A Review of Commonly Used Prosthetic Feet for Developing Countries: A Call for Research and Development

valuable study information by referencing levels of evidence, revealing the need for higher quality, clinically relevant, peer-reviewed published research [6]. Ikeda's second review also produced a chart comparing delivery of prosthetics by major organizations, however did not provide as in depth of a comparison of regional to feet as this review [9]. Here we provide an updated and comprehensive review of the majority of low-cost prosthetic foot (>25 total) designs available in the developing world market instead of just a small selection by the prior reviews (4-16 range). Several reviews [1,2,4,7,8] focus on providing historical backgrounds or addressing current prosthetic models and status of service provision with respect to legislation instigators, issues and demographics, fabrication methods (CAD/CAM), assessment procedures, media, and programs. main objective of most of the previous reviews was to evaluate progress on outcomes from the ISPO 1996 consensus conference [10] for prospective studies to identify issues with prosthetic technology durability, performance, user satisfaction and services in developing countries.

Background

A major issue with current prosthetic foot development is that it doesn't target the majority of end users. Approximately 80% of individuals with amputations worldwide reside in developing countries [11]. In 2013, the World Health Organization estimated approximately 30 million amputees live in developing countries with up to 95% lacking access to prosthetic devices [11]. A typical limb made in a developing country costs approximately $125 to $1,875 USD [2,8]. However, the annual income of an individual with an amputation in a developing country averages around $300 [8], with a large portion of the population of making less than $2 a day, including 38% of Vietnam, 57% of Cambodia, 88% of Tanzania, 91% of Malawi, and 28% of Columbia [2,12]. One suggestion to make an option would be to reduce prosthesis cost to 3% or less of the annual income of user [2]. is only considering the cost for the initial prosthetic limb and not the additional costs for maintenance and replacements. Most adult amputees require a prosthetic foot replacement every years and can easily transition through 15-25 limbs in their lifetime [8,13]. Factors depending on age, onset of amputation, activity level, and occupation all contribute to the cost of prosthetic care. expenses may cost thousands of additional dollars in prosthetic expenses over their lifetime. Many amputees resort to pole and crutch limbs that are not conducive for activities of daily living and lead to complications

Republic of the Congo, Ethiopia, Guinea-Bissau, Libya, Niger, South

Jensen in 2004 found defective in 56% of cases for a Jaipur foot and for 19% of cases of PU feet [3,26]. A 2010 study by Jensen found inadequate in prosthetic foot that was not optimal resulting in mostly wide which could not sustain suspension and comfortable walking [5]. Inadequate also led to leg length asymmetries (>1 cm and inadequate socket wall resulting in muscles being unable to transfer forces to the limb [3,5]. Over half of the pain reported from use of the Jaipur foot was attributed to these errors leading to decreased functional capacity. Only half of the amputees were actually able to sit cross-legged and approximately 60% were able to squat. clinical testing of the current high-density polyurethane (HDPE) Jaipur foot concluded that it was not acceptable due to reports of higher user discomfort (38%) even with just low to moderate activity levels [5].

Jensen et al. conducted a clinical study in 2006 in El Salvador, Vietnam, and Cambodia comparing low-income prosthetic feet. CIREC foot was found to have the best performance compared to CR-SACH, SACH, ICRC, and Fujian feet, even with a majority of high intensive users (75% survival two years) [3]. However, continued to be a critical issue as the CIREC users reported high complaints, dropouts, and low and user compliance [3].

An additional issue with current prosthetic feet is versatility. Most feet do not have adjustable toe (making walking and running even more so) or are not multi-purpose for barefoot walking or shoe accompaniment. Lee et al. reported on experiences with SACH feet (BAVI, HI, HCMC, and VI) in a tropical developing world setting. feet lacked interchangeability due to dimensional in the ankle portion and height of the foot device among designs [15]. Most low-cost prosthetic feet, including Jaipur feet, are not height adjustable [2]. Bartkus et al. addressed this height issue with the design of a prosthetic foot in 1994 that utilized low-cost E glass reinforced vinyl ester sheet molding compounds in an alignment adjustment system [20]. system is composed of interchanging conical retaining sleeves that are slotted over an inner bore that is incrementally angled in one-degree steps from zero to eight degrees [20]. alignment method is used to modify the prosthesis for each amputee's gait. heel can also be changed easily with durometer heel inserts [20].

With regard to obtaining prosthetic feet in developing countries, there can be problems importing material or the foot itself may be It is suggested that locally availe o ¤imÑ el' s cls ö c]in

above the keel is kept to a minimum to retain the keel's elastic properties.

Eventually, the whole keel was expulsed, and the foot

PF Thai (14, 19)	Thailand	PU-foam	Nylon	Finger	PU-foam	Cushion	PU-foam	PU-foam	Failed static strength after UV exposure	
CIREC (8, 14, 19, 24)	Colombia	PU-foam, 2 spring blades	PP	Wedge	PU-foam	Cushion	PU	PU	PU-foam under keel deformed, delamination	25%/24 m 20%/18 m 15%/12 m 7-22 m
Fujian (8, 14)	Vietnam	Flat belt drive	Wood							

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