Access to prosthetic devices in developing countries: Pathways and challenges

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Access to Prosthetic Devices in Developing Countries: Pathways and Challenges

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***Abstract*—As the number of amputees continues to grow in low-resource settings, their demand for prosthetic devices continues to be unmet. Consequently, these amputees face exhausting physical, emotional, and economic challenges like navigating unfriendly terrain, emotional trauma, loss of income, and social rejection, all on a daily basis. While there have been attempts to meet this demand, the challenges in doing so are difficult and complex. Many organizations, including governments, nongovernmental organizations (NGOs), and private entities, are trying to deliver low-cost and durable prostheses to amputees. However, all of these organizations face a wide array of challenges related to infrastructure, technology and business in achieving this goal. With numerous distribution approaches used amongst these organizations in low-resource settings, little has been done to provide a comprehensive study of major distribution pathways and their respective challenges. This article presents the current pathways and challenges in delivering prostheses to amputees through a rigorous analysis of current organizations' approaches and the existing infrastructure in low-resource settings. The end goal of this article is to enable the reader to thoroughly understand the available options and obstacles to deliver prostheses in low-resource settings.**

Keywords—prostheses, amputees, nonprofits, for-profits, FBOs, prosthetists, resource-limited settings, pathways and challenges

I. INTRODUCTION

The World Health Organization estimates that, in the developing world, there are 40 million amputees, and only 5% of them have access to any form of prosthetic care [1]. As the number of people requiring amputations increases, the importance of establishing systems for providing proper care becomes more important [2]. Diabetes—a disease leading to a 25 times increased risk of amputation [3]—is expected to affect over 590 million people by 2030, with the greatest increases in numbers seen in low-income and lower middle-income countries [4]. Furthermore, humanitarian crises—the earthquake in Haiti or the civil war in Sierra Leone, for example—can lead to large numbers of individuals requiring amputations in difficult environments with limited accessibility. A multitude of organizations, including nonprofits, faith-based organizations (FBOs), for-profits, and hospitals, are attempting to improve accessibility to prosthetic devices. Nonprofits working in low-resource settings include Jumping Kids, Prosthetic Suppliers, World Rehabilitation Fund, and the Polus Center. In general, these organizations purchase and distribute materials and/or devices to in-country nonprofits, hospitals, and workshops. FBOs such as Standing With Hope and Christian Blind Mission collect monetary donations as well as new or used prosthetic materials and devices to be distributed in low-resource settings. Nonspec and 3D Life Prints, two examples of a for-profit and hybrid for-profit/nonprofit organization, attempt to improve access to affordable prostheses by manufacturing and selling their own devices. Despite the attempts of all of these various organizations, 95% of the amputee population in developing countries still lacks access to proper prosthetic care and affordable devices. This article provides an extensive review of the current pathways and challenges in delivering prostheses to amputees. With access to proper prostheses, amputees can begin to overcome the everyday issues, such as difficulty finding jobs, forced dependence on others for help, and the social stigma that comes from their own communities.

II. METHODS

Relevant organizations working with prosthetic devices and services were found through online keyword searches as well as through online news articles and publications. Interviews were conducted via phone, email, and Skype with 11 organizations (2 FBO, 2 for-profits, and 7 nonprofits) to gain a better understanding of how each gathers and distributes funds, prosthetic devices and/or materials to low-resource settings. A specific questionnaire was used depending on the type of organization contacted (i.e., FBO, for-profit, or nonprofit). Follow-up interviews were conducted as needed to gather additional information to develop a more in-depth understanding of the prosthetic landscape in resource-constrained settings. Additionally, social media (i.e., Facebook, Twitter and LinkedIn) were also used to contact relevant organizations in Zambia when traditional contact information could not be attained. A number of interviews were then conducted with healthcare workers at hospitals and clinics in Zambia. Finally, literature surrounding the use and distribution of prosthetic devices in low-resource settings was systematically reviewed. The information was aggregated based on organization type to determine commonly occurring trends in the distribution pathways. A general description of the various stakeholders and processes in the distribution chain is provided, followed by a comprehensive description of each

stakeholder and the various pathways for distributing prosthetic devices to amputees in developing countries.

III. Systemic Problem

Prosthetic suppliers in Sub-Saharan Africa face a variety of challenges in trying to effectively deliver prostheses to those in need. A core challenge among these different organizations is funding. Most NGOs require funding to pay for prosthetists, prosthetic materials and rehabilitative costs. The need for external funding arises because the recipients of the prostheses, with an average yearly income of $1,686 US across Sub-Saharan Africa, lack the income to pay any or all of the cost of a prosthesis [5]. One of the primary causes of prosthesis abandonment in one study was the high cost of repairs and replacement [6]. With high rates of poverty in rural areas, it is important to consider the costs associated with the purchase and maintenance of a prosthesis to ensure adoption in both urban and rural areas. Prostheses NGOs are attempting to solve this issue by making affordable prostheses available to people who otherwise would go without. A second challenge for providing access to prosthetists, prosthetic materials and rehabilitation is the distance that people must travel to reach an adequate healthcare facility. Orthotic and prosthetic departments are often available in capitals and urban areas. However, reaching people that live in rural areas is limited, owing to their low annual income, low accessibility to technicians, and the costly nature of importing prosthetic materials and devices to rural areas [7] [8] [2].

The distance that must be traveled to obtain proper care becomes a problem not only during the fitting process but also during follow-up care and rehabilitation. WHO classifies rehabilitation as "a set of measures that assist individuals who experience, or are likely to experience, disability to achieve or maintain optimal functioning in interaction of their environment" [9]. Rehabilitation is a stepping stone to help an individual to start or return to his or her education, work, and day-to-day living. In the context of prosthetic devices and amputees, rehabilitation has the potential to compensate for an amputee's lost limb(s) and sustain that function over a period of time. To improve the chances of successful and continued prosthesis use, rehabilitation should begin immediately after the 3 to 4 week wound-healing phase following amputation and include training on proper use of the prosthesis. The prosthetic device will then require maintenance over time and adjustments according to the patient's needs [10]. Thus, for optimum use and comfort, the patient would need to travel a number of times to maintain his or her device. To compensate for these issues, it is preferable to make prostheses affordable, locally accessible, able to be manually constructed and repaired, and functional without being too technologically advanced [11].

IV. Stakeholders

A. Nonprofit Organizations

The majority of nonprofits that provide prosthetic devices and/or materials to disadvantaged people in low-resource settings receive their funding through partner organizations, private funding, grants and personal donations. Due to the costly nature of prostheses, nonprofits fill the void between supply and demand because their purpose is to create social value rather than to generate a profit [12].

Nonprofits that distribute prostheses are able to accept donations of prosthetic devices and/or materials and funds as long as those assets are used to facilitate the distribution or fabrication of prostheses in developing areas. This funding is also used to cover administrative and material costs as well as training.

While developing world amputees receive free prostheses from international nonprofits, there are challenges associated with distributing used prostheses that make this distribution sometimes difficult to accomplish. First, the supply of prosthetic devices for developing areas, whether locally made or donated from a western nation, is not effective. Locally made prostheses are not reliable due to the materials from which they are made. Concurrently, donated prostheses do not perform well in the more rugged environments and are expensive to maintain [7] [13]. Another challenge is the lack of continued maintenance and rehabilitation after an amputee has received a prosthetic device. Lengthy distances to the clinic not only affect initial treatment of being fitted and taught how to use a prosthetic device, but also continued maintenance and refitting of the device [7].

There are a number of nonprofits working in Africa trying to distribute prostheses to amputees. These nonprofits often provide clinics in specific locations and work with partners already operating in that area. They also work with local doctors, educators, and community leaders. Several nonprofits provide affordable orthopedic care to children with limb disabilities [14]. A number of nonprofits train locals the skills necessary to fit upper and lower extremity prostheses and when the venture has become sustainable, they take on the role of a support network [15] [16] [17].

B. Faith-Based Organizations

FBOs are most commonly classified as religious organizations that use faith as the motivating factor to carry out their goals. FBOs that operate in the prostheses field in low-resource settings have a similar approach to nonprofits in that they both receive monetary donations and therefore share the same funding challenges. However, there are two differences that strengthen the ability of FBOs to effectively distribute prostheses.

FBOs are prevalent in rural areas where the government must work hardest to reach its citizens [18]. In fact, in any given African country, FBOs make up 30-70% of healthcare services [19]. Even though these FBOs may not be able to offer the most up-to-date care, they are trusted and serve as important healthcare providers, especially in resource-constrained settings [20]. FBOs, then, are crucial to the distribution of prostheses to areas where prostheses are least accessible. Given that donated prostheses are generally not built for low-resource settings, there is a need for maintenance and repair [7] [13] [8]. FBOs are equipped to provide this and ensure continued usage of the device. Due to these two differences and a well-coordinated network across Africa,

FBOs represent the best avenue to distributing prosthetic devices to rural amputees.

There are many FBOs that play a pivotal role in the distribution of prostheses in developing countries. Many FBOs involved with prostheses collect the devices in developed countries and ship them to low-resource settings. Donated funds and prosthetic devices and/or materials are received by connected in-country nonprofits and hospitals. This is especially important given that amputees are difficult to locate because of a lack of data on rural locations. With a majority of African populations living in rural areas, FBOs represent a key pathway to this population of amputees [21]. They also employ certified U.S. prosthetists to train local workers on how to construct these devices, creating a more sustainable flow of prostheses from donor to amputee.

C. For-Profit and Hybrid For-Profit/Nonprofit Organizations

On a basic level, a hybrid for-profit/nonprofit organization is one that merges the social philosophy of a nonprofit and the monetary cash generation of a for-profit business [22] [23]. A nonprofit with a for-profit arm might be used to generate extra revenue or a for-profit with a nonprofit arm might be used to help conduct philanthropic activities [24]. As a hybrid, the nonprofit side remains immune to taxes while the for-profit arm can raise funds from investors and make tax deductible donations to the nonprofit side. This assists the nonprofit in achieving its longer term goals of creating social good that it may not have had the funds previously to do so.

The few prosthetic hybrid and for-profit organizations that were identified are relatively new and still growing. For this reason, prosthetic for-profits acquire most of their funding through grants and competitions and are working towards becoming self-sustaining. Because the organizations are start-ups, the challenges that would present themselves to a fully sustainable prosthetic organization are unknown.

Prosthetic for-profits working in developing countries have the opportunity to design novel prostheses that are more applicable to the context, such as a device whose size can be adjusted over time to prevent the need to purchase a new, expensive prosthesis as the patient grows [25]. These organizations strategically choose where they set up their headquarters and manufacturing facilities so that they are as close as possible to their amputee target customer.

D. Prosthetists and Training Centers

Prosthetists are individuals that facilitate the use of prostheses and fall into three categories according to training guidelines set forth by WHO and the International Society for Prosthetics and Orthotics (ISPO): (I) professional prosthetist; (II) prosthetic technician; and (III) technician or bench worker. Because professional prosthetists are able to formulate a full treatment plan, fabricate and fit a prosthesis, and conduct follow-up appointments, they serve as the preferable method of prosthetic care. Category I professional prosthetists attend three to four years of full time schooling which includes theoretical knowledge, supervised practical instruction, and clinical practice. Prosthetic technicians are trained in a number of tasks, such as taking part in the examination and prescription of a prosthesis and advising on the design of the prosthetic device. In low-income countries, a prosthetic technician may replace a professional prosthetist. Category II prosthetic technicians attend three years of full time study that covers theoretical subjects and supervised practical instruction. A bench worker directly assists the professional prosthetist and/or prosthetic technician rather than being directly involved with the end user. Depending on the program, a Category III technician or bench worker may attend two years of formal schooling or four years of on-the-job training. Like the previous two categories, training includes theoretical subjects and supervised practical instruction [26].

Prosthetic devices, new or donated, must be personally fit to each amputee for comfort and ease of use. If a prosthetic device is not fitted properly, then its likeliness of use declines significantly. Therefore, the role of prosthetic professionals is vital to the distribution of prostheses to those in need and lack thereof is commonly cited as a barrier to proper care [8] [13] [7]. Prosthetists are on the front lines and are able to observe and understand many of the challenges of amputees, hospitals, and prosthetic devices. In USAID's 2012 assessment report, survey responses indicated that prosthetists identified common areas of improvement for devices as fit and alignment, partially owing to device deterioration [27]. These findings convey the need for easily customizable, durable, and affordable prosthetic devices that are designed for low-resource settings.

Individuals desiring to work in prosthetics and orthotics fields should first receive training. As of 2008, there were 24 schools that offered any type of training in prosthetic services. Combined, these schools graduated a total of 400 technicians per year across all developing countries [26]. Throughout the years, there have been examples of training programs that have failed and those that have succeeded. The UN, World Rehabilitation Fund, International Committee of The Red Cross and Terre Des Hommes attempted to train new prosthetists and failed. This failure was attributed to, among other drivers, the lack of a permanent government-supported budget as well as the inadequacy of entry eligibility and resulting specialized knowledge after training [28]. Another example is a Tunisian prosthetic and orthopedic training center, which Heim entrusted to new leadership in 1973 [21]. Upon following up five years later, Heim realized that the program had not scaled as envisioned. Although they had prosthetic and orthopedic tools and regularly treated a large group of people, they serviced fewer patients from rural areas. This disconnect was attributed to failing to set up appropriate social services that consider the education, culture and level of transportation of the patients. Heim concluded that for prostheses to be made available to rural Africans, factors like financial situation, education level, religion and available modes of transportation need to be considered [21]. Difficulties in reaching the rural population are not unique to this particular program. A study in Sierra Leone showed that rural patients not only had less access to prosthetic services compared with their urban counterparts but also felt less satisfied with the coordination between these services and other rehabilitation services. Disseminating knowledge about

available prosthetic services as well as dispelling negative stigmas and traditional beliefs surrounding the causes of amputation is important for increasing access to prostheses, particularly for those living in rural areas [29].

Tanzania Training Centre for Orthopedic Technologists (TATCOT) is an excellent example of a facility that has properly scaled. TATCOT teaches its students the skills necessary to provide prostheses and rehabilitation to people with amputations and other disabilities [30]. Between 1984 and 2014, TATCOT graduated a total of 645 students, with 425 of those graduating between 2005 and 2012. These graduates now work in over 30 African countries [27]. The number of graduates working in a specific developing country varies between one and 172, with the majority residing in Tanzania. Given the low numbers of prosthetists in many countries, the needs of amputees are not being met. However, it is important to note that over 80% of the graduated prosthetists continued to practice prosthetics/orthotics, often taking leading positions [28]. More than 75% of African countries do not have the means to train individuals in prosthetics [26]. Sierra Leone is one such country, and thus, students were sent to TATCOT for training [29].

E. Hospitals and Prosthetic/Orthopedic Centers

A review of hospitals and rehabilitative centers that provide prostheses fabrication and/or amputee rehabilitation, known as prosthetic/orthopedic centers or O&P centers, in Africa is provided here. Using available literature and information obtained during interviews, the systems in four countries are included to provide a representative overview of the different levels of prosthetic/orthopedic treatment available in Sub-Saharan Africa.

1) *Kenya*: There are 53 O&P centers in Kenya, which are overseen by the Ministry of Kenyan Rehabilitation Services. The National Association of Orthopedic Technologists is one of three organizations for rehabilitation professionals. This association specifies the needed prosthetic supplies, and to date, the only prosthetic supplier in Kenya is Ottobock. As of 2012, 114 of the 200 orthopedic technologists, some of whom were trained at TATCOT, work for the government in Kenya.

The Department of Orthopedic Technology at Kenyatta National Hospital employs one ISPO Category I prosthetist/orthotist, two ISPO Category II orthopedic technologists, 10 trained orthopedic technologists, and three technicians. On average, 280 patients are seen per month for prosthetic/orthotic consultation or equipping of an assistive device. The annual budget of this hospital is $8,000 US, and supplies are purchased both from Ottobock and locally [27].

2) *Uganda*: In Uganda, very few disabled people actually receive the support that they need. There are 12 O&P centers in Uganda, and an assessment in 1998 showed that the national situation in prosthetics/orthotic is ‘fragmented and uncoordinated’. Although development has been sluggish since that time, the number of O&P centers has grown from 12 to 19. The supply chain for prosthetic and orthotic devices in Uganda depends heavily on donors, leading to an inconsistent supply of materials. Also, although prosthetics and orthotics professionals are recognized, there is no standard career path to follow.

The Department of Orthopedic Technology at Mulago Hospital in Uganda has two ISPO Category II orthopedic technologists, two in house-trained orthopedic technologists, and six orthopedic technology assistants. The conditions of the prosthetic/orthopedic facilities were subpar, including a number of maintenance issues that impact the quality of the clinical and technical working environments. It was concluded that there is little financial contribution in the areas of prosthetics and orthotics at Mulago Hospital. Furthermore, the free services offered were not sustainable due to the limited investment by the government in prosthetics [27].

3) *Tanzania*: The Ministry of Health and Social Welfare is responsible for rehabilitation in Tanzania, which has 18 O&P centers. Tanzania’s Kilimanjaro Christian Medical Center (KCMC) employs four ISPO Category I prosthetists/orthotists, four ISPO Category II orthopedic technologists, one category I lower limb orthotic technologist, and two lower limb prosthetic technologists. This facility assists over 50 new patients each month. KCMC is located directly across from TATCOT, allowing students to practice prosthetics and orthopedics at the center. Graduates rely on memory for patient history, and a clinical record keeping system is a noted improvement that is needed [27].

4) *Zambia*: Reviews of three hospitals and one rehabilitation center were conducted in Zambia. The healthcare system in Zambia utilizes a referral system in which patients requiring more specialized treatment are transferred to a hospital with the next level of care, as required by the specific injury or illness. For example, clinics in Monze refer patients to the nearest general hospital—Monze Mission Hospital. Although this hospital provides amputation services, it does not have a rehabilitation center capable of fabricating and fitting prostheses. Rather, patients receiving an amputation at the hospital are referred to Holy Family Centre.

Holy Family Centre has a workshop for fabricating and fitting prostheses and orthoses. The workshop, which is staffed by two prosthetic technicians, prepares prostheses for two to three people at a time. Each prosthesis requires three to four days to manufacture. The center is funded primarily through FBOs and the Hospital Ministry. Staff salaries are paid by the government, and most materials needed to prepare the prostheses are purchased from Ottobock. Patients requiring a prosthesis are expected to pay a minimal fee, the extent of which is determined based on an economic assessment of the patient. If the patient is unable to pay, the center seeks a donor organization to cover that patient’s cost.

University Teaching Hospital (UTH) is a national referral hospital that has a government-supported O&P workshop in Lusaka. Currently, the UTH workshop employs two ISPO Category I prosthetists, one ISPO Category II prosthetic technician, and one ISPO Category III bench worker. On

average, the workshop prepares prostheses for between 120 and 150 clients from around the country. UTH imports prosthetic materials, components, and machinery and assembles the devices in-house. Through cost sharing, patients are able to receive affordable prosthetic devices and rehabilitation. Common causes of amputation are traffic accidents and diseases such as diabetes. A vast majority of prosthetic devices are for lower limb amputations.

5) *Summary*: Each of the countries reviewed has a plan in place to treat people with disabilities; however, some have been more successful than others. Furthermore, there are differences in the quality of services provided by ISPO graduates. The professional status of these graduates, the majority of whom have graduated from TATCOT, is not always recognized, and therefore, they are sometimes unable to achieve an acceptable living wage.

V. Dissemination Pathways

There are various methods for distributing prostheses to amputees in developing countries, which will be discussed in this section. Much of the information was collected through interviews with FBOs, NGOs, for-profits, and hospitals. It should be noted that while all the content in this section is accurate, it may not capture the full scope of the diverse distribution pathways for prostheses. To help the reader visualize the different pathways, Fig. 1 and 2 are provided detailing how these devices are distributed from manufacturer to the amputee. By the end of this section, the reader should have a thorough understanding of how FBOs, NGOs, for-profits and hospitals are connected as well as how prostheses are distributed between different organizations and then to the amputee.

A. FBO-Mediated Pathways

Due to the extended reach of FBOs in rural areas in developing countries, they are an obvious facilitator for distributing prostheses. FBOs accept donations and funds from prosthetics manufacturers and western world donors. Donations from manufacturers are usually more preferable because the prosthetic devices and materials are then unused, allowing the FBO to provide a higher quality product to the recipient. Acquiring prostheses through donations from the western world allows FBOs to receive a larger quantity of prostheses. Donated prosthetic devices and/or materials are shipped to local nonprofits and hospitals where a prosthetist will size and fit an amputee for a prosthesis or the prostheses are distributed through the next pathway. However, donated prosthetic devices may not be made to withstand the adverse conditions that exist in developing countries, which could inhibit usability of the device [7]. For example, the most commonly found prosthetic feet in developing countries, whether imported or manufactured locally, use the SACH (Solid Ankle Cushion Heel) design. The feet are typically manufactured using either volcanized rubber or polyurethane, with the latter being more common. Although the feet could be manufactured using volcanized rubber, a durable material, the majority is constructed from polyurethane foam, a lighter material, leading to durability limitations [31].

B. Nonprofit-Mediated Pathways

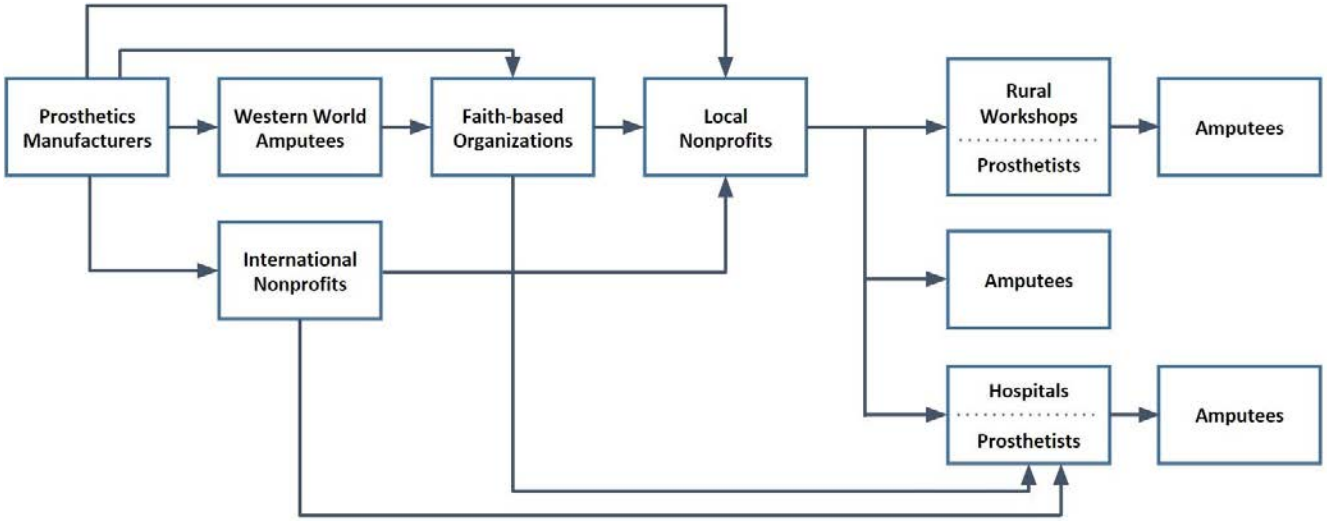
International nonprofits receive prosthetic devices and/or materials through both donations and purchases, the prosthetic devices and/or prosthetic materials will be sent directly to in-country nonprofits and hospitals. The in-country entities then decide how the prosthetic devices and materials should be used. Depending on the local nonprofit, one to three different pathways can be taken.

Pathway 1: Local nonprofits that have received the prosthetic materials will distribute the prostheses to rural areas where a prosthetics and orthotics workshop exists. When needed, a prosthetist will size an amputee, manufacture a prosthesis, and fit it to the amputee.

Pathway 2: If a workshop and prosthetist does not exist in a particular area, a prosthetist working for the nonprofit will go to that area to size the amputee. The prosthetist will then return at a later date with the manufactured prosthesis and properly fit the amputee.

Pathway 3: Hospitals may receive the prosthetic devices

Fig. 1. This visual describes the distribution of prostheses between manufacturers, FBOs, nonprofits and hospitals to amputees.

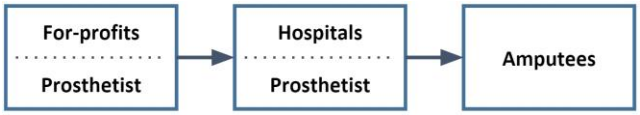


and/or materials directly. Hospitals that receive these materials have a prosthetics and orthotics workshop available with a trained prosthetists or prosthetic technician who will create prosthetic devices as needed.

C. For-Profit-Mediated Pathways

For-profit prosthetic manufacturers that target amputees in developing areas are a new concept that is still being explored. They are fairly small and are not yet able to distribute prostheses on an international level. But because of this, they are able to sell their prosthetic devices directly to hospitals on request. While their reach is shorter, they are able to more effectively sell prostheses from their headquarters to the receiving hospital, which then allocates the prostheses to amputees.

Fig. 2. This figure describes the distribution of prostheses from for-profit to amputee.



D. Hospital/Prosthetic & Orthopedic Center Pathways

Following an amputation, which typically occurs at a hospital, the patient will need to go through a recovery phase of several weeks to allow the residual limb to heal and swelling to decrease. The patient will then have the option to be fitted for a prosthetic limb. Fitting may take place at the hospital or a prosthetic/orthopedic rehabilitation center. Fabrication of a prosthesis might take several days in which the patient may wait at the hospital or rehabilitation center to receive the prosthesis. Once the patient has been fitted with the prosthesis, they will be trained in prosthetic gait training, in which the patient will practice various weight bearing exercises [32]. When training is complete, the hospital or rehabilitative center will conduct follow-up appointments with the patient to ensure that the prosthesis can be comfortably used. As the recipient ages, he or she may need to be resized for a new prosthesis, which is particularly important for pediatric patients. Additionally, the prosthesis may need to be replaced for various reasons such as the patient gains or loses weight or muscle mass; a specific component of the prosthesis no longer works and requires replacement; or the prosthesis no longer fits the level of activity required by the amputee [33].

VI. Conclusion

In this article, potential pathways and challenges to distribute prostheses in low-resource settings have been outlined. The main types of organizations working to deliver prostheses to those in need within low-resource settings are FBOs and nonprofits. However, these organizations face the significant challenge of obtaining the funding necessary to provide prosthetic devices at an affordable price. Funding is also an issue for amputees, who lack the necessary income to purchase the devices. Prosthetic devices that have been donated from Western countries may not be suitable for the context into which they are placed. The mismatch in needs leads to an increase in the required maintenance and repair of the devices. Prosthetists play a key role in preparing, fitting, and repairing the prosthesis as well as training the amputee how to successfully use his/her new device.

However, the number of prosthetists is low, particularly in rural areas. Furthermore, there are few notable training programs in Sub-Saharan Africa to train the necessary numbers of prosthetists and prosthetic technicians needed to support the amputee population. The lack of available personnel not only affects the ability to properly fit amputees but also to properly repair and maintain the prostheses. Designing a prosthetic device specifically for amputees in developing countries is key to the widespread adoption of the technology, which should be both low cost and culturally appropriate. Those seeking to design new prosthetic devices should work relatively close to their target market. This enables more effective iterative design and improvement and makes it easier to distribute the devices. For-profits can take advantage of hospitals as a middleman in the distribution channel or a point of contact to meet an amputee. From a technological standpoint, the prosthesis should be made from readily or locally available materials. This affects not only the upfront cost and construction of the device, but also the ease with which the device can be maintained and repaired. Without adequate numbers of prosthetic professionals to fit and assist with rehabilitation, the device should be designed to be both simple and rugged to withstand the everyday use in developing countries. As such, the highly intricate technology of an electric or myoelectric prosthesis may be less appropriate than the simplified design of a body-powered prosthesis. Furthermore, designs that are transferable to patients with multiple amputation levels will enable broader impact [34]. The optimal manufacturing technique, whether local or abroad, has yet to be established [35]. Therefore, further work should examine not only the design of an appropriate prosthesis but also the methods by which it can be manufactured and distributed to reach the greatest number of users.

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