Global Trends in Incidence of Lower Limb Amputation: A Review of the Literature

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ABSTRACT: *The aim of this paper was to compile a literature report on the global epidemiology of lower limb amputations. Specifically it aimed at capturing information on the incidence of traumatic and non-traumatic lower limb amputations throughout the world, to identify the etiology including diseases and lifestyle habits associated with lower limb amputees (LLA) in both the developed and the developing countries, to identify the demographic characteristics, age, sex, race, geographical location of the people undergoing LLA including the levels of amputation as pointed out by the literature. A literature search was conducted. Different keyword combinations were used to gather as much literature on the subject as possible. The authors systemically reviewed literature from some parts of Europe, Asia, North and South America and South Africa. The data was analyzed and presented under various themes. The existing literature shows that diabetes is the leading cause of LLA and trauma accounts for the minority of these cases. The incidence of LLA can be predicted by gender, age, marital status, level of education and socio-economic status. Information on LLA in South Africa is almost absent.*

KEY WORDS: LOWER LIMB AMPUTATION, LITERATURE REVIEW.

INTRODUCTION

Lower limb amputation which occurs as a result of a wide range of diseases and trauma is associated with significant morbidity, mortality, and disability. An amputation is not merely the loss of a limb- it can mean, disability, joblessness, high insurance payments and a poor quality of life (Spichler et al 2001). The incidence of lower limb amputation (LLA) in the world have been reported (Gujral et al 1993; The LEA Study Group 1995; Calle-Pascual et al 1997; The Global LEA Study Group 2000; Spichler et al 2001; Wrobel et al 2001 ;Abou-Zamzam et al 2003; Resnick et al 2004; Hennis et al 2004; Wong 2005; Boulton 2005; de Godoy et al 2005). The need to investigate and establish these figures is of critical importance for local and international medical literature.

International research and publications are extensive in this field. Epidemiology and follow up studies have been conducted in various parts of the world. The Global Lower Extremity Amputation (LEA) Study Group is one example of a giant project studying the epidemiology of lower limb amputations throughout the world (The LEA Study Group, 1995; The Global LEA Study Group, (2000). Various other studies have been conducted by other researchers. Physiotherapists in South Africa do not have easy access to the available literature hence this review. Awareness about the global trends in the incidence of LLA will allow physiotherapists to compare their experiences and exposures to LLA in South Africa with that globally and plan their roles for their contexts more effectively. These roles may range from preventative to health promotion to rehabilitation and improving quality of life.

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METHODS

The literature used in this study was found through the internet web pages such as PubMed and Google, Sabinet, Elsivier Science Direct, and the EBSCO HOST electronic journal service. Various keyword combinations were used to find studies on the subject. These resulted in international literature. The literature used in this study spans from 1993 to 2006. The National Research Foundation (NRF) was contacted to assist in availing local literature and most of the unpublished theses were retrieved from the various local university libraries through the University of Kwa-Zulu Natal's interlibrary section and reviewed as reflected in the text below.

In South Africa, there are currently no publications on the epidemiology of lower limb amputations. It is evident however that amputations and amputees have been studied and theses written up on this subject. A single study on this topic was traced to Tygerberg Hospital (Henry 1993). In an effort to gather local literature in this field the researcher used the internet and found no local publications. The researcher then con-

tacted the University of Kwa-Zulu-Natal's libraries and used various keywords and found no publications in this field of study. The researcher then contacted the National Research Foundation (NRF) who helped to uncover the unpublished studies shelved in various local university libraries (unpublished but completed thesis projects). In this literature, Henry (1993) conducted a descriptive survey on lower limb amputees admitted to Tygerberg hospital between (1985-1987). Kubheka (1993) studied the rehabilitation management of traumatic lower limb amputations in Durban and Kamel (2002) looked at the psychological aspects of the patient following a limb amputation. Amosun et al (2005) in a study conducted in Rwanda looked at the health promotion needs of lower limb amputees.

Brief description of lower limb amputation (LLA)

Lower limb amputation has been defined as a complete loss in the transverse anatomical plane of any part of the lower limb for any reason (Lower Extremity Amputation (LEA) Study Group, (1995). A distinction must be made between "major" and "minor" LLA. A minor amputation is any amputation which is distal to the ankle joint and a major amputation is any amputation through or proximal to the ankle joint. LLA is usually performed as a life saving procedure. It is often performed when the limb is deemed non-salvageable following severe injury (e.g. war injury or road traffic accident), when there is tissue loss due to vascular occlusive disease, or to control infection (Engstrom et al 1993). Leg amputation is performed at different anatomical levels depending on the need and reason for amputation namely:

1. Toe-ectomy – removal of a single or multiple toes at the level of the metatarso phalangeal joints.
2. Transmetatarsal – amputation through the shafts of metatarsals.
3. Mid-tarsal (Chopart/ Lisfranc) – amputation through the tarsal bones.
4. Through-ankle (Symes) – amputation of the foot at the ankle joint with retention of the plantar heel and removal of the malleoli
5. Below-knee – a leg amputation 11-12 cm distal to the knee.
6. Through knee – the knee joint is disarticulated leaving the patient to weight bear on condyles.
7. Above knee – amputation through the femur, ideal length of 25-30 cm from the greater trochanter.
8. Hip disarticulation – the femur is disarticulated from the acetabulum.
9. Hind quarter – the side of the brim of the pelvis is removed.

Etiology of LLA

According to Boulton (2005), the diabetic foot is a major medical, social and economic problem worldwide. In most developed countries, the annual incidence of foot ulceration amongst people with diabetes is about 2% and in these countries diabetes is the most common cause of non-traumatic amputation with approximately 1% of people with diabetes having to undergo a LLA (Boulton, 2005). In developing countries, foot ulcers and amputations are sadly very common. Often poverty, lack of sanitation and hygiene, and barefoot walking interact to compound the impact of diabetic foot damage (Boulton 2005).

Diabetic complications (neuropathic foot and ischemic foot), peripheral vascular disease (PVD), trauma, malignancy, infection and congenital lower limb defects have been seen to result in LLA, at varying rates (Engstrom et al 1993; Van Houtum et al 1996; Spinchler et al 2001; Wong 2005; Global Lower Extremity Study 2000). Eskelinen et al (2004) also reported that burns, rhabdomyolysis, sepsis and cellulitis can lead to LLA. Geographical site, male gender, duration of diabetes, presence of co-morbidities, and lack of high school education is associated with the high incidence of LLA (Wrobel et al 2001; Resnick et al 2004, Wong et al 2005). In studies on American Indians, smoking was not associated with the risk of lower limb amputation, although excessive alcohol consumption and smoking have been associated with neuropathy (Resnick et al 2004, Hennis et al 2004). In comparison to these findings, LLA may be associated with hypertension, coronary arterial disease, tobacco and end stage renal failure (Abou-Zamzam et al 2003). In the Global LEA study (2000), in 90% of the centers studied, trauma in males accounted for less than 10% of major LLA. Trauma accounted for 50% of major LLAs in one of the sites (center in Global LEA study) and 57% of minor amputations in another study site in the same study. In two other study sites in this study, major LLAs associated with trauma in females were up to 15 percent and 16 percent respectively. In males, the percentage of major LLAs associated with peripheral vascular disease (PVD) ranged from 51% in one study site to 93% in another. This percentage was similar in females with the exception of 30% associated with PVD at a single study site. The proportion of LLAs as a result of PVD was found to be lower in minor amputations and the proportion of LLAs as a result of trauma was high in minor amputations.

Complications of diabetes such as LLA are likely to occur not only late in life considering the early onset of diabetes in today's youth (Abou-Zamzam et al 2003; Resnick et al 2004). Incidence of LLA was significantly increased in patients with high systolic blood pressure, high diastolic blood pressure, high pulse pressure, severe retinopathy, high pack-years smoked (Moss et al1999).

Global trends in Epidemiology of LLA

In diabetics, it has been shown that the incidence of LLA increases with the duration of diabetes (Moss et al 1999; Wrobel et al 2001; Resnick et al 2004; Wong et al 2005). In a Madrid study on non-traumatic LLAs more than 80% of the subjects were over the age of 65 and retired, 5% unemployed and 2% working (Calle-Pascual et al 1997). A Brazilian study suggested that critical limb ischemia culminating in an amputation usually occurs at an advanced age, and thus increasing the inherent physical limitations of age (de Godoy et al 2005). Diabetic subjects are greater than ten times more likely to undergo major LLA even after adjusting for the subjects' characteristics of age, sex, race (Wrobel et al 2001; Spinchler et al 2001). A study in the Netherlands reported that diabetics were 20 times more likely to have a LLA than non-diabetics while male diabetic subjects were 20.5 times more

likely to get a LLA than their non-diabetic counterparts and the female diabetics were 19.8 times more likely to get a LLA than their non-diabetic counterparts (Van Houtum et al 1996). Generally, research has shown that the incidence of LLA is gender related with higher rates in males (Gujral et al 1993; Calle-Pascual et al 1997; Moss et al 1999; The Global LEA Study Group 2000; Pernot et al 2000; Dillingham et al 2002; Resnick et al 2004). Having high school education reduced the risk of LLA by more than 50% (Resnick et al 2004). Vascular occlusive disease is the leading cause of LLA followed by infective causes. Trauma accounted for only 7% of the cases (Wong et al 2005). In this Hong Kong study by Wong et al (2005) the majority of the patients were over the age of 60 and half of all females over 80 years of age. In this cohort, the indications for LLA were vascular occlusive disease, infection, trauma and tumors. Generally, research shows that the incidence of LLA increases with age (Kashani JH et al 1983; Gujral et al 1993; Van Houtum et al 1996; The Global LEA Study Group 2000; Pernot et al 2000; Dillingham et al 2002; Abou-Zamzam et al 2003; Resnick et al 2004; Eskelinen et al 2004; Wong et al 2005). Pernot et al (2000) also found that LLAs as a result of tumors and trauma were evenly distributed in both the younger and the older age groups. Low income and being single (whether divorced, widowed, and never married) and having a history of foot ulcers was associated with a high incidence of LLA in diabetics and patients with cardio-vascular diseases (Resnick et al 2004; Hennis et al 2004).

Incidence among various population groups

Dillingham et al (2002) and Feinglass et al (2005) identified some association between the incidence of LLA and race. These studies reported a dramatic increase in the incidence of LLA among all groups and found that Blacks were twice as likely to have a LLA as a result of dysvascular disease than other races. The risk, in general, in women over the age of 85 was 26 times more than that of Black middle aged women. The risk of LLA in Black women was 18 times more than that amongst non-black women. The rate was 11 times more in Black men and 7 times more in non-black men. For all the groups, the risk of amputation was highest among Blacks. Racial differences in relative risk increased from 2-fold in younger age groups to almost 5-fold in the oldest (Dillingham et al 2002). In the study by Dillingham et al (2002) it was found that racial differences in amputation were consistent in both patients with and without diabetes. This study also found that Blacks were more likely to undergo both primary and repeat major amputations even at centers with high level vascular surgery capacity. Both diabetic and non-diabetic Blacks had an equal risk of primary and repeat amputation, therefore diabetes alone did not shape the racial differences (Feinglass et al 2005). In an English study by Gujral et al (1993), it was shown that Whites had a higher incidence of LLA compared to the Asians in a 5-year retrospective study. This study also showed that this difference was dependent on the two populations' status of diabetes and that the incidence was dependent on the gender and age with males undergoing more LLAs than females. The Global Lower Extremity Study, (2000) found that in area specific data, the incidence of LLAs was similar in males and females in some areas and increased in females compared to males in other areas despite the fact that the overall incidence was higher in males than females. In most areas, the incidence of both first and all major LLAs was greater than the incidence of first and all minor LLAs.

Local trends (unpublished research)

Henry (1993), reported that the mean age at first amputation was 60 years. Colored males underwent their first LLA ten years earlier than their white counterparts and colored females appeared to have an even greater risk of undergoing a LLA prematurely, on average fifteen years earlier than their white counterparts. The mean ages at first amputation for persons with or without diabetes were 66 years and 67 years of age respectively, thus showing an insignificant difference in the incidence and prevalence of LLA in these two sub-groups. The mean age due to Buerger's disease, trauma and malignancy was relatively younger at 38, 37, 33 years respectively. According to this study, the mean age for whites at time of LLA was 64 years and 73 years for males and females respectively.

According to Henry (1993), the major causes of LLA were vascular (83%), traumatic (12%), malignancy (3%), infection (2%) and congenital limb defects constituted 0.2%. In this survey, males consistently outnumbered females for all causes of LLA and in each of the categories, the number of colored participants exceeded that of white patients. When comparing the groups, there was a minimal difference between colored and white males with peripheral vascular disease and the ratio of coloreds to whites with LLA due to trauma was 5:1 and that of females was 3:1. The percentage of white males and colored females who underwent LLA was similar (19%). For subjects amputated due to infection and malignancy, the primary causes were meningococcal septicemia and osteogenic sarcoma.

The most commonly reported co-morbidities were hypertension, chronic obstructive airway diseases (COAD), hemiplegia, ischemic heart disease (IHD) and myocardial infarction (MI) (Henry, 1993). The prevalence of hypertension was 23% for both whites and coloreds. The prevalence of hypertension for females exceeded that of males (27% versus 20%). Hypertension was mostly reported amongst colored females (34%) and white males (27%) with the proportion of hypertension in colored males and white females similar at 16%. COAD was the second most common co-morbidity at 17%. It was mostly reported in males (36%) while females were at 9% (Henry, 1993). The prevalence of hemiplegia at the time of amputation was 14% and was similar for both ethnic groups. The distribution by gender was 13% for females and 15% for males. The second least common co-morbidity was IHD. About 12% of participants had a history of IHD. The prevalence in whites was almost 3 times (21%) compared to the 8% of coloreds and mainly white males (27%) and the least affected group was colored males (5%). The least reported co-morbidity

was MI with only 7% of participants having a history of this condition. About 7% of males and 6% of females were affected. However, there was a marked ethnic difference with the condition being four times more prevalent in whites than coloreds (13% versus 3%) (Henry, 1993).

Kubheka (1993) also reported that traumatic LLA occurs at a young age (mean age of 33 years old). Most LLAs were single with only less than 40% married subjects. Being amputated at an early age was associated with ambulation, independence in activities of daily living and use of a prosthesis. Stump infection was reported to be a major problem and was the principal cause of revision. Stump infection was also associated with a delay in rehabilitation. Physical problems reported by the patients included sores on the stump, infection of the stump, joint stiffness, mobility problems and severe stump pain including phantom pain on stump. Amongst the psycho-social problems expressed by the subjects, 50% of the subjects expressed loneliness, failure of the rehabilitation personnel to identify limitations in home infrastructure (Kubheka 1993). Psychological effects of LLA include drug and alcohol abuse, feelings of worthlessness, loneliness, lack of self motivation to engage in physical exercise (Amosun et al 2005). The economic implications of LLA included disability grants and small business as the main source of income. Financial compensation for motor vehicle accident victims was generally unsuccessful. Although many patients were accepted by their families, some were rejected mainly because they were in some way blamed for their condition. This study showed that most traumatic LLAs in this cohort were unemployed (Kubheka 1993).

Management

The management of an amputee may commence preoperatively or postoperatively depending on the circumstances and cause / or need to amputate. A study conducted in Durban (Kubheka, 1993, unpublished) found that some traumatic amputees were less prepared for amputation as they has to undergo lower limb amputation within hours to a day and some even on admission. An amputee is managed by a multidisciplinary team and according to Engstrom et al (1993) the philosophy of amputation service stipulates that every patient is an individual and must always be considered within the context of their particular abilities, medical and environmental status, never as a level. In the Roehampton model (Engstrom et al 1993) this team consists of: a surgeon, rehabilitation consultant, nurse, physiotherapist, occupational therapist, social worker, prosthetist and a rehabilitation engineer in addition to the patient and his/ her family or relatives. Additional consultation may include the following persons in the team: a Rheumatology consultant, general physician, and geriatrician, general practitioner (GP), dietician, chiropodist, local Authority Social Service Department, speech therapist, Disablement Resettlement Officer (DRO), clinical psychologist, nurse counselor, hospital chaplaincy service, bioengineer and an orthotist. This team meets regularly for ward rounds, or for group case discussions, problem solving and forward planning. The Model is designed such that every member of the team has an equal opportunity to present his or her thoughts which contribute to the group discussion on patient management. In this Model, communication between professionals is considered crucial and may require personal effort. Anything less than daily treatment of amputees in considered unacceptable. Generally the following stages are included in rehabilitation: Preoperative stage, Immediate postoperative stage, Pre-pylon stage, Pylon stage, Prosthetic stage. Through out the rehabilitation programme, the whole multidisciplinary team is involved and special cases (e.g. stroke patients, diabetics etc) are given the necessary special care. With no literature to confirm or refute it, this model may still not yet be a reality in many parts of South Africa and Africa, due to a lack of resources.

Stump complications

These include open areas, sinuses, bone infections, exostoses, dermatitis, edema with suspected underlying pathology, soft tissue lesions, necrosis, neuroma, phantom sensations (Engstrom et al 1993)

Follow up

More proximal levels of LLA can be associated with increasing mortality and revision has been associated with increasing age (Resnick et al 2004). In one American study, the rate of revision in above knee amputations was 19% and was reported to be less frequent than that of below knee amputations which also required more proximal revisions (Abou-Zamzam et al 2003). A Brazilian study showed that as much as critical limb ischemia has been identified as the most frequent indication of amputation, it is also reported to be a severe clinical condition associated with high morbidity and mortality. According to this study, most deaths were recorded in the first year postoperatively. This cohort with a 6-year follow-up, showed that over the whole 6-year period, 72% of the patients died, 44% of them died during the first year post operation (de Godoy et al 2005). Schoppen et al (2003) reported a 15% mortality rate after the first postoperative year. In a Finnish study, the mortality rate during the first post operative year was significantly higher in above knee amputations than in below knee amputations. The reported rate in this study was 12%, 29% and 52% at one week, one month and one year respectively (Eskelinen et al 2005). Pernot et al (2000) reported a 14% mortality rate during hospitalization.

CONCLUSION

Existing literature shows that diabetes is the leading cause of LLA and trauma accounts for the minority of these cases. The incidence of LLA can be predicted by gender, age, marital status, and level of education, socio-economic status and the presence of diabetes. However, in some parts of Africa where there is violence and wars, trauma is the leading cause of LLA.

LIMITATIONS

Non-English literature sources were not used.

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