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ARTICLE

A five-year audit of lower limb amputations below the knee and rehabilitation outcomes: the Durban experience

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Introduction: Lower limb amputation (LLA) due to diabetes mellitus (DM) is a growing epidemic worldwide.
Objectives: To determine the prevalence of LLAs at Addington Hospital from 2010 to 2014 and to explore the rehabilitation outcomes of amputees.
Design and setting: A retrospective chart review of LLAs below the knee was undertaken at Addington Hospital.
Subjects: Patients who underwent LLAs were filtered from theatre registers.
Methodology: A data collection sheet included demographic profile, diabetic status, level of amputation, limb orientation and rehabilitation outcomes.
Outcome measures: Study endpoints were prevalence, compliance and rehabilitation outcomes.
Results: From 2010 to 2014, 767 LLAs in 667 patients were identified. Mean age was 59 (13.2) years. M:F ratio was 1:1. Of these, 354 patients (53.1%) had DM. Level of amputation was below-knee 57%, trans-metatarsal 12.4% and toectomy 30.6%. Only 116 patients (17.4%) were referred for physiotherapy, of whom 95 (81.9%) attended. Median frequency of physiotherapy visits was five and four for diabetic and non-diabetic amputees respectively. Mobility after rehabilitation was with a walking frame (49%), crutches (32%), prosthesis and crutches (8%), wheelchair-bound (9%) and independent gait (1%).
Conclusion: Over half of amputations were associated with DM. The gender incidence was similar. Referral to physiotherapy and adherence thereto was poor.

Keywords: diabetes mellitus, lower limb amputations, physiotherapy, prevalence, rehabilitation

Introduction

Diabetes mellitus (DM) is a chronic, potentially life-threatening disorder that may be accompanied by decreased quality of life.[1] Described as a 'silent killer' by Todkar,[2] DM is a growing threat to public health worldwide.[3] In 2015, 415 million people worldwide had DM and this number is expected to increase to 642 million by the year 2040.[4] In Africa 14.2 million people were diagnosed with DM in the year 2015 and by the year 2040, 34.2 million people are projected to be having DM.[4] South Africa has an estimated population of 52.98 million people and the exact prevalence of diabetes is not known. It is estimated to be between 5% and 7% of the general population with the Indian population comprising 11–13%, Coloured 8–10%, Black 5–8% and the White population consisting of 4%.[5] In Sri Lanka the prevalence of DM is 16.4% in the urban population and 8.7% among rural populations.[6]

DM is associated with several complications including cardiovascular disease, nephropathy, retinopathy and neuropathy, which are directly related to diabetes-related morbidity and mortality.[6] Peripheral vascular disease (PVD), known as impairment to the major blood vessels in the lower limbs, and neuropathy, classified as loss of sensation in the feet, are the two chief pathological mechanisms of LLA in people with DM.[6] A symmetrical peripheral polyneuropathy is the most commonly observed peripheral neuropathy in DM.[6] Progressive peripheral neuropathy leads to loss of sensation, which causes trauma and altered proprioception as well as wasting of the small muscles. These pathological entities initiate changes in the weight-bearing areas under the foot during standing and walking. As a result of these altered changes the foot is prone to injury leading to ulceration, which can subsequently become infected and, if not remedied timeously, can lead to amputation.[6]

In the USA, almost 2 million people have an amputated limb. There are 185 000 new cases of amputees each year and this is predicted to rise to 3.6 million by 2050.[7] In 54% of Americans living with limb loss the cause is vascular disease whereas in Sri Lanka 4.8% of amputations are due to diabetes and in South East Nigeria 71.4% of all amputations are attributed to diabetes.[6–8] Furthermore the most common level of amputation appears to be below-knee amputation (BKA) (63.7%).[6–8]

Addington Hospital is a regional South African hospital located in the eThekwini municipality and is a referral hospital for patients requiring major surgical intervention such as amputations. A study on the prevalence and management of the diabetic foot at Addington Hospital has not been previously conducted. The objectives of this study were to determine the prevalence of LLAs below the knee among patients at Addington Hospital during the period 2010–2014 and to determine the proportion of those amputations that were attributed to DM and other factors. In addition, the referral of patients for rehabilitation following amputation and the outcomes were studied.

The significance of the study will serve to highlight the burden of LLAs in our setting and emphasise the importance of referring patients with LLAs to physiotherapy.

Method

An observational descriptive retrospective chart review was conducted on patients presenting with LLAs below the knee attending Addington Hospital during the period January 1, 2010 – December 31, 2014.

Data collection

Employing purposive sampling, all patients who presented with LLAs below the knee during the period January 1, 2010 to December 31, 2014 were included in the study. A data collection sheet including the following variables was developed for gathering data: patient's age, gender, diabetic status, date of amputation, level of amputation, referral to physiotherapy, number of physiotherapy visits and rehabilitation outcome. Data were obtained from theatre registers for the years 2010 to 2014. Rehabilitation information was sourced from physiotherapy records retained in the physiotherapy Department at Addington Hospital. The frequency of visits was allocated a 'zero' frequency if patients failed to present themselves for physiotherapy after referral. Among the patients who did present for physiotherapy, the frequency of physiotherapy visits was categorised into groups of 10 visits. Data collection commenced following regulatory approvals for the study from the Biomedical Research Ethics Committee of the University of Kwa-Zulu Natal (BE 411/15), the provincial Department of Health (KZ_2016RP2_732), the hospital manager/CEO, the physiotherapy manager and the theatre unit manager.

Data were analysed with the Statistical Package for the Social Sciences (SPSS version 22; IBM Corp, Armonk, NY, USA). Categorical variables were summarised using proportions/percentages and graphically using bar charts or tables while continuous variables were summarised using means (standard deviations). Ninety-five per cent confidence intervals (95% CI) were constructed around point estimates. Comparison of various categories was tested using Pearson's chi-square test. If an expected cell count had fewer than five observations, then Fisher's exact test was employed. If the normality assumption was not upheld, then the non-parametric equivalent (namely the Wilcoxon rank-sum test) was used instead. Adjustment for multiple testing (using the Bonferroni correction) was employed. An adjusted p-value of < 0.05 was considered statistically significant. Odds ratios (OR) were employed to quantify a strong presence or absence between two entities.

Results

A total of 667 patients with LLAs below the knee were included, of whom 87 had more than one amputation giving a total of 767 amputations during the five-year period from 2010 to 2014.

Table 1: Profile of patients

Patient characteristics	*n*
Total no. of patients	667
LLAs below the knee	767*
Mean age (SD)	59 (13.2)
Gender	Males: 329 Females: 338 M:F ratio = 1:1
Diabetic status	Diabetes: 354 No-diabetes: 313
Orientation of amputated limb	Left: 363 Right:404

*Some patients had more than one amputation.

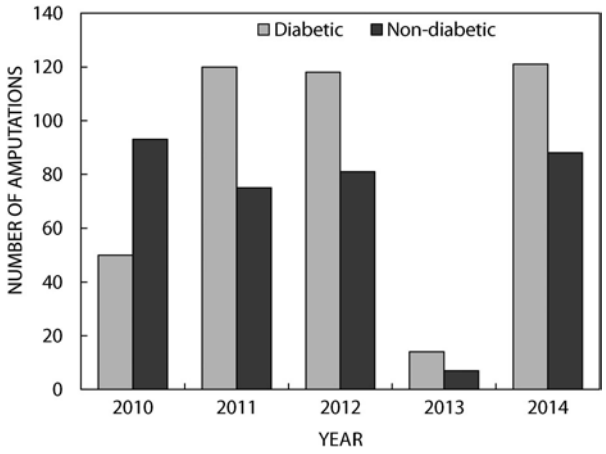

Figure 1: Prevalence of amputations 2010–2014. *Note: p-value trend over study years: 2010/2011, $p = < 0.001$; 2011/2012, $p = 0.6$; 2012/2014, $p = 0.08$; 2013 excluded (numbers too small).

Table 1 describes the profile of patients undergoing LLA during the study period. Of the 667 patients who had undergone amputation, 354 (53.1%) were as a result of DM. Of these, 329 were males providing a M:F ratio of 1:1.

Figure 1 illustrates the number of amputations that were performed per year from 2010 to 2014. A total of 767 amputations were performed over a five-year period. Diabetes-related amputations increased in the first two years and, except for a dip in 2013, the number plateaued in the ensuing years. Conversely, the numbers of non-diabetes-related amputations remained the same throughout the study period except for a dip in 2013. The increase in numbers for diabetic amputees in 2010–2011 was significant ($p = <0.001$).

Figure 2 shows the number of amputees stratified according to age. The median age was 60 (IQR 18; range 5–97). Diabetes-related amputations increased with age up to the sixth decade and declined with age in patients older than 60 years.

As shown in Figure 3, BKAs were the most commonly performed amputations with a frequency of 437 (57%), followed by amputations of toes 235 (30.6%) and trans-metatarsal amputations (TMAs) at 95 (12.4%). There were more amputations attributed to DM (55%).

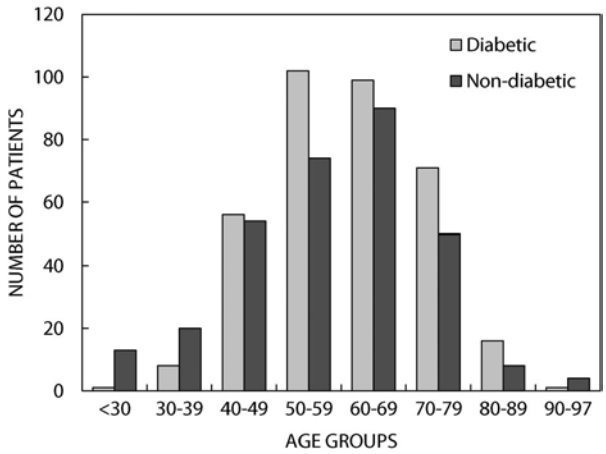

Figure 2: Profile of diabetic and non-diabetic lower limb amputees stratified according to age groups.

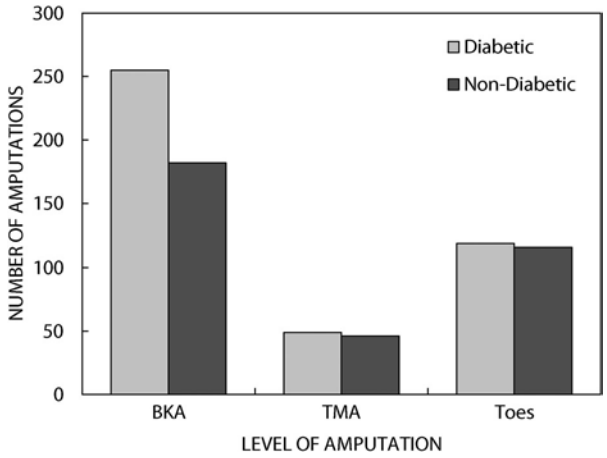

Figure 3: Frequency of amputations according to level of lower limb amputation.

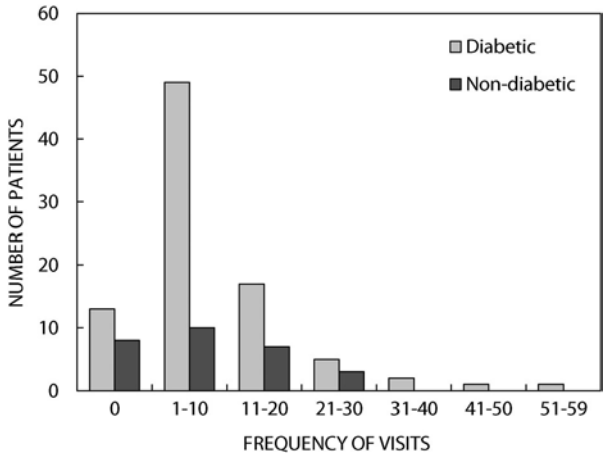

Figure 4: Frequency of physiotherapy visits for all amputees who were referred to physiotherapy.

Table 2 shows that only 116 of the 667 amputees (17.4%) were referred to physiotherapy for rehabilitation post-surgery. Among diabetic amputees 24.9% were referred for physiotherapy and among non-diabetic amputees only 8.9%. Thus more diabetic amputees than non-diabetic amputees were referred for physiotherapy. Some 75% of diabetic amputees and 91% of non-diabetic amputees were not referred to physiotherapy. Among the 551 amputees not referred to physiotherapy 48.3% (266 amputees) had DM.

Figure 4 shows the frequency of physiotherapy visits following referral to physiotherapy. In total, 18% of those referred to physiotherapy were non-compliant and did not attend at all. The median number of visits was five and four respectively for diabetic and non-diabetic amputees. In both groups, the largest number of patients attended for 10 or fewer visits and, after 10 visits, there was a progressive attrition in numbers until 30 visits, beyond which only a small number of diabetic amputees continued to attend.

Table 3 shows that of the 95 patients who attended physiotherapy 75 were diabetic and 20 were not diabetic. Following rehabilitation, patients were able to mobilise with walking frames (49, 52%), crutches (30, 32%), crutches and a fitted prosthetic leg (8, 8%). Seven (7%) patients were wheelchair bound and one (1%) was independently mobile. There was no significant difference in outcome between diabetic and non-diabetic patients ($p = 0.9$).

Discussion

Results from this study showed that more than half (55%) of the LLAs were attributed to diabetes. A total of 767 LLAs below the knee from the years 2010–2014 were identified from Addington Hospital's theatre registers. Apart from 2013 all other years displayed numbers of over 100 amputations per year and diabetic amputations predominated throughout. The small number of amputations in 2013 was related to renovations of the theatres at Addington Hospital and transfer of patients to Wentworth Hospital for surgery. The increasing numbers of patients with diabetes could be the contributing factor to the high number of LLAs at Addington Hospital. This is in keeping with the 2015 study by Ndukwu and Muoneme,[8] who found that below-knee and trans-tibial amputations comprised 64.4% of LLAs, and Kayssi *et al.*,[9] who reported that 60–70% of BKAs were performed as a result of PVD or circulatory complications. These results also concur with findings from Odatuwa-Omagbemi,[10] who noted that 63.6% of non-traumatic LLAs were due to diabetic foot complications.

The median age was shown to be 60 years. This is consistent with the 2012 Nigerian study, which reported that the majority (91%) of patients underwent BKAs and were in the age group 60–69 years.[10] The majority of the LLAs occurred in the 50–70-year age range with the highest proportion occurring in the 60–69 age group. Of these, 7% of patients in the age group < 30, 46.9% in the age group 30–59 and 52.8% in the age category 60–97 were diabetic. These data reflect that LLAs are prevalent in every age group but tend to dominate in the older age groups. DM was responsible for the majority of the LLAs through diabetic foot complications. This may be explained by prolonged poor glycaemic control, foot care practices and delayed foot examinations among other factors.

Table 2: Referral of patients with amputations to physiotherapy for rehabilitation

Factor	Overall	Diabetes *n* (%)	No diabetes *n* (%)
Total	667	354	313
Referred to physiotherapy	116 (17.4%)	88 (24.9%)	28 (8.9%)
Not referred to physiotherapy	551 (82.6%)	266 (75.1%)	285 (91.1%)

*Likelihood of referral to physiotherapy among diabetic and non-diabetic amputees, $p = < 0.001$.

Table 3: Mobility outcome in 95 patients who attended physiotherapy

Mobility	Diabetic *n* (%)	Non-diabetic *n* (%)	Total number of patients *n* (%)	*p*-value
Walking frame (WF)	37 (49)	12 (60)	49 (52)	
Crutches (C)	24 (32)	6 (30)	30 (32)	(WF/C) 0.9
Prosthesis with crutches (PWC)	6 (8)	2 (10)	8 (8)	(C/PWC) 0.9
Wheelchair (W)	7 (9)	0	7 (7)	(PWC/W) 0.9
Independent gait (IG)	1 (1)	0	1 (1)	
Total	75	20	95	

The equal sex incidence in this study was notable and it differs from the male predominance of 1.6:1 to 6:1 reported in the world literature.[10,11] This observation suggests that, whereas the sex incidence was similar, there was a relatively lower M:F ratio compared with the world literature. A local study by Omar *et al*. in 1993 showed a female preponderance.[12] Mbanya *et al*. have pointed out that, whereas sex has little effect on diabetes, sex distribution varies widely in sub-Saharan Africa, with no discernible trend.[13] We share this view. Although the trend in sex incidence is not quite distinct, a closer look at the literature reveals that the M:F ratio tends to be lower in environments where diabetic foot disease and PVD are the major indications for amputation and higher where trauma is the main indication for amputations, due to trauma being a more common event in males than females.[10,14]

More amputations were performed on the right lower limb than the left lower limb at Addington Hospital. This finding was in contrast to the South Nigerian study, which showed that 52% of patients presented with a left LLA.[10] Riskowski *et al*. reported in 2011 that, since gait depends on symmetry and asymmetry patterns, the dominant leg was found to be the leg with the superior propulsive force.[15] They suggest that people may step forward with the leg they perceive as the stronger limb or the limb with the better force. It is thus tempting to postulate that the pattern of putting the best foot forward could perhaps be the limb that may be at additional risk for injury.

This study revealed that BKAs were more frequently performed than other levels of amputation. This finding was in keeping with other international studies, which made a similar observation.[10,11] This is possibly due to patients presenting at an advanced stage of the disease, thus requiring a higher amputation such as a BKA. Most surgeons lean towards the most distal or trans-tibial amputation as a means to salvage as much of the limb as possible while at the same time enhancing function and the use of a prosthesis.[16]

A multidisciplinary team including surgeons, physiotherapists, orthotists, podiatrists etc. is required to assist an amputee with the change in life following amputation. Only 17.4% of patients with amputations were referred to physiotherapy for rehabilitation following surgery in this series; this suggests that referral to physiotherapy is not widely practised in our setting. Similar observations have been made by a number of studies. A Nigerian study by Igwesi-Chidobe highlighted poor knowledge of health professionals and community dwellers regarding the role and scope of physiotherapy services as impediments to patients receiving optimal physiotherapy services.[17] Other contributing factors cited by this author were poor healthcare-seeking behaviour by community dwellers, patronage of traditional health workers and poor referral practices by healthcare workers.[17] We are in agreement with Racy[18] that every amputee should be warranted a trial period of rehabilitation with a prosthesis under careful supervision irrespective of circumstances that may inhibit adjusting to a prosthetic limb.

In South Africa, most of the patients treated in the state sector fall into the low to medium socioeconomic status. Chen *et al*. in 2014 underscored certain barriers to adherence to rehabilitation including functional, disability and social or perceptual barriers as well as financial constraints.[19] This could explain the poor compliance of patients to rehabilitation in this study bearing in mind that the target population at Addington Hospital tend to be low-to-average income citizens.

Patients with LLAs characteristically present with decreased mobility, which impacts negatively on the performance of their activities of daily living and thus reintegration into society. However, evidence suggests that BKAs achieve a better functional outcome after rehabilitation compared with above-knee amputations (AKAs).[20]

It is concerning that only 17.4% of patients with amputations were referred to physiotherapy. This deprives patients of the opportunity to reduce their burden of challenges that present with the loss of a limb. Furthermore, among those referred to physiotherapy the attrition rate was very high. This highlights the need for a study of patients' and doctors' attitudes towards physiotherapy referral. We are unable to explain the reason for a higher referral of diabetic amputees compared with non-diabetic amputees. It is tempting to postulate that this may be due to the perception of doctors that diabetic amputees need more close attention.

In the current study, 1% of the very few patients referred to physiotherapy were wheelchair bound and the remaining patients were mobile with either an assistive device only or an assistive device and prosthesis. This is in contrast to findings among vascular amputees where 85% are fitted with a prosthesis after major lower limb amputation.[21] Brown and Attinger[22] in 2013 underlined the importance of rehabilitation after amputation and further emphasised that advanced technological prosthetics have led to an improved quality of life following rehabilitation among patients with LLA. These authors, however, emphasise patient selection when considering the level of limb amputation. They maintain that, despite the stated advantages of BKA, salvaged limbs with amputations below the trans-tibial level are still appropriate for ambulation in a selected group of patients. They contend that, when counselling a patient regarding limb salvage versus amputation, the clinician needs to consider the patient's quality of life in terms of functional needs, goals and the condition of the extremity. In support of this assertion, they point out that severely compromised patients who can ill-afford to mobilise with a prosthesis are sometimes better off with a supposedly poor functioning salvaged leg than being burdened with a BKA and prosthesis that they cannot use.

Limitations

The study has some limitations. It is a retrospective study and thus some data were missing from the charts. The renovations of theatres at Addington Hospital in 2013 possibly led to some patients, who would otherwise be referred to Addington Hospital, being sent to other hospitals. Hence the numbers in 2013 are not a true reflection of amputations being undertaken at Addington Hospital.

Conclusion

A higher percentage of LLAs in this series was attributed to diabetic foot disease. The gender incidence was similar. The most common site for amputation was the trans-tibial aspect of the lower limb. Patient referral to rehabilitation was extremely poor and so was their adherence to the rehabilitation programme. It is, however, pleasing to note that patients who did attend physiotherapy did achieve some form of mobility even if it was with an assistive device. We recommend that the knowledge and awareness of DM and foot care practices need to be

forcefully implemented at primary health care level as a start to reduce the incidence of LLAs.

Disclosure statement

No potential conflict of interest was reported by the authors.

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References

1. Clark EAM, Tsubane M. The role of the podiatrist in managing the diabetic foot ulcer. Wound Healing Southern Africa. 2008;1(1):40–2.
2. Todkar SS. Diabetes mellitus the 'silent killer' of mankind: an overview on the eve of upcoming world health day. J Med Allied Sci. 2016;6(1):39–44. doi:10.5455/jmas.214333
3. Gholap MC, Mohite VR. To assess the knowledge and practice regarding foot care among diabetic patients at Krishna Hospital, Karad. Indian J Sci Res. 2013;4(2):69–75.
4. Ogurtsova K, da Rocha Fernandes JD, Huang Y, et al. IDF diabetes atlas: global estimates for the prevalence of diabetes in 2015 and 2040. Diabetes Res Clin Pract. 2017;128:40–50.
5. Tudhope L. Diabetic foot sepsis. IDF diabetes atlas. 5th ed. Belgium: International Diabetes Federation, Brussels; 2011. Available from: http://www.up.ac.za/media/shared/Legacy/ … /45/ … /controversies 2013/diabeticfootsepsis.pdf
6. Jinadasa CVM, Jeewantha MA. Study to determine the knowledge and practice of foot care in patients with chronic diabetic ulcers. Int J Collab Res Intern Med Public Health. 2011;3(1):115–22.
7. Ziegler-Graham K, MacKenzie EJ, Ephraim PL, et al. Estimating the prevalence of limb loss in the United States: 2005 to 2050. Arch Phys Med Rehabil. 2008;89(3):422–9.
8. Ndukwu CU, Muoneme CA. Prevalence and pattern of major amputation in a tertiary hospital in Nnewi, South East Nigeria. Trop J Med Res. 2015;18(2):104–8.
9. Kayssi A, de Mestral C, Forbes TL, et al. A Canadian population-based description of the indications for lower-extremity amputations and outcomes. Can J Surg. 2016;59(2):99–106.
10. Odatuwa-Omagbemi DO. Extremity amputation in Warri, South-South Nigeria. J West Afr Coll Surg. 2012;2(1):14–24.
11. Pooja GD, Sangeeta L. Prevalence and etiology of amputation in Kolkata, India: a retrospective analysis. Hong Kong Physiother J. 2013;31(1):36–40. doi:10.1016/j.hkpj.2012.12.002
12. Omar MAK, Seedat MA, Motala AA, et al. The prevalence of diabetes mellitus and impaired glucose tolerance in a group of urban South African Blacks. S Afr Med J. 1993;83:641–3.
13. Mbanya JCN, Motala AA, Sobngwi E, et al. Diabetes in sub-Saharan Africa. Lancet. 2010;375:2254–66.
14. Ogeng'o JA, Obimbo MM, King'ori J. Pattern of limb amputation in a Kenyan Rural Hospital. Int Orthop. 2009;33:1449–53. doi:10.1007/s00264-009-0810-5
15. Riskowski JL, Hagedorn TJ, Dufour AB, et al. Evaluating gait symmetry and leg dominance during walking in healthy older adults. Boston: Institute for Aging Research, Harvard Medical School; 2011. Available at: http://www.isbweb.org
16. Moore TJ. Planning for optimal function in amputation surgery. In: Atlas of limb prosthetics: surgical, prosthetic and rehabilitation principles. Chapter 3, 2nd ed. St. Louis: Mosby Inc.; 1992, p. 59–65.
17. Igwesi-Chidobe C. Obstacles to obtaining optimal physiotherapy services in a rural community in southeastern Nigeria. Rehabil Res Pract. 2012; 2012:1–8. doi:10.1115/2012/909675
18. Racy JC. Psychological adaptations to amputation. In: Atlas of limb prosthetics: surgical, prosthetic and rehabilitation principles. Chapter 28, 2nd ed. St. Louis: Mosby Inc.;1992, p. 707–16.
19. Chen AWL, Koh YT, Leong SWM, et al. Post community hospital discharge rehabilitation attendance: self perceived barriers and participation over time. Ann Acad Med Singapore. 2014;43(3):136–44.
20. Cox PSTL, Williams SKP, Weaver SR. Life after lower extremity amputation in diabetics. West Indian Med J. ISSN 0043-3144. 2011;60(5):1–7. Available from: http://www.caribbean.scielo.org
21. Congdon W. Standard of care: lower extremity amputation. The Brigham and Women's Hospital, Inc., Department of Rehabilitation Services; 2011. Available at: http://www.brighamandwomens.org
22. Brown BJ, Attinger CE. The below-knee amputation: to ambulate or palliate? Wound Healing Southern Africa. 2013;2(1):30–35. doi:10.1089/wound.2011.0317. Available from: http://www.ncbi.nlm.nib.gov

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