Ethiopian Medical Journal 2024, 62(4)
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ISSN 0014-1755 eISSN 2415-2420 Mengesha et al.

Original Article

Assessing the Burden of Preventable Amputations in Hawassa: The Role of Health Care Access and Appropriate Early Interventions

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Background: *Limb amputation become one of the commonest procedures for various causes where the indications can be reduced by combination of public health interventions, improved public health access and early appropriate medical care. This study was aimed to highlight indications and patterns of amputation, compare to published data and provide possible ways in which the number can be reduced in Hawassa, Sidama region, Ethiopia.*
Method: *This was a retrospective study on 304 patients who underwent all types of amputations performed at Hawassa University Comprehensive Specialized Hospital from January 2019 to December 2021. Data was extracted from the operation registration log- book and patients' chart.*
Result: *There were 231 (75%) male patients with mean age 32.8 years. Main indications for amputation were trauma in 87 (28.6%) patients, peripheral arterial disease (PAD) in 69 (22.7%) and severe infection in 54 (17.8%). Complications due to treatment by traditional bone setters (TBS) was the most common cause of amputation in those under 18 years. 13.8% of amputations were deemed preventable, 14.1% potentially preventable, and 72% not preventable.*
Conclusion: *sixty six percent of observed amputations occurred in children and working-age adults under 40 years, giving rise to a massive societal cost. Through enhanced health education regarding severe trauma prevention as well as early severe infection treatment, fostering collaboration with TBS, data collection via trauma registries, and affordable, timely trauma services, the number of amputations could be significantly reduced.*

Keywords: *Hawassa, Ethiopia, Complication, Amputation, Low- and middle-income country (LMIC's), Traditional bone setter*
Citation : *Mengesha MG, Garikapati V,Adem EG et al. Assessing the burden of Preventable Amputations in Ha wassa: The role of health care access and Appropriate Early Interventions.Ethiop Med J 62 (4) 261-268*
Submission date : *26 July 2024 Accepted: 27 September 2024 Published: 01 October 2024*

Introduction

Amputation remains a standard orthopedic procedure in modern clinical practice, with a history dating back over 2500 years. Limb amputation is performed as a last option when limb salvage is impossible; the limb is viable but non-functional or has a high risk of mortality to the patient's life (1).

The indications for amputations vary from region to region, where peripheral vascular disease and diabetes are the leading causes in High-Income Countries (HICs) (2,3), whereas, in low-and-middle-Income Countries (LMICs), trauma is the leading cause (4,5). Also seen in LMICs is gangrene secondary to tight bamboo application by traditional bone setters (TBS), which may not be seen in HICs. Severe infection, which does not respond to aggressive repetitive debridement and culture-guided therapy, is another common indication to perform amputation in addition to high voltage electrical burn injury.

Within HICs, most patients undergoing amputation are over the age of 60 years (2,3,6), whereas in LMICs, the average age is much younger, specifically affecting those of working age (7,8).

Amputation within LMICs can have huge health, socio-economic, and psychological effects on the patients and their families. These operations have a high risk of mortality and morbidity, with disability representing a sig-

nificant burden to shoulder. Also, within these areas, a significant lack of prosthetic and rehabilitative services, leads to difficulty in rehabilitative and integrative challenges (9).

Here, we present a three-year (2019 to 2021) clinical experience showing the main reasons for amputation in our centre, one of the most prominent orthopaedic centres in the country and serves more than 20 million catchment population. We look to determine the patterns and indications of amputations in Hawassa, how this number can be reduced, and any strategies which could help to prevent and alleviate these complications that arise.

Material and Methods

Study design and Period

This is a retrospective study on 304 patients who underwent all types of amputations performed at Hawassa University Comprehensive Specialized Hospital (HU-CSH) from January 2019 to December 2021.

Study setting

HU-CSH is located in Hawassa, which is 275 km south of Addis Ababa, the capital city of Ethiopia. It is a 500-bed tertiary level Public University Hospital. It is the only referral hospital in the Sidama region serving a catchment population of approximately 20 million, including the nearby regions of Oromia, Central Ethiopia, and Somalia (10).

Sample size calculation and sampling

All of major amputation done at HU- CSH during the three-year period (2019 to 2021) were included without sampling.

Study population

The study population included all patients of all age groups and genders who underwent major amputations at HU-CSH within the study period.

Inclusion and Exclusion parameters

All age groups and genders who underwent major amputations at HU-CSH within the study period were included. Those amputations done in other departments and minor amputations (digital or finger amputations in both upper and lower extremities) were excluded.

Operational definition

Major amputation in this paper is defined as the surgical removal of the extremities by passing through the bone or joint, including upper and lower extremities; excluding amputation done through the digits or fingers.

Data Collection and statistical analysis

The dataset, including age, sex, primary diagnosis, immediate indication for amputation, and type of amputation, was collected from a hospital database of patients' acceptance logbook, operation theatre registry, and patient chart during the study period. All the data was collected by two trained third- and fourth-year orthopedic surgery residents under close supervision of the principal investigator and collected in open text form, which was coded later during data cleaning and analysis. In this study, we were not able to code diabetes mellitus as a primary cause of amputation, and cases that were listed as PAD or severe infection may also have had type 2 diabetes mellitus as a contributing diagnosis. The data was then retrospectively subdivided into whether the amputation was preventable, potentially preventable, or non-preventable by the researcher based on the diagnosis, causes, and risk of patients considering access to timely care (e.g., avoiding delays causing compartment syndrome, gangrene, severe infection), access to appropriate care (e.g., antibiotics for infection) as well as avoidance of harmful care (e.g., tight bamboo splints). We then defined preventable as those avoidable if appropriate steps had been taken; potentially preventable as amputations that could have been avoided with optimal care; and non-preventable as non-avoidable due to the injury or mechanism. We note that much trauma may be preventable, but our definition was applied only to the post-injury phase of care. All of the cases included in this study are those of major amputations performed by trauma and orthopedic surgeons where almost all of the amputations are being done under department of orthopedic surgery. The focus of this study is to describe the indications and patterns of amputations with possible explanation on how to reduce it. The data was entered onto Microsoft Excel software programme and descriptive analysis was performed. The results are presented in the form of text, figures, and tables.

Ethical Considerations

Since the study uses anonymized secondary data from the hospital registry, the study was approved by the orthopedics departmental ethical approval committee, and since it was considered a quality improvement audit, there was no need for further ethical approval.

Results

Three hundred four patients underwent amputation at HS-CSH from January 2019 to December 2021. Of these, 231 (76%) patients were male. The patients were aged eight days to 89 years, with mean age of 32.8 years and median age of 30 years. Most patients were under 40 years old (62.1%) (Table 1).

Table 1. Age group distribution of patients who underwent amputation at HU-CSH from 2019 to 2021

Age category	Number of Patients	Percentage (%)
< 18	91	29.9
19 – 39	98	32.2
40 - 59	74	24.3
> 60	41	13.5

The most common indication for amputation was trauma in 87 (28.6%) patients, followed by peripheral arterial disease in 69 (22.7%) patients and then severe Infection in 54 (17.8%) patients (Table 2). It is of note that only 4.2% of our data set have diabetes, leading to complications such as PAD or infection.

Table 2. Overall Indication for Amputation done at HU-CSH from 2019 to 2021

Indication for Amputation	Number	Percentage (%)
Trauma	87	28.6
Peripheral Arterial Disease	69	22.7
Severe Infection	54	17.8
Treatment from TBS	44	14.5
Malignancy	44	14.5
Electrical Burn	5	1.6
Congenital	1	0.3
Total	304	100

Complications due to treatment by TBS were the most common cause (33/91 patients) of amputation in those under 18. Trauma was the most common indication for amputation in those ages 19-39 (50/98 patients), whereas peripheral arterial disease was the most common in those aged 40-59 and greater than 60 (Table 3

Table 3. Age Groups of patients with Indication for amputation at HU-CSH from 2019 to 2021

Age group	Trauma	PAD	Infection	TBS	Malignancy	Burns	Congenital	Total
< 18	23 (7.6%)	6 (2%)	7 (2.3%)	33 (10.9%)	19 (6.3%)	2 (0.7%)	1 (0.3%)	91 (29.9%)
19 – 39	50 (16.4%)	16 (5.3%)	15 (4.9%)	6 (2%)	9 (3%)	2 (0.7%)	-	98 (32.3%)
40 - 59	9 (3%)	28 (9.2%)	17 (5.6&)	5 (1.6%)	14 (4.6%)	1 (0.3%)	-	74 (24.3%)
> 60	5 (1.6%)	19 (6.3%)	15 (4.9%)	-	2 (0.6%)	-	-	41 (13.5%)
Total	87 (28.6%)	69 (22.7%)	54 (17.8%)	44 (14.5%)	44 (14.5%)	5 (1.6%)	1 (0.3%)	304 (100%)

The types of amputations are shown in Table 4. The most common indications for lower limb amputation were trauma (25.1%) and peripheral arterial disease (25.1%). Trauma (33.7%) and treatment by TBS (28.1%) were the primary indications in upper limb cases.

Table 4. Type of Amputation at HU-CSH from 2019 to 2021

Type of Amputation	Number	Percentage (%)
Foot	24	7.9
Below-Knee	85	28
Through-Knee	10	3.3
Above-Knee	85	28
Hip Disarticulation	7	2.3
Other	2	0.6
Total Lower Limb	213	70.1
Hand	20	6.6
Wrist Disarticulation	3	1
Below-Elbow	12	3.9
Elbow Disarticulation	8	2.6
Above-Elbow	45	14.8
Shoulder Disarticulation	3	1
Total Upper Limb	91	29.9
Total	304	100

The causes of amputation were further subdivided into degrees of preventability. Of the cases that were presented, 13.8% of amputations were deemed preventable, 14.1% were potentially preventable, and 72% were not preventable.

Discussion

Amputation is associated with significant social, psychological, and economic effects on patients and their families. The indication and pattern of amputation can vary depending on the country, region, and the hospital. This is the largest series of amputations in an Ethiopian population within the literature. It was undertaken to describe our experience, compared to similar studies, allowing us to identify any patterns. It was also part of a quality improvement program aimed at identifying preventable amputation and addressing the underlying causes.

Similar to other studies, most patients undergoing amputation were male (75%) (11–13). In our study, the most common age group affected was those aged 19-39 years. Most LMICs have similar age group involvement because trauma is the leading cause of amputation in these age categories. This can be seen in similar studies done in Tanzania, Sudan, Nigeria, and Kenya (5,7,12–15). This is in contrast to high-income countries (HICs) where most amputated patients are aged 60 and above, as seen in The Netherlands, Canada, Hungary, and Sweden (2,3,6,16).

Despite a variation in causes of amputation between the different age groups, trauma was the most common cause, followed by PAD and severe infection. Trauma affected 28.6% of our population. This is a similar pattern noted by other studies (14,17–19). It is also seen that treatment by TBS was the most significant cause of amputation in those aged under 18.

Lower limb amputation was more common than amputation of the upper limbs. This is akin to other studies within Africa. We had an even distribution of above knee to below knee amputations. Studies show a varied distribution between above and below-knee amputations (4,7,12,13). The expected functional outcome varies hugely depending on above-knee to below-knee amputation, with above-knee amputees having increased morbidity and mortality (20,21).

Within LMIC, trauma is one of the leading causes of amputation. The decision to limb salvage versus amputation is a complex one that is influenced by patients' premorbid status, the nature of the injury, the location, contamination, the patient's wishes, and the resources available, including financial cost. There are many scoring systems, including the mangled extremity severity score (MESS), which can help guide decision-making. Most importantly, a multidisciplinary approach involving vascular, plastic, and orthopedic surgeons must be undertaken (22).

By improving the organization of trauma care, its management could become more sustainable and affordable, leading to lower morbidity and mortality rates (23). One such method is implementing trauma registries, which provide valuable data for injury surveillance, health system development, and resource allocation (24). Since 2019, HS-CSH has been collecting data through such a trauma registry, using the data to improve services and help reduce mortality by providing local data for decision-making (25).

Many studies have shown complications of diabetes mellitus to be a leading cause of amputation (8,15). Within our data set, only 4.2% were noted to have diabetes leading to complications such as PAD or severe infection. The prevalence within our population is likely to be underestimated due to a lack of diagnostics tools, preventative measures, and education (26,27). The rate of diabetes has been reported in Ethiopia between 2-6.5% (28). This is in comparison to India, another LMIC, where the prevalence is as high as between 9.3-24.5%. Across the globe, 10.4% of the population from high-income countries, 9.5% from middle-income and 4.0% from low-income countries were diabetic in 2019 (29). To help tackle diabetes, appropriate interventions towards patient self-care practice, lifestyle modification, and continuous follow-up are essential to prevent diabetic foot ulcers and subsequent amputations. Health care professionals are key to tackling diabetic foot ulcers through proper health education and patient treatment. To help control the amount of sugar in Ethiopia's diet, the Ministry of Finance of Ethiopia has implemented a 'sugar tax' of 20% on sugar products to help prevent the rise in diabetes mellitus that is seen in many other LMICs (30). In Ethiopia, 3.7% of the population are smokers, and 20.6% of Hawassa University undergraduate students smoke (31,32). Smoking and complications of Diabetes are common causes of PAD, which was the second most common cause of amputation in our study. This burden of smoking could be avoided through effective health promotion and disease prevention programs that tackle risk factors with low-cost and highly efficacious initiatives to curb tobacco. The taxation of tobacco products has also been effective in HICs.

Patronage towards TBS is a substantial reason for amputation in our study, particularly for those under 18. The main reasons for utilization of TBS included cheap fees, cultural beliefs, quick service, easy accessibility, and pressure from family and friends (33). Many strategies have been brought into place to help alleviate the complications that may arise from TBS treatment, including amputations. These strategies include educating TBS to provide training and recognize their limitations, formal engagement with orthodox services as well as a referral system, and providing regulation, certification, and licensing to TBS after preparation of the scope of practice with a monitoring and evaluation system. Many studies have shown that TBS are keen and willing to engage in such services and training courses (34,35). Within Ethiopia, a local initiative known as the BOne Setting Associated Disability (BOSAD) Study has been launched with its aim by 2025 to reduce complications by TBS to near zero prevalence by training practitioners, developing education materials, and producing a national database (36). In Hawassa, Trauma and Orthopaedics specialist service has only been available since 2016, and with this, patronage of TBS is expected to decrease as patients gain access to and understanding of safe, timely, and affordable care in the modern health sector.

Amputation represents the beginning of a new care journey for patients and their communities. While we considered that 28% of the amputations were preventable or potentially preventable, effective public health measures towards injury reduction, healthy lifestyle, and appropriate health seeking behaviour could also offer considerable reductions in the remaining 72% amputations. There is a need for post-amputation care and rehabilitation programs, including psychological support, physiotherapy, mobility devices, and prosthetics. Within Hawassa, there is only one such rehabilitation program, and it is difficult to access as it is funded by Non-Governmental Organisations (NGOs) and/or needs to be subsidized by the patient themselves, a far distance of travel and poor linkage of patients to centers. For those few who are able to access the program and be provided with prosthetics, many find they are not comfortable or fit for purpose. Due to this, most lower limb amputees will be crutch users (37). Within LMICs, there needs to be a holistic MDT approach combining the surgeons, physiotherapists, and prosthetists. An improved service can be achieved with collaboration between the patient, the doctors, and prosthetists in a regional rehabilitation hub and spoke model. Beyond the scope of this study, there is a need for analysis in subsequent studies into life after amputation in Hawassa.

In general, there are multiple studies done in different parts of Ethiopia that show nearly similar findings to our studies, specifically on the indication for amputation, pattern of amputation, and the age distribution. The studies done in Tikur Anbessa Specialized Hospital show that TBS-associated complications were the leading indication for amputation in the pediatric age group, which is similar to our current findings (38, 39). Similar findings were also reported from a study done by Mekelle specifically on the indication and patterns of amputation (40). A recent systematic review and meta-analysis done in Ethiopia show that different types of amputation, including for preventable causes, are being done throughout the country (41).

Although many publications are being produced in the country, there needs to be more effort to identify preventable and non-preventable causes of amputation. Furthermore, there has been a lack of initiatives to imple-

ment, such as awareness creation, improving access to modern orthopedic service, and focus on primordial prevention, all of which are crucial to reducing the number of amputations.

This study is limited by its retrospective methodology and absence of outcomes data. There are some gaps in our data set, including timing of amputation, significant comorbidities including diabetes, complications, re-operation rate, duration of hospital stay, and mortality rate. It is, therefore, difficult to fully assess the etiology of the patients or to review the patient outcomes.

This review had limited scope to study access prosthetics, return to school in children, and return to work in adults. An economic analysis including these societal costs would be beneficial.

The strengths of this study include its duration, number of cases, and our ability to ascertain various trends of amputation in Hawassa, and it provides a baseline against which to compare the impact of local TBS and trauma care initiatives.

Conclusion

Trauma, PAD, and severe infection are the leading causes of amputation for those over 18, whilst treatment by TBS is the leading indication in those under the age of 18 years. A significant number of these indications are potentially preventable. Eighty six percent of observed amputations occurred in children and working-age adults, giving rise to a massive societal cost. We have identified the need for public health and hospital improvements, which have proven effective in HICs to reduce this burden of human suffering and economic waste. Through good health education, collaboration with TBS, data collection via trauma registries, and affordable services, the number of amputations could be redacted, and for those that undergo amputation, an improved pre- and post-operative amputation rehabilitation program could improve outcomes.

Financial Support

There is no financial support since it was a quality improvement audit.

Conflict of Interest

The authors declared that there is no conflict of interest in this publication.

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