SIRUMED©, software for wheelchair selection. A preliminary report.

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Abstract— **Rehabilitation organizations have recognized that personal mobility plays a significant role in the lives of many people with disabilities. It has been estimated that the number of people with disabilities in developing countries who require wheelchairs is approximately 1% of the population. In Latin America medical insurance, socialized or private, does not prescribe nor provides wheelchairs, therefore the only way to acquire one is through charity or through direct purchase. This represents a major obstacle particularly if considering that the economic resources of the population with disabilities throughout this region are very limited. Given that they are not prescribed, wheelchair users receive minimal advice from clinical personnel and end up buying a device based on salesman recommendation. With the purpose of facilitating the provision of properly fitted wheelchairs for Latin America, a software program, to be used by clinical personnel, was developed. Two versions were developed, a PC stand-alone and a Web based version. Fifty recommendations were made and compared to experienced wheelchair manufacturer representatives. Software recommendations coincided with the manufacturer's suggested sizing in 49/50 cases within +/- 1 cm. This paper presents the functions of the software and illustrates individual wheelchair recommendations. With this information, wheelchair users and their families can acquire a better fitted wheelchair for their patients.**

Keywords— **software, wheelchair selection, Latin America**

I. Introduction

Based on the 2010 population estimates and the 2004 disability prevalence estimates [1], including children, over a billion people (or about 15% of the world's population) were estimated to have a disability [2]. This is higher than the 1970s estimates that suggested a prevalence of 10% [3]. According to the WHO 80% of people with disabilities, particularly children, live in low income countries [4] where Assistive Technology (AT) is rarely available. AT device means any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve the functional capabilities of a person with a disability [5]. Wheelchairs are considered AT. Global data on the need for rehabilitation services (including mobility devices) and estimates of unmet need are very limited [6]. However, it has been estimated that the number of people with disabilities in developing countries who require a wheelchair is approximately 1% of the population [7].

The number of people with disabilities increases mainly for two reasons: the aging population and the increase in chronic degenerative diseases, especially common non-communicable diseases (NCD) such as diabetes, stroke and cancer. This suggests a correspondence increase in the need for mobility devices.

Exceptional rehabilitation organizations have recognized that personal mobility plays a significant role in the lives of many people with disabilities. They have focused their efforts exclusively in the provision of wheelchairs to low income countries. Organizations like Wheelchairs for the World [11], Joni and Friends [12], and pioneer organizations like the Wheelchair Foundation [13] have been providing wheelchairs since 1979. As meaningful, helpful, well structured, and funded as these organizations are, their lack of long term involvement with local organizations has rarely resulted in development and sustainability [14]. Their work is perceived mainly as charity.

When considering the reasons for not having commercially available quality wheelchairs specifically in Latin-America, literature comes short of answers. One potential explanation may be that as long as medical insurance, socialized or private, will not provide for these devices, the only technology that will be available are those received through charity or devices that people can acquire out of pocket. This condition represents a major obstacle for procuring quality wheelchairs, particularly if considering that the economic resources of the population with disabilities throughout this region are very limited. Given that wheelchairs are not recommended, therapists and physicians are not familiar with the recommendation process.

In consequence, not recommending, not providing and the lack of availability leave the wheelchair users to their own resources, and forces them to choose by price.

Therefore, if quality personal mobility devices are needed to improve the lives of people with disabilities in Latin America, it is necessary to develop alternate sustainable methods of designing, producing and distributing these technologies.

With the purpose of facilitating the provision of quality wheelchairs for Latin America, the Rehabilitation Engineering and Technology Center (CITeR® for its name in Spanish) at Universidad Iberoamericana in Mexico City, em-

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barked in the development of a wheelchair recommendation software (Section 1: SIRUMED Ligera©, 03-2013-111413315900-01, and Section 2: SIRUMED Estándar©, 03-2013-111413282300-01) that would assist therapists and physicians in Latin America to properly recommend a customized wheelchair.

II. System Requirements

A. General requirements

SIRUMED© would be integrated by two separate sections: a. rigid frame design, and b. folding frames design. Software would require patient upper and lower limb measurements (measured by therapist or physician) and will result in a wheelchair recommendation that will indicate: 1. seat length, 2. seat width, 3. seat height, 4. footrest height and 5. back height.

Software should be user friendly and easy to use by clinical personnel. They will learn to use it through an online tutorial.

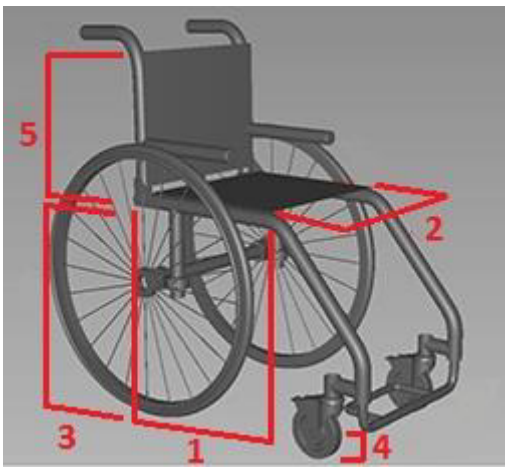

Fig. 1 Wheelchair dimensions

Software would recommend wheelchair parameters procuring to keep a propulsion angle (elbow) between 100 and 120 degrees. Wheel diameter would be limited to 24" given that other adult sizes wheels are rarely available. Hand breaks, push handles and arm rests are treated as accessories.

B. Special requirements

SIRUMED© will provide four possible configurations: three obtained automatically by the algorithm and a fourth that considers a manual mode where specific parameters can be entered by clinical personnel. These four options take into account therapist and physician clinical experience and individual considerations specific to each patient. Figure 2 illustrates the block diagram of the software.

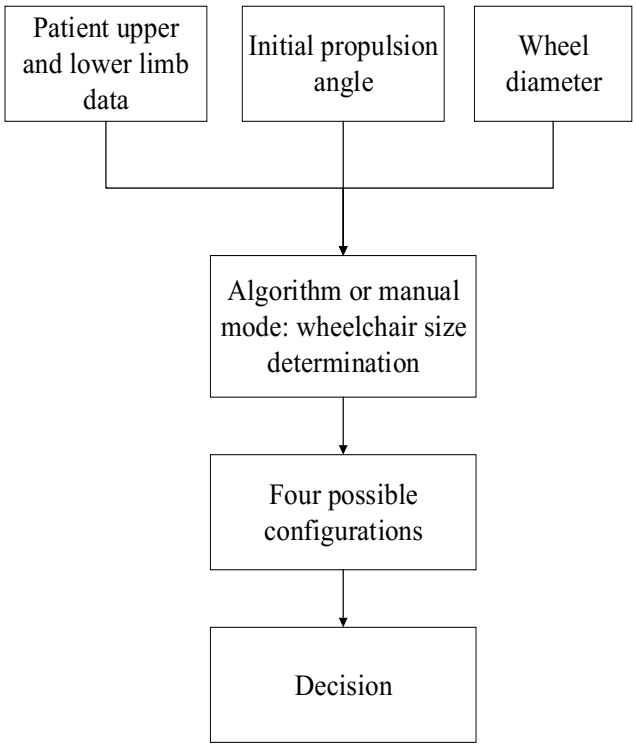

Fig. 2 Wheelchair recommendation process

III. Results

A software program was developed to facilitate recommending of manual wheelchairs, both, rigid and folding frames. Software is Windows® based. Two versions were developed, the stand alone version for PC was written in JAVA®, and for the Web based version, PHP® was used. Algorithm function is to calculate proper sizing of the wheelchair attending to the individual's upper trunk and leg measurements. If both calculations coincide a recommendation is made. If they do not coincide, software recalculates wheelchair dimensions by lowering (reducing the propulsion angle) or elevating (increasing the propulsion angle) the seat height. Software allows the clinician to select the final recommendation, taking into account the wheelchair user level of expertise.

Software is intuitive to use and was easily learned and applied by clinical personnel. Figure 3 illustrates the software results shown on a table where four options are presented. From this table, clinical personnel will select the most appropriate option for the client based on client information and condition.

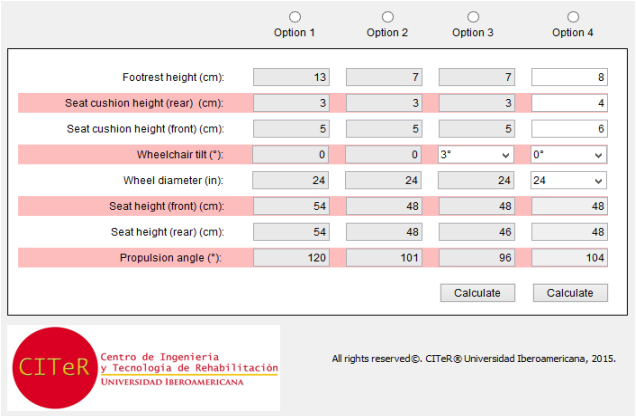

Fig. 3 Wheelchair recommended options (labels are originally in Spanish for use in most Latin American countries)

Figure 4 illustrates the final recommendation report where all required dimensions to custom fabricate the wheelchair are provided.

Fifty wheelchair recommendations were made to volunteer "expert" male adult wheelchair users. Disabilities included spinal cord injury at different cervical and thoracic levels. Age range was from 21 to 45 years. While entering the users data to the software, two experienced wheelchair manufacturer representatives were present and were asked to produce their own recommendations.

The suggested wheelchair recommendations by the software program coincided with the manufacturer's suggested sizing in 49/50 cases within +/- 1 cm on each of the reported parameters. In one case, the recommendation made by the manufacturer representatives had a better fit for the client.

Twenty five wheelchairs were fabricated locally by manufacturer Fundación Bertha O de Osete A.C., sizing them according to the dimensions recommended by the software. Volunteers that received these customized wheelchairs recognized a better fit and ease of use than their existing wheelchair

IV. Conclusions

The results of this qualitative study suggest that a recommendation made by the software is quite similar to those issued by an expert provider. Therefore in most clinical setting in Latin America where no expert is available, the use of this program could enhance wheelchair recommendation practices.

More wheelchairs would have to be prescribed by the software in conjunction with the experts to assess its true clinical value.

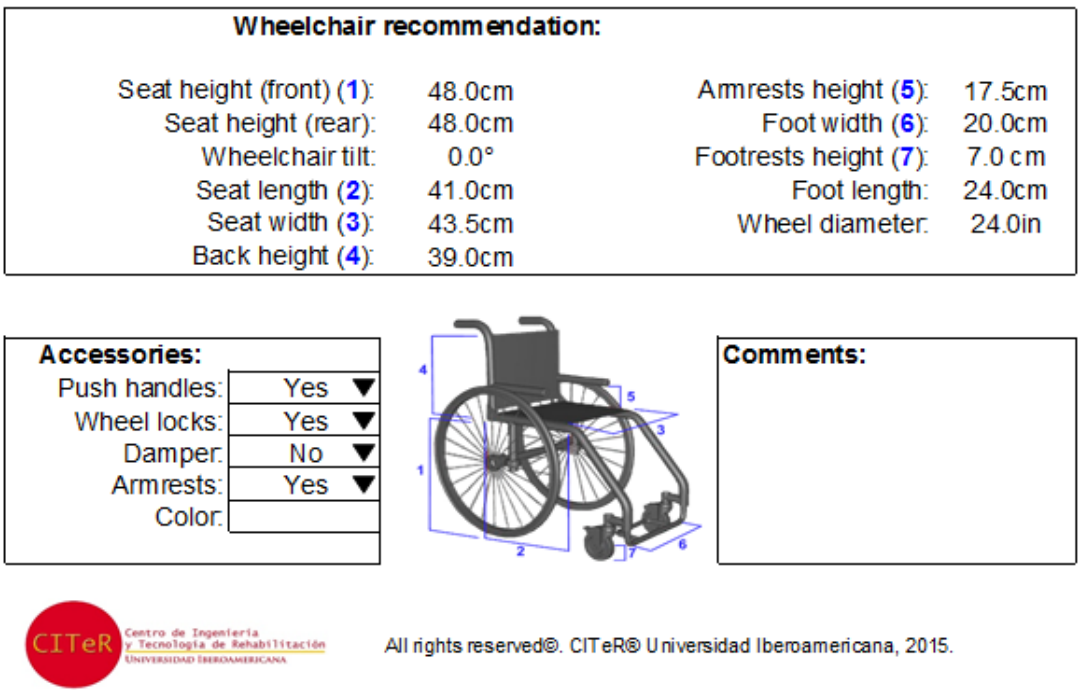

Fig. 4 Recommended Wheelchair

The recommendation generated by SIRUMED© could be used by the patient or his/her family to order a customized wheelchair, when available. Or at least, can be used as a guide to purchase one commercially available that is close to the proper size. This would facilitate individual propulsion for the active user and provide better comfort.

However, proper wheelchair size recommendation by itself is not a complete solution. For that reason, CITeR has also developed a seating fabrication system that in concert with the properly fit wheelchair would enhance mobility and comfort. For that purpose, a Web based application is being developed with the interest of providing a clinical tool to Latin American therapists and physicians.

As long as wheelchairs are not provided by the public or private health care system in Latin America, therapists and physicians will not see the need to prescribe them. Individuals with disabilities will rely entirely on the opinion of vendors to acquire them, a system that has proven not to be in the best interest of the wheelchair user, especially if he/she is paying out of pocket.

This software will provide interested clinical personnel with a tool to guide the patient in acquiring as close to their best fit wheelchair as possible, and in some instances, local manufacturers could fabricate the wheelchair to the specific needs of the user.

V. Compliance with ethical requirements

A. Statement of Informed Consent

Participants signed an informed consent allowing the use of their ergonomic measurements to be used as input data into the software. All subjects were assigned an identification number and no personal information was recorded.

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Conflict of Interest

"The authors declare that they have no conflict of interest".

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