

Carers Perspectives of Usability of Standing Assistive Devices

Chia-Jung Kang & Alexandra Lang

¹University of Nottingham, UK

SUMMARY

Recently, assistive technology has gained a significant interest in research from various domains due to the rapid increase in the elderly, disabled, and immobile patient populations. This study introduced usability into caregivers' perspectives in using assistive devices with a particular focus on standing aid devices, facilitating the movement of patients and caregivers in a safer transfer. Furthermore, the techniques for examining the caregiver burden and physical activities delivered the mental and physical aspects concerning the usability and devices. These also combined the approaches commonly used in assessing medical devices in human factors engineering (HFE).

KEYWORDS

Usability, Medical Device, Caregiver, Healthcare, Assistive Technology

Introduction

The research aimed to investigate caregivers' perspectives on the usability of using standing aids with a particular focus on the Molift Raiser standing transfer devices for evaluating assistive devices in view of human factors. From 2007 to 2032, there is an anticipated increase of over one million individuals aged 65 and above who will be in need of informal caregiving (Hon Oliver Letwin, 2016; Lindt, van Berkel, & Mulder, 2020). Due to the increasing number of home care needs, more focus on the caregivers, interaction with patients, and home environment is essential, especially in applying human factors to minimize risks and promote safety performance.

To better understand caregivers' burdens and unmet needs in transferring tasks, the usability tests of standing aid devices were employed in the application of HFE. By investigating caregivers' perspectives toward standing devices, the association between burdens and usability of devices could be identified, which could influence caregivers' multi-faceted performance and cause risks. In addition, knowing the requirements of caregivers helps health professionals provide timely and suitable support or interventions to improve caregivers' health in various aspects and reduce the development of musculoskeletal disorders (MSDs), establishing a more robust healthcare system. Furthermore, the potential exists for assistive technologies, health monitoring equipment designed for home use, and intelligent utilization of extensive data to bring about transformative changes in home and community care (Hon Oliver Letwin, 2016) with the future ageing society. This transformation could lead to decreased national healthcare and care expenditures while simultaneously enhancing overall well-being.

Method

To understand caregivers' perspectives towards the usability of standing devices, interviews and questionnaires about usability were carried out. The design of usability questions in interviews and questionnaires followed the ISO 9421 definition. Standard ISO 9241 defined usability: 'Software is usable when it allows the user to execute his task effectively, efficiently and with satisfaction in the specified context of use.' (Abran, Khelifi, Suryan, & Seffah, 2003). The questionnaires were distributed in three sections: (1) Background Information, (2) Safety and Harm, and (3) General Questions. The Likert scale of 5 points was used for the questionnaires as the quantitative method. The interviews were divided into three sections: (1) Degree of Difficulty, (2) Interacting Experiences, and (3) Psychological and Physical Health. Four questions were asked for 'Degree of Difficulty'. A hierarchical task analysis (HTA), based on the video of the Molift Raiser standing transfer, was presented for users to identify the challenges and difficulties when performing the transferring tasks.

In addition to gauging the usability level of assistive devices, an evaluation of caregiver strain using the Caregiver Strain Index (CSI) was conducted to comprehend the overall burdens faced by caregivers. Furthermore, the Rapid Entire Body Assessment (REBA) analysis was employed to identify physically demanding postures during the transfer process. These methodologies delved into concealed hazards or unresolved issues that have an impact on the quality and safety of caregiving. Moreover, they gave insights into future assistive device improvement and incorporated the human factors approach from the caregivers' standpoint.

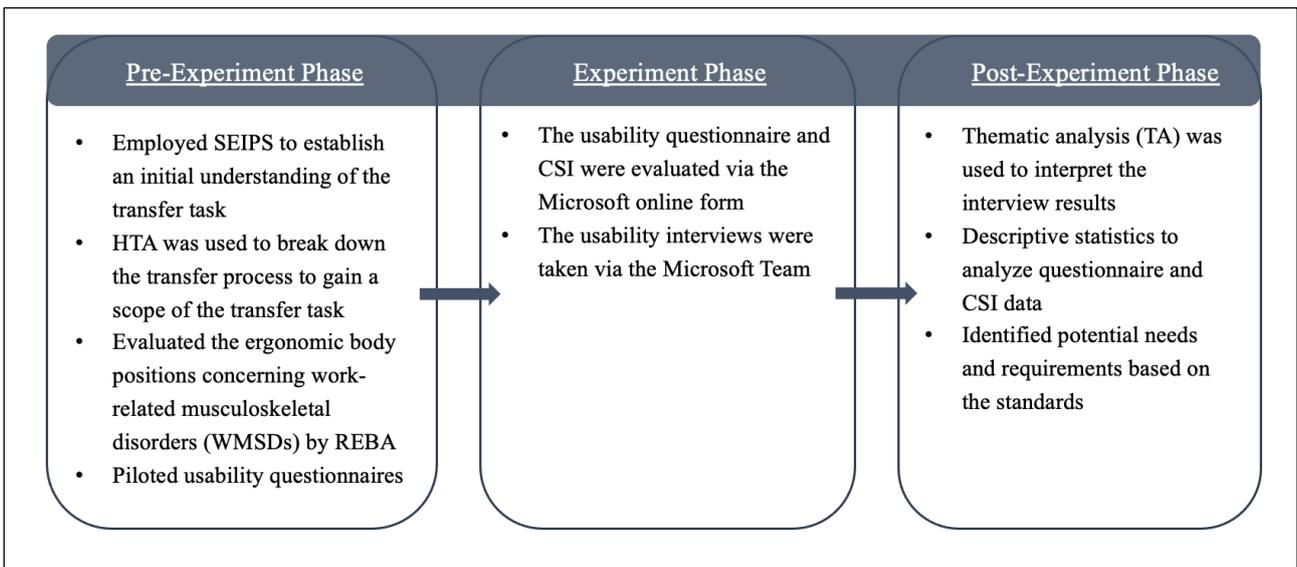


Figure 1: Overview of methodologies at different phases.

Result

The System Engineering Initiative for Patient Safety (SEIPS) Model was employed to identify the expected outcomes and performance. The hierarchical task analysis (HTA), based on the video of the Molift Raiser standing transfer, pinpointed challenges and difficulties in task execution. These analyses facilitated the categorization of tasks and the development of usability tests.

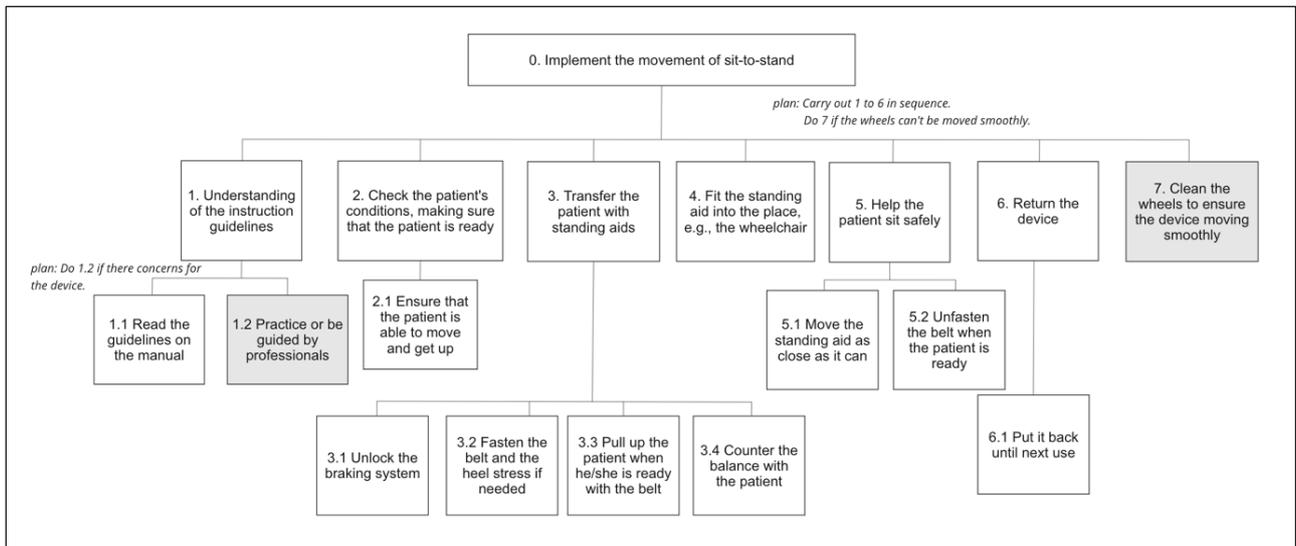


Figure 2: The HTA focused on informal caregivers using standing aid devices for transfer tasks.

The REBA scores

The aim of utilizing the REBA analysis was to evaluate and compare the risk of injury and work-related musculoskeletal disorders (WMSDs) associated with manual transfers and the use of assistive devices.

Three manual actions and three actions utilizing devices were selected for presenting REBA scores, taking into account (1) challenging postures and tasks, (2) prolonged sustaining duration, and (3) the necessity for high force loads (Al Madani & Dababneh, 2016). The scoring of these actions was based on criteria derived from Hignett and McAtamney (2000), which defined scoring parameters for 'Activity,' 'Coupling,' and 'Force/Load.'

Overall, the scores in the manual transfer were more than three times higher than those in the assistive transfer. The adoption of assistive devices has the potential to reduce the occurrence of musculoskeletal injuries and alleviate the physical strain experienced by both formal and informal caregivers (Darragh et al., 2015; Pompeii, Lipscomb, Schoenfisch, & Dement, 2009). Concerning the findings from the REBA outcomes and previous studies, the utilization of standing aid devices would likely result in a lower risk of WMSDs, or injuries compared to manual transfers.

Table 1: The REBA results.

	Score A	Score B	Table C Score	Final REBA Score
Manual 1	7	5	9	10
Manual 2	7	9	10	12
Manual 3	7	9	10	12
Use of Device 1	3	4	3	3
Use of Device 2	3	2	3	3
Use of Device 3	2	2	2	2

Analysis of data from the questionnaires

A total of 19 participants, 13 females and 6 males, were enrolled in the questionnaire stage, which was completed through the Microsoft online form (table 2). Three questions of background information were investigated: gender, caregiving duration, and device usage frequency. Regarding caregiving duration, eight participants had caregiving experiences for 1 to 3 years. Seven individuals had the experiences over three years, and three were less than one year old. As for the device usage frequency, the number of using 2 to 3 times and above three times was the same as the amount of 8 participants.

Table 2: Demographic information.

Participant no.	Gender	Caregiver Duration	Device Usage Frequency
1	Male	Under 1 year	1 time
2	Male	1 to 3 years	Above 3 times
3	Female	Under 1 year	2 to 3 times
4	Male	1 to 3 years	2 to 3 times
5	Male	1 to 3 years	2 to 3 times
6	Female	Above 3 years	Above 3 times
7	Female	Above 3 years	1 time
8	Female	1 to 3 years	Above 3 times
9	Female	Above 3 years	Above 3 times
10	Male	Under 1 year	2 to 3 times
11	Female	1 to 3 years	Above 3 times
12	Female	1 to 3 years	Above 3 times
13	Male	Above 3 years	2 to 3 times
14	Female	1 to 3 years	Above 3 times
15	Female	Above 3 years	Above 3 times
16	Male	Under 1 year	1 time
17	Female	Above 3 years	Above 3 times
18	Female	1 to 3 years	2 to 3 times
19	Female	Above 3 years	2 to 3 times

Descriptive statistics were chosen for processing the questionnaire data. The value of ‘Mean’ showed 7.53 in the ‘CSI Score’ (table 3), indicating that most participants were in a high-stress state. A score of 7 or higher in CSI presents a high level of stress (Sullivan, 2002). In terms of the ‘Mean’ in usability total score, it scored 46.79 out of 60. The outcome of the usability questionnaire could be split into two sections: usability safety and harm and usability general questions. The mean in the safety and harm was 26.68 out of 35 and 20.11 out of 25 in the general questions section. The value of SD in the ‘Usability Safety & Harm’ was larger than that in the ‘Usability General Questions’, indicating a relatively more diverse outcome.

The values in ‘Gender’, ‘Caregiving Duration’, and ‘Device Usage Frequency’ represented participants’ demographic information. In ‘Gender’, ‘Female’ was labelled as 1, while ‘Male’ was 2. In ‘Caregiving Duration’, ‘under 1 year’, ‘2 to 3 years’, and ‘above 3 years’ were coded as 1, 2, and 3, respectively. The value of the ‘Device Usage Frequency’ value follows a similar pattern, where ‘1 time,’ ‘2 to 3 times,’ and ‘above 3 times’ were converted to 1, 2, and 3, respectively.

Table 3: The results of descriptive statistics.

	Minimum	Maximum	Mean	Std. Deviation (SD)
Gender	1	2	1.32	.478
Caregiving Duration	1	3	2.16	.765
Device Usage Frequency	1	3	2.26	.733
CSI Score	1	13	7.53	3.323
Usability Safety & Harm	1.86	4.86	3.81	.733
Usability General Questions	3	4.8	4.02	.533
Usability Total Score	2.92	4.83	3.9	.546

Analysis of data from the interviews

The thematic analysis (TA), which is a methodology or approach used to construct and decipher patterns or significance (or themes) from qualitative information (Lyons & Coyle, 2021) was applied and processed using NVivo. Four themes were established prior to the interviews during the formulation of the interview questions: (1) effective transfer, (2) health improvement, (3) safety considerations, and (4) environmental considerations. Two new themes emerged from the transcripts as additional codes were examined and processed, which were (1) user limitations and (2) efficiency concerns (table 5).

Table 4: The demographic traits of the interview participants.

	Gender	Caregiving Duration	Device Usage Frequency
P1	Female	Above 3 years	1 time
P2	Male	1 to 3 years	2 to 3 times
P3	Female	Above 3 years	Above 3 times

Table 5: Each theme with the corresponding questions and participants' answers.

	Description	Interview Content
Theme 1: Effective transfer	Theme 1 aligned with the section on 'Degree of Difficulty', which were designed to ascertain whether the device has the capability to facilitate the transfer task effectively, the required minimal physical exertion and cognitive capacity.	Easy-to-understand When asked 'Do you feel the standing aid is physically easy to use?' or 'Do you feel the use of standing aid is easy to understand?', every participant confirmed that comprehending it is truly straightforward.
Theme 2: Health improvement	Theme 2 came with three subthemes: posture correction, improving physical health, and improving the problems of stress and fatigue. The questions were reflected in the section dedicated to 'Psychological and physical health'.	Posture correction P1: 'Reducing the need to bend over. ' P3: 'I personally adjust my posture and pay attention to points of exertion and positioning, so I generally feel okay. However, my dad sometimes strains his waist.' Improving physical health P1: 'If we're talking about reducing the burden, that's definitely an option.'

		<p>P2: 'It's true that it's not as tiring.'</p> <p>P3: 'It does provide relief.'</p> <p><u>Improving the problems of stress and fatigue</u></p> <p>P1: 'They won't worry about the patient getting hurt.'</p>
Theme 3: Safety considerations	<p>Since suitable lifting and transfer devices and technology can potentially decrease the risk of injuries and work-related musculoskeletal disorders (WMSDs) (Jung, 2004), the inclusion of questions concerning injury reduction was aimed at gaining deeper insights into the viewpoints of caregivers.</p>	<p><u>Injury reduction</u></p> <p>P1: 'Decrease the likelihood of getting injured.'</p> <p>Additionally, the participants expressed a perspective that using devices gave them a sense of assurance, as it allowed them to ensure the safety of their performance.</p>
Theme 4: Environmental considerations	<p>In contrast to the controlled setting of clinical environments, home care devices must account for complex conditions within homes, including factors like noise, constrained space, and narrow passages.</p>	<p>P1: 'I think the usability depends on the home environment. For instance, on certain carpets, I would need to exert more force to manoeuvre them, and there could be limitations based on the location as well.'</p>
Theme 5: User limitations	<p>Theme 5 emerged as the data was coded and interpreted.</p> <p>Four subthemes emerged from the analysis: communication concerns, caregiver characteristics, and patient conditions.</p>	<p><u>Communication concerns</u></p> <p>P3: 'It depends on the emotional connection between the patients and the caregivers themselves.' P1: 'I always prepare them mentally before we start moving, maybe by counting 1, 2, 3.'</p> <p><u>Caregiver characteristics</u></p> <p>P1: 'The caregivers using this device are generally within the age range of 30 to 50.'</p> <p>P2: 'It might still be challenging for smaller-sized or less physically strong girls.' P3: 'This can vary due to factors such as weight, body size, and so on.'</p> <p><u>Patient conditions</u></p> <p>P1: 'Patient's muscle strength might be insufficient.' P2: 'At home puts even more emphasis on the patient's own strength to support themselves.'</p>
Theme 6: Efficiency concerns	<p>Theme 6 highlighted the issue that using assistive devices consumes time, potentially leading caregivers to opt for completing tasks promptly, thereby reducing the frequency of device usage.</p>	<p><u>Time-consuming</u></p> <p>P1: 'The process of moving takes too long, the patient can become impatient.' P3: 'I still tend to use manual methods more often to move patients.'</p>

Discussion

The usability questionnaires and interviews showed participants' significantly positive perspectives on the safety and effectiveness of the standing devices. However, the CSI results indicated an average high-stress mental state for caregivers, which was noted to be the burden of work adjustments and life changes.

Based on the findings from the questionnaires and interviews, healthcare systems, practitioners, or manufacturers could address the safety performance of devices through education, or workshops to minimize human errors or use problems. The results from the interviews also indicated some issues, such as physical difficulties for female caregivers, elderly patients, or toileting.

Future work

Future work can include more demographics of caregivers and patients, such as age, employment status, educational background, economic income, caregiving status (whether shared with family, relatives, or a professional.), and types of disease and severity of illness of patients. Moreover, the home-care development may focus on the elderly more, given that old adults have been regarded as a significant outcome and a fundamental obligation of those responsible for caring for this population (Geron et al., 2000). More tools for measuring usability in the domestic setting could be developed to meet the specific needs of in-home care systems; for example, observing or simulating scenarios could yield an expert view and underlying insights into usability. Lastly, older users could be a key target population for further research, although older individuals have not been traditionally adequately represented (Areán, Alvidrez, Nery, Estes, & Linkins, 2003; Levy, Kostea, Slade, & Myers, 2006). Therefore, the concerns of older users will be critical in future usability studies.

Conclusion

This study integrated usability considerations for understanding caregivers' perspectives, specifically focusing on standing aid devices. The assessment of caregivers' perspectives and physical activities addressed both mental and physical aspects, incorporating approaches to human factors engineering (HFE) commonly used in medical devices. Despite existing challenges and limitations, this study presents opportunities to apply HFE principles to assistive devices in-home care, emphasizing a caregiver-centred approach to meet the growing demand for assistive technology in response to the needs of caregivers and ageing populations.

Acknowledgements

I extend my sincere gratitude to my supervisor, Dr Alexandra Lang, for her invaluable guidance and insightful feedback throughout this research. Additionally, I am thankful for the assistance of caregiver-related organizations, especially Age UK, Enable Ireland, and Helping Hands, for advertising my study poster in the participant recruitment phase, as well as the unwavering support of my family and friends. Finally, I am truly grateful to each participant for placing their trust in me and for openly sharing their experiences.

References

- Abran, A., Khelifi, A., Suryan, W., & Seffah, A. (2003). Usability meanings and interpretations in ISO standards. *Software quality journal*, 11, 325-338.
- Al Madani, D., & Dababneh, A. (2016). Rapid entire body assessment: A literature review. *American Journal of Engineering and Applied Sciences*, 9(1), 107-118.
- Areán, P. A., Alvidrez, J., Nery, R., Estes, C., & Linkins, K. (2003). Recruitment and retention of older minorities in mental health services research. *The Gerontologist*, 43(1), 36-44.
- Darragh, A. R., Sommerich, C. M., Lavender, S. A., Tanner, K. J., Vogel, K., & Campo, M. (2015). Musculoskeletal discomfort, physical demand, and caregiving activities in informal caregivers. *Journal of Applied Gerontology*, 34(6), 734-760.

- Geron, S. M., Smith, K., Tennstedt, S., Jette, A., Chassler, D., & Kasten, L. (2000). The home care satisfaction measure: A client-centered approach to assessing the satisfaction of frail older adults with home care services. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 55(5), S259-S270.
- Hignett, S., & Lu, J. (2009). An investigation of the use of health building notes by UK healthcare building designers. *Applied ergonomics*, 40(4), 608-616.
- Hignett, S., & McAtamney, L. (2000). Rapid entire body assessment (REBA). *Applied ergonomics*, 31(2), 201-205.
- Hon Oliver Letwin, S. H., Mark Walport. (2016). *Future of an Ageing Population*.
- Jung, J. (2004). Obesity—the new majority: Special considerations for the case manager. *The Case Manager*, 15(6), 51-54.
- Levy, B., Kostead, J., Slade, M., & Myers, L. (2006). Exclusion of elderly persons from health-risk behavior clinical trials. *Preventive medicine*, 43(2), 80-85.
- Lindt, N., van Berkel, J., & Mulder, B. C. (2020). Determinants of overburdening among informal carers: a systematic review. *BMC geriatrics*, 20(1), 1-12.
- Lyons, E., & Coyle, A. (2021). *Analysing qualitative data in psychology*: Sage.
- Pompeii, L. A., Lipscomb, H. J., Schoenfisch, A. L., & Dement, J. M. (2009). Musculoskeletal injuries resulting from patient handling tasks among hospital workers. *American journal of industrial medicine*, 52(7), 571-578.
- Sullivan, M. T. (2002). Caregiver strain index (CSI). In (Vol. 28, pp. 4-5): SLACK Incorporated Thorofare, NJ.