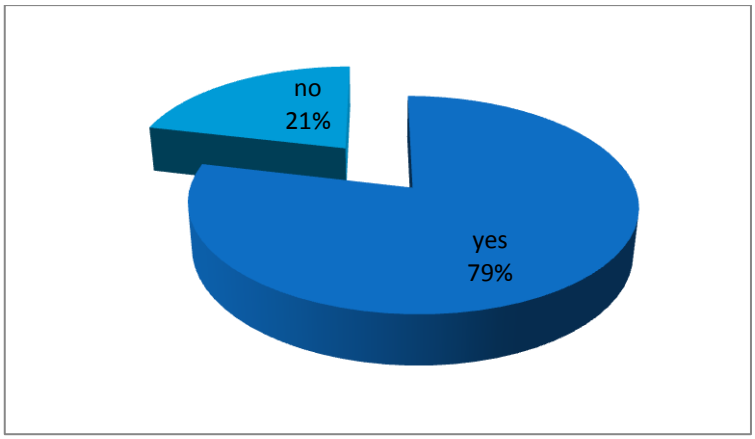


**Figure 6: Whether discussed prosthesis use and type with your surgeon**

Majority (79%) reported to have discussed prosthesis use and the type with the surgeon.

**Table 11: Patient review by Prosthesis Officer**

| | Frequency | Percentage |
|---|---|---|
| Yes | 6 | 7.10% |
| No | 79 | 92.90% |
| Total | 85 | 100% |

Majority of the patients were not reviewed by a prosthesis officer both preoperatively and postoperatively. Only 7.1% reported to have had review by a prosthetist post operatively.

**Table 12: Urgency of Surgery**

| | Frequency | Percentage |
|---|---|---|
| Emergency | 55 | 64.70% |
| Urgent | 16 | 18.80% |
| Elective | 14 | 16% |
| Total | 85 | 100% |

The majority of the amputations were done as emergency procedures 64.7%. Urgent and elective were 18.8% and 16% respectively.

# CHAPTER FIVE: DISCUSSION

## 5.1 Socio-Demographic Characteristics

In this study, the age distribution ranged from 3 months to 97 years with a male to female ratio of 1.9:1. This is comparable to a study by Awori et al 2007 at the Kenyatta National Hospital where they reported a range of 7months to 96 years and predominant male involvement(Awori and Atinga 2007). Muyembe et al 1999 in a retrospective study at a Kenyan Provincial hospital recorded a similar age distribution, 1year 9months to 85years(Muyembe and Muhinga 1999, Awori and Atinga 2007). A study in southern Nigeria by Ekeru et al 2003 in a private hospital found a male to female ratio of 2.1:1(Ekere 2003). The demographic findings in this study compare well with local and regional data.

Regarding age distribution, this study revealed the majority of the patients fell in the age group of between 40 and 69 years that constituted 49.4% cumulatively. This is similar to results of a study by Muyembe et al that reported a 41-60 year age group as constituting the majority of the amputees(Muyembe and Muhinga 1999). Other studies from Nigeria by Ekeru et al 2008 found a similar pattern though the patients were younger with the age range from second to fourth decade constituting 67% of the respondents(Ekere 2003)

This study revealed that 53.3% of the respondents were self-employed. Awori et al 2007 reported 55.4% as being unemployed and 39% as self-employed(Awori and Atinga 2007). Other studies have revealed similar patterns of employment (Yakubu, Muhammad et al. 1996, Yinusa and Ugbeye 2003, Ogeng'o, Obimbo et al. 2009)

Regarding education level, this study showed that 44.6% of the study subjects had secondary education while 33.8% had primary education. Only 7.7% had tertiary level of education. Awori et al 2007 revealed that the majority (89%) had primary/no formal education(Awori and Atinga 2007). Thus, findings of this study report a fairly well informed patient population.

**5.2 Levels of Amputation**

Regarding the levels of amputation, this study revealed a preponderance of above knee amputations (AKA) which constituted 43.5% of all the amputations. Below knee amputations were 36.5% while foot amputations were 16.5%. Knee disarticulation and hip disarticulations formed 2.3% and 1.2% respectively. Assessment of foot amputations revealed metatarsophalangeal amputations being the majority at 63.6%, Transmetartarsal amputation (TMA) 18.2% while Syme's and interphalangeal amputations formed a 9.1% each. Similar analysis by Awori et al 2007 revealed same trend with AKA forming the bulk 42% of the amputation, BKA 31% while foot amputations were 9% and 5% being hip disarticulation(Awori and Atinga 2007). Abbas et al 2007 in a study in a Nigeria teaching hospital had a majority (62.8%) of amputations being BKA, though this was due to the predominant indication of amputation being trauma(Abbas and Musa 2007). Ekere et al found BKA to be common in a private hospital in Nigeria (Ekere 2003). A retrospective Finish study by Lim et al 2006 found BKA to be the majority 58.6%, AKA 35.6% giving a BKA:AKA ratio of 1.65:1(Lim, Finlayson et al. 2006). Kidmas et al 2004 findings agreed with the current study where they reported AKA being common 48.9% against BKA (37.2%) in Jos Nigeria (Kidmas, Nwadiaro et al. 2004). Obalum et al 2009 in a private tertiary hospital in Nigeria reported a high BKA rate of 75% which was attributed to trauma (Obalum

and Okeke 2009). The accepted BKA:AKA ratio is 2.5 as described by Dormandy et al 1999 in a systematic review(Dormandy, Heeck et al. 1999). In determining the level of amputation, Barber et al 1983 concluded that clinical observation was the best determinant of amputation level while Holstein 1982 had concluded previously that ischemia at the BKA site could not be ruled out by clinical examination alone(Holstein 1982). While this study revealed a small percentage of through knee amputation, Penn-Barwell et al 2011 systematic review and meta-analysis concluded that surgical strategy of maintaining maximum length of stump and thus performing through knee was preferred over AKA(Penn-Barwell 2011).

### 5.3 Laterality of Amputation

This study found that 44% of the amputations were done on the right while 51% were on the left. Only 5% were bilateral. This study did not identify the dominant limb. Nyamu et al 2003 in their study at KNH assessing risk factors and prevalence of diabetic foot ulcers (DFU) at KNH, Nairobi Kenya found males to have predominantly right sided DFU while females had left sided DFU(Nyamu, Otieno et al. 2003). There was however, no explanation in his study and there was no control for the dominant limb.

### 5.4 Indication of Amputation

Indications of amputations in the studied population revealed vascular indications comprising 51.7% of the cases while non-vascular contributing to 48%. There was only one case of amputation due to severe lower limb congenital deformity. Of the vascular group, diabetes related microangiopathy formed the majority (59.1%). Peripheral vascular disease (PVD) were 36.3%, deep venous thrombosis complication and vasculitis complicated with wet gangrene formed 2.3% each. Regarding the nonvascular indications, this study found trauma as the majority with 48.7%. Non-diabetes related

infections were 21.9%, tumours contributed to 19.5%. Burns and snake bite formed 7.3% and 2.6% respectively.

Muyembe et al 1999, in a retrospective study on amputations in a Kenyan Provincial hospital found the leading etiology of amputations in general to be trauma in 26.5% of the subjects.(Muyembe and Muhinga 1999), which differed with the current findings. However, Awori et al in KNH found peripheral vascular disease (PVD) as the main indication of lower extremity amputation(Awori and Atinga 2007). Diabetic related gangrene was 17.5% while tumours mainly osteogenic sarcoma and trauma were about 18%. They concluded PVD unrelated to diabetes as the main indication. This is comparable with the current findings. A study by Ogeng'o et al at Kikuyu hospital revealed diabetes vasculopathy accounted for 11.4% of amputations while 69.6% were dysvascular(Ogeng'o, Obimbo et al. 2009). The same study showed trauma to be prevalent at 35.7% while congenital defects were 20%. Infections and tumours constituted 14.3% and 12.8% respectively. The studied population in Kikuyu showed diabetic vasculopathy, congenital defects and infections as the major causes of amputation. This compares with the findings in the current study. A study on amputations in rural Kenyan children and adolescents in Tenwek and Kikuyu by Ogeng'o et al 2010 established trauma to constitute 42%, congenital defects 29.5%, infections 12.5% and tumours 11.4%. This showed that the younger the population, the less the vascular indications of amputations and less diabetes vasculopathy. Regional studies in Nigeria revealed varying findings with trauma being most common (Abbas and Musa 2007, Thanni and Tade 2007, Obalum and Okeke 2009). Lim et al 2006 in a study in Finland reported limb ischemia as the major indication (75.9%) while diabetes related vasculopathy accounting for 17.2%(Lim, Finlayson et al. 2006).

There was a statistically significant finding when age was compared with indication with a p value < 0.001. Patients who underwent lower limb amputation from vascular indications were older compared to nonvascular indications.

The diabetic population in this study had the majority of the DFU being Wagner class 4 at 38.4% followed by stage 5, 30.7%. Stage 3 were 23% while stage 2 were 7.9%. Nyamu et al 2007 in a study assessing risk factors and prevalence of DFU at KNH reported a prevalence of ulcers at 4.6%. Wagner class 2 ulcers were the commonest at 49.4% which differs with the current findings. In a retrospective study in Mombasa by Muthuuri 2007 where he assessed characteristics of patients with diabetic foot, he found a mortality of 13%(Muthuuri 2007).

**5.5 Comorbidities**

Comorbidities contribute to the outcome of amputations. This study found diabetes to account for 51%, hypertension 14% while infections (non-diabetes related) accounted for 9%. Lim et al 2006 in a retrospective study in Finland found diabetes to be 49.4% which compares with the current study, hypertension however, was high at 77%(Lim, Finlayson et al. 2006). Trautner et al 2001 in Germany, Urwin et al 2000 and Trautner et al 2007 consistently found diabetes as the main comorbidity with ranges of 25-90% in populations studied(Unwin 2000, Trautner, Haastert et al. 2001, Trautner, Haastert et al. 2007). Aulivola 2004 concluded in his study that long term survival was dismal for patients with diabetes and end-stage renal failure(Aulivola, Hile et al. 2004).

**5.6 Complication Profile**

This study revealed surgical site infection (SSI) as the main complication (61.9%). Stump failure with dehiscence occurred in 19%. About 8% had amputation revision. There were 5 fatalities in the study. Dunkel et al 2012 reported wound dehiscence

16.3% as the main complication in his series majority being diabetic associated(Dunkel, Belaieff et al. 2012). This appears lower than the current study. Lim et al 2006 noted wound infection formed 26.4%(Lim, Finlayson et al. 2006) while Obalum et al in Nigeria reported stump infection at 26.5%(Obalum and Okeke 2009) which are all low compared to the current findings  Muyembe et al 1999 reported a 55% mortality rate for amputations secondary to diabetes(Muyembe and Muhinga 1999) which was higher than the findings by Muthuuri in Mombasa Kenya where he found post amputation death in diabetic population to be 28% and was attributed to uncontrolled sugars (Muthuuri 2007).

Assessment and comparison of either vascular or nonvascular indication against developing complication did not reveal any statistical significance. This however, does not tie with the ACC Guidelines 2005 in which diabetes mellitus increased the risk of lower limb PAD 2-4 fold.

**5.7 Clinical Decision Maker**

Consultant orthopaedic surgeons made the majority of the decisions to carry out the amputations (73%) while orthopaedic residents made the decision in 25% of the cases. 79% of the consenting doctors discussed prosthesis use and type with the patients while only 7.1% of patients were visited/reviewed by prosthesis officer. This is contrary to Lim et al 2006 who reported that successful prosthesis rehabilitation depended on patient selection and multidisciplinary approach(Lim, Finlayson et al. 2006). Yakubu et al 1996 found fitting of prosthesis to be uncommon in Zari Nigeria(Yakubu, Muhammad et al. 1996). Yinusa et al 2003 reported poor prosthetic services resulted in unsatisfactory results(Yinusa and Ugbeye 2003)

# CHAPTER 6 – CONCLUSIONS AND RECOMMENDATIONS

## 6.1 Conclusions

- The main indication of amputation was vascular aetiology mainly diabetic vasculopathy and peripheral vascular disease (PVD).
- Above knee amputation was the major level of amputation with a BKA:AKA ratio of 1:1.19
- Diabetes mellitus was the main comorbidity.
- Surgical site infection was the main complication.
- There was low planning of rehabilitation as regards prosthesis use

## 6.2 Recommendations

- Amputation prevention programs in diabetic population need to be strengthened
- The hospital should strengthen postoperative infection prevention
- Multidisciplinary teams should be involved in planning surgery and subsequent rehabilitation
- Further research should be done on the discharge destination and uptake of prosthesis services

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**APPENDIX 1: CONSENT FORM**

THE CHARACTERISTICS AND OUTCOMES OF LOWER LIMB AMPUTATIONS AT MOI TEACHING AND REFERAL HOSPITAL, ELDORET

INVESTIGATOR – DR. ISAAC BIRECH KOGOSS OF P.O BOX 4606, ELDORET, KENYA

I…….of P.O Box……

Tel……..hereby give informed consent to participate in this study in MTRH. The study has been explained to me clearly by Dr. Isaac Birech Kogoss (or his appointed assistant) of P.O. Box 4606 Eldoret.

I have understood that to participate in this study, I shall volunteer information regarding my amputation and undergo medical examination. I am aware that I can withdraw from this study at any time without prejudice to my right of treatment at MTRH now or in the future. I have been assured that no injury shall be inflicted on me from my participation in this study. I have also been assured that all information shall be treated and managed in confidence. I have not been induced or coerced by the investigator (or his appointed assistant) to cause my signature to be appended in this form and by extension participate in this study.

Name (initials) of participant……

Signature……

Date……

Name of witness……

Signature……

Date……

**APPENDIX 2: QUESTIONNAIRE**

1. Demographic Data
    - Case identity……
    - Age…….
    - Sex ☐Male ☐Female
    - Age at amputation……
    - Occupation- Non/Dependent☐ Self-employed☐ Informal/Casual☐ Formal ☐ Others ☐
    - Level of education Primary ☐ Secondary ☐ College ☐ No formal education ☐ other ☐
    - Religion- Christian ☐ Muslim☐ Hindu☐ Other ☐
2. Level of Amputation
    (a) Foot Amputation
        - Toe disarticulation ☐
        - Metatarsophalangeal disarticulation ☐
        - Transmetartarsal (TMA) ☐
        - Lisfranc ☐
        - Chorpat's ☐
        - Syme's ☐

    (b) Transtibial (BKA) ☐

    (c) Knee disarticulation ☐

    (d) Transfemoral (AKA) ☐

    (e) Hip disarticulation ☐
3. Laterality of amputation
    - Left ☐ Right ☐ Bilateral ☐
4. Comorbidity
    - Diabetes mellitus ☐ Hypertension ☐ Burns ☐ Trauma ☐ Infection ☐Others ☐
5. Indication of amputation
    - Vascular- Diabetes ☐ Peripheral Vascular Disease ☐ Others ☐
    - Non Vascular- Trauma ☐ Infections ☐ Burns ☐ Tumors ☐ Congenital ☐ Others ☐
6. Clinical decision maker
    - Consultant surgeon ☐ Resident ☐ Medical Officer ☐ Clinical Officer
7. Urgency of Surgery ☐Emergency ☐Urgent ☐ Elective

8. Antibiotics prophylaxis preoperatively ☐ Yes ☐ No
9. Have you discussed prosthesis use with your surgeon ☐ Yes ☐ No
10. Were you reviewed by prosthesis/rehabilitation officer ☐ Yes ☐ No
11. Outcome ☐ Discharged ☐ Death
12. Complications
    - Surgical Site Infection ☐ Stump failure/Dehiscence ☐ Amputation revision ☐ Death ☐ Other ☐

## APPENDIX 3: IREC APPROVAL

**INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)**

MOI TEACHING AND REFERRAL HOSPITAL
P.O. BOX 3
ELDORET
Tel: 33471/2/3

MOI UNIVERSITY
SCHOOL OF MEDICINE
P.O. BOX 4606
ELDORET
Tel: 33471/2/3

Reference: IREC/2012/136
***Approval Number: 000871***

30th August, 2012

APPROVED
30 AUG 2012
P.O. Box 4606 ELDORET

Dr. Isaac Birech Kogoss,
Moi University,
School of Medicine,
P.O. Box 4606-30100,
**ELDORET-KENYA.**

Dear Dr. Birech,

**RE: FORMAL APPROVAL**

The Institutional Research and Ethics Committee have reviewed your research proposal titled:

***"Characteristics of Lower Limb Amputations at Moi Teaching and Referral Hospital, Eldoret."***

Your proposal has been granted a Formal Approval Number: **FAN: IREC 000871** on 30th August, 2012. You are therefore permitted to begin your investigations.

Note that this approval is for 1 year; it will thus expire on 29th August, 2013. If it is necessary to continue with this research beyond the expiry date, a request for continuation should be made in writing to IREC Secretariat two months prior to the expiry date.

You are required to submit progress report(s) regularly as dictated by your proposal. Furthermore, you must notify the Committee of any proposal change (s) or amendment (s), serious or unexpected outcomes related to the conduct of the study, or study termination for any reason. The Committee expects to receive a final report at the end of the study.

Yours Sincerely,

**PROF. E. WERE**
**CHAIRMAN**
**INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE**

| | | | |
|---|---|---|---|
| cc: | Director | - | MTRH |
| | Principal | - | CHS |
| | Dean | - | SOM |
| | Dean | - | SPH |
| | Dean | - | SON |
| | Dean | - | SOD |

**APPENDIX 4: APPROVAL FROM MOI TEACHING AND REFERRAL HOSPITAL**

# MOI TEACHING AND REFERRAL HOSPITAL

Telephone: 2033471/2/3/4
Fax: 61749
Email: director@mtrh.or.ke
P. O. Box 3
ELDORET

**Ref:** ELD/MTRH/R.6/VOL.II/2008

30th August, 2012

Dr. Isaac Birech Kogoss,
Moi University,
School of Medicine,
P.O. Box 4606-30100,
**ELDORET-KENYA.**

**RE: APPROVAL TO CONDUCT RESEARCH AT MTRH**

Upon obtaining approval from the Institutional Research and Ethics Committee (IREC) to conduct your research proposal titled:

***"Characteristics of Lower Limb Amputations at Moi Teaching and Referral Hospital, Eldoret".***

You are hereby permitted to commence your investigation at Moi Teaching and Referral Hospital.

**DR. J. KIBOSIA**
**DIRECTOR**
**MOI TEACHING AND REFERRAL HOSPITAL**

CC - Deputy Director (CS)
- Chief Nurse
- HOD, HRISM