

User evaluation of the Neater Uni-wheelchair in the home environment: an exploratory pilot study

Anne Mandy, Graham Stew, Jon Michaelis

Background: The Neater Uni-wheelchair was designed as an alternative to powered wheelchairs, lever drive and dual handrim wheelchairs for hemiplegic users. It is a standard Action 3 chair to which a kit has been attached which enables users to self-propel and steer independently of attendants. The aim of this pilot study was to explore users' experiences of the Neater Uni-wheelchair in the home environment.

Methods: Six users from a previous study, carried out in 2009, agreed to evaluate the Neater Uni-wheelchair in their home environments. The methodological approach was micro-ethnography (Holloway and Wheeler, 2010) and data were transcribed and analysed using Framework Analysis (Ritchie and Spencer, 1994).

Findings: Key themes identified were independence and freedom, ease of use and manoeuvrability, usefulness and change in activity. This pilot study would support the notion that the Neater Uni-wheelchair is a viable alternative to those that are currently available to hemiplegic users.

Conclusions: The results from this exploratory study would support the need for a larger study. There are no storage issues, it is a cheaper option than a powered wheelchair and it would appear to increase independence, activity and participation in the short term.

Key words: ■ hemiplegia ■ home environment ■ Neater Uni-wheelchair ■ wheelchair

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The standard manual wheelchair is an effective, but inefficient means of transport (Veeger et al, 1992) particularly for people who have experienced a stroke and have a resultant hemiplegia. Moreover, the Fully Equipped report (2002), identifies that the provision of equipment and, in particular, wheelchairs, to older or disabled people by the NHS or social services in England and Wales, is limited, and that wrist, hand and shoulder injuries are widely reported. The National Service Framework for Older People (NSF) (Department of Health, 2007) promotes independence, autonomy and quality of life for both users and carers, while the National Stroke Strategy (2010) endorses the need for rehabilitation to embrace evidence based technologies in rehabilitation.

Mandy et al (2007; 2009) summarized the literature regarding wheelchair provision for hemiplegic subjects, and identified a lack of suitable provision. In response to this issue, and in conjunction with a stroke rehabilitation team, stroke patients and an engineer (Neater

Solutions), the team designed a novel ergonomic self propelled steering (ESP) mechanism kit which could be attached to a standard manual wheelchair (*Figure 1*) and called it the Neater Uni-wheelchair. The novel steering mechanism kit enables the user to steer with the footplate, and propel the wheelchair with only one pushrim. In addition, the kits can be attached to either side, for use by either right or left handed users and enable the wheelchair to be steered independently from the propulsion.

The ESP kit incorporates two innovations: a gear differential built into one drive wheel and an engageable/disengageable foot steering involving one front castor. The axle is not fixed and can still be removed in order that the wheelchair can be collapsed for storage. These devices are fitted to the wheelchair on the user's functional side (see *Figure 1*). The differential enables a single pushrim to drive both rear wheels equally, resulting in the wheelchair moving in a straight line with steering that can be employed as required. The differential ensures that the load on the push-

Dr Anne Mandy is Reader, Clinical Research Centre, University of Brighton, **Dr Graham Stew** is Principal Lecturer, University of Brighton and **Jon Michaelis** is Neater Solutions

Correspondence to: Dr Anne Mandy
E-mail: Am86@bton.ac.uk

rim stays constant, whatever the direction of steering. Steering is intuitive: rotating the foot to the right turns the wheelchair to the right; rotate the foot to the left and chair turns left. A drive between the front castor and the foot plate ensures that small rotational movements of the footplate result in large movements of the front castor in a ratio of 2:1. This feature enables the wheelchair to make tight turns.

The resultant prototype product appeared to meet these criteria and was tested for ergonomic efficiency (Mandy et al, 2007). A randomized controlled cross-over pilot study involving non-disabled users ($n = 10$) measuring heart rate (bpm), oxygen consumption (O_2 ml/min) and exhaled carbon dioxide (CO_2 ml/min) demonstrated that levels were significantly lower in the modified wheelchair ($P < 0.001$, $P < 0.006$ and $P < 0.014$, respectively) when compared to a dual handrim equivalent wheelchair. All comfort ratings were reported to be significantly higher in the ESP ($P < 0.05$).

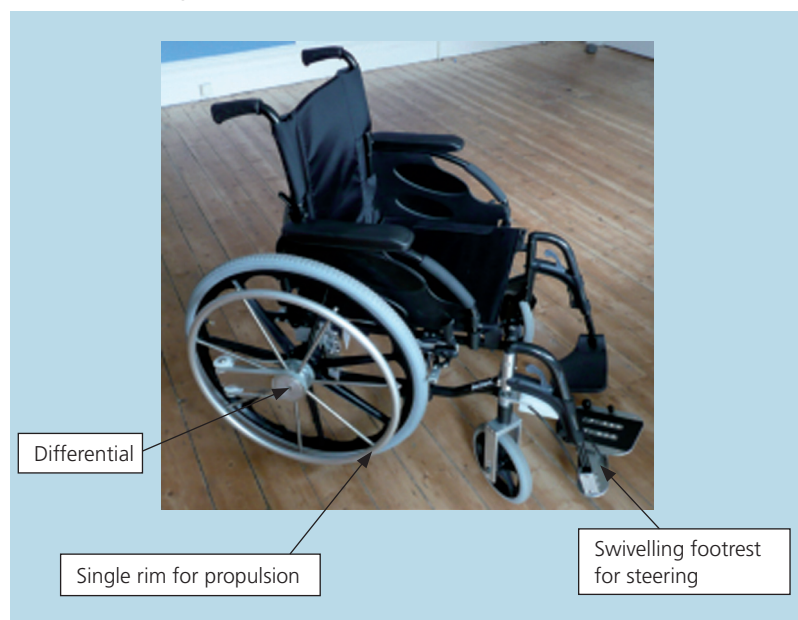
In 2009, Mandy et al reported a follow up study, involving 12 hemiplegic subjects, which replicated the original study. The same variables of interest were measured. These included oxygen and carbon dioxide usage, heart rate levels, ease of use, comfort, hand position comfort and preference. The Neater Uni-wheelchair was again compared to a standard Action 3 dual handrim wheelchair. The results endorsed the initial findings that oxygen consumption and carbon dioxide production were lower in the Neater Uni-wheelchair. There was no differ-

ence in heart rate, but time taken to complete the indoor driving course was significantly quicker in the Neater Uni-wheelchair. Comfort and ease of use were measured using the Wheelchair Ergonomics Questionnaire (DiGiovine, 2000) an Overall Ride Comfort Scale (DiGiovine, 2000), and a visual analogue Ride Comfort Scale to measure manual wheelchair ride (Lawrence et al, 1996). The Neater Uni-wheelchair was reported to be significantly more comfortable ($P < 0.02$), easier to manoeuvre ($P < 0.02$) over different surfaces (carpet, matting and linoleum), and significantly easier to use ($P < 0.001$) than the dual handrim. These results endorsed the earlier work that the Neater Uni-wheelchair was easier to manoeuvre and ergonomically more efficient in the clinical environment. The ESP was crash tested and received Medicines and Healthcare products Regulatory Agency approval in 2008, and became commercially available in April 2009. However, although the clinical trials demonstrated ergonomic efficiency they were undertaken in a laboratory setting which is not representative of 'real life' environments and usage. Therefore, all users from this study were invited to contribute to designing a study to evaluate the Neater Uni-wheelchair in the home environment. In doing this, they were asked to consider what issues they had with their current wheelchair provision in the home. A common response was difficulty in manoeuvring, resulting in fatigue, lack of independence, and reliance on carers. These issues were used to inform the design of the pilot study to explore users' experiences of the Neater Uni-wheelchair in the home environment.

It is known that a greater sense of control, independence and self-efficacy enable older persons to attenuate the impact of declining physical health on everyday function and disability (Kempen et al, 1999; Seeman et al, 1999). It is also known that there is a strong association between disability and control, self-efficacy and social engagement (Mendes et al, 1996). Thus, it could be suggested that by enabling greater independence and thus social engagement, the personal resources that enhance resilience against chronic disease processes that become more severe over time may be promoted or reinforced (Bath et al, 2005).

The aim of this study was to explore change in wheelchair use and quality of use, ease of use and practical issues including limitations of the Neater Uni-wheelchair in the home

Figure 1. The Neater Uni-wheelchair showing the novel components to enable independent driving.



environment. It also aimed to explore whether the provision of the Neater Uni-wheelchair altered the user and/or the carer's independence and active participation, and whether this differed to their usual wheelchair. The research question was: How does provision of a Neater Uni-wheelchair affect the users' level and quality of use? The users were asked to record their experiences in relation to these aims and also to record anything else that they thought may be of helpful.

The same users from the clinical studies were invited to participate in this home environment study.

METHODS

Ethical approval was gained from the University of Brighton Faculty of Health Research Governance and Ethics Committee and from Local Research Ethics and Governance Committee for both the clinical study and the home evaluation study. All the users from the original clinical study were recruited from voluntary organizations such as stroke clubs. The same users were invited to participate in the home evaluation study and were provided with participant information sheets and informed consent sheets.

All participants met the inclusion criteria as detailed by Mandy et al (2009) in their earlier studies which included:

- Willingness to participate
- Competence to give informed consent,
- Hemiplegia due to stroke
- Hemiplegic propulsion pattern (1 arm and 1 leg on the same side)
- Controlled hypertension

Exclusion criteria included

- Unstable medical condition (e.g. angina, uncontrolled hypertension, seizures)
- Height and weight restrictions of 163–185 cm and 54–90 kg in order that they would fit in the wheelchairs.

The participants were all experienced manual wheelchair users whose needs had been assessed by rehabilitation teams prior to participation in the study. The rehabilitation therapists acting as advisors to the research ensured that provision of the Neater Uni-wheelchair was appropriate for those users who chose to participate in the study.

PARTICIPANTS

All 13 original users (9 males and 4 females) were invited to participate in the evalua-

tion study. Twelve participants had left sided weakness and one male had right sided weakness. The mean age for the men was 65.78 (SD 8.56), height 176.1 cm (SD 8.49) and weight 79.67 kg (SD 10.7). For the women, the mean age was 66.75 (SD 5.25), height 154.2 cm and weight 61.5 (SD 6.03).

Of the original users, 6 male, and 2 female participants and 1 carer chose to participate in the evaluation study. Of the users, two used a dual handrim wheelchair, five used self propelling wheelchairs, one relied on a partner for propulsion. The mean age for the female participants (not including the partner) was 65.5 yrs (SD 2.12) and for the males 62.5 (SD 11.4).

Eight users and one partner agreed to participate in the study and to the publication of findings. All of the users were experienced manual wheelchair users. However, following careful explanation, two decided that their homes were unsuitable and withdrew. One male lived in a small grade II listed cottage, and the other, a female, in a small flat with access difficulties. Both felt that they were only 'outdoor wheelchair users' and that the data that they could contribute would be of limited value.

METHODOLOGY

The methodological approach was micro-ethnography, which focuses on small research units or activities (Holloway and Wheeler 2010). It was considered appropriate because it explores the study of a smaller experience or 'a slice of everyday reality'. Micro-ethnography is the process of data collection, content analysis, and comparative analysis of everyday situations for the purpose of formulating insights (Smith, 1978). This methodology is rich and important in better understanding the textured nuances of social interaction and is appropriate for exploration of experiences (Cloherty, 2004) and is commonly used in user involvement studies (Fudge, 2008). Trustworthiness in this study is demonstrated through a transparent and valid data analysis procedure (Srivastava and Thomson, 2009) and through the use of authentic citations (Elo and Kynga, 2008).

SETTING AND TIMESCALES

Following agreement to participate from interested users and completion of the informed consent forms, the wheelchairs were delivered to their homes and collected from them after one month's usage, at mutually convenient times. All users were provided with a digital

recorder or a diary to record their feelings and experiences each time they used their wheelchair, for a period of one month. In particular they were asked to record 'what worked', and 'what did not work' for them, and to describe the type of activities they were able to undertake and if this differed from their activities in their standard issue wheelchair. At the end of the month they were also asked to reflect and report on whether they had used the Neater Uni-wheelchair more or less than their standard issue wheelchair.

DATA ANALYSIS

The users, and carer, recorded their experiences in diaries, or in files recorded onto digital recorders at the end of the period of wheelchair use. The entries were not date stamped, but presented simply as either oral or written text. The entries were transcribed and analysed using Framework Analysis (Ritchie and Spencer, 1994). Framework analysis permits the researcher to analyse all the data following collection, which was the case in this study. The five step process of familiarization, identifying a thematic framework, indexing, charting, mapping and interpretation (Ritchie and Spencer 1994) was undertaken. The data for each participant was initially explored to consider if the type of activities that the users were able to undertake in the Neater Uni-wheelchair differed from the norm, and also whether they reported any change in their activities. The data from the six users and one partner was transcribed verbatim for framework analysis (Ritchie and Spencer, 1994). The users were shown copies of their transcripts and the identified themes, which they then endorsed.

Familiarization occurred through repeated reading of the transcripts in order to gain an overview of key issues and recurrent themes. A thematic framework was developed to filter and classify the data using a priori knowledge, literature and earlier studies (Mandy, 2009). The following key themes were identified: independence and freedom, ease of use and manoeuvrability, usefulness and change in activity.

Independence and freedom

All the users, including the partner of one user, identified that the Neater Uni-wheelchair afforded greater independence.

Within this theme, three users reported a sense of freedom from having to wait for someone to propel them: 'I am able to take

myself to the bathroom when I need to' and another just said 'Freedom'.

The partner of one user also reported a sense of freedom and independence: 'My husband was able to browse the shops on his own (I kept losing him!). It also meant that I could browse on my own too'.

Ease of use and manoeuvrability

All the users reported on the ease of use and manoeuvrability of the wheelchair, and some compared it to their standard issue wheelchair. One user commented that 'the steering was very sensitive and responsive, and was a great improvement over standard wheelchairs.', while a second valued the steering capability 'I liked the turning circle and being able to move in confined spaces'. A third commented on the fact that the wheelchair could be easily collapsed and 'easily stored'.

When the wheelchairs were initially delivered some of the diaries reported concerns about using it. One user stated: 'I thought it would be difficult to move over my carpet, but it was easier than I thought'. Another stated: 'I didn't think I would use it, but found myself using it everyday'. Further comments from different users included: 'It is easy and intuitive to drive' and 'I don't have to think about using two handrims to propel myself'.

Usefulness

Several of the users had underestimated the usefulness and value of the Neater Uni-wheelchair. In particular one commented: 'I didn't think I would use it, but having had one it is a fine piece of work and I am very pleased with it'.

Change in activity

Users reported that the Neater Uni-wheelchair resulted in changes to their daily routines. One user, in a care home, reported that he was able to 'take himself to the dining room and not be exhausted. This means I can take part in the after lunch activities'. A different user reported: 'I am able to take myself to the computer room when I feel like it'.

All agreed that they had been more active and enjoyed using the Neater Uni-wheelchair because of its ease of use.

No negative comments were reported.

DISCUSSION

The aim of this pilot study was to explore whether the Neater Uni-wheelchair demon-

strated the same user friendly attributes in the home environment as it did in the laboratory environment, where it was compared to a dual handrim equivalent. The laboratory environment included driving around obstacles and over different surfaces in an indoor test circuit. It is acknowledged that while the indoor circuit replicated different surfaces and hazards that users meet while driving a wheelchair that the home environment is a better test of user satisfaction. In the home environment all the users normally used their standard issue wheelchairs. The feedback from the users supported the findings from the laboratory study which indicated that Neater Uni-wheelchair is easy to use and intuitive to drive.

It is, however, acknowledged that this is a small pilot study which needs to be replicated in a larger population, and over a longer period of time. A further limitation is the use of the same users who may be demonstrating participant bias and a desire to please the researcher.

Framework analysis is a valuable method of analysing qualitative data, however, there are limitations which should be acknowledged. Firstly, the use of the researchers' understanding, experiences and a priori knowledge could be considered as pre-determining themes in the framework. However, providing that the data is analysed rigorously and with transparency, then this ceases to be an issue. Moreover, it permits within-case and between-case analysis through a combination of deductive and inductive reasoning, which results in a comprehensive analysis of the data collected.

It is also acknowledged that there is a debate within the literature about whether rehabilitation should promote bilateral activities or a compensatory model (Mayston, 2006; Raine, 2007a; b). In particular, some consider that abnormal/atypical patterns of coordination need to be suppressed and unwanted movements controlled, but never at the expense of any individual's participation in everyday life (Mayston, 2008). During the preliminary phase of the clinical study where the users were learning to propel the Neater Uni-wheelchair wheelchair and familiarise themselves with the indoor course, two users demonstrated a small increase in tone. However, while engaged in the actual clinical trial neither demonstrated any increase in tone. This was also the case during the home use, where none of the users noted any increase in tone or tiredness, and, on the contrary, reported greater ease of use and increased activity.

Analysis of the data gave rise to evidence which identified key themes that suggested that the Neater Uni-wheelchair does increase independence in the short term. The theme of independence and freedom was highlighted by all the users and also one partner. Early work by Labi (1980) identified the importance of independence in elderly people. He also highlighted that environmental and social factors, including socialization, both within and outside the home, are significant contributors to social isolation. This finding concurs with the importance of control, independence, and self-efficacy in elder people highlighted by Bath et al (2005) and Mendes et al (1996). More importantly it endorses the work of Salter et al (2007), that few studies explore the impact of rehabilitation interventions on more complex areas of social participation. Independence was identified as a main category within the data and this clearly warrants further exploration.

Furthermore, it also highlighted the importance and value that users and carers place on having choice, independence and freedom, and in particular the importance of carer spouses having freedom and choice and independence from their partners. This was clearly articulated by the partner of one of the users. Social activity and stress in relatives/carers has also been reported to be highly correlated with individuals with a Cerebrovascular accident who use a wheelchair, being unable to propel themselves (Shaw and Taylor, 1991).

The usefulness theme arose from several statements by several users. Some of the statements suggested that the users underestimated the value of the Neater Uni-wheelchair and the impact that it would have on their lives. These statements may also reflect the inappropriateness of their present provision and the assumption that the new wheelchair may not be any better. The final theme reflected a definite change in activity and increase in participation. Participation is the result of interaction between the individual's health and contextual factors, that include both personal and environmental factors. There is a need for more knowledge about how elderly people with disability perceive their environmental factors and use their assistive technology (Vik et al, 2007). Successful integration of assistive technology into daily lives requires potential device users to explore the meanings they assign to their assistive technology, their expectations of the assistive technology and the anticipated social costs (Louise-Bender Pape et al, 2007). The

result of this pilot study would clearly suggest that Neater Uni-wheelchair could meet the unmet needs of this user group, and provide them with further choice in their wheelchair provision. Moreover, it also provides an alternative to the current catalogue of one arm drive wheelchairs available to rehabilitation therapists, and has recently been adopted by several local trusts.

It was interesting to note that there were no negative comments expressed by the users. However, all the users had been involved in the earlier clinical study (Mandy et al, 2009) and provided feedback which contributed to the development of the final wheelchair design. It therefore would have been surprising at this stage to have received any negative comments.

CONCLUSION

This pilot study would support the notion that the Neater Uni-wheelchair is a viable alternative to those that are currently available to hemiplegic users. The results from this exploratory study support the need for a larger study. There are no storage issues, it is a cheaper option than a powered wheelchair, and it would appear to increase independence, activity and participation in the short term. **IJTR**

Conflict of interest: none

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KEY POINTS

- The Neater Uni-wheelchair is viable alternative to current one arm drive wheelchairs.
- It provides independence to both users and carers and enables greater integration, activity and participation in activities.
- The study highlights the importance that users and carers place on having choice.
- The results show how successful integration of assistive technology can empower the user.

COMMENTARIES

Speaking as both a wheelchair user and an academic, any equipment that contributes to the empowerment, social inclusion and improved quality of life of persons with impairments is encouraging. However, an aid that does this and is also economically viable, easy to use, preferred by users, ergonomically and physiologically more efficient is to be warmly welcomed, by both users and rehabilitation professionals alike.

This study

This small scale pilot study examines the viability (by employing a user centred methodology) of mobility equipment that appears to meet all the requirements any user and rehabilitation professional could reasonably expect from a mobility aid. According to the authors they received no negative feedback in relation to the equipment.

It is refreshing to see that the authors of the study, while acknowledging the benefits of the Neater Uni Wheelchair (NUW), accept some of the study's limitations, i.e.:

“Any equipment that contributes to the empowerment, social inclusion and improved quality of life of persons with impairments is encouraging.”

- The use of the same users in the clinical trial and home study, as this may give rise to participant bias

- The small sample size used, and the short timescale in which the study was conducted.

While it would have been interesting for the authors to work with a wider age range, as this might suggest that the NUW could be beneficial to those outside the elderly population, it should be remembered that this is a pilot study, and the authors may choose to do this in the main study, thus developing this interesting work.

Conclusions

In conclusion, despite these limitations, I believe the authors should be congratulated on a well-planned, executed and explained study, that sensitively captures real users in their home environments using

the NUW. Furthermore, the study clearly meets its defined aims and provides justification for the need of a larger study to determine whether the NUW has the same affects on the participants in the long-term, as in the short term. Some final observations, is it legitimate to include carers in a study that relates to a device that is designed to improve a person's independence? Also, the authors report only favourable findings and do not make explicitly clear that they are part of the same team who designed the NUW.

Wesley Scott

*PhD candidate, School of Art and Design, Department of Industrial Design (Design and Ergonomics Research Group); and Lecturer, Faculty of Health and Life Sciences Coventry University, Coventry, UK
scottw@uni.coventry.ac.uk*

There is no doubt that the independent mobility needs of people with hemiplegia have not been well-met by the traditional range of wheelchairs, so this pilot study of a new approach to facilitating independent wheeled mobility is to be welcomed.

This article presents information from part of an ongoing study into the development of an alternative means of providing effective independent wheelchair mobility for people with hemiplegia. It is exciting to see a collaborative research programme being fostered through the involvement of an academic researcher, clinical experts, service users and an engineer. While the ongoing input of the same group of wheelchair users to the different phases of the research is questioned in the article in terms of participant bias, it does provide a continuity that informs the development of the new wheelchair adaptation.

Conventional dual-rim wheelchairs are often found to be difficult to use, requiring a considerable level of manual dexterity and cognitive ability. In addition, they can be relatively

“It is exciting to see a collaborative research programme being fostered through the involvement of an academic researcher, clinical experts, service users and an engineer.”

heavy and lacking in manoeuvrability. While the article provides no information about comparative weights and dimensions, the intuitive nature of the steering mechanism combined with use of a single handrim clearly facilitates use of the wheelchair in the confined settings of people's homes.

The two aspects demonstrated in this study that will be most influential in the uptake and use of the NUW are the energy-efficiency of its use, and its ability to allow wheelchair users to fulfil their occupational goals more effectively. The authors, rightly, comment on the theoretical background and debate surrounding the promotion of bilateral activities or a compensatory approach to the provision of self-propelled wheelchairs to people following a stroke. However, in this aspect, it is the skills of the therapist and his or her clinical decision-making in conjunction with the service user's own occupational goals that will determine whether, and when, the provision

of the NUW may be appropriate for an individual.

Conclusions

The findings from the two studies undertaken so far certainly support the need for a larger study in order to ascertain whether the findings are replicable across a more significant sample size. Outcomes to date suggest that the NUW could be an extremely useful addition to the range of wheelchairs that is currently available, and it is to be hoped that, ultimately, the adaptation will be taken up by the commercial sector and prescribed via (in the UK) NHS wheelchair services.

Dr Elizabeth White

*College of Occupational Therapists
London,
UK
elizabeth.white@cot.co.uk*