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The Physical Abilities and Mobility Scale (PAMS): reliability and validity in children receiving inpatient brain injury rehabilitation

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Abstract

Objective—To investigate the psychometric properties of the Physical Abilities and Mobility Scale (PAMS) in children receiving inpatient rehabilitation for acquired brain injury.

Design—Admission and discharge PAMS item and total scores were evaluated. The Functional Independence Measure for Children (WeeFIM) was used as the criterion standard. A case study was used to illustrate the complementary nature of the PAMS and WeeFIM.

Setting—A single free-standing academically-affiliated pediatric rehabilitation hospital

Participants—107 children aged two through eighteen years receiving inpatient rehabilitation for acquired brain injury between March 2009 and March 2012. 42 additional children treated during this time were excluded due to missing PAMS data.

Interventions—Not applicable

Main Outcome Measures—Internal consistency was evaluated using Cronbach alpha. Inter-rater reliability was evaluated through overall agreement, Pearson correlations, and intraclass correlations. Construct validity was examined through exploratory factor analysis. Criterion validity was explored through correlations of PAMS overall and factor scores with WeeFIM total and subscale scores. Sensitivity to recovery was examined using paired *t* tests examining differences between admission and discharge scores for each item and for the total score.

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Reprints are not available.

Data from an older version of the PAMS was presented at the 2nd Federal Interagency Meeting on Traumatic Brain Injury (March 2006, Bethesda, MD).

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We certify that we have affiliations with or financial involvement (eg, employment, consultancies, honoraria, stock ownership or options, expert testimony, grants and patents received or pending, royalties) with an organization or entity with a financial interest in, or financial conflict with, the subject matter or materials discussed in the manuscript AND all such affiliations and involvements are disclosed on the title page of the manuscript.

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Results—Internal consistency and inter-rater reliability were high. Factor analysis revealed two factors: lower level skills and higher level mobility skills. Correlations with the WeeFIM ranged from moderate to very strong; total PAMS score most strongly correlated with the WeeFIM mobility subscore. Total PAMS score and each item score significantly increased between admission and discharge.

Conclusions—The PAMS is a reliable and valid measure of progress during inpatient rehabilitation for children with acquired brain injury. By capturing fine grain progress toward both lower level and higher level mobility skills, the PAMS complements the WeeFIM in assessing functional gains during the rehabilitation stay.

Keywords

brain injury; children and adolescents; rehabilitation; motor; assessment

Acquired brain injury (ABI) from traumatic and non-traumatic etiologies is a common diagnosis among children receiving inpatient rehabilitation ^{1,2}. Goals for motor function during inpatient rehabilitation for ABI vary based on the severity and pattern of the injury and may include lower level skills, such as tolerance to passive positioning and head and trunk control, or higher-level skills including assisted mobility or independent ambulation. While return to prior level of function is often expressed as an ultimate goal, when that is not possible, achieving lower level milestones has important ramifications for a child's comfort, ease of care, and prevention of secondary complications.

Two measures are commonly used to track motor function during pediatric inpatient rehabilitation: the Functional Independence Measure for Children (WeeFIMTM, Uniform Data System for Medical Rehabilitation, Buffalo, NY) and the Pediatric Evaluation and Disability Inventory (PEDI, Health and Disability Research Institute, Boston University, MA). More recently the Gross Motor Function Measure (GMFM, CanChild, McMaster University, Ontario), originally developed for use in children with Cerebral Palsy, was validated for use during inpatient rehabilitation of children with traumatic brain injury (TBI) ³. These measures include items to assess physical ability and mobility but do not assess more subtle changes in motor functioning that commonly occur during inpatient rehabilitation. For example, these measures do not include evaluate child's tolerance to positioning, handling, and orthotic wear or physical assistance needed for ambulation independent of ambulation distance and type of assistive device.

The ability to track smaller changes in function is useful during rehabilitation. More detailed description of a child's function provides benefit for day to day therapy planning; particularly for patients with lower physical abilities, a measure marking more milestones in the lower range of function is useful for setting goals and tracking progress towards those goals. Evaluating smaller increments of change would also facilitate identification of responses to intervention which may be missed by scales capturing only larger degrees of change. Lastly, the ability to track and describe finer increments of change facilitates communication within the rehabilitation team and between the rehabilitation team and insurance companies, families, and schools.

The Physical Abilities and Mobility Scale (PAMS) was developed as a brief and repeatable measure of physical skills and mobility to complement the WeeFIM by detecting subtle changes in a child's status, including items reflecting degree of caregiver burden, in relationship to goals for an inpatient rehabilitation admission ⁴. A preliminary version of the PAMS demonstrated good reliability and validity ⁴. Changes were made to the preliminary version in February 2009 based on clinical feedback, and an instruction manual was written at that time to improve consistency in interpretation and scoring of items. The purpose of

this project was to explore the reliability and validity of the updated version of the PAMS in a group of children receiving rehabilitation for ABI at a single pediatric inpatient brain injury rehabilitation program. A secondary goal was to highlight the means in which the PAMS complements the WeeFIM.

METHODS

Data were collected for clinical care and entered into a program evaluation database. The Johns Hopkins Medicine Institutional Review Board granted approval for creation of a separate de-identified research database and for medical record review for this study.

Participants

Potential participants consisted of 149 children, ages two through eighteen years, consecutively admitted to one pediatric inpatient brain injury rehabilitation unit between March 2009 and March 2012. Children with ABI of traumatic and non-traumatic etiologies were included. Forty-two children were excluded due to missing PAMS data, yielding a final data set of 107 children. Demographics are presented in Table 1.

PAMS Measure Description and Test Development

The PAMS is a 20 item quantitative scale designed for serial measurement of positioning and mobility in children ages two years and older during intensive rehabilitation. Items were developed through consensus by several inpatient physical therapists with input from other pediatric rehabilitation specialists, incorporating quality of movement in different positions and with the goal of capturing progress of severely injured children.

The 20 PAMS items assess tolerance to positioning, tolerance to sitting in a wheelchair, tolerance to orthosis or splinting, support needed for seating system, head control, trunk control, rolling, transition from supine to sit, transition from sit to stand, standing, transition from floor to stand, environmental transfers, transfers into and out of a car, assistive device needed for ambulation, distance of ambulation, level of assistance for ambulation, community ambulation skills, wheelchair mobility, standing balance, and stairs. Typical time for PAMS administration during an initial evaluation is 20–45 minutes depending on the child's functional level. Scoring for each item ranges from 1 to 5; total possible score ranges from 20 to 100. Higher scores represent higher levels of function. As an example, "Standing" item scoring is: 1=Does not bear weight through lower extremities or is positioned in body weight support system, 2=Stands in prone or supine stander for up to 15–30 minutes, 3=Stands with upper extremity support (i.e. parallel bars or walker) for 30 seconds, 4=Stands with one hand support only or against wall with posterior support for at least 30 seconds, 5=Stands without support >five seconds.

Other measures: WeeFIM

The WeeFIM is an 18 item scale evaluating functional independence; it yields a total score and mobility, self-care, and cognition subscale scores⁵. WeeFIM Developmental Functional Quotients (DFQs,²²) for total and subscale scores were used to account for the effect of age on WeeFIM scores for children <7 years¹⁷; DFQs reflect a percent of age-appropriate functioning. WeeFIM items are rated on a scale from 1–7, and total DFQs can range from 14 to >100. While the WeeFIM captures developmental progress in typically developing children aged six months through seven years, the WeeFIM also is broadly applicable to children older than seven years with developmental and/or acquired disabilities⁷. For children with acquired brain injury specifically, the literature reflects use of the WeeFIM up to 18⁸ and 21 years of age⁹.

Procedure

The PAMS was administered by trained inpatient physical therapists for clinical purposes during initial patient evaluation, every other week during the admission, and just prior to discharge. The WeeFIM was scored by the interdisciplinary treatment team at the same time points. For this study, only admission and discharge PAMS and WeeFIM scores were examined. Inter-rater reliability was determined based on evaluation of 10 distinct children by two trained inpatient physical therapists at the same time; for these 10 evaluations, the second trained inpatient physical therapist attended the session(s) during which the PAMS was completed for clinical purposes and independently scored the PAMS based on observation of the session(s).

Data analysis

Descriptive statistics were used to examine sample characteristics and admission and discharge PAMS scores. Cronbach alpha was calculated as a measure of internal consistency. Inter-rater reliability was evaluated through overall agreement, Pearson correlations, and intraclass correlations using a two-way random effects model¹⁰. Construct validity was examined through exploratory factor analysis. A principal factor analysis was chosen, given that some of the item ratings were skewed; as the factors were expected to be correlated, oblique rotation was used¹¹. Factors were selected if they had eigenvalues of one or more and at least three variables loading at 0.30 or higher¹¹. Internal consistency (Cronbach alpha) was calculated for each factor. Factor scores were calculated as an average of the scores for items loading on each factor. Criterion validity was explored through correlations of PAMS overall score and factor scores with WeeFIM scores. Strength of correlations, based on correlation coefficient, was assigned using the following parameters: $r=0-0.2$ (very weak), $r=0.2-0.4$ (weak), $r=0.4-0.7$ (moderate), $r=0.7-0.9$ (strong), $r=0.9-1.0$ (very strong). Sensitivity to recovery was examined using paired t-tests examining differences between admission and discharge scores for each item and the total score. For each t-test, effect size were calculated as: [(mean at admission mean at discharge)/standard deviation at admission]¹². Strength of effects was assigned as follows: 0.20–0.50 (small), 0.50–0.80 (moderate), and >0.80 (large)^{13,14}. The percentage of individuals with scores at the floor and ceiling for total PAMS score and individual items at admission and discharge were examined to further assess sensitivity to the full range of physical abilities and motor skills in this population. A descriptive case was used to illustrate the complementary nature of the PAMS and WeeFIM.

RESULTS

Reliability

Internal consistency—Internal consistency for the measure was high at admission ($\alpha=.97$) and discharge ($\alpha=.96$).

Inter-rater reliability—Absolute agreement in item ratings between raters ranged from 70 to 100% (mean agreement 95%). Discrepant ratings typically (90%) differed by one point. Inter-rater correlation for total PAMS scores was very high ($r=0.999$, $p<.001$); intraclass correlation coefficient for total scores was also very high (0.999).

Validity

Construct validity—Exploratory factor analysis revealed two factors at admission: tolerance/lower level skills and higher level mobility skills. Two factors were identified at discharge: lower level skills and higher level mobility skills. . The internal consistency of

each factor was high (alpha 0.94); Cronbach alpha values for each factor and factor loadings for each PAMS item are listed in Table 2.

The tolerance items in the PAMS are Tolerance to Positioning, Tolerance to Sitting in a Wheelchair, and Tolerance to Orthosis or Splint. At admission these tolerance items loaded with the lower level skills. At discharge these items no longer loaded with either factor.

The loading of the motor skills on “lower level” versus “higher level” factors were consistent from admission to discharge. The motor skills items that loaded with the “lower level” mobility skills factor at admission and discharge included those measuring head and trunk control, amount of assistance needed for transfers, rolling, and standing, and device and amount of assistance needed for ambulation. The skills that loaded with the “higher level” mobility factor at admission and discharge included transitions from the floor to standing and into and out of a car, community ambulation skills, wheelchair mobility, standing balance, and stairs.

Criterion validity—Correlations with the WeeFIM ranged from moderate to very strong. At admission and discharge, total PAMS score most strongly correlated with the WeeFIM mobility subscore and most weakly correlated with the WeeFIM cognitive subscore. At both admission and discharge, the higher level mobility skills factor correlated more strongly with the WeeFIM mobility subscale score than did the lower level skills factor. Correlations are provided in Table 3.

Responsiveness

Total PAMS score and each item significantly improved between admission and discharge, with effect sizes ranging from small to large. The effect was large (1.14) for the total score; the item with the largest effect size (1.232) was “Community (Ambulation) Skills.” Concerning subjects with scores at the floor and ceiling, one child had the lowest possible total score and one child had the highest possible total score at admission. At admission, “Head Control” and “Tolerance to Orthosis or Splint” were the items for which the largest percentage (66%) of children scored a 5 (for the Orthosis item, this includes children who tolerate orthoses for 100% of recommended time and children who do not have orthoses). At admission, “Community (Ambulation) Skills” was the item for which the most children (88%) met criteria for the lowest score. At discharge no child had the lowest possible total score and 16 children had the highest possible total score. At discharge, almost all children scored a 5 for “Tolerance to Orthosis or Splint” (95%) and “Tolerance to Sitting in a Wheelchair” (97%). At discharge “Community (Ambulation) Skills” remained the item for which the largest percentage of children (45%) scored a 1.

Case—The patient is a two year old boy with severe TBI. He was admitted to inpatient rehabilitation 35 days post-injury. His progress in physical therapy during the admission is described below. WeeFIM and PAMS scores are summarized in Figure 1.

Admission to inpatient rehabilitation (Dayzero): The patient spontaneously moved all extremities but had purposeful movement of only the left arm. He required total assistance for positioning, balance, and functional mobility. He was transferred between uneven surfaces dependently by one staff member. He had difficulty tolerating positioning and handling for daily activities and did not tolerate upright sitting in a wheelchair. He did not have orthotics. WeeFIM mobility scores: raw-5, DFQ-21. PAMS score: 22/100

Inpatient rehabilitation day 14: He rolled with maximal assistance and demonstrated head control for more than 10 seconds at a time. He could short sit with maximal trunk support.

He remained dependent for transfers and was unable to ambulate. He tolerated therapeutic positioning and handling by staff and trained family members. He tolerated sitting in a fully supportive adapted stroller for two to three hours at a time. WeeFIM mobility scores: raw-5, DFQ-17 (DFQ decreased from prior due to child's age and transition from 50–52 month to 53–55 month norms). PAMS score: 33/100.

Inpatient rehabilitation day 41: The patient no longer required the tilt/recline feature of his adapted stroller. He tolerated ankle foot orthotics for 100% of recommended wear time. He had head control for more than one minute at a time and maintained static sitting for at least one minute with therapist support only at his pelvis. He rolled with minimal assistance but required total assistance for supine to sit. He transitioned from sit to stand with maximal assistance and maintained static standing with bilateral upper extremity support and moderate to maximal assistance; he tolerated positioning in a stander. He participated in trials of body weight supported ambulation with maximal to total assistance. WeeFIM mobility scores: raw-5, DFQ-17. PAMS score: 50/100.

Inpatient rehabilitation day 80: The patient maintained static sitting with upper extremity support for at least one minute without external support. He transitioned from supine to sit with maximal assistance. He transitioned from sit to stand with moderate assistance. He ambulated in a body weight supported walker up to five feet on even surfaces with maximal assistance. WeeFIM mobility scores: raw-5, DFQ-17. PAMS score: 54/100.

Discharge from inpatient rehabilitation (day 114): The patient required a seating system with only pelvic and lateral trunk support and maintained static sitting balance without upper extremity support for at least one minute at a time. He transitioned from supine to sit and from sit to stand with minimal assistance. He ambulated up to 25 feet with a walker with pelvic support and bilateral forearm prompts with maximal assistance. He required total assistance to transfer in and out of his adapted stroller and was unable to manage stairs. WeeFIM mobility scores: raw-5, DFQ-16 (decrease in DFQ due to child's age and transition from 53–55 month to 56–58 month norms). PAMS score: 63/100.

DISCUSSION

The objective of this study was to explore the psychometric properties of an updated version of the PAMS, a measure designed to track small changes in physical abilities which may impact treatment and discharge planning. Based on these data, the PAMS has adequate reliability and validity and demonstrates sensitivity to recovery in gross motor functioning and mobility commonly seen in an inpatient rehabilitation setting. The very high inter-rater reliability obtained for the total PAMS score (ICC=0.99) is similar to that reported in the literature for assessment of children with disabilities using the WeeFIM total score (ICC=0.97)¹⁵, the motor subscale of the PEDI (ICC=0.92)¹⁶, and the GMFM total score (ICC=0.96)¹⁷. The very strong correlation of the PAMS total score with the WeeFIM mobility subscale ($r=0.91$) is similar to the reported correlation between the PEDI mobility subscale and WeeFIM mobility items ($r=0.96$)¹⁶ and is stronger than the reported correlation between the GMFM Dimensions D (standing) and E (walking, running, and jumping) and WeeFIM mobility subscale ($r=0.65$ – 0.66)¹⁸. Overall, these results suggest that the PAMS is a good measure of recovery of physical ability and mobility following pediatric ABI. The high internal consistency of the PAMS suggests that the items collectively measure a single construct.

The two factors identified by factor analysis of PAMS scores at admission and discharge generally correspond to lower level skills/household mobility versus higher level skills/community mobility. While ratings for the items reflecting tolerance to positioning,

wheelchair sitting, and orthoses were variable at admission, children almost universally achieved the highest score for tolerance items at discharge, making them distinct from other items, which continued to reflect more variability at discharge.

The “lower level” motor skill items, such as head and trunk control and assistance required for transfers,, reflect skills with more variability in scores at admission. Some children admitted to inpatient rehabilitation already demonstrate ability in these areas while others do not. At discharge, these are the items with less variability in scores, as many children demonstrate gains in motor control, strength, balance, and endurance during the admission and obtain scores of 4 or 5 on these items at discharge.

The “higher level” motor skills, such as car transfers and community ambulation skills, reflect advanced mobility skills. For children with severe enough injuries to require inpatient rehabilitation, these advanced skills typically would not be addressed during the acute medical admission and often are not appropriate to address until later in the rehabilitation admission. At admission, most children scored at the lowest level for these skills, and at discharge, these items had more variability in scores, reflecting the known variability in outcomes among children requiring inpatient rehabilitation for ABI ^{8,9}.

The PAMS was designed to complement the WeeFIM by 1) measuring progress towards goals not captured by the WeeFIM and 2) measuring smaller gradations of change in mobility ultimately addressed by the WeeFIM. For children not yet able to make progress towards independent mobility, other important goals often exist for inpatient rehabilitation. The most basic, universal goal may be tolerance for activities important for the child’s care. These data show that the PAMS captures progress made in this type of goal during an inpatient rehabilitation admission. Furthermore, the case study illustrates the responsiveness of the PAMS to functionally important gains not captured by the WeeFIM. This child made notable progress during the admission, demonstrating potential for continued functional gains associated with decreased burden of care. While his PAMS score increased from 22 to 63, capturing this change, the raw WeeFIM mobility score did not change; his WeeFIM DFQ decreased over time, reflecting that he did not achieve developmental progress expected over a period of months during toddlerhood. The stronger association between the WeeFIM and the PAMS factor capturing higher level skills, in comparison to the factor capturing lower level skills, also reflects the WeeFIM’s measurement of more advanced mobility skills.

As the PAMS captures progress towards goals not reflected in WeeFIM scores, the PAMS can serve an important role in communication among the rehabilitation team members, with families, and with insurers. By providing an objective measure of more fine-grained progress, the PAMS may be useful for setting and evaluating team goals. Team members may also use the PAMS as a means of illustrating progress and incremental future goals when discussing a child’s care with family members. Furthermore, documentation of improving PAMS scores and progress towards goals set based on the PAMS may be useful for justification to insurers of ongoing benefit of the inpatient rehabilitation setting even if no change in WeeFIM scores is observed. To further enrich the description of a child’s progress, the PAMS could be used in conjunction with similar measures designed to capture goals in the other domains addressed during inpatient rehabilitation; the Cognitive and Linguistic Scale ¹⁹ is similar to the PAMS but addresses progress towards goals related to the child’s neurobehavioral status.

Study Limitations

While demonstrating sufficient reliability, validity, and consistency to merit ongoing use of the PAMS, these data were generated from a limited population -- children with a diagnosis

of ABI in the inpatient phase of rehabilitation at a single institution. This sample represents the minimum size needed for factor analysis, and the factors in particular should be re-evaluated with a larger sample. These data were generated at the institution where the PAMS was developed; while data were generated by many therapists not involved in PAMS development, exploration of PAMS consistency when used by raters at another institution would be useful. Furthermore, use of the PAMS in different rehabilitation settings including at other institutions may provide additional useful feedback for further optimizing this measure.

Conclusions

The PAMS shows promise for detailing progress toward both lower and higher level goals involving positioning and motor skills during inpatient rehabilitation for children with ABI. There may be utility for combining the PAMS with more established measures of functional independence, such as the WeeFIM, for clinical, administrative, and research purposes. Further exploration of the PAMS in additional settings and with other populations will be useful.

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Abbreviations

ABI	acquired brain injury
WeeFIM	Functional Independence Measure for Children
TBI	traumatic brain injury
PAMS	Physical Abilities and Mobility Scale

References

1. Dumas HM, Haley SM, Ludlow LH. Achieving a minimally important difference in physical function during pediatric inpatient rehabilitation. *Int J Rehabil Res.* 2008; 31:257–60. [PubMed: 18708850]
2. Chen CC, Bode RK, Granger CV, Heinemann AW. Psychometric properties and developmental differences in children's ADL item hierarchy: a study of the WeeFIM instrument. *Am J Phys Med Rehabil.* 2005; 84:671–9. [PubMed: 16141744]
3. Linder-Lucht M, Othmer V, Walther M, Vry J, Michaelis U, Stein S, Weissenmayer H, Korinthenberg R, Mall V. Validation of the Gross Motor Function Measure for use in children and adolescents with traumatic brain injuries. *Pediatrics.* 2007; 120:e880–6. [PubMed: 17908744]
4. Suskauer S, Slomine B, Salorio C, Bradley E, Madigan L, Sesma H, Christensen J. The Physical Abilities and Mobility Scale. *Journal of Head Trauma Rehabilitation.* 2006; 21:420.
5. Msall ME, DiGaudio K, Rogers BT, LaForest S, Catanzaro NL, Campbell J, Wilczenski F, Duffy LC. The Functional Independence Measure for Children (WeeFIM). Conceptual basis and pilot use in children with developmental disabilities. *Clin Pediatr (Phila).* 1994; 33:421–30. [PubMed: 7525140]
6. Msall ME, Tremont MR. Measuring functional status in children with genetic impairments. *Am J Med Genet.* 1999; 89:62–74. [PubMed: 10559760]
7. Uniform Data System for Medical Rehabilitation. The WeeFIM II Clinical Guide, Version 6. Buffalo: UDSMR; 2006.

8. Suskauer SJ, Slomine BS, Inscore AB, Lewelt AJ, Kirk JW, Salorio CF. Injury severity variables as predictors of WeeFIM scores in pediatric TBI: Time to follow commands is best. *J Pediatr Rehabil Med*. 2009; 2:297–307. [PubMed: 20467579]
9. Rice SA, Blackman JA, Braun S, Linn RT, Granger CV, Wagner DP. Rehabilitation of children with traumatic brain injury: descriptive analysis of a nationwide sample using the WeeFIM. *Arch Phys Med Rehabil*. 2005; 86:834–6. [PubMed: 15827941]
10. Shrout PE, Fleiss JL. Intraclass correlations: uses in assessing rater reliability. *Psychol Bull*. 1979; 86:420–8. [PubMed: 18839484]
11. Costello AM, Osborn JW. Best practices in exploratory factor analysis: four recommendations for getting the most from your analysis. *Practical Assessment, Research & Evaluation*. 2005; 10:1–9.
12. Dunlop WP, Cortina JM, Vaslow JB, Burke MJ. Meta-analysis of experiments with matched groups or repeated measures design. *Psychological Methods*. 1996; 1:170–177.
13. Cohen, J. *Statistical Power Analysis for the Behavioral Sciences*. 2. Hillsdale, NJ: Lawrence Erlbaum Associates;
14. Kane, RL. Outcome measures. In: Kane, R., editor. *Understanding Health Care Outcomes Research*. Gaithersburg, MD: Aspen Publishers; 1997. p. 17-18.
15. Ottenbacher KJ, Msall ME, Lyon NR, Duffy LC, Granger CV, Braun S. Interrater agreement and stability of the Functional Independence Measure for Children (WeeFIM): use in children with developmental disabilities. *Arch Phys Med Rehabil*. 1997; 78:1309–15. [PubMed: 9421983]
16. Ziviani J, Ottenbacher KJ, Shephard K, Foreman S, Astbury W, Ireland P. Concurrent validity of the Functional Independence Measure for Children (WeeFIM) and the Pediatric Evaluation of Disabilities Inventory in children with developmental disabilities and acquired brain injuries. *Phys Occup Ther Pediatr*. 2001; 21:91–101. [PubMed: 12029858]
17. Russell D, Palisano R, Walter S, Rosenbaum P, Gemus M, Gowland C, Galuppi B, Lane M. Evaluating motor function in children with Down syndrome: validity of the GMFM. *Dev Med Child Neurol*. 1998; 40:693–701. [PubMed: 9851239]
18. Sullivan E, Barnes D, Linton JL, Calmes J, Damiano D, Oeffinger D, Abel M, Bagley A, Gorton G, Nicholson D, Rogers S, Tytkowski C. Relationships among functional outcome measures used for assessing children with ambulatory CP. *Dev Med Child Neurol*. 2007; 49:338–44. [PubMed: 17489806]
19. Slomine B, Eikenberg J, Salorio C, Suskauer S, Trovato M, Christensen J. Preliminary evaluation of the Cognitive and Linguistic Scale: a measure to assess recovery in inpatient rehabilitation following pediatric brain injury. *J Head Trauma Rehabil*. 2008; 23:286–93. [PubMed: 18815505]

Figure 1.

Summary of total PAMS scores and WeeFIM Mobility Subscale raw scores for the patient presented in the case study during inpatient rehabilitation. Total PAMS scores increased over time during the inpatient admission as progress was made toward PT goals; progress made was not sufficient to change WeeFIM score.

Table 1

Patient Demographics (n = 107)

	Mean (SD)	Range
Age at Admission, in years	11.0 (5)	2.1–18.8
Male / Female, %	61/39	
Etiology of ABI	Traumatic: 40%	
	Infectious: 8%	
	Epilepsy-related: 7%	
	Stroke: 7%	
	Oncologic: 7%	
	Anoxic: 5%	
	Other: 26%	
Inpatient Rehabilitation Length of Stay, days	40.9 (39)	3–189
Admission Total WeeFim DFQ	39.4 (23)	14–90
Discharge Total WeeFim DFQ	60.2 (26)	14–99
Admission Total PAMS score	53.7 (24)	20–100
Discharge Total PAMS score	80.6 (19)	32–100

DFQ=Developmental Functional Quotient

Table 2

Factor Loadings at Admission and Discharge*

PAMS Items	Admission Factors		Discharge Factors		Tolerance to Sitting in a Wheelchair	Tolerance to Positioning and Orthoses
	Tolerance, Lower-level skills and Household Mobility	Higher-level skills and Community Mobility	Lower-level skills and Household Mobility	Higher-level skills and Community Mobility		
Cronbach α for factor	0.956	0.940	0.954	0.951		
Tolerance to Positioning	0.637	0.172	0.022	0.065	0.004	0.680
Tolerance to Sitting in a Wheelchair	0.442	0.128	.103	0.122	0.591	0.025
Tolerance to Orthosis or Splint	0.417	0.094	-0.019	-0.034	0.007	0.418
Support for Seating System	0.487	0.367	0.606	0.200	-0.247	0.094
Head Control	0.842	-0.215	0.732	-0.091	0.467	-0.030
Trunk Control	0.961	-0.127	0.830	-0.079	0.281	0.051
Rolling Supine to/from Prone	0.892	-0.045	0.882	0.005	0.114	-0.056
Transitioning from Supine to Sit	0.977	-0.061	0.879	0.004	0.087	0.094
Transitioning from Sit to Stand	0.855	0.137	0.790	0.170	-0.019	0.064
Standing	0.887	0.113	0.723	0.221	-0.364	0.040
Transitioning from Floor to Stand	0.444	0.525	0.337	0.605	-0.035	0.140
Environmental Transfers	0.638	0.221	0.417	0.382	-0.028	0.298
Transfers Into and Out of a Car	0.188	0.590	0.078	0.842	0.056	-0.015
Walking on Level Ground – Assistive Device	0.858	0.014	0.768	0.060	-0.222	0.143
Walking on Level Ground-Distance	0.471	0.524	0.352	0.625	-0.252	-0.092
Walking on Level Ground– Level of Assistance	0.785	0.221	0.631	0.390	-0.273	-0.065
Community Skills	-0.136	0.935	-1.09	1.007	0.154	-0.012
Wheelchair Mobility	0.066	0.842	0.016	0.712	0.099	0.210
Standing	0.030	0.875	-0.062	0.924	-0.021	-0.028
Balance Stairs	0.123	0.831	0.117	0.733	-0.095	0.110

* All factor loading .30 are set in bold

Table 3

Correlations Between PAMS Scores and WeeFim Developmental Functional Quotients at Admission and Discharge

	Admission			Discharge		
	PAMS Total Score	PAMS Lower Level Skills Factor	PAMS Higher Level Skills Factor	PAMS Total Score	PAMS Lower Level Skills Factor	PAMS Higher Level Skills Factor
WeeFim Total DFQ	0.80 *	0.77 *	0.76 *	0.81 *	0.71 *	0.84 *
WeeFim Cognition DFQ	0.60 *	0.60 *	0.55 *	0.54 *	0.50 *	0.55 *
WeeFim Self-care DFQ	0.72 *	0.71 *	0.66 *	0.78 *	0.68 *	0.81 *
WeeFim Mobility DFQ	0.91 *	0.82 *	0.93 *	0.91 *	0.77 *	0.96 *

* p < .001

Table 4

Item and Total PAMS Scores at Admission and Discharge

PAMS Item	Admission Mean	Discharge Mean	T-test p Value	Effect Size
Tolerance to Positioning	3.32	4.74	<0.001	0.987
Tolerance to Sitting in a Wheelchair	3.71	4.94	<0.001	0.944
Tolerance to Orthosis or Splint	3.88	4.83	<0.001	0.567
Support for Seating System	2.44	4.16	<0.001	0.949
Head Control	4.00	4.78	<0.001	0.506
Trunk Control	3.36	4.66	<0.001	0.750
Rolling Supine to/from Prone	3.22	4.50	<0.001	0.729
Transitioning from Supine to Sit	3.12	4.44	<0.001	0.760
Transitioning from Sit to Stand	2.84	4.30	<0.001	0.950
Standing	2.91	4.35	<0.001	0.901
Transitioning from Floor to Stand	2.10	3.60	<0.001	0.943
Environmental Transfers	3.04	4.12	<0.001	0.807
Transfers Into and Out of a Car	1.69	3.28	<0.001	1.205
Walking on Level Ground – Assistive Device	3.07	4.31	<0.001	0.674
Walking on Level Ground - Distance	2.26	3.97	<0.001	1.174
Walking on Level Ground – Level of Assistance	2.58	4.03	<0.001	0.984
Community Skills	1.38	2.74	<0.001	1.232
Wheelchair Mobility	1.72	3.20	<0.001	0.965
Standing Balance	1.48	2.69	<0.001	1.206
Stairs	1.75	3.23	<0.001	1.066
Total Score	53.72	80.62	<.001	1.137