POWERED MOBILITY DEVICES ASSESSMENT AND COGNITIVE IMPAIRMENT: A SYSTEMATIC REVIEW OF STRATEGIES ASSESSMENT AND MEASURES

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Often, when we evaluate a powered mobility devices (PMD) for a child with disabilities, as well as motor issues we must also consider cognitive issues. Many clinicians ask themselves how to get around these issues, and often ask certain questions:

'Can children with cognitive impairments access these mobility technologies? Are there tools that can help clinicians in the evaluation of powered mobility devices? What are the tricks you can use to personalise the power wheelchair (PWC) and improve safety?'

This publication aims to answer these questions via a systematic review of the scientific literature, and accompanying discussion of the results.

Abstract

Objectives: *to summarize and examine studies about power mobility assessment for individuals with cognitive and motor impairments exploring strategies and measures.*

Method: *A search of the literature including articles published from 1999 to 2015 was conducted using one electronic database. Studies involving individuals with cognitive impairments and the need of PMD (Powered Mobility Devices) assessment; key terms included power(ed) mobility, power(ed) wheelchair, and database-specific terms. Three reviewers independently screened titles, abstracts, and full-text articles. Inclusion criteria: Studies that included a description of strategy assessment or measure of power mobility skills for users with cognitive and motor impairments.*

Results: *Of 1111 titles, 7 articles met inclusion criteria. Some cognitive functions seem predictive variables or more related to powered mobility skill. Several studies refer to powered mobility skill measures even for individuals with cognitive impairments to organize an appropriate PMD training.*

Conclusions: *There is not a minimum score (at neuropsychological tests) to exclude anyone from the use of PMD before an appropriate training by AT professionals, at all ages.*

Keywords: POWERED MOBILITY DEVICE, POWERED MOBILITY, POWERED WHEELCHAIR, SYSTEMATIC REVIEW, TRAINING, ASSESSMENT, COGNITIVE IMPAIRMENT, COGNITIVE FUNCTIONS, PSYCHOLOGICAL TEST

Background

Mobility is a foundational skill for participation in the roles and activities of daily life [1]. The identification of a powered mobility device (PMD; e.g., powered wheelchairs, electric scooter, balancing wheelchair) is a complex process, which requires validated strategies. However, in the Italian context, this process is rarely supported by validated

instruments: in many instances it depends exclusively on the expertise of the single operator/service or refers to the technicians [2,3,4,5]. One of the main barriers to the introduction of validated measures in clinical settings is the possibility to include them in well-consolidated practices. Increasingly, professionals in the field of rehabilitation are requested to employ validated tools in each phase of the service delivery process [6], from the identification and selection of the device to the evaluation of the outcomes of the intervention, in particular when the PMD assessment is for a person with motor and cognitive impairments.

We think appropriate to reconsider these issues and devote time and resources to the assessment process because the number of people with disabilities who use wheelchairs is constantly growing and wheelchair has become a gradually more accepted solution [2,6,7]. Furthermore, users that are often not satisfied with their mobility aids and its services [8, 9] also remind us that to provide an adequate service is essential having a process centered on resources, activities and desires of the person with disability [10].

To pursue the best "matching" between the person and the PMD it is essential to consider several factors related both to the person with disabilities and to their context: among personal factors certainly an important role have the cognitive aspects that often put the clinicians decisively in crisis [10, 11].

The purpose of this systematic review was to summarize and examine studies about power mobility assessment for individuals with cognitive and motor impairments exploring strategies and measures.

Method

A search of the literature including articles published from 1999 to 2015 was conducted using one electronic database (Medline). Studies involving individuals with cognitive impairments and the need of PMD assessment. Our clinical question were "What cognitive functions are related to PMD driving?", "Are there any tests related to PMD driving skills for people with cognitive problems?".

Keywords agreed by the three reviewers are summarized in Table I. Study selection was verified by three reviewers, two occupational therapists and one social educator. The three reviewers used a 3-step selection process: specific inclusion/exclusion criteria were applied to assess titles (1° step), abstracts (2°step), and full-texts (3 ° step). The selected full text has been summarized in a table and discussed in a focus group by three reviewers and 1 PMD user.

Inclusion criteria: studies including PMD assessment with cognitive impairment, at all ages; description of measure used to assess power mobility skill and/or cognitive function.

Exclusion criteria: studies the were non -English language; involving participants whose ages were not specifies; focusing only on technology development; using complex measurement technology not feasible in clinical setting (e.g. robot device, computerized assessment).

In each step the reviewers assigned a score (2= relevant), (1=quite relevant), (0=no relevant) to titles and abstracts. Only the titles with a total score (sum of the three reviewers score) greater than 2 had access to the next phase. Only the abstracts with a total score greater than 2 had access to the third phase for reading the full text.

Table I: key terms

#	Term
TARGET	Power wheelchair
	Powered wheelchair
	Electric wheelchair
	Powered mobility
	Electric mobility
	Self-help devices [MESH]
	Wheelchair [MESH]
INTERVENTION	Psychological Tests [MESH]
	Neuropsychological Tests [MESH]
	Evaluation studies as topic [MESH]
	Cognitive assessment
	Neuropsychological evaluation
	Cognitive functions

Results

The electronic database search identified 1111 titles, 35 of them received a ≥ 2 score and were selected for the 2°step, 21 abstract obtained a score ≥ 2 and were selected for the 3° step. Then, 7 studies were considered relevant and are included. The study selection process is summarizes in Image I: Flowchart of study selection process.

Table II summarizes the study design, authors, participant and sample, interventions, outcomes and findings in the included studies.

Problem solving and spatial relations appeared to be a good predictor of successful powered mobility. [12] Verbal recall, visual construction ability and global cognition are predictive variables correlated to the indoor use of PMD and the use of indoor and outdoor PMD was predicted by verbal recall. However there is not a minimum score (at neuropsychological tests) to exclude anyone from the use of PMD before an appropriate training by AT professionals, at all ages. [12, 13, 14]. The use of PMD, even in protected contexts, can improve the independence, socialization and quality of life for people with profound cognitive disabilities [13, 15, 16, 17].

Several studies report on programs and measures to plan the PMD training, such as Wheelchair Skills Program (WSP) and the Wheelchair Skills Test (WST) that was used, even for individuals with cognitive impairments [18,19]. The measures may be suitable as guides for progressing use of PMD skills [14]. Authors emphasize the importance to have expert clinicians dedicated to PMD/AT assessment process.

Image I: Flowchart of study selection process

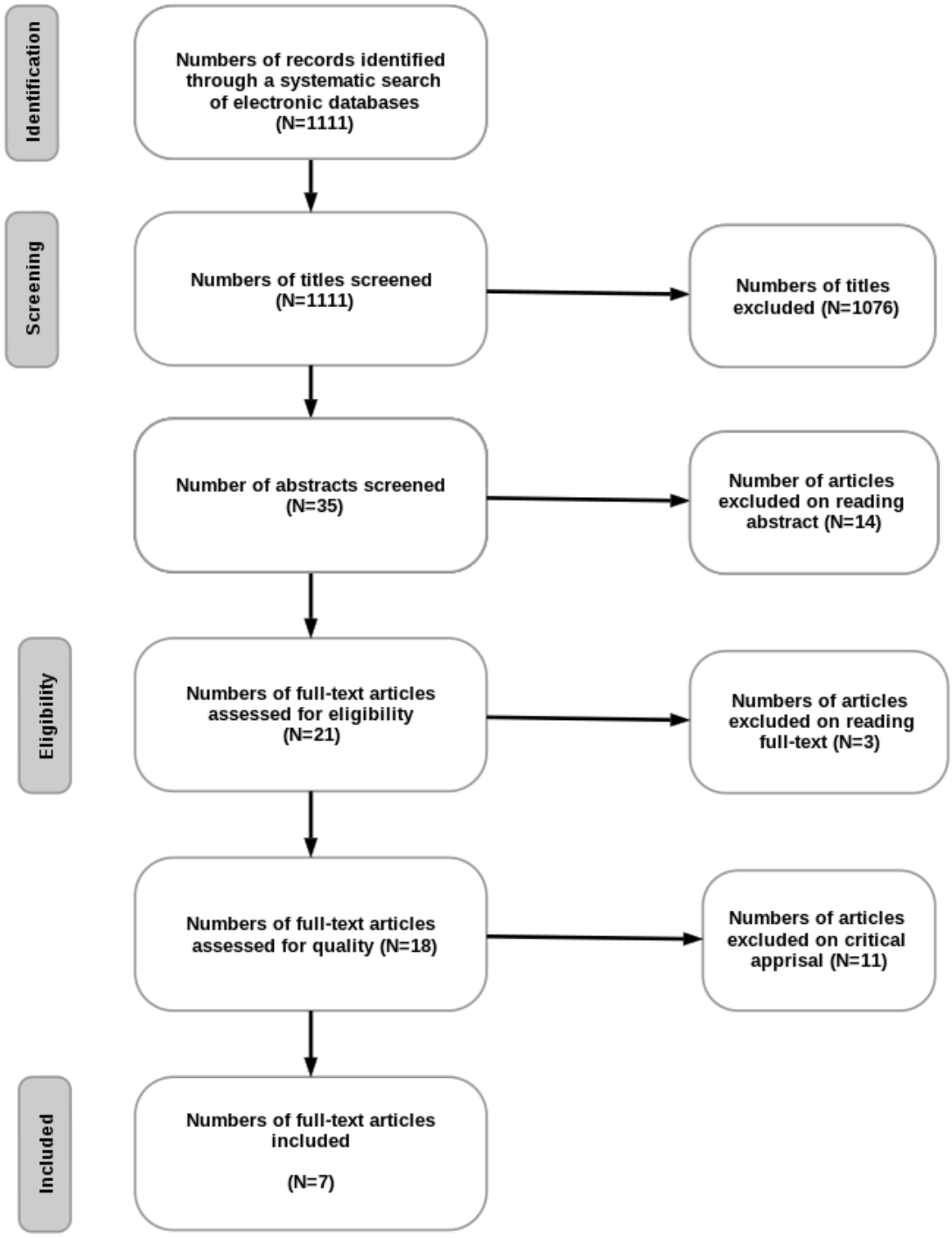

Table II: Qualitative summary of included studies

Study author and country	Methods	Participants	Assessment	Intervention	Frequency and duration of interventions	Key outcomes	Key findings
L Nilsson, M Eklund, P Nyberg; Lund, Sweden, Oct 2011	Inter-rater reliability	The participants on the 24 video sequences were all engaged in the Driving to Learn project. 16 participants with profound cognitive disabilities, 7 participants with other degrees of cognitive disabilities and one infant with typical development.	**Driving to Learn Method**: • "**Growing Consciousness of Joystick Use**" • One questionnaire during the assessment • One questionnaire after the assessment	The first author was one of the raters. Other 3 independent raters were all occupational therapists living in different parts of the country, had no connection to each other, had been OTs for more than 10 years and had different professional experience of PW provision. They assessed the video-clips using "Growing Consciousness of Joystick Use".	/	Kappa value of 0.85 comparing the 3 raters' assessment with that of the first author. High degree of usability for assessing phases of joystick use. Minimal differences between experienced and inexperienced raters.	Very good inter-rater reliability of the assessment tool. The tool is reliable and has clinical usability in occupational therapy practice.
L Nilsson, M Eklund, P Nyberg, H Thulesius; Lund, Sweden, Nov/Dec 2011	RCT, data analysis	45 children and adults with profound cognitive disabilities. Reference groups included 17 typically developing infants and 64 participants with lesser degrees of cognitive disability.	**Growing Awareness of Facilitating Strategies** **Mutual Interactions Among Actors in the Process** **Growing Consciousness of Joystick Use** **Identification of Phases in Learning Tool Use.**	Free driving in PW and the facilitators used the constantly developing strategies to stimulate each participant's curiosity, mutual interaction, and initiative to explore and experiment with joystick and powered wheelchair functions.	1 hour for each session, but it depended on the participant's endurance and level of alertness. The frequency varied according to the participant's health status, the facilitator's motivation to continue, the availability of an appropriate PW and any important changes in the participant's circumstances.	8 participants with profound cognitive disabilities reached goal-directed driving or higher.	Participants were empowered by attaining increased control over tool use, improving their **autonomy and quality of life.**
L M Nilsson, P J Nyberg; Sweden, Apr 2003	Case studies	2 preschool children with profound cognitive disabilities	Video recordings (at T1= time of instructions and at T2= 12-month follow up visit) Field notes In-depth interviews.	The first author carried out the intensive training with the PW. Manually guided actions were accompanied by verbal descriptions of the activity. The PW was only set in motion when the child had his hand on the joystick.	Training session 30-90 minutes one to three times for a week for 4 months in a special playroom in the clinic. After 4 months, the training was transferred at home where parents and assistants carried out the training. 2 visit by the author (at the delivery and after 12 months).	Description of the changes of the children's behaviours in PW and the effects observed during the training period.	Training in a PW can increase wakefulness and alertness, stimulate a limited use of the arms and hands and promote the understanding of very simple cause-effect relationships.

AD Mountain, RL Kirby, GA Eskes, C Smith, H Ducan, DA MacLeod DA, K Thompson; Apr 2010	Prospective uncontrolled pilot study using within-participant comparison.	Inpatients (N=10, 6 with visuospatial neglect), all with a primary diagnosis of stroke.	**WST-P version 3.2 (t1, t2=3 days after training)**	Participants received 5 wheelchair skills training session of up to 30 minutes each using Wheelchair Skills Training Program (version 3.2).	5 training session (WSTP), each of which was up to 30 minutes in duration, aimed at improving the wheelchair skills that the participant had difficulty performing during WST-P.	Powered wheelchair skills were tested before and after training using the Wheelchair Skills Test, Power Mobility version 3.2 (WST-P).	Many people with stroke, with or without visuospatial neglect can learn to use powered wheelchairs safely and effectively with appropriate training.
Study author and country	**Methods**	**Participants**	**Assessment**	**Intervention**	**Frequency and duration of interventions**	**Key outcomes**	**Key findings**
B Cullen, B O'Neil, J J Evans; Scotland, Oct 2007	Prospective follow up study	Volunteer adults with impaired mobility. Of 155 approached, 103 had baseline assessments. Of these 81(79%) provided outcome data. Mean age was 65.6 years (SD=13.5); 55% were male.	Baseline cognitive assessment Follow up: Self-rated powerchair use questionnaire FEW	Participants were assessed by either the first or the second author using the baseline assessment materials.	Baseline assessments and one month after the delivery a follow up telephone contact.	Rate of day-to-day powerchair use, and users' perceptions of how well the powerchair allowed to perform functional tasks. **Rate of indoor use was predicted by verbal recall, figure coping and global cognition. Total rate of use was predicted by verbal recall.**	Powered wheelchair use was predicted by cognitive measures. Rates of use were relatively low, despite users' reports that the PW facilitated their everyday functioning well.
M Bottos, C Bolcati, L Sciuto, C Ruggeri, A Feliciangeli; Bologna, Italy; 2001	Case studies	29 children with spastic or dystonic tetraplegia (15 males, 14 females; mean age 6 years 3 months, age range 3 to 8 years). All participants had severe motor impairment.	Performance IQ, Verbal IQ, Gross Motor Functional Measure, COPM, Furumasu's Driving Test, Childhood Illness Scale	PWC provision: same type, different sizes of PWC were available and they were tailored to suit younger children. The electronic system of the PWC allows for a smooth start, which was particularly important for children with spastic or dystonic tetraplegia.	Initial no treatment period: 6 to 8 months. Treatment period 6 to 8 months.	Several dimensions of disablement: Impairment, Functional Limitation/Activity, Disability/Participation. **The level of independence improved significantly after PWC provision, while motor impairment, IQ and quality of life did not.**	The majority of children (21 of 27) reached a level of driving competence, which allowed them to move around with or without minimal adult support. Achievement of this competence was correlated to the time spent in the PWC. PWCs can aid independence and socialization and the majority of children can achieve a good-enough driving competence, even those with severe learning disability or motor deficit. PWCs should not be viewed as a last resort but as a means of providing efficient self-locomotion.
D Tefft, P Guerette, J Furumasu; California, USA, 1999	Stepwise regression analysis	26 children with physical disabilities between the ages of 20 and 36 months were evaluated on the cognitive assessment and participated in the wheelchair training and assessment program.	Cognitive assessment battery based on 5 Piagetian cognitive developmental domains.	Cognitive assessment battery by 2 clinicians. Training and assessment based on power mobility program (Furumasu et al. 1996).	6 sessions based on power-mobility training program, each of which lasts 1 hour.	Stepwise regression analysis was used to determine which of the cognitive skills predicted wheelchair mobility performance.	The cognitive domains of **spatial relations and problem solving** were found to be significant and accounted for 57% of the variance in wheelchair skills.

Limitations

This review included only English-language studies and was conducted using one electronic database (Medline); studies in other languages, or in other sources, manual and electronic, may have been missed. The authors did not rate quality and strength of evidence in individual studies that were included in the review and they did not use a technique for assessing the risk of bias. The authors state that they had a written guide that included a search strategy and inclusion/exclusion criteria but the protocol has not been registered (on electronic database e.g. PROSPERO) before starting the study.

Conclusion

PMD driving tests are an essential step in the assessment process and are essential to set up a custom device and training. There is evidence that the use of power wheelchair has a positive impact even on adults and especially on children with motor and cognitive impairments. Even a person with motor and cognitive impairments after an individualized training program can have a significant increase in drive performance. This systematic review shows the importance to develop and define a PMD assessment process and training program in many clinical Italian context [20] in order to achieve the best match between the user and PMD. Furthermore, it is necessary that AT professionals validate procedures and assessment tools, such as WST 4.3 PW [21], that will be further tested for validity and reliability in order to assess its efficacy in helping health professionals to select the most adequate PMD for users with motor and cognitive impairments. The advancement of mobility devices and innovative training and equipment provision schemes may development PMD users inclusion, furthermore, future research will continue the development of strategies and measure to support clinicians in to PMD assessment process.

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