A STUDY ON UNDERSTANDING OF WHEELCHAIR TRANSFERRING ACTION

Comparison of Transferring Action Between Manual and Electric Wheelchair Users

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Abstract: This study is focused on understanding the usage patterns of wheelchair, and transferring action of wheelchair users. Transferring mishaps are one of the major causes for injuries. Moreover, all the transferring actions between wheelchair and other surfaces are difficult for wheelchair users. To learn about the importance and details about proper transferring action for wheelchair users a standardized several observations and an Internet-based survey were conducted. In this survey, respondents were divided into two groups by taking into account their using type of wheelchairs. The purpose of this grouping was to learn more about the potential users of the two major wheelchair types and to compare the transferring actions in two cases. The comments from respondents were learned to comprehend their conditions and requirements of proper transferring. The aims of this study were to determine the viability of easier transferring solutions, suggest new wheelchair and component designs.

Keywords: Wheelchair design, Assistive technology, Physical disability, Mobility

1. Introduction

An important aspect of daily life for majority of people with disability is their dependence on a wheelchair [1]. Wheelchair use is conditional for achieving independent mobility for people with physical disability. To function independently, wheelchair users must possess a variety of wheelchair skills, enabling them to deal with the physical barriers they will inevitably encounter in various environments [2]. Mastering wheelchair skills can make the difference between dependence and independence in daily life [3,4]. Therefore, training of these skills is a vital part of the rehabilitation process [5]. Individuals with physical disability need new options dealing with architectural barriers; completing essential daily bed, shower, or toilet transfers and gaining access to high cabinets, cupboards, or shelves that are difficult or impossible to reach from a wheelchair. In spite of advances in social life, environmental conditions, and wheelchair design, almost one-third of all individuals with disability still need assistance with activities of daily living, community mobility or essential transfers [6].

Ability to perform transfer depends on several factors such as age, time since injury, shoulder motion, strength, pain, arm length related to the trunk and spasticity. However, the individual with physical disability is ready to perform the independent transfers when they acquire a good trunk balance and adequate push up. A person performs from 14 to 18 transfers a day [7]. Due to the fact, these activities are essential for functional independence and quality of life [8].

Transferring mishaps were cited second most common cause to injuries [9]. Because of the difficulty of the action people are improving their transferring skills at rehabilitation centers in order to prevent transferring mishaps [10]. The sharing of transferring introductions, abilities and skills in social media and the transferring guidance books show also importance of subject for wheelchair users. Despite its significance, there are very few existing researches done today in design view of point. Literature reviews showed most of the studies are medical focus on muscle and joint pain/injuries in transferring and rehabilitation of people with mobility problems.
2. Objectives
The objective of this study was to examine the use of wheelchairs with a specific goal of understanding the factors associate with transferring action, emphasize the important of this subject as a transferring need for wheelchair users suggest new design ideas for more convenient and easier transferring. Specifically, we focused attention on transfers between wheelchair and other surfaces as bed/sofa, toilet, floor, other wheelchair and vehicle seat. Examination of variety of factors might potentially affect the wheelchair transfer and provide gaining insight into design elements of a wheelchair that may act as barriers or facilitators.

3. Methods

3.1. Literature Review and Observation
For this study there has been several other research and observation stages, as interviews with real users, observation of product usage, self use of wheelchair and transferring performance and visiting several store and Welfare exhibitions. The purpose was to detect the problems and possible unique solution points.

3.2. Survey Study, Structure and Analysis
An Internet-based survey was also conducted between 15th December 2012 and 16th January 2013. Participants were members of association, groups and circles that were contacted first. Participants were mostly from Turkey, USA and UK. Our main criterion was that the participants have to be wheelchair users. The questionnaire was divided into sections related to their personal and wheelchair usage characteristics. Respondents had the option of selecting more than one answer in several multiple-choice questions and were allowed to give their unprompted opinions in other open-ended questions. These responses were summarized in tables, and common themes were extracted after all surveys were completed. Descriptive statistics for the usage characteristics of the study participants (means, standard deviations) were computed. Subjects also reported the difficulty of transferring actions using a five-leveled scale. Likert scale was summarized as any vs. no difficulty, and people reported whether the wheelchair met their needs (agreed vs. disagreed). This numerical values work as percentage of the responds in 5 and shows the importance and difficulty depending on question.

3.3. Study Variables

3.3.1. Dependent Variables
Outcomes of interest were wheelchair use in different transferring surfaces between wheelchair and other seating places. These surfaces were selected for measurement in this study based on the conceptual model for mobility in the life space diameter of disabled people, with life spaces identified as indoor or outdoor. These surfaces included several life spaces within the home (sofa, bed, toilet, floor) and several other surfaces outside the home (vehicle seat, ground). Main concerned surfaces were divided as same level as sofa, closet, chairs (approximate height is 44-46 cm), a higher level as bed, some sofas (60 cm), lower surface as lower stool, stairs (30-32 cm). Grouping was done to considering the wheelchair seat height (44-46 cm).

3.3.2. Independent Variables
We classified independent variables as patient characteristics, wheelchair-related characteristics.

1) Patient characteristics: This part consisted of socio-demographic characteristics like age, sex, and type of disability. We also used the year of using a wheelchair, number of hours the subject reported spending out of bed per day as a measure of overall frailty.

2) Wheelchair-related characteristics: Participants were asked about their usual wheelchair usage. The types of the wheelchair gave the information of user groups. First task was identifying the wheelchairs whether they were self-propelled manual (Group M) or electric/power wheelchairs (Group E).

4. Results

4.1. Literature review and Observation Findings
Literature review and interviews are showed the lack of related researches done before, importance of the independent transferring, difficulty of action and requirement of proper design.

The problems detected in various observations on conditions created by wheelchair and environment. The first group of problems was wheelchair based-problems. The parts and components as rims, armrest, footrest block the user in action. Although these parts and parts like seat, frame are used commonly in transferring action, they are not designed considering users transferring actions. The standardized features of the wheelchair also direct for a proper standardized transferring angle of 30 degree [11]. This angle between wheelchair and transferring surface also
creates a gap that constituted danger for users. Other group of problems was based on circumstances of wheelchair and environments created in transferring action. Different heights and surroundings ease or complicate the action. The diversity of the height of the surfaces create distances and angles the user had to perform in transferring. Because this people need extra products or components to support them while transferring as transferring boards, pillows, holding bars, canes etc. When the circumstances are harsher they require other people’s help to this action.

4.2. Survey results

Group M consisted of 122 people. This group included Spinal Cord Injury (Paraplegic) (n=47), Spinal Cord Injury (Quadriplegic) (n=11), Multiple Sclerosis (n=12), Muscular Dystrophy (n=3), and other type disabilities. 74.5% of this group was using a wheelchair more than 5 years. Almost half of the participants (54.8%) used their wheelchair all day. 21.3% of them used wheelchair 5-10 hours in a day. In addition to their manual wheelchair 20 different users had sports wheelchair, 5 of them had transit manual wheelchair; one had a mobility scooter, 14 of them had other types of wheelchair.

54 people were categorized as Group E. This group included Spinal Cord Injury (Paraplegic) (n=7), Spinal Cord Injury (Quadriplegic) (n=6), Multiple Sclerosis (n=3), Muscular Dystrophy (n=12) and others type of disabilities. 64.1% of the participants used their wheelchair more than 5 years and 24.5% of them used since 3-5 years. 68.5% of the participants used their wheelchair all day long. Other periods were: 5-10 hours (9.2%), 2-5 hours (18.4%) and less than 1 hour (1.8%). Among Group E, 6 people had transit wheelchairs; 1 person had bariatric and 3 people had another type of wheelchairs in addition to their electric/power wheelchair.

4.3. Satisfaction and Adaptation

Most of the participants were more close to being neutral about the satisfaction with wheelchairs. The satisfaction level did not differ so much between each group (Table 1).

After getting a new wheelchair the adaptation period is also important. It also indicates the ability and the satisfaction level of the subject and the wheelchair’s adequacy. There was not a big difference between the groups and the difference in our findings. Most of the participants were more than neutral that it takes time to get used to their wheelchair (Table 1).

<table>
<thead>
<tr>
<th>Table 1. Satisfaction and adaptation of wheelchairs</th>
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<tr>
<td><strong>Group M</strong></td>
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<tr>
<td>n</td>
</tr>
<tr>
<td>Satisfaction</td>
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<tr>
<td>Takes time to get used to</td>
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4.4. Pain and Injury Cause

One of the research points was to learn about the injuries which wheelchairs cause and to maintain an opinion on the transferring mishaps. On this account, whether the wheelchair caused any injuries and pains were inquired in survey. According to survey results, mean scores of wheelchair caused pain were 2.97 for Group M and 3.35 for Group E. The injury levels were not different from each group (Table 2).

<table>
<thead>
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<th>Table 2. Wheelchair cause pain and injury</th>
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<tr>
<td><strong>Group M</strong></td>
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<td>n</td>
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<tr>
<td>Cause pain</td>
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<td>Cause injury</td>
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The main reason asking about the causes of injuries was to compare transferring mishaps with other causes of injuries and find out the ranking among them. Transferring mishaps was not an initial injury cause problem for both groups (Table 3). Group E encountered with transferring mishaps more than the Group M.

<table>
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<th>Table 3. About transfer</th>
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<tr>
<td><strong>Group M</strong></td>
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<tr>
<td>n</td>
</tr>
<tr>
<td>Takes time to transfer properly</td>
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<tr>
<td>Prefer sitting instead of transferring</td>
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4.5. Transferring

In the beginning, transferring action is always an issue to cope with. Different abilities and the wheelchair designs may make adaptation process easier. It also takes time to able to do a proper transferring. Most of the people agreed (Group M= 3.58, Group E = 3.63) on long period of learning how to transfer properly. Because of the difficulty of transferring some of the participants preferred (Group M = 2.85, Group E = 3.18) staying on wheelchair and not to transfer even they need. Even though, there was an increase for Group M, there was not that significant distinction.
There are several surfaces that the subjects have to transfer. Transferring from one surface to another has different degree of difficulty. To learn the how it is problematic for each group, participants' responses compared for different surfaces.

14 to 18 times daily-performed transfer action referred to transferring to toilet (3 times), bed (3-4 times), sofa-chair (2-3 times), floor (1-2 times), vehicle seat (2 times), different wheelchair (2 times) and bathroom (1-2 times) for both groups.

The most difficult transferring was done from wheelchair to floor (Group M = 3.97, Group E = 4.51) (Table 5). Despite their better physical abilities, Group M agreed on its difficulty either. Difficulty of transferring from floor to wheelchair was also highly agreed by Group E (Table 5). The lowest score was given for transferring from a wheelchair to bed/sofa (Group M = 2.75, Group E = 3.87) and transferring from bed/sofa to a wheelchair (Group M = 2.72, Group E = 3.77).

4.7. Transferring Patterns

There are several ways to transfer from wheelchair. These ways may differ between people depending of their comfort of transferring, even with the same wheelchair and disability. Table 6 shows the choices of transferring patterns of two groups.

The most preferential transferring pattern for Group M was using the seat (32.2%). Even though Group M was a more active group than the Group E, transferring was done with the help of someone (19.7%). Arm rest was the third most popular part for transferring with the proportion of 14.5%. Most of the wheelchair user has to perform transfer into a vehicle daily or periodically. The transfer onto a car seat means the transfer from wheelchair to the vehicles seat or vice-versa. Both transferring from wheelchair to vehicle’s seat had the same difficulty (Table 5).
part for transferring with the proportion of %10.7. The next one was others (9.2%) with the answers (lift 6.15%, slide board 1.5%, service dog 1.5%). 7.6% of people used nothing, but none of them used a lift to transfer that means actually he/she was not capable of transferring. For the first time usage of a cane for transfer first appears in this group (4.6%). Other parts or the ways were; holding bars (4.6%), wheel 1.5%, a specialized part/s. Some of the other parts or ways mentioned by people were lift (n=4) sliding board (n=1), service dog (n=1).

Survey also resulted with several comments from participants. Repeated comments were considered as significant points. One of the repeated comments was difficulty onto bad and closet. Other is transferring from lower surface to lower surface to wheelchair. It is mostly floor to wheelchair. Two of the participants mentioned about a lifting mechanism for transferring from lower surface to higher and complained the need of others’ help in this transferring case. Transferring in toilet area and reaching the toilet basement found difficult by two participants. Two comments were about problems caused wheelchair itself. The armrest, footrests were considered as problem and suggested as foldable parts.

5. Discussion

Transferring action has various factors base on user based factors as health conditions and skills, experience of transferring etc. User’s factors also affect the capability of the user in transferring conditions.

Survey study confirmed the transferring mishaps causes injuries. However, from the findings from previous studies, transferring mishaps were expected to cause more injuries than others. However, it is one of the ordinary problems that disabled people encountered. There was an increase of the difficulty level in transferring mishaps from Group M to Group E. This means because Group M is more active and they can cover the mishaps of transferring and have less injuries. Although we expected Group E had more injuries caused by transferring mishaps, they get assistance they have less complication while transferring. However, the difference is not so noticeable (Table 2).

Some of the exterior causes are also related to each other. Environmental problems, inexperience and carelessness cause to tips/fall and even transferring mishaps. Moreover, some of the tips/falls may be result of transferring mishaps.

Transferring between wheelchair and bed/sofa seemed to be the easiest action. It must be because these activities are done in many instances and experienced more; also the safe and larger surfaces of the beds and sofas. However, the comments were included the difficulty of transferring onto bed. By the other comments, some of previous findings were also confirmed.

Although the most used part of the wheelchair for transferring is seat, this does not mean it is the most proper part to improve. Focus point can be diverse. Almost half of the Group E depend on someone help and despite Group M is more active they also require help.

6. Conclusions

According to researches and people reviews transferring is one of the major problems that wheelchair users daily face with this action several times. The survey that conducted for deepen the transferring pattern of user also showed the difficulty of action and demand of solution by design.

Transferring mishaps is not the first or second important cause of injuries but one of the major one. The improvement of better products and accessories and rehabilitation facilities people can perform this action easier. Transferring action is difficult for two groups of manual and electric wheelchair users. Although manual wheelchair users have better health conditions they find transferring hard, but not as much as electric wheelchair users.

The most difficult transferring action is performed between wheelchair and floor. Second difficult one is transferring between wheelchair and vehicle seat. The easiest transferring can be done onto bed and sofa.

Transferring pattern is various. People use different parts of the wheelchair. The most popular part is seat. This shows the difference in pattern of transferring actions performance. All these using parts and the pattern carry potential design focus for improvement of transferring.

One of the finding that underlines the difficulty of transferring action is people’s dependence of others’ help in transferring. Even though manual wheelchair users have less severe disabilities one out of five need someone’s assistance. This percentage is more for electric wheelchair users. Almost half of them depend on caregiver’s help for transferring.

The comment section of the survey is important due to receive expressions for transferring issue. They can emphasis of the importance of issue by commenting more, giving more details, asking for solutions or giving their own ideas. In this case, survey was respondents with comments that show the importance of the subject for wheelchair users.

To gain a background and vision for better solutions
researches had to be enriched with observations, interviews, literature reviews, individual experiences, learning about present market situations and future considerations.

In the light of findings and detected main problems design approached can be generated. One of the approaches can be transferring direction. The standardized transferring way (cross-wise with 30°) should be improved by directing users to different directions. It can be back, side or front transferring. These directions also bring unique features and approaches to designs comparing to existing models. The blockage of parts and components should be eliminated. Armrest, frame, rims, footrest has to design or revised considering their first function and other functions as transferring. They should support users’ transferring needs. Even they can be redesign, new components or attachments can be develop for this action. Wheelchair, parts and component designs also assist the user for different surface transferring needs. Lower, same, higher surface and opposite transferring and floor transferring is vital for independent living. Lifted backrest, footrest, foldable/movable parts and unique design as side converging wheelchairs should fill the gabs and distances between surfaces.

This study also designates the viability of develop a wheelchair, accessory or system design by learning the current conditions and needs. New developments and better design solutions are required for transferring action that we pointed out it is one of the challenging point for disabled people. Our study underscores, the responsibility of designers for new developments to improve technologies, products and their efficacy in ameliorating obstacles and the life quality of wheelchair users.

References