The Cause of Costly Prosthetics

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

Over 1 million amputations occur globally every year, meaning about every 30 seconds someone undergoes amputation (*Limb Loss in the USA* 2016). This number is expected to increase annually as diseases such as diabetes continue to rise, with a projected 150 million more diabetics by the year 2030. The World Health Organization (WHO) estimates that 30 million people are in need of prosthetic devices, yet 75 percent of developing countries do not have access to prosthetic care (Burt, 2018). The cost of owning a prosthetic device is recognized as a primary issue behind its accessibility to amputees. While affordability appears to be a larger issue for lower-class patients, amputees in both low and high income settings have limited access to prosthetic and orthotic services (Donnelly, 2021). Those at risk of amputation and consequently in need of prosthetics extend further than only diabetics and military personnel; cancer, trauma, blood clots, and infections, of which everyone could be at risk of at some point in their life, all make up major causes for amputation. Accessibility of orthotic services for amputees has a major societal impact, not only benefiting the patients, but rather an entire network of actors. Inadequate, unsuccessful, or an absence of prosthetic care results in long-term negative side effects for amputees, but also long-term and significant costs for insurance companies (Baumann et al., 2020). Through conducting a literature review on the present topic, the cause of prosthetic inaccessibility and more specifically the reason for its high cost will be studied. The cause of costly prosthetics is the result of the most vulnerable demographic of people undergoing amputation having the least amount of resources to compensate for its resulting complications along with a lack of infrastructure on an international level to aid amputees as a whole.

Background

The topic of this STS research study is examining the reason why prosthetic and orthotic services and devices are globally inaccessible to amputees and similarly impaired individuals. Access to both these services and devices impacts an array of actors beyond just the patient, with research suggesting that it is societies benefit for the above to be available to amputees.

Although birth defects such as Amelia exist and cause affected individuals to be born without one or more limbs, creating a need for prosthetic and orthotic services, only approximately 1000 people in the United States have the disease (U.S. Department of Health and Human Services, 2024). The primary demographic of individuals who are missing limbs are people who have undergone an amputation. Currently there are 35 and 40 million amputees around the world and 185,000 annual amputations that occur in the United States primarily caused by diabetes. In underdeveloped countries, the major cause for a significant increase in amputations are humanitarian crises, natural disasters, and motor vehicle accidents, such as with the Haiti earthquake or the civil war in Sierra Leone. (Cabrera, 2022).

The Centers for Disease Control and Prevention (CDC) publishes in their *National Diabetes Statistics Report* the prevalence of diabetes classified by age, gender, race, and residence.

Figure 1

Crude prevalence of diagnosed diabetes by detailed race and ethnicity among adults aged 18 years or older, United States, 2019–2021

Race and Ethnicity Subgroup	Total Percentage (95% CI)
American Indian or Alaska Native, non-Hispanic	16.0 (12.1–20.6)
Black, non-Hispanic	12.5 (11.6–13.4)
Native Hawaiian or Other Pacific Islander, non-Hispanic	11.7 (7.4–17.2)
Asian, non-Hispanic	9.2 (8.2–10.4)
Asian Indian, non-Hispanic	10.8 (8.3–13.7)
Chinese, non-Hispanic	7.1 (5.2–9.3)
Filipino, non-Hispanic	12.2 (9.4–15.6)
Japanese, non-Hispanic	6.8 (4.1–10.5)
Korean, non-Hispanic	6.1 (3.8–9.1)
Vietnamese, non-Hispanic	6.4 (3.7–10.0)
Other Asian, non-Hispanic	8.9 (5.9–12.8)
Hispanic	10.3 (9.4–11.1)
Mexican or Mexican American	11.1 (9.9–12.3)
Central American	7.3 (5.6–9.4)
South American	5.0 (3.3–7.1)
Puerto Rican	13.3 (11.0–15.9)
Cuban	9.0 (6.5–12.1)
Dominican	9.4 (5.9–14.2)
Other Hispanic, Latino, or Spanish	7.2 (5.5–9.2)
White, non-Hispanic	8.5 (8.2–8.8)

As shown from the figure above, American Indians and African Americans as a whole make up the largest percentage of diagnosed diabetics in the United States (*National Diabetes Statistics Report*). The Pew Research Center with data from the U.S. Census Bureau found that

as of 2014, African Americans have twice the likelihood of being poor compared to both White and Asian individuals in the United States (*Demographic trends and economic well-being* 2016).

For amputees, there is both a financial and physical benefit for the utilization of prosthetic services. Individuals who lack access to prosthetic care tend to live more sedentary lifestyles which can lead to complications such as diabetes, which in turn causes increased medical expenditure (Dobson et al., 2016). A meta-analysis of ten studies found that individuals who live primarily sedentary lifestyles had a 112% greater risk of developing type 2 diabetes (Hamilton et al., 2014). Additionally the consequences of a lack of prosthetic care extends to insurance companies as the side effects of poor, failed, or no prosthetic care creates an increase in healthcare expenditure in the long-term (Baumann et al., 2020). In meeting the CDCs exercise guidelines, there is an average reduction of $2,5000 per patient annually when compared to individuals who do not meet those guidelines (*Insurance reform: A cost-saving investment in amputees' health* 2024). These guidelines would appear to not be overly demanding and achievable for most individuals, with recommendations such as spending 30 minutes a day walking, and working out at least twice a week (*Adult activity: An overview*). For amputees, however, without access to prosthetics, these minimal daily tasks recommended for their general health become impossible challenges.

Economic analyses of prosthetic devices and services conclude that out of the annual 1 million amputations that occur globally, amputees in both low and high income settings have limited access to prosthetic and orthotic services. Even in comparatively modern and high income countries with prosthetic services in place, the demand for these outweighs the resources available. In low income countries, access is limited due to the lack of established prosthetic services and high delivery costs, and since these countries are already in a financial struggle,

resourcing these services has not been prioritized. (Donnelley et al., 2021) Additionally, the amount of amputees in need of services far outweighs the prosthetists available – over 100,000 prosthetists would be needed to address the needs of the 30 million people in need of orthotic services in developing countries. (Johnson et al., 2012).

By analyzing academic journals and research studies focusing on individual aspects behind prosthetic inaccessibility, this STS project will compile the combined reasons for why prosthetics are so costly. In doing so, an Actor Network Theory will map out the relationships between the various causes for the expenses of prosthetics, from the reasoning behind why amputations occur to the different parties at stake by not having access to orthotic services. In order to analyze these relationships, the data collected will be from research studies that perform quantitative analysis based on statistics or relevant qualitative experiences such as time spent in undeveloped countries examining the effects that prosthetic care had on amputees, or both. Through these methods of analysis, the network of actors that influence or are influenced by costly prosthetics will be examined.

Methodology

By using a compilation of literary studies which examine causes of prosthetic device cost and orthotic service inaccessibility, a more well rounded conclusion can be drawn towards the overall reason behind expensive prosthetics. In addition to a literature review, data and statistics from government organizations, public health offices, and similarly relevant and reputable sources will be used as evidence to support conclusions made within the thesis. Sources of the literature review will include statistics on amputee demographics, surveys of quality of life of those with and without access to prosthetic care, and journals including financial analysis of prosthetic economy (healthcare systems, infrastructure, etc.). Questions asked in these sources of

literature may vary from asking how insurance factors in, the economy of the country and its access to raw materials, research costs that factor into prosthetic market price, and others. By compiling multiple forms of literature dissecting the various components that factor into the overall prosthetic inaccessibility problem a conclusive thesis can be written. The frameworks used to analyze the research question will be social construction of technology and actor-network theory. Social construction of technology argues that technology is not a neutral force but rather is shaped by social factors, meaning that technology is influenced by social groups both in use and development (Bijker, 2001). This analytical framework is especially important in the context of this thesis as the research question at hand is determining how the non-technological actors, that is not the prosthetics themselves, have influenced its inaccessibility or lack of development. The importance in understanding how factors outside of a prosthetic device as a technological agent, that is its complexity, cost, and developmental stage, lies in the fact that humans and the infrastructure they interact with, such as insurance agencies, hospitals, and relevant programs, play just as big a part in its accessibility. These actors directly shape all the aforementioned attributes of the technological agent that is a prosthetic device, meaning that understanding how these actors have affected accessibility of prosthetics will answer the question of why this technology is so seemingly inaccessible. Actor-network theory views the world as a constantly shifting network of relationships between people, objects, and technology (Crawford, 2020). Both humans and non-humans have agency, meaning that they play a part in affecting how social systems change. With such a large number of actors all a part of prosthetic services, actor-network theory would best analyze how the array of actors interact in prosthetic development, accessibility, care, and use.

Literature Review

Academic journals and other sources of literature researched potential causes for prosthetic inaccessibility or discussed specific relevant components that tie into this issue, such causes for amputation. Cabrera discusses the latter component arguing that the major cause for a significant increase in amputations in less developed countries are humanitarian crises, natural disasters, and motor vehicle accidents, such as with the Haiti earthquake or the civil war in Sierra Leone. With the large volume of amputees globally, Cabrera states that the largest obstacle in the way of their recovery "is the lack of access to quality and affordable prostheses" (Cabrera, 2022).

Authors such as Dobson et al. research the importance and relevance of amputees having access to prosthetics by studying the economic value of utilizing prosthetic services, specifically through the use of Medicare. Along with analyzing the financial benefit, this study examined the physical benefit access to prosthetic care provides to amputated individuals, such as the reduced risk of secondary complications. The journal states that individuals who lack access to prosthetic care tend to live more sedentary lifestyles which can lead to complications such as diabetes, also leading to increased medical expenditure (Dobson, 2016). Not only does a lack of complete prosthetic care result in sedentary lifestyles, but poor orthotic care can cause amputees who utilize prosthetics to either rarely utilize the device or not use it at all. Poor orthotic care in this context includes lack of breathability, functionality, and overall comfort of prosthetics. In a study with 70 Australian upper-extremity prosthetic users, 56% either scarcely wore their device or almost never at all as a result of the poor orthotic care they received, with 64% stating that the quality of prosthetics they received was either "fair" or "not acceptable" (Davidson et al., 2002).

It is argued that orthotics and prosthetics services can lead to long term savings in healthcare, however, legislation offering access to these services is currently limited, with only

nineteen states passing laws ensuring amputees and similarly disabled individuals have appropriate access to such care. Researchers Malouff and Cain, through the examination of 11 So Everybody Can Move (SEBCM) bills, calculated an average $0.01 to $0.38 increase in insurance premiums in order for amputees to gain access to at least decent orthotic care (*Adult activity: An overview*). Furthermore, these researchers found that by providing amputees a prosthetic device through their insurance, everyone's premium would only increase by $0.00001, meaning that for every cent increase in insurance premiums, 1000 amputees could receive a device that enables them to be closer to getting back to living life as they did before their limb loss.

While increased accessibility has demonstrated importance, improving existing prosthetic care services is also of great importance. Bauman et al. analyzes the improvements of prosthetic care from the perspective of social science research. The journal argues that prosthetic care not only improves the quality of life of users, but also reduces long-term negative side effects of poor, failed, or no prosthetic care (Bauman et al., 2020). The use of prosthetic devices benefits insurance companies in the long term as well, and with the implementation of low-cost manufacturing methods such as 3D printing, there is even greater reason for attention to be brought to the accessibility of prosthetic care for amputees. With factors such as importance, relevance, and background discussed, the reason why prosthetics seem to be greatly inaccessible is discussed through economic studies, design considerations, and analyses on infrastructure. Donnelley et al. conducted a study on the former and latter, arguing that out of the annual 1 million amputations that occur globally, amputees in both low and high income settings have limited access to prosthetic and orthotic services (Donnelley et al., 2021). Even in comparatively modern and high income countries with prosthetic services in place, the demand for these outweighs the resources available. In low income countries, access is limited due to the lack of

established prosthetic services and high delivery costs, and since these countries are already in a financial struggle, resourcing these services has not been prioritized. Building off of problems related to infrastructure, researchers Johnson and Veatch argue that underdeveloped healthcare and limited governmental prosthetic infrastructure reduce the accessibility of prosthetic devices for those in need. An important figure is brought up stating that over 100,000 prosthetists would be needed to address the needs of the 30 million people in need of orthotic services in developing countries (Johnson & Veatch, 2012). Tied with the fact that 80% of the world's population lives off of $2 a day, these researchers discovered a significant limiting factor in providing access to most amputees. Johnson and Veatch's journal highlights a new cause behind prosthetic inaccessibility, specifically being social infrastructures which are partly independent of an individual's social and economic status, though certain wealthy individuals may have access to resources outside of the governmental infrastructure that the majority of the population utilize. Marino et al's journal states that while attempts have been made by many organizations such as governments, nongovernmental organizations, and private entities to deliver low cost prosthetic devices to amputees, they have faced challenges related to infrastructure, technology, and business. Marino et al. "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" (Marino et al., 2015). Riccio-Ackerman offers a comprehensive analysis of the overall high cost and inaccessibility of prosthetics, arguing that the lack of coverage offered by insurance companies plays a role in why people cannot afford prosthetics; Riccio-Ackerman states that the correlation between individuals missing limbs and their economic status is the true root behind the accessibility of prosthetics (*Person overview ' Francesca Riccio-Ackerman*). In many countries, including the United States, prosthetic limbs

are grouped with “durable medical equipment”, such as wheelchairs and walkers, rather than equipment such as hip replacements, causing low insurance coverage. While this is argued to be a major issue, Riccio-Ackerman discovers that system issues may play a bigger role in that households close to the poverty line have a much higher risk of needing an amputation. Evidence is presented through the use of statistics, such as compared to rich neighborhoods, diabetics in poor neighborhoods have 10 times the amputation rates. Additionally, diabetic people as whole are 30 times as likely to lose a limb, and minority groups in the U.S experience a higher likelihood of undergoing amputation, with Black women having as much as a 7.6 times higher likelihood of getting an amputation.

Discussion/Results

Inaccessibility of prosthetic devices and orthotic services derives from social issues, such as ethnicity and economic status, lack of relevant government and healthcare infrastructure, and lack of aid from insurance companies. Certain ethnic groups have increased risk of health-related issues such as diabetes, which if left untreated, result in amputations, consequently leading to the need of prosthetic and orthotic services. While individuals of low economic status will have a harder time of getting the healthcare they need for their amputee related issues, the same ethnic groups that are of higher risk of diabetes also tend to have a larger impoverished demographic in the United States making it so that the most susceptible people of needing prosthetic and orthotic services are those with the least amount of resources to afford the related services that go with it. Health insurance was created to help individuals afford larger medical needs through their own smaller contributions, however, due to the way orthotic services are labeled in healthcare, the amount of resources amputees get for these services is not nearly enough to cover the full cost of

the care that they need. Additionally, while governments have developed certain infrastructures and programs for amputees, they happen to be heavily biased towards veterans, which is not nearly the largest demographic of amputees, thereby resulting in a large population of individuals without access to prosthetics. Although there is a current lack of programs for amputees, bills such as SEBCM propose plans to increase access to orthotic and prosthetic services while keeping costs for everybody as low as a $4 increase in yearly insurance premiums.

Conclusion

Individuals with the highest risk of needing amputation have the largest disadvantage amongst amputees in affording orthotic services. While the consequences of remaining impartial to the lack of accessibility for amputees seems to be limited to only the affected individuals, being an actor a part of a larger network, more than only amputees end up affected. A lack of orthotic care results in increased medical complications, sometimes costing insurance companies more than if they had just treated amputees for their orthotic services in the first place. This increase in cost can end up being spread out amongst all insurance users, increasing premiums for everyone, not only amputees. Aside from non-amputees being affected, there is a moral and ethical obligation for at least advocacy of increased accessibility of these services. Amputees struggle with both physical and mental distress as a result of their complications, with specific issues such as basic mobility, personal hygiene, and reintegration into a post-amputation life affecting them for their entire life. Working towards finding and developing solutions to combat prosthetic inaccessibility aids to relieve some extraordinary suffering that amputees would have to deal with for the rest of their life. With the common theme present throughout humanity’s

history where technology has been created to make life a little bit easier, these solutions deserve to be equitable so that everyone can live with a bit less suffering.

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