

Assistive technology outcome measures: a review.

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Biographical notes

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Assistive technology outcome measures: a literature review.

Objectives: Identifying outcome measures for individual assistive technology (AT) interventions, applicable to any kind of assistive products.

Study design: Literature review.

Methods: Three investigators searched and reviewed scientific papers published in sector journals in the past 13 years in relation to AT outcome measures.

Results: 53 papers met the inclusion criteria. Overall, they describe 86 measures. 37 of them were found to be related to the outcome of the whole rehabilitation process rather than to AT purposely. 41 are restricted to specific categories of AT products. Only five are actually applicable to any AT products: FIATS, IPPA, PIADS, QUEST, and SCAI. In addition, three further measures were found that - although unable to fully capture the AT outcome if used alone - can add useful information on the quality of the AT intervention (KWAZO, SATS) and the individual predisposition to AT use (ATD-PA).

Conclusions: A careful monitoring of the achieved outcome is an essential aspect of any individual AT interventions. This study provides a list of measures that help monitoring the intervention effectiveness and cost.

Keywords: assistive technology intervention; outcome measurement; follow-up.

Introduction

In clinical practice, there is a growing need for standardized methods to track individual assistive technology (AT) interventions. Instruments collecting information (Andrich 2017) at each step of the AT individual programme can help professionals gather the information they need to prepare the AT assessment, organize ideas while decisions are in process, describe the assistive solution identified when it has to be acquired, verify which devices or interventions have actually been acquired and put in place, capture data about the impact of the AT solution in the real life context over time.

One of the emerging issues in this field is outcome measurement (AAATE, 2012). A number of instruments have been developed and their applicability studied in order to measure whether AT interventions lead to successful outcomes at individual level, and more in general to collect evidence about AT appropriateness and cost-effectiveness. The use of internationally validated AT outcome measures can be useful to AT assessment teams in their everyday's activities and informs improvement of clinical practice.

Effects, costs and economic impact of assistive technology have been indicated as first priority subject in the recently-published World Health Organization Global Priority Research Agenda on Assistive Technology (WHO, 2017); the need for evidence-based strategies in this field is also mentioned in the WHO Executive Board Resolution adopted on February 26th 2018 (WHO Executive Board, 2018). A serviceable definition of AT outcome research was provided by M. Fuhrer as follows: "*systematic investigation aimed at identifying the changes that are produced by AT in the lives of users and their environments.*" (Fuhrer, 2003).

In the AT service delivery process, the most appropriate time to implement outcome measurement is at follow-up, after significant time of usage in daily life context. An AT solution brings about a "perturbation" in the system composed of the person (involving his/her clinical condition, personality and life goals), his or her environment (architectural, human, organizational) and his or her occupation (activities, life roles, lifestyle) (Federici, 2017). The system needs time to absorb the perturbation and evolve towards a new balanced situation; the outcome is positive when this new situation is perceived by the person and by his or her primary network as beneficial to their lives (Fuhrer, 2007). A variety of actors and factors are involved in this system, some of them being predictable and others unpredictable; thus the actual outcomes can be detected only when the perturbation transient has expired: outcome measurement should be carried out not "*in the clinic*" but "*in real-life environment*"; not "*here and now*" but "*there and tomorrow*" (Andrich, 2007).

The authors, being part of AT assessment teams of rehabilitation and AT centers, were interested in finding out outcome measures applicable to any AT categories, which could be used at the follow-up stage of AT interventions and integrated in the daily clinical practice.

In 2002 a special issue on AT outcome, effects and cost (Gelderblom, 2002) was published by "Technology and Disability", providing a state-of-the-art overview of ongoing research and validated instruments available at that time. Shortly after, a paper was published on "Disability and Rehabilitation" depicting a general conceptual model to be used in AT outcome measure research (Fuhrer, 2003). Starting from these seminal work, the authors decided to undertake a review of the instruments developed in the following years, in order to identify validated outcome measurement tools that could be applied to any individual AT intervention.

Method

Sources and procedure

Three AT experts identified a list of journals (**Table 1**) whose field of interest included AT. The articles published between January 2003 and December 2016 (overall, 1284 issues) were considered by the review work. The journals issues were randomly split into 3 groups and assigned to the three researchers. Each researcher extracted from the assigned group all articles responding to the search terms "OUTCOME" or "MEASURE" or "EFFECTS" or "TOOL", as appearing in their title, keywords, abstract or in the body of their text. For journals that are not exclusively focused on assistive technology, the term "ASSISTIVE TECHNOLOGY" was also used in conjunction to the above terms (e.g. "ASSISTIVE TECHNOLOGY" AND "OUTCOME"). Overall, 459 papers were found meeting these requirements.

Inclusion and exclusion criteria

Each of the three authors - independently of each other - read the abstracts of all 459 papers and assigned a relevance score (0= "not relevant", 1= "uncertain", 2= "relevant"), depending on how much the article was considered relevant for this review.

Papers were considered "not relevant" (score=0) if one of the following conditions occurred:

- The instruments described are intended for use only during AT assessment, thus they not include follow-up information related to actual AT use in daily life;
- The instruments described are intended to assess the usability and the efficacy of AT prototypes, rather than to assess individual AT interventions.

Conversely, papers were considered "relevant" (score=2) if the abstract explicitly declared that the instruments described were intended to measure the outcome of individual AT interventions, by capturing the actual use experience of the acquired assistive products in daily life.

Papers that didn't fall within any of the above categories were scored "uncertain" (score = 1).

The 53 papers which got the maximum score ("2") by all authors were admitted to the last phase of content analysis.

Coding syllabus

Each of the 53 papers was assigned randomly to the three authors, who read it and extracted the essential information needed for the study. This information was condensed in two tables (whose structure was mainly inspired to (Mortenson, 2008), (Samuelsson, 2012), (Desideri, 2013), (Kenny, 2014)):

- In the first table, each *paper* is described through the following dataset: reference, study objective, study design, assistive products considered, subjects involved, measurement tools cited or used, administration method, main conclusions of the study;
- In the second table, each *instrument* is described through the following dataset: short name, extended name, number of papers quoting it, references, instrument classification, outcome domain, purpose of the measure, concise description of the instrument, expected administrative burden, assistive products considered, whether an Italian version is available.

The instrument classification included three categories: 1) instrument intended for general use in rehabilitation programs, independently of whether the program includes assistive products or not; 2) instrument designed to be applied to specific categories of assistive products, and 3) instrument applicable to any AT products.

The *outcome domain* was classified according to the taxonomy proposed by Jutai et al. in 2005 (Jutai, 2005): 1) Effectiveness - ICF functioning; 2) Effectiveness - ICF contextual factors; 3) Effectiveness - User longevity; 4) Social significance - Caregiving; 5) Social significance - Cost; 6) Social significance - Residential care placement; 7) Social significance - Service utilization; 8) Social significance - Device utilization; 9) Subjective well being - Psychological functioning; 10) Subjective well being - Quality of life; 11) Subjective well being - Satisfaction.

Results

The 53 papers that were judged relevant for this review are listed in **Table 2**. They include 9 review articles, 43 research papers and 1 reporting both a review work and a follow-up research. The research design was defined as retrospective/follow-up (9 papers), multi-phase/pre-post (5 papers), cross-sectional (6 papers), observational test-retest (3 papers), pilot (3), cohort (2), case series (1) and exploratory (1); in the remaining 23 papers it was not declared.

86 measures were reported in the selected papers, resulting from a review work or actually applied in research studies.

However, not all these instruments turned to be specifically designed for AT outcome measurement. In fact, 37 are primarily intended to measure the outcome of individual rehabilitation programs which may or may not include assistive products, and no solid evidence of their specific sensitiveness to AT is provided; in particular, 31 assess ICF functioning, 4 quality of life, 2 psychological functioning; examples of these instruments are *10mWT*, *FIM* and *SF-36*.

The majority of the remaining instruments (41) focus on specific AT categories: 34 on mobility AT (i.e. *Wheelchair Outcome Measure*), 2 on ICT accessibility AT (i.e. *Usability Scale of Assistive Technology / Computer Access*), 2 on learning AT (i.e. *School Function Assessment-Assistive Devices*), 1 on AAC AT (i.e. *Family Impact of Assistive Technology Scale for AAC systems*), 1 on continence AT (i.e. *Psychosocial Impact Of Assistive Devices Scale for Continence*), 1 on environmental control AT (i.e. *Lincoln Outcome Measure for Environmental Controls and Audit of Installation Quality*).

Only 5 instruments turned out to be outcome measures that are actually applicable to any category of assistive products: PIADS (Jutai, 2002), QUEST 2.0 (Demers, 2000), FIATS (Ryan, 2006), SCAI (Andrich, 2002), IPPA (Wessels, 2000); they were quoted by 29 of the selected papers.

In addition, the authors consider worth mentioning three further instruments resulting from the review: KWAZO (Dijcks, 2006), SATS (Sund, 2013) and ATD-PA (Scherer, 2000). KWAZO and SATS - although not being stand-alone outcome measurements – can be useful in conjunction with the above 5 outcome instruments to provide additional information on the quality of the AT intervention process; ATD-PA is a useful predictor of future outcome, to be used before AT adoption to decrease the risk to undertake unsuccessful interventions.

Discussion

The five instruments identified by the review fall within the following outcome domains (Jutai, 2005):

- Effectiveness (ICF functioning): IPPA;
- Subjective well-being (Psychological functioning): PIADS;
- Subjective well-being (Satisfaction): QUEST;
- Social significance (Cost): SCAI;
- Social significance (Caregiving): FIATS.

PIADS (Psychosocial Impact of Assistive Technology Scale) asks the respondents for their judgments on how their life has been affected by the AT equipment they are using. It is a 26 items self-rating scale that uses a 7-point Likert scale ranging from -3 to +3, depending on whether and to what extent the adoption of the assistive device increased or decreased – in the user's perception – the personal characteristic described by such items. The items fall within three sub-scales, namely Competence, Adaptability, and Self-esteem.

QUEST 2.0 (Quebec User Evaluation of Satisfaction with assistive Technology) asks for the individual's satisfaction with the AT equipment he or she is using. It contains 12 questions, eight of

them focusing on the device and four on the associated services. The respondent is asked to rate the satisfaction with the assistive device and the related services on a 1 to 5 scale, with 1 representing 'not satisfied at all' and 5 'very satisfied'. In addition to this, the user is requested to choose the three most important items related to that specific assistive device. It is worth mentioning that not all QUEST 2.0 items are applicable to software AT.

FIATS (Family Impact of Assistive Technology Scale) evaluates the changes in family functioning resulting from the adoption of an assistive product. It includes 89 items clustered round 9 subscales (autonomy, caregiver relief, contentment, daily activities, effort, family and social interactions, caregiver supervision and safety, technology acceptance). Each item is scored on a 7-point scale to measure the level of agreement ("strongly agree" to "strongly disagree").

SCAI (SIVA Cost Analysis Instrument) estimates the social costs involved in an individual AT intervention. Social cost is defined as the sum of the costs incurred by all actors involved in a given situation, including technology investment, maintenance, human assistance, and associate services. The social cost is measured over a pre-defined period of time, according to the estimated clinical duration of the AT solution.

IPPA (Individually Prioritised Problem Assessment) evaluates the perceived effectiveness of an AT intervention. In the first interview (baseline) - to be administered before the user starts to actually use the AT solution in daily life - the user is asked to express some "problems" (up to seven problematic activities he/she expects to solve thanks to the AT solution) and rate each of them on a 5-point scale in relation to its importance and the difficulties it brings about in daily life. In a follow-up interview, the user is asked to rate again the difficulty encountered now (i.e. with the assistive solution in use) with each problem. In this way, a baseline and a follow-up score are calculated. The difference between the follow-up and the baseline scores provides the IPPA indicator of perceived effectiveness.

The three additional instruments that have been identified work as follows.

KWAZO is composed of seven questions related to the quality of the AT service delivery process (Accessibility, Information, Coordination, Knowledge, Efficiency, Participation, Instruction). The respondent is requested to rate his/her degree of satisfaction with each indicator on a 3-point Likert scale (1 = insufficient, 2 = sufficient, 3 = good) and to write a comment to justify any rating below 3. It is worth mentioning that in the Italian (Desideri, 2016) and Finnish (Ahtola, 2011) localizations, the answering options have been changed to a 5-point Likert scale.

SATS is very similar to KWAZO. It consists of nine items: Accessibility, Knowledge, Information, Coordination, Efficiency (waiting times), User participation, Instruction, Follow-up services, Overall satisfaction. The questions are rated on a 5-point scale (1 = very dissatisfied to 5 = very satisfied) plus a "don't know" option.

ATD-PA (Assistive Technology Device Predisposition Assessment) is part of the MPT model (Scherer, 1998); it involves a clinician-client collaborative process to evaluate the individual's predisposition to AT and facilitate user-device matching by taking into account the user's skills, task priorities, device preferences, and environmental support systems. The ATD-PA consists of two forms: the Person Form (54 items across three domains) and the Device Form (12 items).

Conclusions

The review work led to the identification of 5 outcome measures that are applicable to any AT intervention. These measures were described in 29 of the 53 papers resulting from the review, which indicates that they are quite widely known and used in several Countries. 3 additional measures were identified, that can be used in conjunction with the others.

A limitation of this work is that the review sample has been limited to a selected group of journals - those indicated by the group of experts who informed the beginning of the study - instead of systematically searching the main bibliographic databases.

The authors are currently engaged in implementing the outcome measures identified by this review in the clinical practice of the AT assessment teams within the network of the rehabilitation and AT centers of the institutions they work for.

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Table 1. List of Journals considered in the review.

Title	Editor	ISSN
Disability and Rehabilitation: Assistive Technology	Taylor & Francis Group	Print: 1748-3107 Online: 1748-3115
Assistive technology: The official journal of RESNA	Taylor & Francis Group	Print: 1040-0435 Online: 1949-3614
Journal of Enabling Technologies (formerly Journal of assistive technology)	Emerald Publishing	ISSN: 2398-6263
Gerontology	Karger	Print: 0304-324X Online: 1423-0003
Occupational Therapy international	John Wiley & Sons, Inc.	Print: 1557-0703 Online: 1557-0703
International Journal of Rehab Research	Wolters Kluwer Health, Inc.	Print: 0342-5282 Online: 1473-5660
Augmentative and Alternative Communication	Taylor & Francis Group	Print: 0743-4618 Online: 1477-3848
Gerontechnology	International Society for Gerontechnology	Print: 1569-1101 Online: 1569-111X
Archives of Physical Medicine and Rehabilitation	Elsevier	ISSN: 0003-9993
American Journal of Occupational Therapy	American Occupational Therapy Association, Inc.	Print: 0272-9490 Online: 1943-7676
Prosthetic and Orthotic international	SAGE Publications	Print: 0309-3646 Online: 1746-1553
Canadian Journal of Occupational Therapy	SAGE Publications	Print: 0008-4174 Online: 1911-9828
Technology and Disability	IOS Press	Print: 1055-4181 Online: 1878-643X
Disability and Rehabilitation	Taylor & Francis Group	Print: 0963-8288 Online: 1464-5165
JMIR Rehabilitation and Assistive Technology	JMIR Publications	ISSN 2369-2529

Table 2. The 53 papers admitted to the content analysis.

Citation	Study objective	Study design	Assistive products considered	Subjects involved	Measurement tools cited or used	Administration method	Main conclusions of the study
Andrich, 2007	Describing a method for assessing the cost of individual assistive technology interventions and introducing a new Cost Analysis instrument	Retrospective study	Any assistive product	31 AT users who received an AT intervention in the previous 3 years	SCAI	The instrument was administered between 6 months and 3 years after the acquisition	1) providing an appropriate assistive solution produces significant savings in social costs and 2) no relations was found between clinical conditions and related economic impact of assistive technology
Anttila, 2012	Gathering evidence that could be used when designing AT service delivery processes through a systematic review of 44 systematic reviews	Systematic review	Assistive products for personal care and protection, mobility, home adaptations, communication & information, hearing aids, vision aids, and others	AT users with any types of functional limitations and any severity level, in all age groups	-	-	High-quality evidence was found only in specific AT categories for limited populations
Arthanat, 2007	Conceptualise the usability of assistive products in order to start development of a new measure of AT usability called USAT	-	Wheeled mobility and computer access	10 AT users of either wheeled mobility or computer access devices	USAT-WM, USAT-CA. Cited: SmartWheel, Compass , Batavia-Hammer checklist, ATD-PA, QUEST, PIADS, PEDI, OTFACT, ICF Checklist	Coded interviews	Changing in functioning (pre- and post-device) can be measured in terms of quantity (effectiveness) and quality (efficiency). The instrument should investigate four dimensions: 1) activity and participation 2) device performance 3) environmental factors and 4) user ability and skills. Further work is needed to operationalize the instrument
Arthanat, 2009	Examine the usability of PWCs, identify factors associated with PWC usability in specific contexts, identify issues with users' interaction with the wheelchair, map and describe the findings, and provide a descriptive guide to evaluation and intervention of the identified usability issues	-	Powered wheelchairs	70 powered wheelchair users using used their wheelchairs outdoors and in the community	USAT-WM	45 minutes interview	Descriptive analysis of the data revealed usability issues with the use of power wheelchairs in all contexts. Users confronted far more significant issues within the community and outdoor environment compared with those at home and in the workplace
Auger, 2009	Development of the French-Canadian version of the LSA-F and testing/validation with powered mobility devices users	Validity and reliability study	Powered wheelchairs	40 French-Canadian speaking people powered wheelchair users	LSA	Phone interviews, 2 times (one 2 weeks after the other)	The French version of LSA showed reliable and stable. Administration time is about 10 minutes

Bergström, 2006	Investigate how adults with spinal cord injury assess their satisfaction with various aspects and use of their AT	Cross sectional study	Manual wheelchairs.	124 adult wheelchair users with Spinal Cord Injury	QUEST 2.0 (limited to 7 items)	Self-administered	A discrepancy was found between users not being as satisfied with comfort in sitting in various activities, as opposed to satisfaction with propulsion. This indicates the need for increased knowledge and developments concerning individual solutions, incorporating comfort as well as ease of use of a manual wheelchair
Bettoni, 2014	To identify which validated questionnaires are used to investigate patient satisfaction with limb orthoses and to analyse their main fields of clinical application, the orthosis-related features considered by the questionnaires and their psychometric properties	Systematic review	Limb orthoses	People (orthoses users) with orthopaedic, rheumatologic, neurological, vascular, or miscellaneous diseases	QUEST 2.0, CSD-OPUS, QUE, MOS	Depending on the instrument	Only four questionnaires - out of the various ones that are used to investigate the patient's satisfaction with orthoses - are adequately validated: two for generic orthotic use and two for specific application with orthopaedic shoes. Further development, refinement and validation of outcome measures in this field are needed
Brandt, 2010	Preparing the conceptual framework for the development of a new instrument for measuring the mobility-related participation and satisfaction (NOMO). The article investigates on the constructs of mobility-related participation and user satisfaction and their relationships	Cross-sectional	Powered wheelchairs	111 older powered wheelchair users, average age 77 (with at least 1-year use experience)	QUEST, NOMO	Interviews within home visits	Participation (12 items) and satisfaction (10 items derived from QUEST by excluding "weight" and "Easy to adjust", and by adding the "non applicable" answer) appeared to be separate constructs. The satisfaction scale appeared reliable while the participation scale didn't. Further work is needed to develop the NOMO
Brandt, 2012	Developing a new mobility-related participation scale, called NOMO	-	Mobility devices	387 powered wheelchair or scooter users and 37 experts	NOMO 1.0	Interview	The NOMO 1.0 exhibits satisfactory content validity, feasibility and test-retest reliability
Burton, 2008	To assess the experiences, opinions and satisfaction levels of 24 individuals with disabilities using of computer-related ATD; to investigate their awareness of health risk factors related to computer usage; and to examine the psychosocial impact of computer-related ATD on users	Exploratory pilot study	Computer related ATD	24 computer related ATD users, with at least 6 months of experience using an ATD	QUEST, PIADS, ad hoc questions (117 items in total)	Telephone interviews. When a combination of ATD was used one key ATD was chosen for QUEST	Training appeared to be an important component for ATD users. Respondents with visual impairments revealed a higher level of adaptability versus those without visual impairments. First five questions of QUEST not applicable to software
Chan, 2007	Investigate the relationships among wheelchair users' satisfaction, perception of community participation and quality of life (QoL) in users with spinal cord injury (SCI)	Retrospective cohort study	Manual and powered wheelchairs	31 wheelchair users with SCI	C-QUEST, WHO QoL-BREF (HK), selected items of ICF 'Participation Restrictions' and 'Environmental Factors'	Interview (face-to-face or telephone)	Community participation (e.g. use of transportation) and human environment (e.g. friends and peers) were more related to QoL, than to the users' satisfaction with a wheelchair

Delarosa, 2012	Test the content and face validities of the questionnaire, demonstrate its internal reliability and stability over time, and estimate its convergent construct validity when compared to a standardized measure of family impact	Multy-phase study	Augmentative and alternative communication systems	179 parents of children with complex communication needs participated and clinical experts in AAC	FIATS-AAC	-	FIATS-AAC is a promising multidimensional measure of AAC system impact. The scale demonstrated content and face validity, and showed acceptable internal consistency and test-retest reliability
Demers, 2002	Validating the QUEST 2.0	Test-retest	Mobility devices	83 subjects with multiple sclerosis	QUEST 2.0	Interviews and self administered	QUEST 2.0 proved highly valid, reliable and applicable, especially its product subscale. There are significant correlation with the PIADS scale, especially with its adaptability and self esteem subscales
Demers, 2008	Characterize trajectories of mobility AT device use in the temporal course according to critical factors that can influence rehabilitation services	Follow-up study	Mobility ATDs (canes, crutches, walkers, and wheelchairs)	139 mobility ATDs users	SF-36	Questionnaires administered during face-to-face interviews	Though 70% of participants were still using some kind of mobility ATD at follow-up, only 42% were using the device procured at baseline. Changes in the severity of impairments are an important element to consider in relation to trajectories of device use
Desideri, 2013	Review of models and instruments for AT individual assessment	Systematic review	-	Children with multiple disabilities	About assessment 10 models and related instruments were identified by the review		This study does not provide specific information on outcome measurement. However, outcome is significantly influenced by the process and thus it is useful to have a knowledge of the state-of-the art of the assesement models. Thys article provide a useful systematic review
Desideri, 2016	Evaluating outcomes of AT interventions targeting children with physical and multiple disabilities.Evaluating the feasibility of the follow-up assessment adopted in this study with a view to implement the procedure in routine clinical practice	pre-test/post-test quasi-experimental follow-up study	Communication, ICT access solutions, adapted toys, educational software	45 children users of AT devices	IPPA, KWAZO, QUEST, SCAI, structured interview	Face to face interview, telephone interview, online survey, follow-up at 3 months	An overall positive attitude toward the instruments employed was found among professionals administering them, except for the SCAI. IPPA also elicited some concerns. Some issues needs to be solved, for example the exigency to shorten the time needed to perform the whole interview
Dijcks, 2006	Measure satisfaction with assistive technology service delivery system and assessing the psychometric properties of the KWAZO	Observational	14 AT categories	4627 subjects who had received a device 1-3 months before	KWAZO, D-QUEST	Postal questionnaire	The KWAZO has good psychometric properties and well measures the satisfaction with the service

Fuhrer, 2007	Identify the guiding principles for outcome research in mobility assistive products	Systematic review	Mobility devices	Users of mobility AT	QUEST, PIADS, ATOM, ATOP/M	-	Few well-developed scales with sound psychometric properties are available today for assessing AT outcomes. The complexity of an AT intervention should be acknowledged. The preparatory steps for a study should be 1) formulating an intervention theory 2) developing means of documenting intervention delivery and 3) selecting domains to be measured and measures
Harris, 2008	Collect outcomes data related to a wheelchair intervention by using three outcome instruments, and to develop methodological procedures that could be incorporated easily into busy clinical practices.	Repeated measures, pre-post research design	Wheelchairs	31 experienced wheelchair users	ATOM, OTFACT (AOP and ENV), PIADS	Interviews (face to face). One baseline and two at 1 and 12 months post-intervention	Recommendations arising from this study: 1) clearly determine the parameters of the intervention to be measured 2) length of user experience with AT should be considered in the sample 3) use self-reporting instrument that involve minimal clinical and user burden 4) device-specific instruments are more precise than non specific ones. There were difficulties in tracking the population over time
Harris, 2010	Present the PAMS instrument and give an example of its application	Pre-post study	Tilt-in-space wheelchairs	5 tilt-in-space wheelchair users	PAMS	Wheel revolution counters, seat occupancy sensors and positioning systems + interview	The combination of objective and subjective data afforded by the application of PAMS reflects a complex relationship between wheelchair use and the role of mobility as people go about their daily home and community activities. PAMS can be adapted to a variety of research questions and may be used as an alternative or supplement to self-report assessments of activity and participation
Hong, 2016	Determine if people with different types of wheelchair backrests on their personal wheelchairs reported different levels of comfort	Comparative analysis	Manual wheelchairs	131 manual wheelchair users	TAWC	Interview. GDA section of the TAWC	The study revealed that rigid backrests are less comfortable than sling backrests, especially for quadriplegics
Inkpen, 2012	To test the hypotheses that self-reported manual wheelchair skills capacity and performance are highly correlated and that capacity significantly exceeds performance	Cross-sectional study design	Manual wheelchairs	26 manual wheelchair users, with at least 3 months of experience of use	WST-Q	Interview of the questionnaire version of WST	Manual wheelchair skills capacity and performance are highly correlated but capacity exceeds performance, more so for some skills than others
Jarl, 2012	To evaluate the validity of a modified version of the Orthotics and Prosthetics Users' Survey (OPUS) with persons using different prosthetic and orthotic devices	Cross-sectional study	Upper and lower limb prostheses and orthoses, shoe insoles, orthopaedic shoes.	282 adults using prostheses, orthoses, shoe insoles or orthopaedic shoes.	mOPUS	Self-administered	The study supports the validity of a modified version of OPUS for persons using different P&O devices, but also reveals limitations to be addressed in future studies. OPUS could be useful in clinical rehabilitation and research to evaluate P&O outcomes

Kenny, 2014	Survey and critical appraisal of outcome measures that can be used for wheelchair and seating provision.	Systematic review	Wheelchairs and seating systems	Wheelchair users	WhOM, FEW, PIADS, QUEST, GAS. Mentioned: OTFACT, ATOM, KWAZO, RNLI, IPPA, ATOP-M, WUFA, USAT-WM, TAWC, WcS-DAT, Wheelchair Circuit, PIDA, PCDA, NOMO	Depending on the instrument	A critical appraisal is given of the 5 included instruments. No outcome measure emerges as best suited to service evaluation in this area. When choosing a measure the specific context of the service should be considered. However WhOM and GAS emerge as the most responsive to wheelchair interventions
Lindner 2010	Compare the contents of outcome measures for upper limb prosthesis users by using the ICF. Measurement focus and psychometric properties of these measures were also investigated	Systematic review	Upper limb prosthesis	Upper limb prosthesis users	ACMC, CAPP-FSI, CAPP-PSI, PUFU, UBET, UNB, OPUS, TAPES	Depending on the instrument	There are a few outcome measures with proven psychometric quality for use in evaluation of upper limb prostheses users. These different measures cover different aspects of health; using a mix of outcome measures would provide a better picture of the individual outcome
Löfqvist, 2012	The aim was to investigate outcomes of powered wheelchair and scooter interventions regarding need for assistance when moving around, frequency of mobility-related participation, easiness/difficulty in mobility during participation, and number of participation aspects performed in everyday life	Prospective cohort study	Powered wheelchair and scooters	34 powered wheelchair and scooter users	NOMO 1.0	Interviews at baseline, 4 months, and 1 year follow-up	The results show that the outcomes in terms of participation frequency and easiness in mobility occur in a short time perspective, and that the effects remained stable at 1-year follow-up. Independence outdoors and indoors increased
Long, 2014	To explore whether the PIADS requires modification to address the needs of continence device users	Pilot study	Continence AT devices	40 continence AT devices users	PIADS and C-PIADS	Face-to-face semi-structured interviews	The PIADS appears to address many, but not all, psychosocial concerns of adults who have continence difficulties. A version for continence will require modification of the PIADS. 8 potential new items were added and tested with 20 people out of the 40 participants to the study
Malcolm, 2016	examine AT service outcomes related to performance and satisfaction of common academic tasks as well as how students with disabilities use and experience AT and AT services	Retrospective study	-	216 students with disabilities participated to a pre-post AT intervention survey	AT use survey, mCOPM	Semi-structured interview	Study results support the use of the COPM as a useful and sensitive tool for assessing outcomes related to AT interventions in higher education
Martin, 2011	To examine the relationships among the user involvement in the pre-purchase decision-making process, their perceptions of feeling informed, and their degree of being satisfied with AT	Exploratory study	Any assistive product	145 AT users	Ad-hoc questionnaire	Web-based questionnaire	When users feel informed, they are more likely to be satisfied with the AT and retain it

Mills, 2007	Establish test-retest reliability and content validity of the FEW instrument to determine its ability to measure the effectiveness of seating-mobility interventions on the functional performance of individuals	-	wheelchairs and scooters	33 manual/power wheelchair or scooter users + 221 seating-mobility technology users + 32 seating-mobility technology users + 5 seating-mobility AT users	FEW	Interview and self administration at 2nd administration	FEW Version 2.0 enabled consumers to identify consistently the problems they had using their manual/power wheelchairs and scooters in performing functional tasks in their daily lives
Mortenson, 2007	Developing the WhOM, a tool to provide individualized goal-oriented measure of outcome after the wheelchair provision	Mixed research design	Wheelchairs	13 wheelchair prescribers, 14 individuals who used wheelchairs, 7 wheelchair users' caregivers	WhOM	Interview	The new outcome instrument will allow clients to identify and evaluate the outcomes they wish to achieve with their wheelchairs and seating system, and provide clinicians a method to quantify outcomes of their interventions in a way that is meaningful to both the client and the funding sources
Mortenson, 2008	Compare the properties of activity/participation measures applicable to wheelchair provision interventions	Systematic review	Wheelchairs	Wheelchair users	WUFA, FEW-Q, FFT, WST, AML, OCAWUP, WhOM, WC, PIDA, PCDA	Depending on the measure	The article offers a useful overview (with comparative tables) of the properties of the various measures. Most of the measures are focused on the pure wheelchair mobility capability, while 3 measures (FEW-Q, WUFA and WhOM) look at activities and participation more broadly. WhOM is the only measure that can potentially measure all participation dimensions
Mortenson, 2015	Compare several measures included in a multidimensional wheelchair outcomes toolkit	Retrospective	Powered wheelchair	128 powered wheelchair users	WST/P, LLDI, LSA, ATOP/M, WUCS	Home interview after 1 to 5 years from provision	The five measures capture various dimensions of the wheelchair outcome. Significant relationships were found between the scores detected by the various scales
Murchland, 2011	development of QUEST 2.1 Children's version, explore level of satisfaction of children with AT items used to assist them in school-work	-	Communication, computer access AT and software to assist children in school-work	98 children using AT to assist them in school-work	QUEST 2.1+AT ad hoc survey	Face to face assessment and mailed survey	QUEST 2.1 was sensitive in showing different patterns and levels of satisfaction with subgroups of Atd. It was simple to administer. It displays the potential to provide useful information on features of Atd and services
Nordström, 2014	Investigating into the psychosocial impact of standing devices	Observational study	Standing devices	284 standing device users	PIADS, EQ5	Self administered questionnaire, sent by post	Standing devices yield a significant positive psychosocial impact, especially for older users who use a wheelchair or are highly dependant. The more they are used the higher the impact is. People with acquired disabilities tend to score higher than people with congenital disabilities

Palmer, 2012	Looking for suitable outcome measures for provision of environmental control systems	Retrospective study	Environmental control systems (ECS)	30 environmental control system users	PIADS, PIADS-10	PIADS telephone interview 2 months or more after provision	PIADS-10 is more likely to be fit for this purpose, as it is shorter, more understandable for the uses, and easier for the clinician to administer
Parvaneh, 2014	Checking the reliability and the validity of the WhOM within a residential care context	Observational study with test-retest	Manual wheelchairs	55 wheelchair users, for 17 answers were provided by caregivers	WhOM. Cited: LLDI, GDS, SSMMSE	Two interviews, one two weeks after the other	The WhOM showed valid and reliable.
Pousada Garcia, 2015	To determine the influence of wheelchair use on psychosocial aspects of QoL (e.g., competence, adaptability, and self-esteem) in people with NMD and to determine the influence of contextual factors on QoL of wheelchair users with NMD	Cross sectional study	Manual and powered wheelchairs, no scooters	60 wheelchair users with neuro-muscular disorder disease	PIADS, FIM and ad-hoc questionnaire	Face-to-face interview, sent by post or e-mail and self-administered, phone interview	Wheelchair use was associated with positive changes in QoL, especially for powered wheelchairs. Measuring the outcomes of AT adoption could improve the efficiency of interventions and increase their beneficial impact on users' QoL
Raggi, 2010	To evaluate the WHO-DAS II responsiveness in detecting short-time changes following the provision of an Assistive Technology	Pilot study	AT for walking, personal self-care AT, adapted cutlery	10 persons with neurological diseases	WHO-DAS II	Two interviews: one at baseline and another at 2-month follow-up	The WHO-DAS II is responsive in detecting domain-specific changes over a short-term period and provides preliminary encouraging evidence for the usefulness of its utilization in clinical settings
Rice, 2015	To examine the relationships between wheelchair type, self-esteem and participation, in young adult manual and power wheelchair users with various physical disabilities	Cross-sectional study	Manual and powered wheelchairs.	39 manual and powered wheelchair users	Rosenberg Self-Esteem Scale, CHART	CHART CI, mobility, SI subscales were administered	High self-esteem was found to be the strongest predictor of participation
Rigby, 2005	Evaluate the impact of electronic aids to daily living on functional abilities and psychosocial well-being	Comparative study design	Environmental control units	32 adults with cervical spinal cord injuries (16 users of electronic aids to daily living and 16 non users)	SMAF, LOMEC, PIADS	Face-to-face and phone interviews	The study demonstrates the benefits of EADL usage. EADLs positively influenced users' psychosocial health and perceptions of quality of life. PIADS fulfills its intended purpose to evaluate the impact of EADL on users' perceptions of their psychosocial well-being, which influences their QoL
Robinson, 2012	Suggest a methodology to decide which instruments to be used in clinical practice to assess the outcome of an orthotic intervention for stroke	Systematic review	Mainly Ankle Foot Orthoses	-	10mWT, 6MWT, TUG, RMI, Chedoke-McMaster Stroke Assessment, mEFAP	Depending on the measure: self-assessment; professional assessment; performance test	The article provides a useful guide for clinicians to decide which instruments to use for outcome assessment of orthotic management of stroke. Key decisions are 1) what to measure 2) how responsive is the measure 3) how to interpret the scores and 4) how to make use of them to inform the intervention. A guideline is provided to choose among the 6 instruments reviewed

Rousseau-Harrison 2009	Assess the impact of the wheelchair on participation	Pre-post and retrospective study	Wheelchairs	42 wheelchair users	RNLI	Interview (pre- and post-acquisition)	The wheelchair has a significant effect on social participation. The most significant impact was detected in five dimensions: self care, daily activities, family role, feeling of ease in the company of others and feeling able to deal with life events
Ryan, 2006	Development and testing (content validity and face validity) of a new measure (FIATS) designed to detect the multidimensional effect of AT use on families who have young children with disability	-	Postural devices	14 people, including clinical expert and parents of young children with cerebral palsy	FIATS	Interview	The experts agreed that the Family Impact of Assistive Technology Scale contains the key variables needed to study the effect of assistive technology use on child and family functioning. The parents agreed that the items displayed on the preliminary version were relevant and clear
Ryan, 2007	Validating the FIATS scale	Observational study with test-retest	Postural devices	50 young children with cerebral palsy	FIATS	Two interviews to the caregivers (the second one after two weeks) at home	The FIATS shows promising and potentially applicable to any AT device. It is a relevant measure because it was proved that families of children with disabilities have higher stress than those without; reducing stress impacts positively on the relationships with their children
Ryan, 2013	To determine the parent-reported functional outcomes associated with adaptive seating devices for wheeled mobility devices used by young people. Estimate the internal consistency and test-retest reliability of the FIATS-AS	Longitudinal case series	Adaptive seating devices for wheeled mobility devices	70 parents of children with adaptive seating needs	FIATS-AS, home environment interview, GMFCS, HUTCH diary	Initial interview and following phone interviews	Adaptive seating interventions for wheeled mobility devices are associated with functional changes in the lives of children and their families that interact inversely with age
Salatino, 2016	Measuring the effectiveness and the cost effectiveness of powered wheelchair provision	Retrospective observational study	Powered wheelchairs	79 powered wheelchair users	QUEST, PIADS, SCAI, FABS/M	Home interview after 1 to 5 years from provision	The results indicated positive outcomes, especially in relation to user satisfaction and psychosocial impact. A number of barriers were identified in various settings that sometimes restrict user mobility, and suggest corrective actions. In economic terms, the provision of a powered wheelchair generated considerable savings in social costs for most users. The study also provided an opportunity to develop and test a follow-up protocol that proved to be applicable to routine service delivery
Samuelsson, 2012	Detect how lower limb prostheses affect activity, participation and quality of life	Systematic review	Lower limb prostheses	Adults with amputation	AMP, D-EEARB, EEARB, EQ5D, HAD, HAI, PEQ, PEQ-A, Q-TFA, RSE, SAI, SAM, SCS, SF-36	Depending on the scale	The study offers a useful overview of the instruments used by the 8 studies. The study was inconclusive in relation to which instrument is more powerful in measuring activity, participation and quality of life, as the findings of the various studies are often contradictory

Samuelsson, 2014	To evaluate the effect of electric powered wheelchairs/scooters on occupational performance, social participation, health and life satisfaction. In addition, this study estimates the costs and benefits of PWC/S and describes users' experiences with the delivery process	Prospective study that uses a before-and-after design	Electric powered wheelchairs/scooters	24 first-time PWC/S users	A specific instrument was developed	Self-administered postal questionnaires. Baseline before delivery. Follow-up 4 months later	PWC/S seems to improve occupational performance, social participation and life satisfaction for users. Moreover, these improvements seem to have an economic advantage for both users and society
Schreuer, 2009	To test accommodations as facilitators of return to work and participation: test whether different alternate outcome variables help in the prediction of evidence-based outcomes in various contexts	Follow-up study	Adaptations of computer workstations	90 adults with physical disabilities who received adaptations of computer workstations	Introductory ad-hoc questionnaire, Activity card sort, Self Esteem Assessment (cognitive), mACE	Face-to-face interview and tests	The combination of the measures hypothesized from the various levels of outcomes and the relations suggested for the study fits into a construct confirmed by the data collected
Sund, 2013	Compare the user satisfaction related to the provision of electric scooters in Norway and Denmark	Cross-country comparative study	Powered scooters.	136 electric scooters users	NOMO, SATS	Face to face interview with NOMO before the provision; second phone interview with SATS 1-2 months later	The structure of the service clearly impacts on the outcome while the process does not; however the process does impact on satisfaction
Tam, 2005	Using the example of measuring the outcomes of word cueing technology to present an approach for measuring AT outcomes	-	Word cueing software	29 children with physical and learning disabilities users of a word cueing software	mCOPM	COPM face-to-face interview and follow-up phone interview after 3 months of use	The COPM was an effective tool for measuring clients' perceived outcome of word cueing technology
Watson, 2012	Evaluate the measurement properties and the time needed to use the 2 instruments designed to measure AT outcomes in special education	-	ATD used by students in special education: oral or written communication, computer access, curriculum access	13 children from 3 to 21 years old, with intellectual, behavioural, or learning disabilities	SFA-AT part III (activity and performance) and SPP	Pre-test without AT and post-test with AT administered to the case-manager or the student	Both measures have advantages, but the SPP appeared most efficient and sensitive for the population of students in special education