



Neurological Rehabilitation Outcomes for TBI

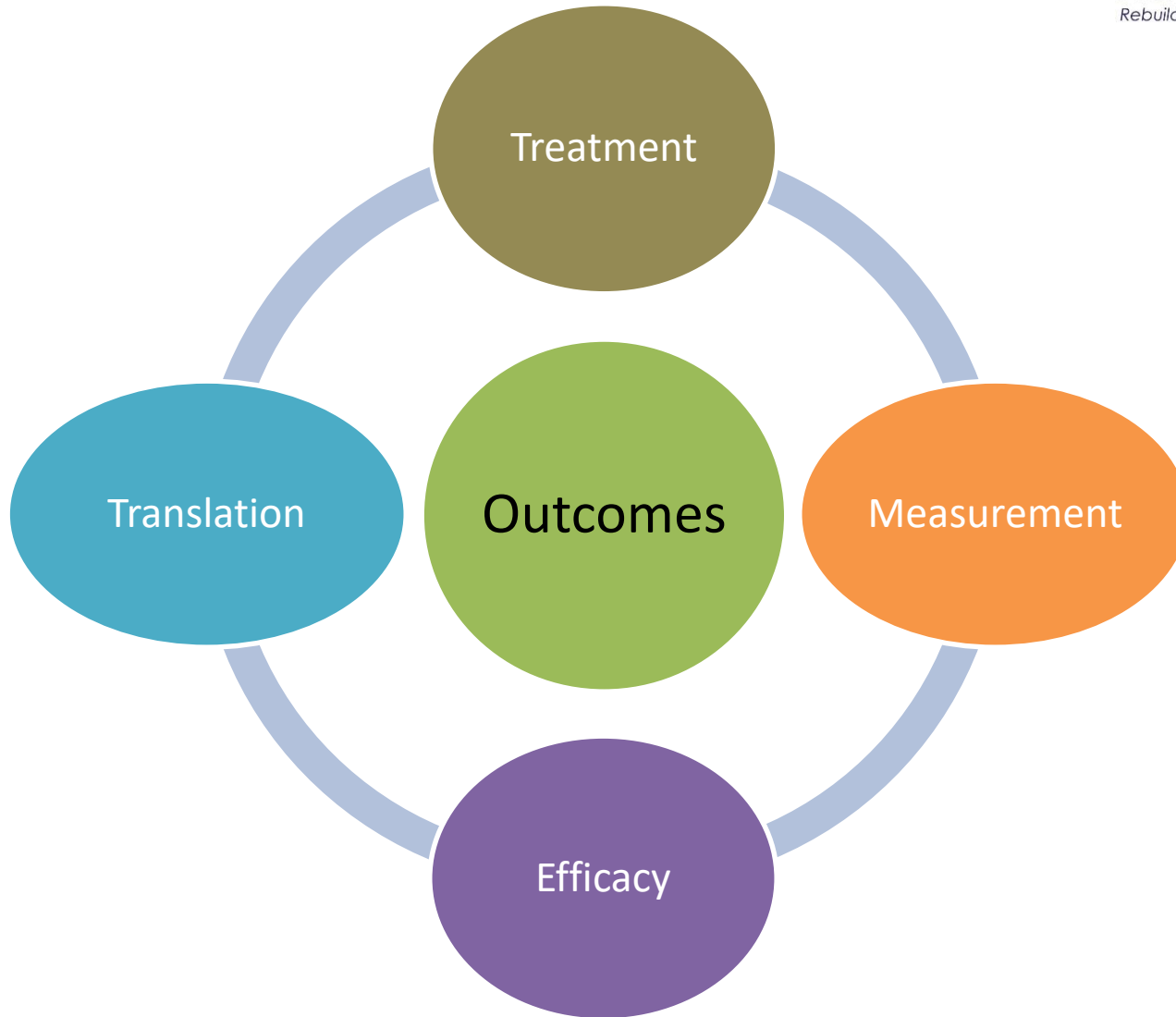
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NeuroRestorative's COVID-19 Response



- We are committed to protecting the health and safety of the individuals we serve, our staff, and the community. Our services are considered essential, and we are taking precautions to minimize disruption to services and keep those in our care and our team members safe. In some programs, that has meant innovating our service delivery model through Interactive Telehealth Services. We provide Interactive Telehealth Services throughout the country as an alternative to in-person services. Through Interactive Telehealth Services, we deliver the same high-quality supports as we would in-person, but in an interactive, virtual format that is HIPAA compliant and recognized by most healthcare plans and carriers.
- You can learn more about our COVID-19 prevention and response plan at our Update Center by visiting neurorestorative.com.

Introduction – Overview of Outcomes Analysis



Neurological Rehabilitation Outcomes Objectives

Participants will be able to ...

- Identify the levels of neurological rehabilitation services.
- Compare outcome measurements for levels of care.
- Understand advanced knowledge of post-hospital care and outcomes.
- Discuss the use of Rasch Analysis techniques for improved translational outcomes.

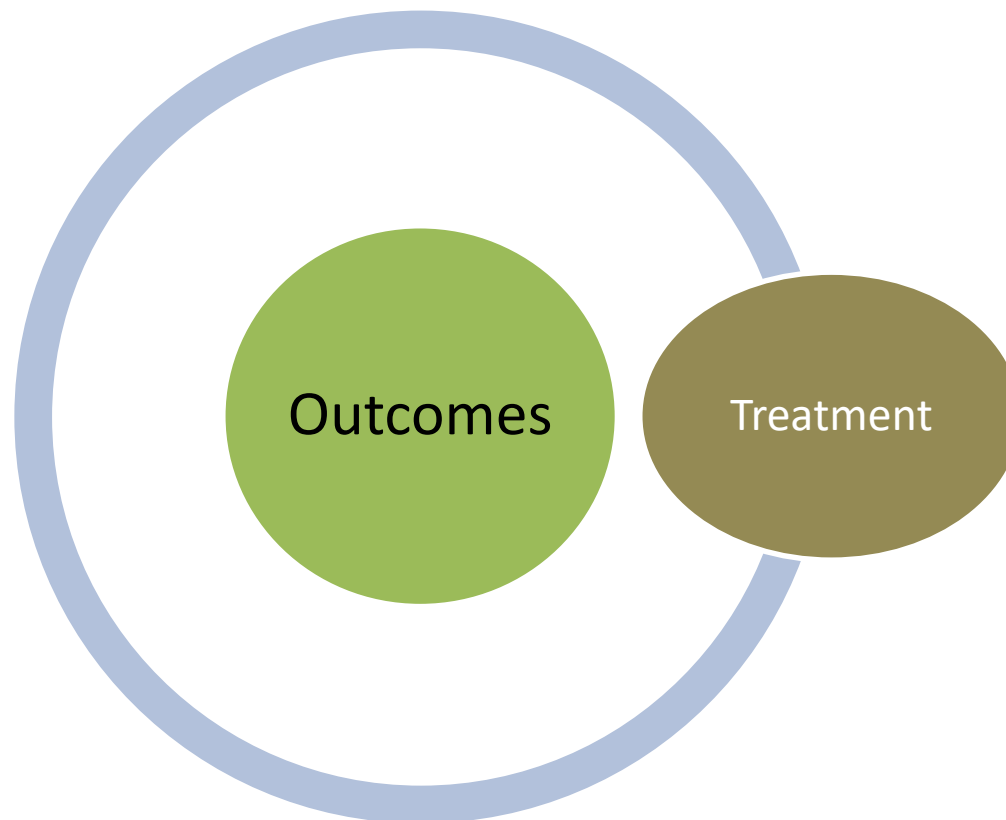
| Outcomes Overview

Outcomes can be complex and broad. The key metrics can include outcome measurement of a process or program effectiveness. Outcomes can also incorporate quality assurance and improvement, along with understanding interactions with multiple types of data sets (e.g., program outcome, cost, and referral patterns, etc.).

The primary focus of any outcomes is using reliable and valid measurement to provide evidence-based modeling. In addition, translation of the data should be continuous rather than expecting static measurement. When these methods are met, then large data sets provide incredible sources of information to predict, correct, and change current practices in healthcare.

The following information is provided as a comprehensive review of neurological rehabilitation outcomes at the post-hospital level of care.

Treatment Levels – Outcomes Analysis



Levels of Neurological Rehabilitation Services

There are multiple types and levels of care. The following are examples within the continuum of care in neurological rehabilitation.

Hospital Level (Inpatient) – only accounts for 10% of recovery

- *Intensive Care and Acute Care – Medical stability is the focus*
 - Length of Stay in hospital = 0-7 days for ICU and Step down care
 - Supervision = 1:1 care; 24 hour nursing and physician supports; medical personnel to provide supervision to the next level of inpatient care
 - Therapy Services typically include physical therapy, and speech therapy
 - Transition to an LTAC if deficits are more severe (Disorders of Consciousness)
- *Acute Inpatient Rehabilitation Facility (IRF) – increased mobility and medical stability is the focus*
 - Length of Stay in hospital = 7-21 days for Traumatic Brain Injury
 - Length of Stay in hospital = 7-12 days for stroke/CVA as a comparison
 - Supervision = 1:8 nursing care; 24 hour nursing and physician support
 - Therapy Services typically include physical therapy, occupational therapy, speech therapy, neuropsychology, case management, family supports
 - Family training for home (when possible), and family to provide full-time supervision at discharge

Levels of Neurological Rehabilitation Services

Post-Hospital Level (Inpatient-Community Residential)

- *Skilled Nursing Facility Care (SNF)*
 - Full time supervision by nursing staff (RNs and CNAs); weekly / monthly review with physician; Physician support is with Internal or Family Medicine
 - Includes Physical, Occupational and Speech Therapies
 - 50% return to acute care within 90 days of admission; LOS is 3 – 16 weeks
 - No neurobehavioral specialty
- *Post-hospital rehabilitation Care (PHR)*
 - Full time supervision by residential trained staff, nursing and weekly review with physician; Physician support is with Physical Medicine and Rehabilitation
 - Includes Physical, Occupational and Speech Therapies
 - Includes Life Skills adaptation and training
 - Includes behavioral supports and specialty behavioral care
 - 2% return to acute care within 1,000 days of admission; LOS is 3 – 18 weeks
- *Nursing Home Care (NH)*
 - Full time supervision by residential nursing staff and CNA supports
 - Minimal therapy is provided
 - Long-term care is primary focus; LOS is undetermined

Levels of Neurological Rehabilitation Services

Non-Residential Care *

- *Day Treatment Comprehensive Care*
 - Coordinated care with PT, OT, SP, Neuropsychology, Counseling, Case Management ranging from 3-5 days per week initially.
 - Continued services from inpatient residential programs with Inpatient Rehabilitation Facilities, and Post-hospital residential programs
 - Services provide a tapering effect so that each therapy services is “peeled away” from the individual as skills are learned and generalized.
 - Supervision: at the facility only during therapy; home supervision is part-time by family or caregiver support.
 - Vocational assistance may be provided.
- *Outpatient – Single service or uncoordinated care*
 - Combination of various services such as PT, OT, SP, and/or Psychology. Services continued until the need is completed.
 - Services range from 1-3 days per week.
 - Home supervision only – part-time or less by family.
 - Vocational assistance may be provided.
 - Highest level achieved prior to discharge.

Levels of Neurological Rehabilitation Services

Non-Residential Care

- *Home & Community Services*

- In home application of skills with professional services including PT, OT, SP
- Some therapy services may be provided at an outpatient center such as psychology / counseling.
- The focus is on the application initiation, self-care, home skills, money management in real world settings both at home and in the community.
- Supervision tends to be minimal in the home, but may be necessary at a visual level in the community.
- This level of care is necessary when deficits are likely chronic but the person is able to manage in the community with a “limited safety net” approach.
- The goal is to keep a person living and interacting in the community despite deficits that limit complete independence.
- A trend in the last few years has been on home and community emphasis to reduce cost overall.
- Non-employment productivity may also be the focus in activities such a volunteering, or participating in education programs.

| Treatment Efficacy



The efficacy of care has to be demonstrated to show that gains can be made for most levels of care; an underlying assumption is to prevent decline.

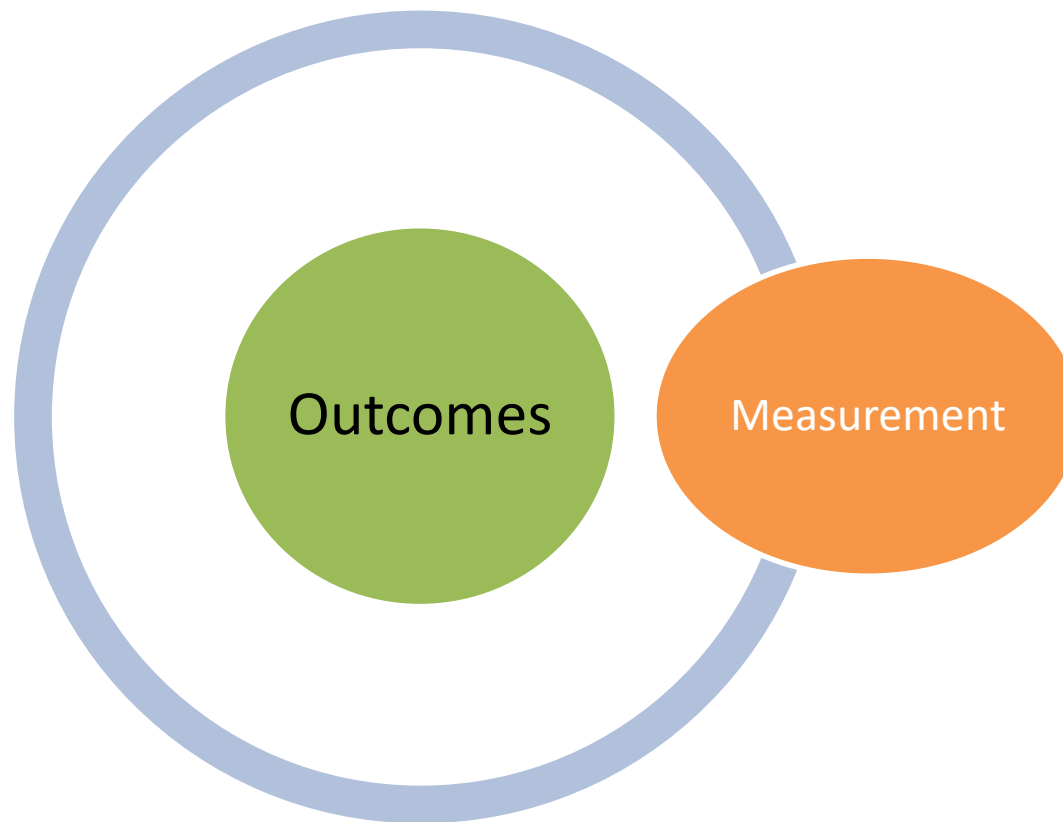
Considerations of Efficacy...

- Reduce disability over time.
- Application of skills to real-world context.
- Improved functional outcomes for community living.
- For those with long-term care needs, provide a healthy and safe environment with focus on producing medical, physical, cognitive, and emotional stability.
- Prevention of decline through the aging process.

Question: Does it work?

Answer: YES. Findings are clinically and statistically significant.

| Measurement – Outcomes Analysis



FIM vs. Mayo Portland

Understanding the differences between the use of the Functional Independence Measure (FIM) and the MPAI-4

- When to use the Functional Independence Measure (FIM) – Acute Care measurement (0-7; Higher is better); measures the level of assistance of an individual.
 - Acute Hospital Floor – NICU, Neuro step down
 - Acute Rehabilitation Center

- When to use the Mayo Portland Adaptability Inventory-4 (MPAI) Post-Acute Care Measurement (0-4; Lower is better); measures functional skills in applied setting – measures disability.
 - Post Acute Rehabilitation
 - Day Treatment
 - Outpatient
 - Home and Community



FIM vs. Mayo Portland

Understanding the differences between the use of the Functional Independence Measure (FIM) and the MPAI-4

Functional Independence Measure	Mayo Portland Adaptability Inventory – 4 th Edition
1 = Total Assistance (100%) or not testable	--
2 = Maximal Assistance (75%)	4 = Severe problem; interferes >75% of the time
3 = Moderate Assistance (50%)	3 = Moderate Problem, interferes 25-75% of the time
4 = Minimal Assistance (25%)	2 = Mild problem, interferes 5-24% of the time
5 = Supervision	1 = Mild problem, no interference
6 = Modified Independence	--
7 = complete independence	0 = Independent; No disability

Mayo Portland Adaptability Inventory 4th Edition

| MPAI-4 Subscales

- The Mayo Portland is now in the 4th revision; the ratings have been tested in multiple ways to refine what is measured and how this relates to rehabilitation planning and outcome (e.g., clinical interventions).
- Measure: 29 items that are evaluated with ratings that range from 0-4, and 6 additional items that record pre-injury and post-injury information about the person.
- Three subscales:
 - **Ability Index** (sensory, motor, and cognitive abilities)
 - **Adjustment Index** (mood, interpersonal interactions, family interactions)
 - **Participation Index** (social contacts, initiation, money management, residence)

Scoring Levels Review

Focus: think about the level of functional impairment of the participant

0 = no problems; no adaptive devices are used

1 = Mild problem, but does not interfere with activities; may use assistive device or medication to manage

2 = Mild problem; interferes with activities 5-24% of the time; 75% of the time the person adapts

SOME OF THE TIME

3 = Moderate problem; interferes with activities 25-75% of the time; 24% or less the person adapts

MUCH OF THE TIME

4 = Severe problem; interferes with activities 76-100% of the time; rarely can the person adapt

MOST OF THE TIME

| Abilities (Physical, Communication, Cognition)

Physical

Mobility (01): walking, moving, balance

Use of Hands (02): strength or coordination in one or both hands

Vision (03): problems seeing; double vision; visual field deficits

High Impact

Audition (04): problems hearing, ringing in the ears

Dizziness (05): feeling unsteady, lightheaded, or dizzy

Communication

Motor Speech (06): articulation, phonation, rate of speech

Verbal Communication (07-A): problems expressing / comprehending

Non-Verbal Communication (07-B): problems expressing thoughts through gestures, facial expression, or other non-language behaviors or understanding such expressions from others

| Abilities (Physical, Communication, Cognition)

Cognition

Attention/Concentration (08): problems ignoring distractions; difficulty shifting attention

Memory (09): problems learning and recalling new information

Fund of Information (10): information learned in school or on the job or general knowledge

Novel Problem Solving (11): problems generating solutions or picking the best solutions

Visual-Spatial Abilities (12): problems drawing, assembling things together, being visually aware of both the left and right sides

| Adjustment (Mood, Behavior, Social)

Anxiety (13): tense, nervous, fearful, phobic, symptoms of post-traumatic stress disorder such as nightmares, flashbacks of stressful events.

Depression (14): Sad, blue, hopeless, poor appetite, poor sleep, worry, self-criticism.

Irritability, Anger, Aggression (15): verbal or physical expressions of anger.

Pain and Headache(s) (16): pain complaints and behaviors; if pain originates from multiple body areas (head, back), then rate overall impact.

Fatigue (17): feeling tired, low in energy; fatigability, that is, feeling low in mental or physical energy after a relatively low level of mental or physical activity; fatigue may be a symptom of depression and should not be rated here.

Adjustment (Mood, Behavior, Social)

Sensitivity to Mild Symptoms (18): focusing on post-traumatic cognitive, physical, or emotional problems; this rating is based on how distressed or concerned the individual is about their functioning.

Inappropriate Social Interaction (19): acting childish, silly, rude; behavior not consistently fitting to the time and place or age-appropriate.

Impaired Self-Awareness (20): lack of recognition of personal limitations and disabilities and how they interfere with everyday activities, work or school.

Family/Significant Relationships (21): interactions with close others; describes stress within the family or those closest to the person with brain injury.

Participation (Initiation, Community Skills)

Initiation (22): problems getting started on activities without prompting

Social contact with friends, work associates, and other people who are not family, significant others or professionals (23): the frequency of contacts and consistency of relationships with people who are not related to or have a professional relationship with the person with brain injury

Leisure and Recreational Activities (24): involvement in hobbies, sports, and other active and passive activities primarily for enjoyment either alone or with others

Self-Care (25): involves eating, dressing, bathing, and hygiene; this considers the amount of independence with which basic self-care activities are performed

Residence (26): responsibilities of independent living and homemaking (such as meal prep, home repairs and maintenance), medication management, and personal health maintenance beyond basic hygiene

Participation (Initiation, Community Skills)

Paid Employment (28-A): work for pay; you can only rate on 28-A or 28-B; an unemployed person that is looking for employment is rated on 28-A, but if that person were returning to school or homemaking, then they are rated on 28-B.

Other Employment (28-B): unpaid work, such as, formal schooling, volunteer work, homemaking, and retirement for those over age 60.

Managing Money/Finance (29): shopping, keeping a checkbook or other bank account, managing personal income and investments

Supervision Rating Scale

Level 1: INDEPENDENT	
1	The patient lives alone or independently. Other persons can live with the patient, but they cannot take responsibility for supervision (for example, a child or elderly person).
2	The patient is unsupervised overnight. The patient lives with one or more persons who <i>could</i> be responsible for supervision (for example, a spouse or roommate), but they are all sometimes absent overnight.
Level 2: OVERNIGHT SUPERVISION	
3	The patient is only supervised overnight. One or more supervising persons are always present overnight but they are all sometimes absent for the rest of the day.
Level 3: PART-TIME SUPERVISION	
4	The patient is supervised overnight and part-time during waking hours, but is allowed on independent outings. One or more supervising persons are always present overnight and are also present during part of waking hours every day. However, the patient is sometimes allowed to leave the residence without being accompanied by someone who is responsible for supervision.
5	The patient is supervised overnight and part-time during waking hours, but is unsupervised during working hours. Supervising persons are <i>all</i> sometimes absent for enough time for them to work full-time outside the home.
6	The patient is supervised overnight and during most waking hours. Supervising persons are <i>all</i> sometimes absent for periods longer than one hour, but less than the time needed to hold a full-time job away from home.
7	The patient is supervised overnight and during almost all waking hours. Supervising persons are <i>all</i> sometimes absent for periods shorter than one hour.
Level 4: FULL-TIME INDIRECT SUPERVISION	
8	The patient is under full-time indirect supervision. At least one supervising person is <i>always</i> present, but the supervising person does not check on the patient more than once every 30 minutes.
9	Same as #8 plus requires overnight safety precautions (for example, a deadbolt on outside door).
Level 5: FULL-TIME DIRECT SUPERVISION	
10	The patient is under full-time direct supervision. At least one supervising person is always present and the supervising person checks on the patient more than once every thirty minutes.
11	The patient lives in a setting in which the exits are physically controlled by others (for example, a locked ward).
12	Same as #11 plus a supervising person is designated to provide full-time line-of-sight supervision (for example, an escape watch or suicide watch).
13	The patient is in physical restraints.

Vocational Independence Scale

Vocational Independence Scale

5 = Competitive (MPAI-4 Item 28A/B – Rating 0, 1)

Community-based work without external supports for >15 hours p/wk. Full-time school enrollment without external supports.

4 = Transitional (MPAI-4 Item 28A/B – Rating 1)

Community-based work with temporary supports (e.g., job coach, reduced hours) < 15 hours p/wk. School enrollment with temporary supports or less than full-time student course load.

3 = Supported (MPAI-4 Item 28A/B – Rating 2)

Community-based work, including volunteering, with permanent supports. School enrollment with permanent supports.

2 = Sheltered (MPAI-4 Item 28AB – Rating 3)

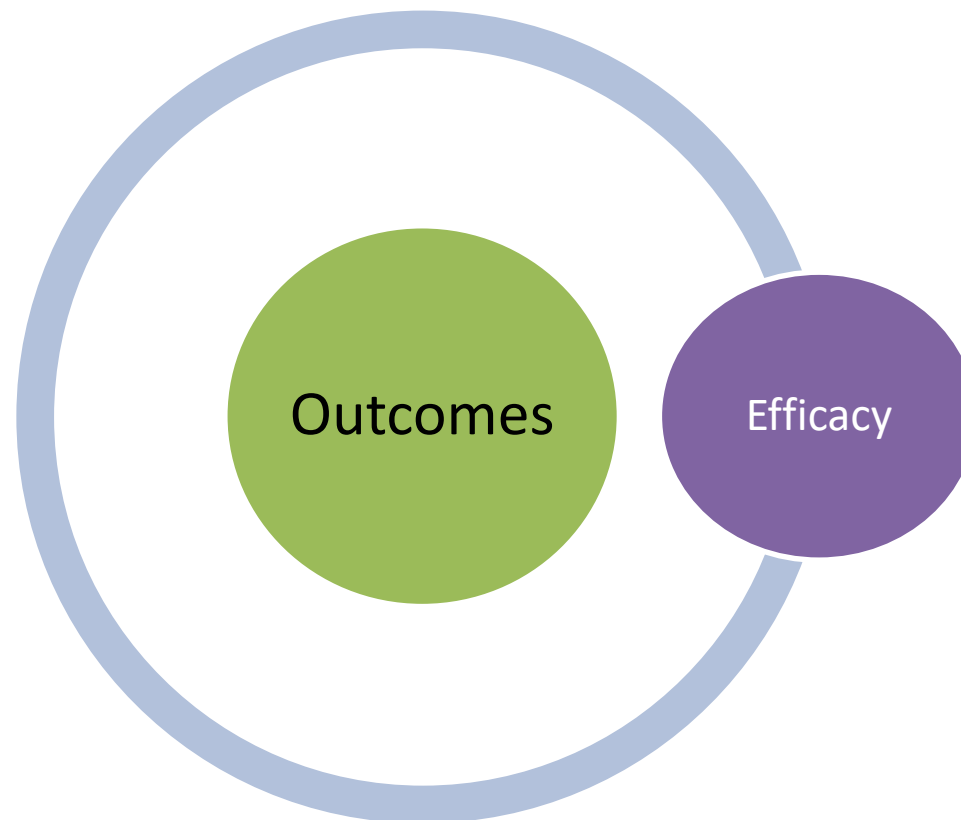
Work in a sheltered workshop (constant supervision)

1 = None (MPAI-4 Item 28A/B – Rating 4)

Unemployed / Not in school

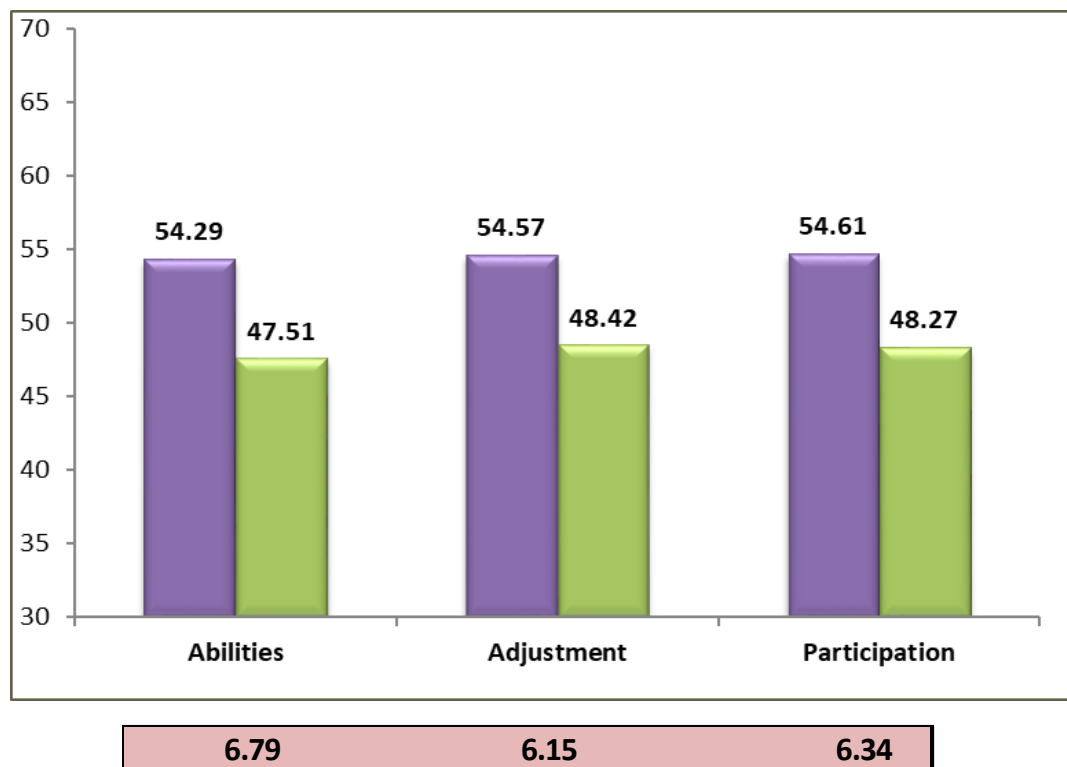
Note: 28A is for those with paid employment; 28B is non-paid employment

| Efficacy – Outcomes Analysis



Treatment Efficacy – post hospital

Reduce disability over time. This graph shows that lower scores are achieved across all types of treatment at the post-hospital level of care (N = 6,716).



Program Types:

Residential

Neurorehabilitation
Neurobehavioral
Supported Living
Adolescent Intensive

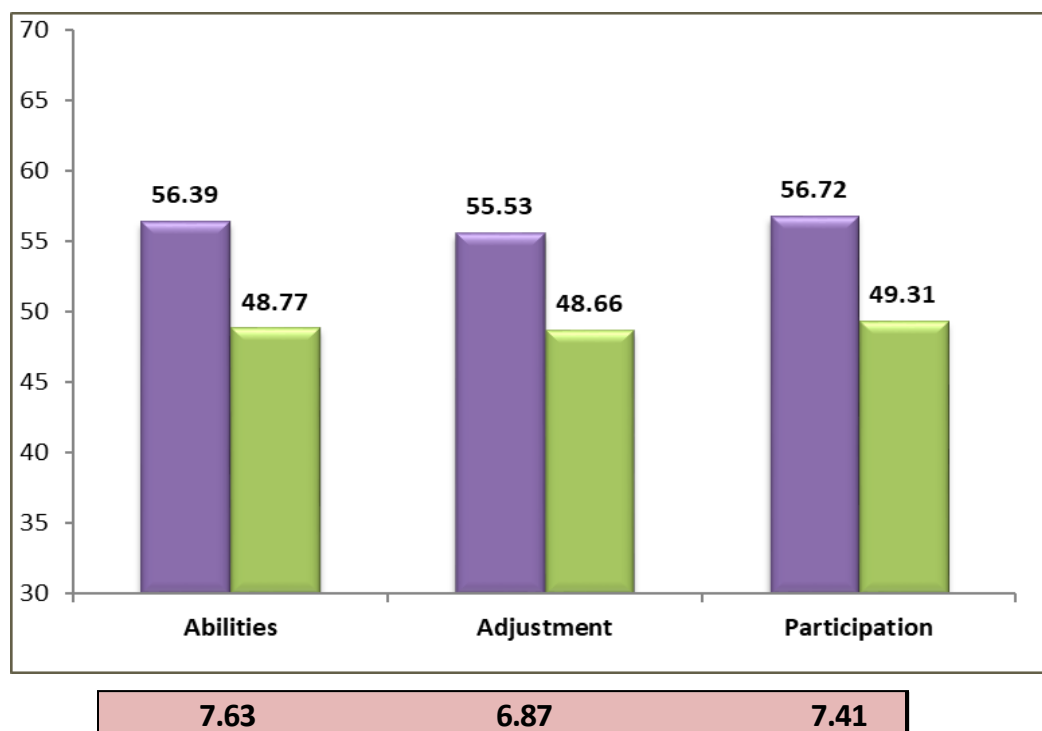
Non-Residential

Day Treatment
Outpatient
Home & Community

Average Age: 44 years

Treatment Efficacy

Reduce disability over time. This graph shows that lower scores are achieved with neurorehabilitation.



Program Types:
Neurorehabilitation
(N = 3,511)

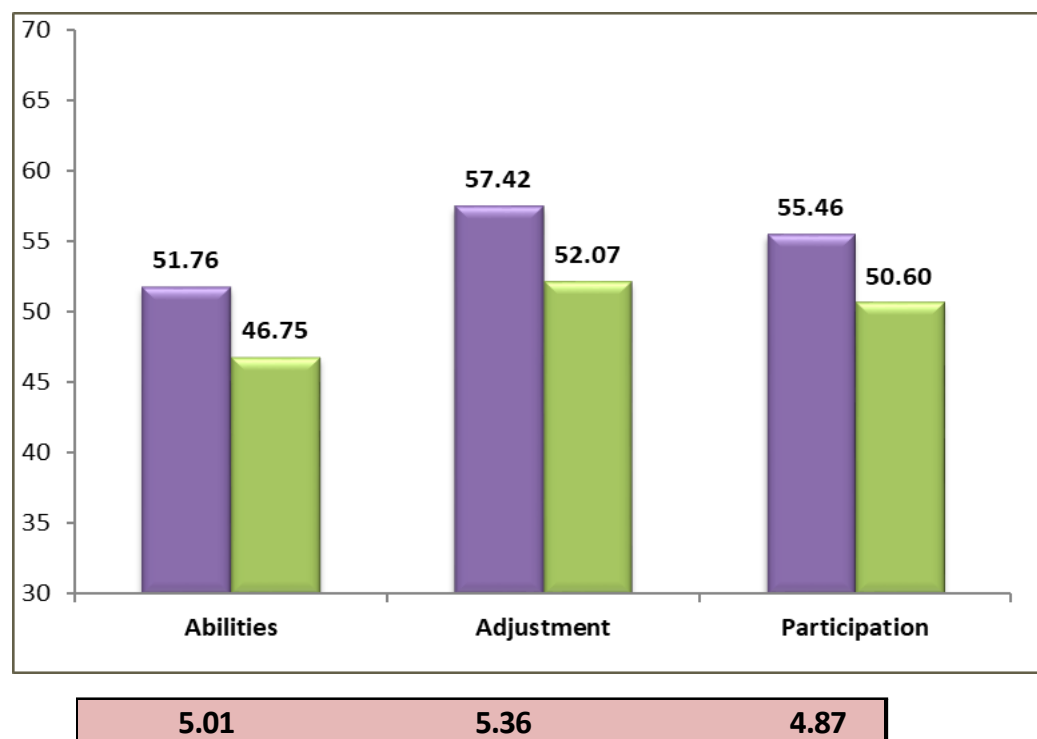
Average Age: 46 years

Greatest changes:
72% have services within a year of injury.

Improved: Mobility,
Upper extremities,
Communication,
Attention, Memory,
Problem solving, Visual
spatial skills; fatigue,
awareness; Initiation,
Self-care, Home Skills.

Treatment Efficacy

Reduce disability over time. This graph shows that lower scores are achieved with neurobehavioral intense persons.



Program Types:
Neurobehavioral (N = 461)

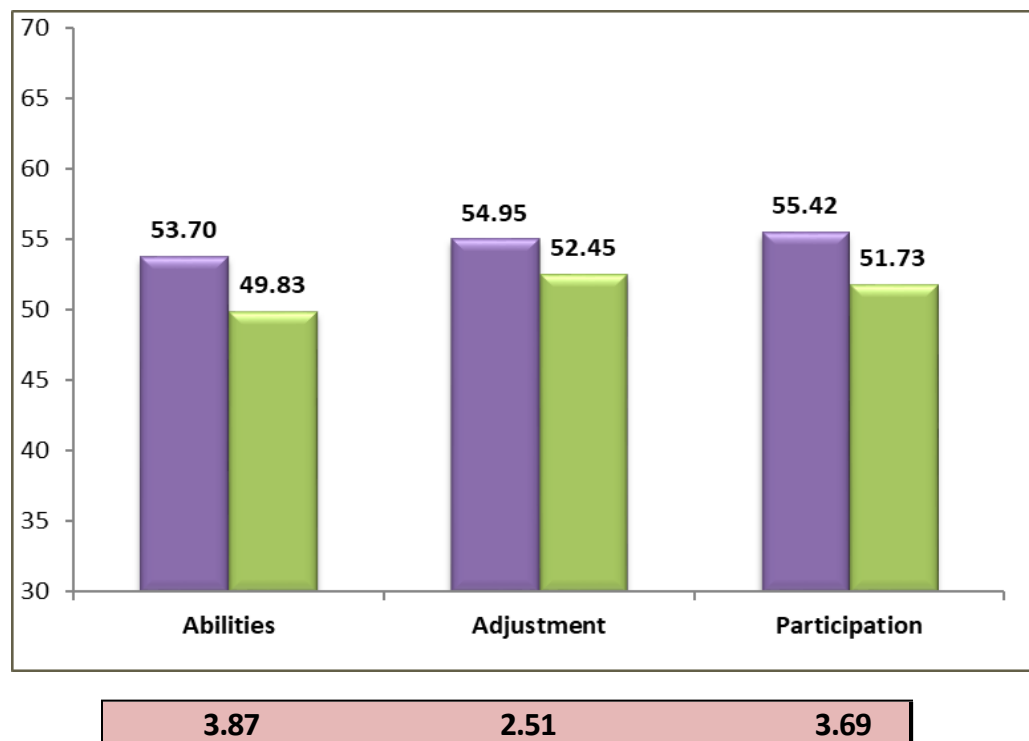
Average Age = 39 years

Greatest changes:
27% receive services
within a year of injury.

Improved: Communication,
Attention, Memory,
Problem solving; Anxiety,
Depression, Irritability,
Social Skills, Awareness;
Initiation, Social contact,
Leisure, Self-care, Home
skills, pre-employment

Treatment Efficacy

Reduce disability over time. This graph shows that lower scores are achieved with supported living environments focusing on health, safety, and quality of life.



Program Types:
Supported Living (N = 770)

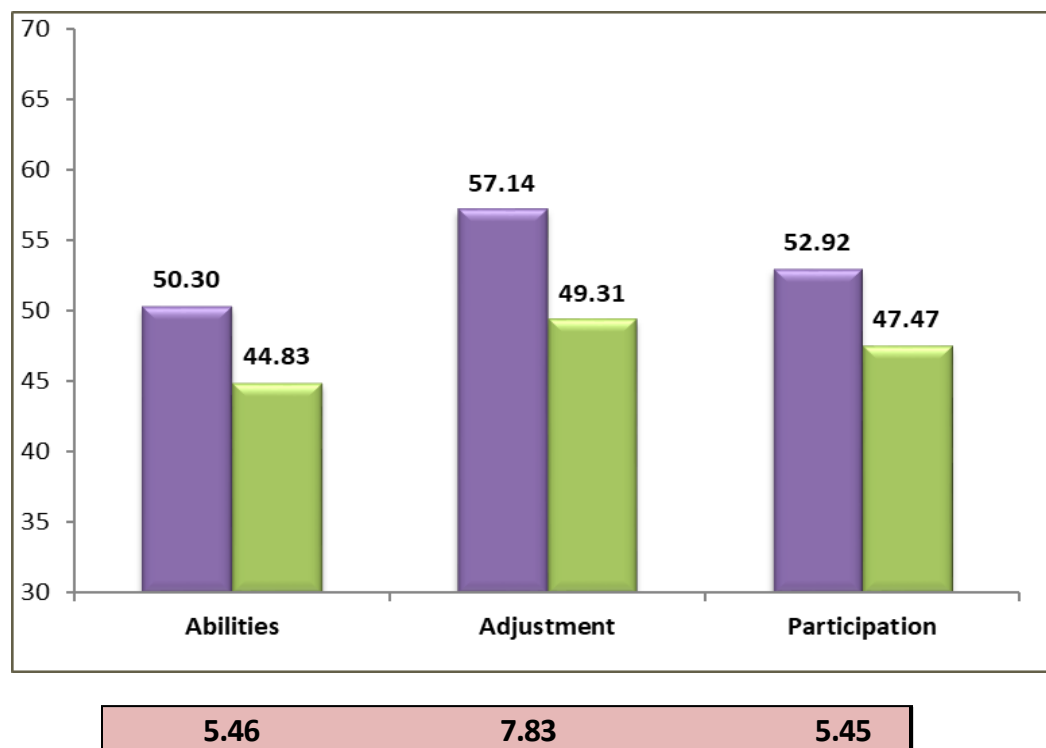
Average Age = 49 years

Greatest Changes:
25% of persons receive supported services within 1 year of injury.

Improved: Mobility, Communication, Memory; emphasis on Instrumental Activities of Daily Living including initiation, self-care, home skills, social and leisure activities, productive activities in the community.

Treatment Efficacy

Reduce disability over time. This graph shows that lower scores are achieved with pediatrics/ adolescents and with behavioral intensity.



Program Types:

**Adolescent Intensive
(N = 331)**

Average Age = 15 years

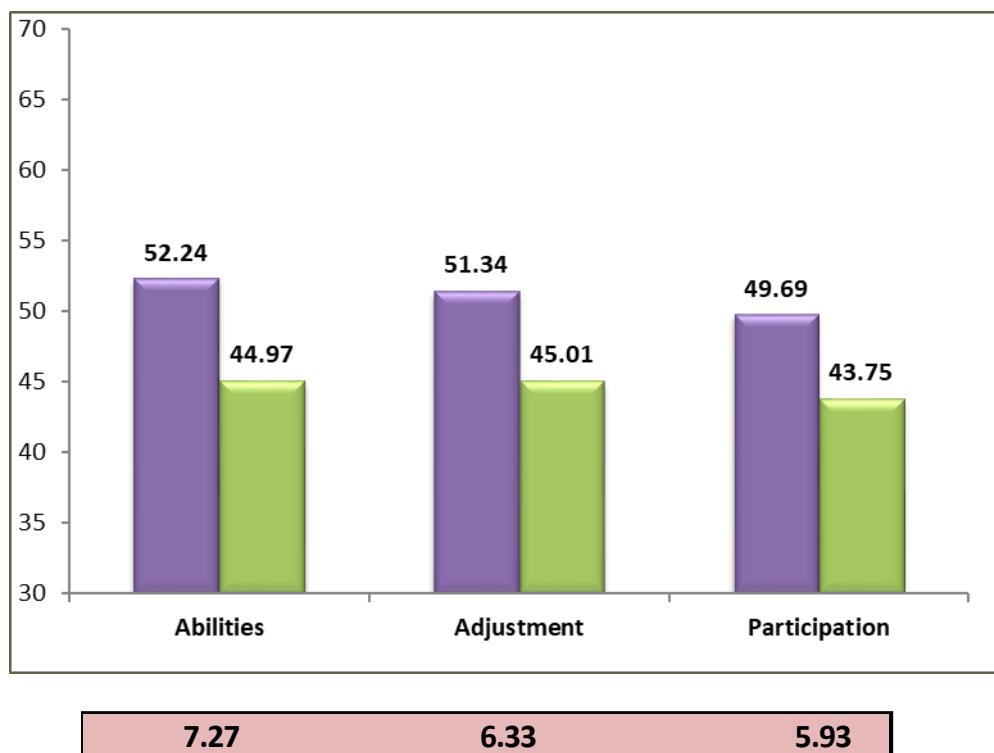
Greatest changes:

28% received services within
1 year of injury onset.

Improved: Mobility, upper
extremities; communication;
Attention, Memory,
Problems solving, Visual
spatial skills;
Neurobehavioral
improvements, Social skills,
Self-awareness, family
relationship; Initiation/
inhibition, leisure develop;
self-care and home skills.

Treatment Efficacy

Reduce disability over time. This graph shows that lower scores are achieved with a day treatment focus.



Program Types:
Day Treatment
(N = 1,147)

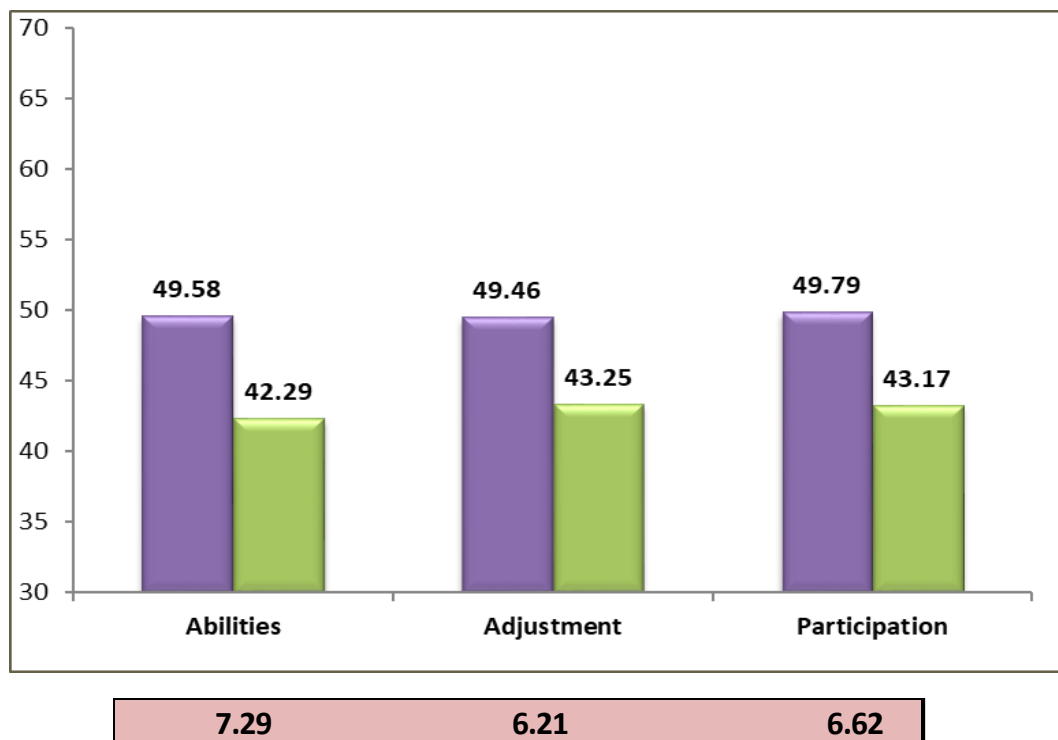
Average Age = 45 years

Greatest changes:
60% received services
within 1 year of their
injury.

Improved: Mobility, Upper
extremities,
Communication,
Attention, Memory,
Problem solving, Visual
spatial skills; fatigue,
awareness; Initiation, Self-
care, Home Skills.

Treatment Efficacy

Reduce disability over time. This graph shows that lower scores are achieved at the outpatient level.



Program Types:
Outpatient (N = 359)

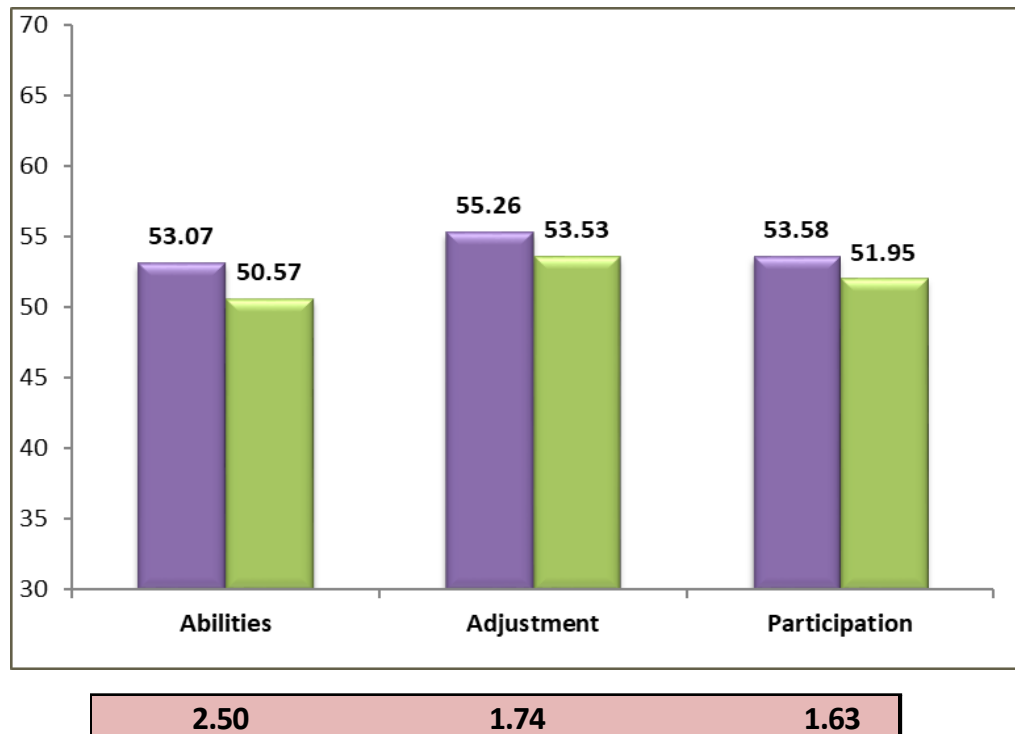
Average Age = 45 years

Greatest Changes:
46% individuals received services within 1 year of injury.

Improved: Mobility, Upper extremities, communication, attention, memory; Fatigue, self-awareness; Initiation, Social and Leisure, self-care, home skills, transportation, and productive activities.

Treatment Efficacy

Reduce disability over time. This graph shows that lower scores are achieved at the home and community integration level.



Program Types:
Home & Community
(N = 76)

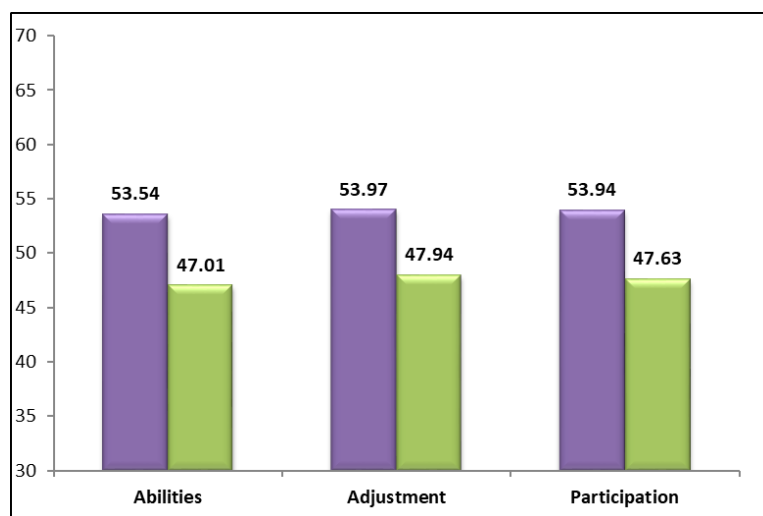
Average Age = 47 years

Greatest Changes:
30% of individuals
received services within
a year of injury.

Improved: Attention,
Memory, non-verbal
communication;
Irritability; Social Skills;
Home skills; Productive
activity; Managing
money.

Treatment Efficacy

Reduce disability over time. This graph shows that lower scores are achieved for men and women in program.



6.54

6.03

6.31

No differences in gains
between men vs. women in all
program types.

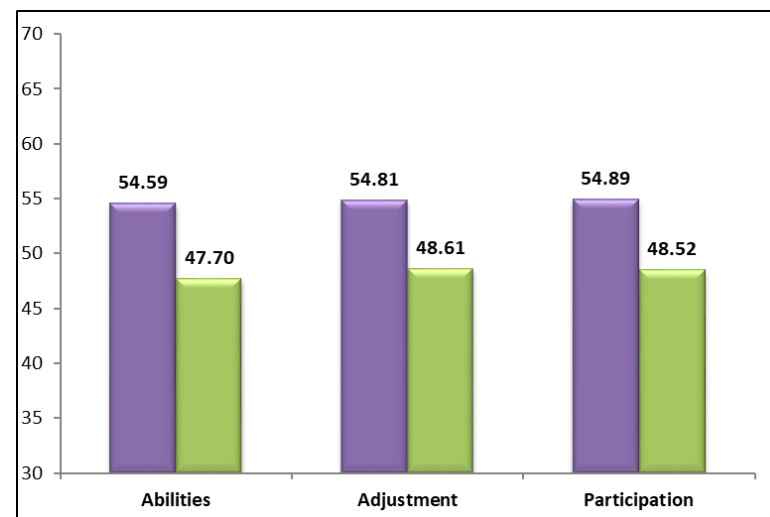
Program Types: ALL

Women = 1,935

Ave Age = 45 years

Men = 4,763

Ave Age = 44 years



6.89

6.20

6.37

Modeling Outcomes – Rasch Analysis

Statistical Methods

Demonstrating efficacy, reliability, validity and application.

Current Research emphasis:

1. Multiple Analysis of Variance – differences in treatment
2. Multiple Regression – prediction items
3. Quartile Analyses for performance – bias effects
4. Rasch Analysis for reliability, validity, and modeling

Infit

Outfit

Person Reliability

Item Reliability

Treatment Model of Care using Rasch



Audition

Dizziness

Motor Speech

Pain/Headache, Vision, Use of Hands

--

Inappropriate Social, Irritability, Symptom Sensitivity

Depression, Fund of Information, Visual Perception

Anxiety, Fatigue, Mobility, Non-Verbal Communication, Verbal Communication

--

Self-Care

Family Function

--

Initiation, Productivity

Attention, Impaired Awareness, Memory

Novel Problem Solving, Social Contact

--

Leisure and Recreation

Money Management

Home Skills

Transportation Use

Study 1 (2016) - original

N = 1,700 persons

Horn, Lewis & Malec

Study 2 (2023) - replication

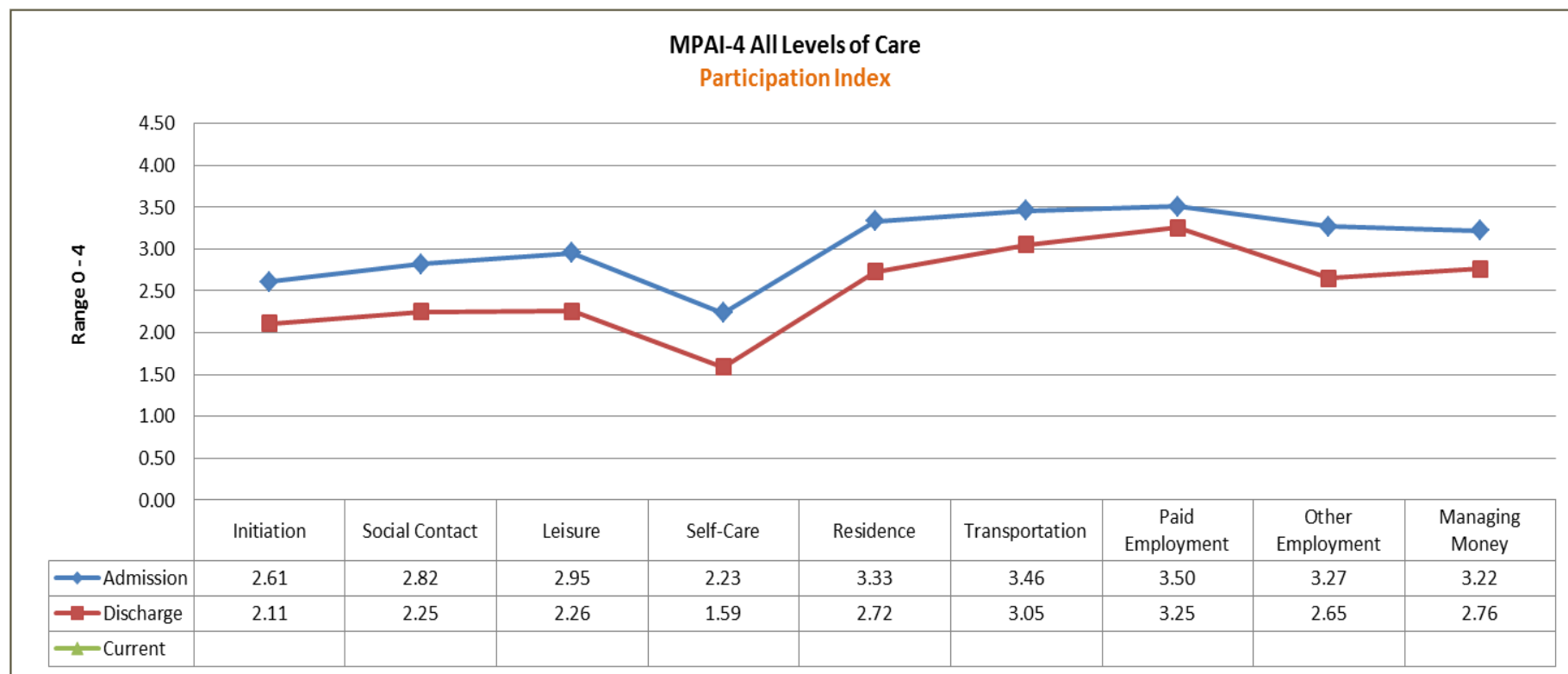
Lewis & Horn

Both studies provided the same model of care.

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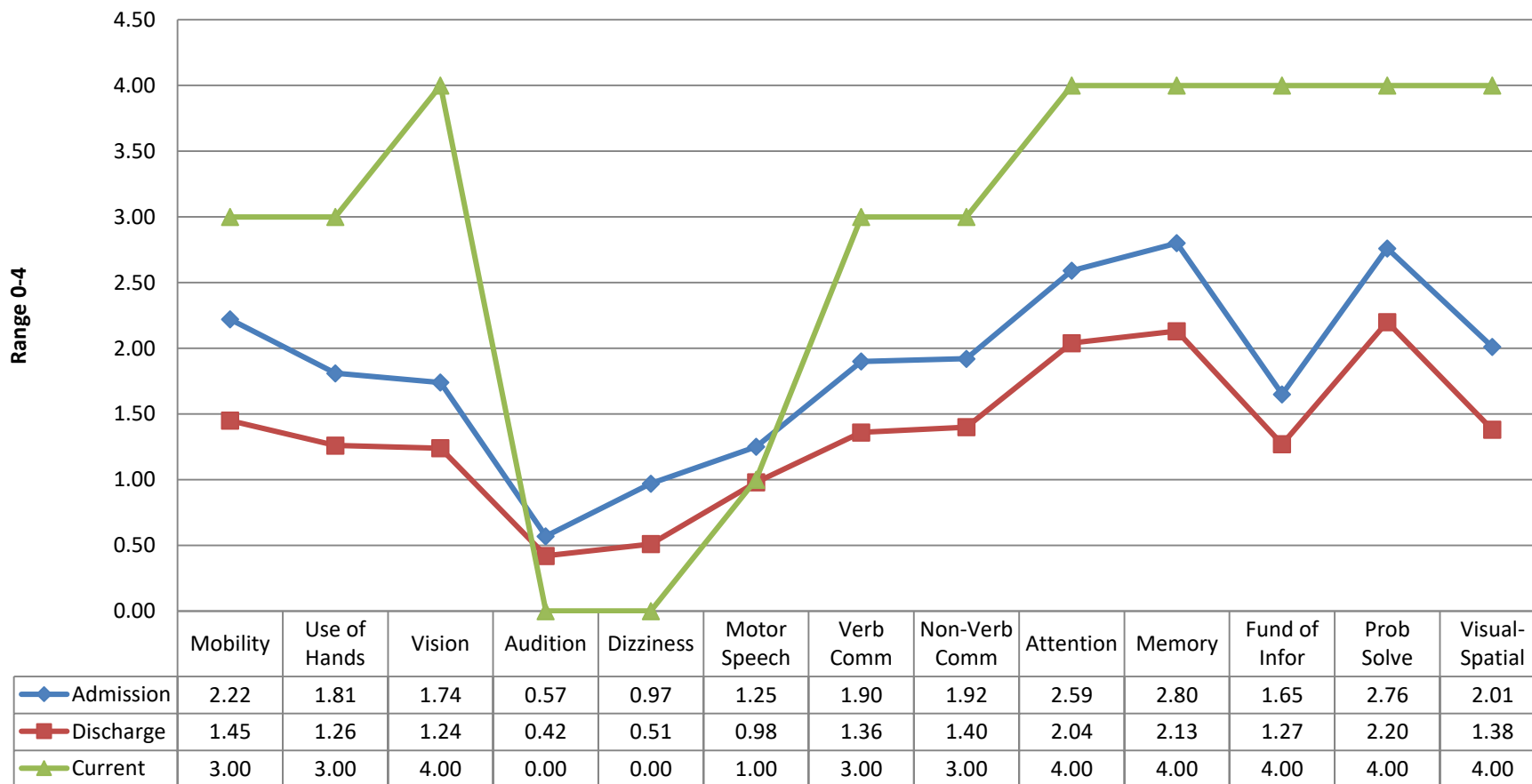
Considerations of Efficacy...

- Application of skills to real-world context.



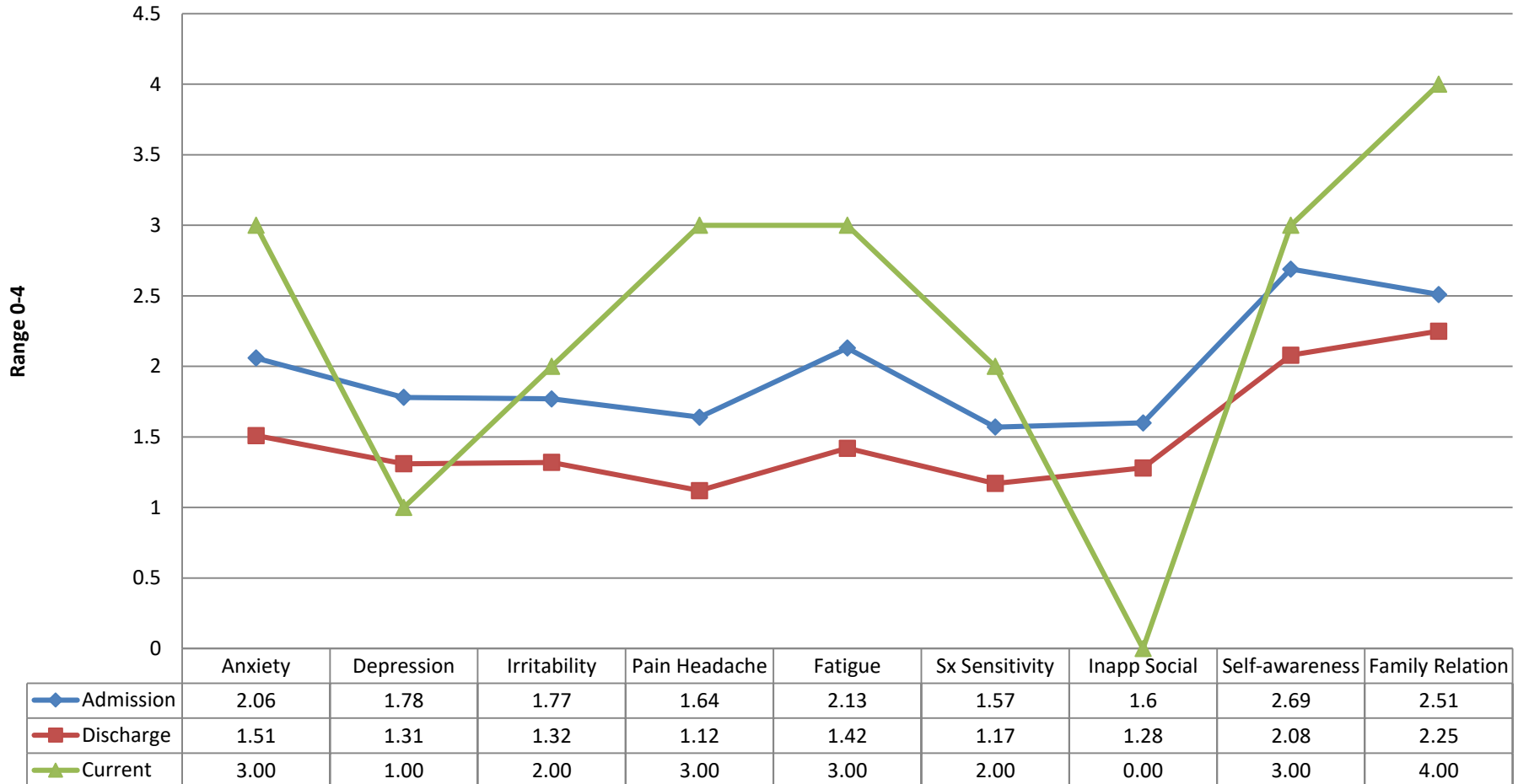
Clinical Application - Abilities

MPAI-4 Neurorehabilitation Ability Indices



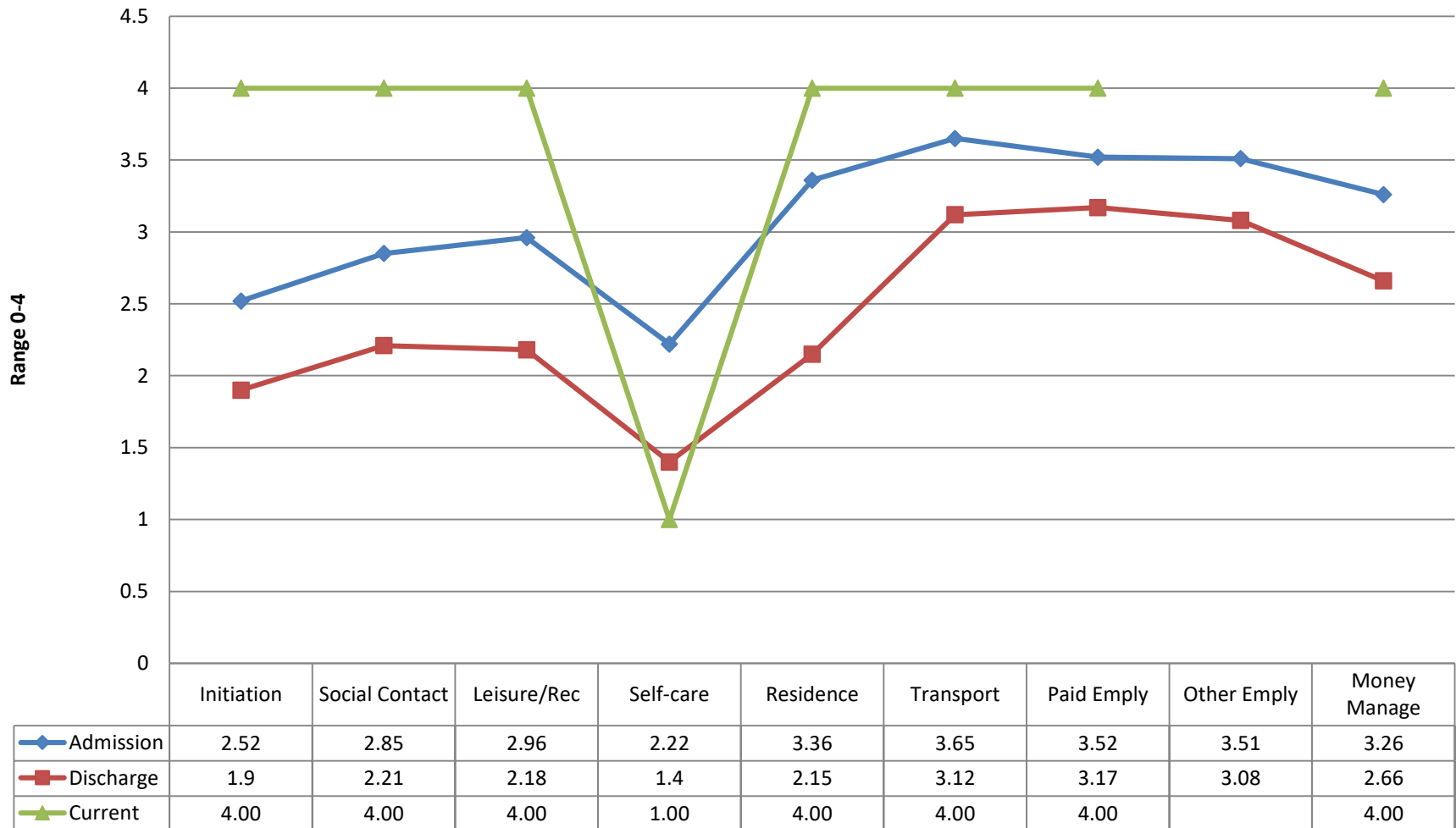
Clinical Application - Adjustment

MPAI-4 Neurorehabilitation Adjustment Indices

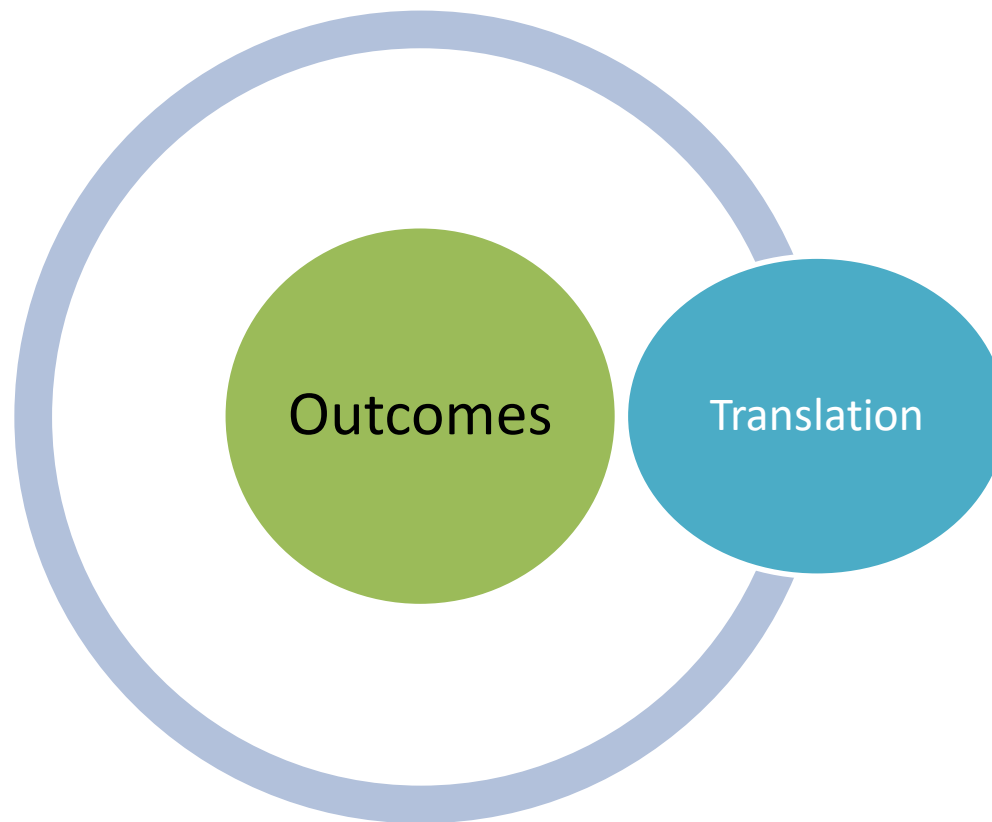


Clinical Application - Participation

MPAI-4 Neurorehabilitation Participation Indices



| Translation – Outcomes Analysis



| Treatment Efficacy



Targeted Interventions

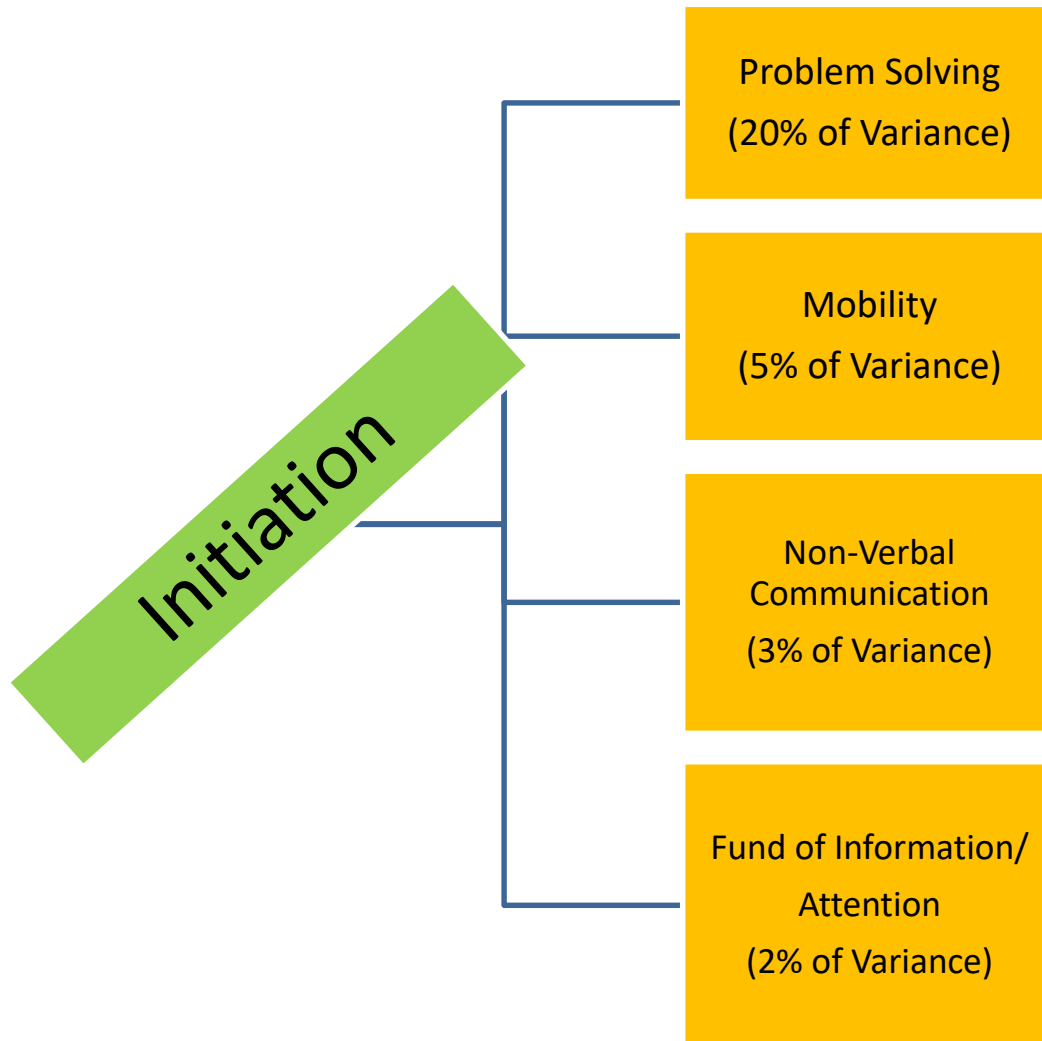
Improved functional outcomes for community living.

Targeted Interventions

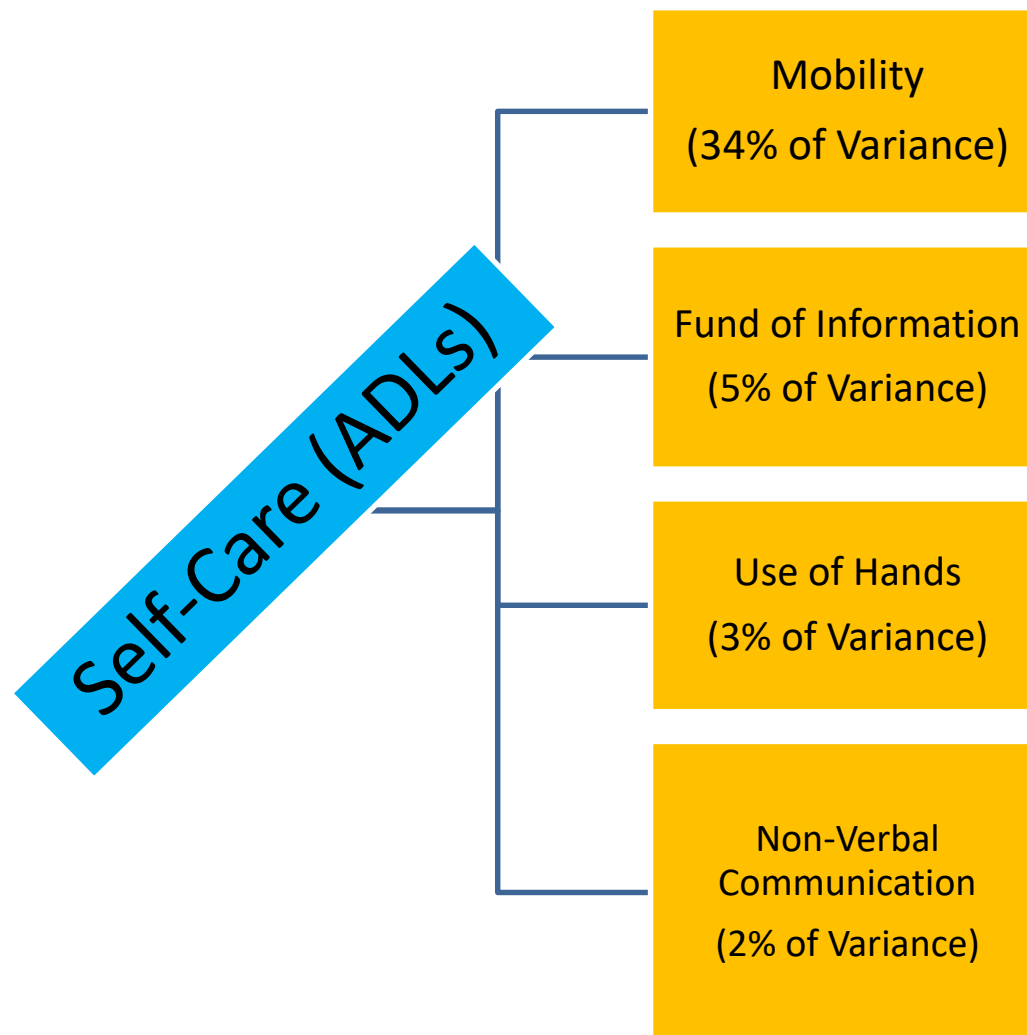
Research has demonstrated that Initiation, Self-Care skills and Home Skills are the key ingredients to all levels of care. Combined, these elements account for 48% of outcome in post-hospital care.

For long-term care, these skills are essential to healthy living and continue to work the brain in a capacity that reduces care cost (e.g., lower cost of supervision, greater focus toward independence).

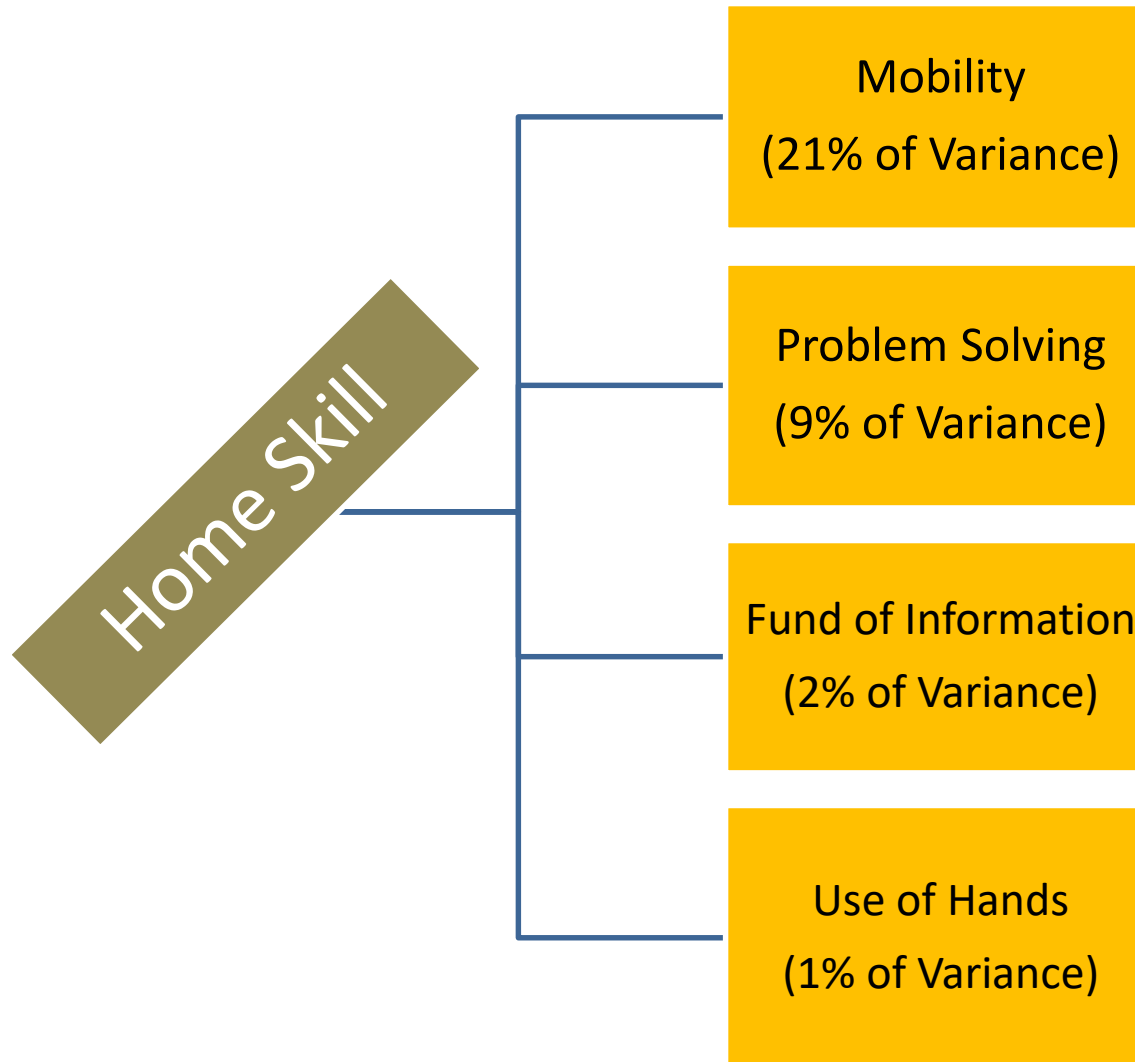
Treatment Efficacy – Targeted Interventions



Treatment Efficacy – Targeted Interventions



Treatment Efficacy – Targeted Interventions



| Long-term Outcomes – 1 year post discharge



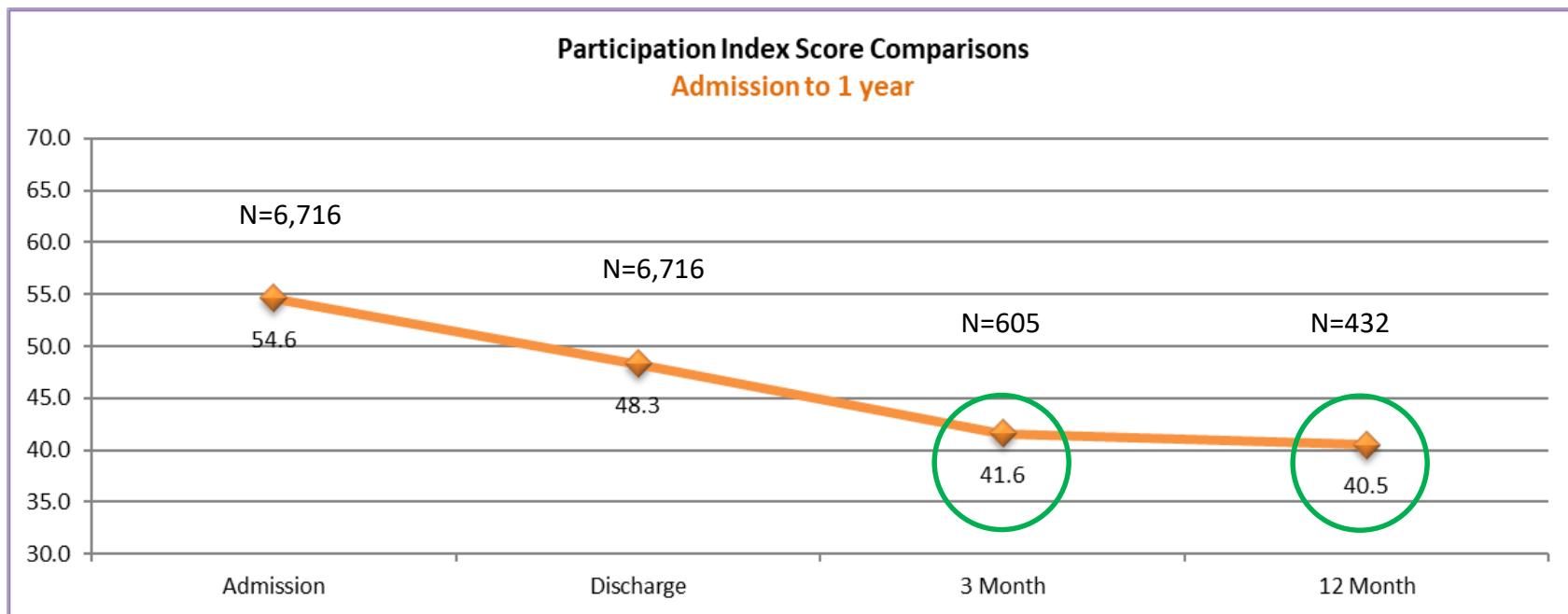
The efficacy of care has to be demonstrated to show that gains can be made, then maintained beyond treatment.

Considerations of Efficacy...

- Prevention of decline through the aging process.
- Treatment reduces disability at any level of care.
- Greater gains are made early in recovery.
- Durability of treatment has been demonstrated.

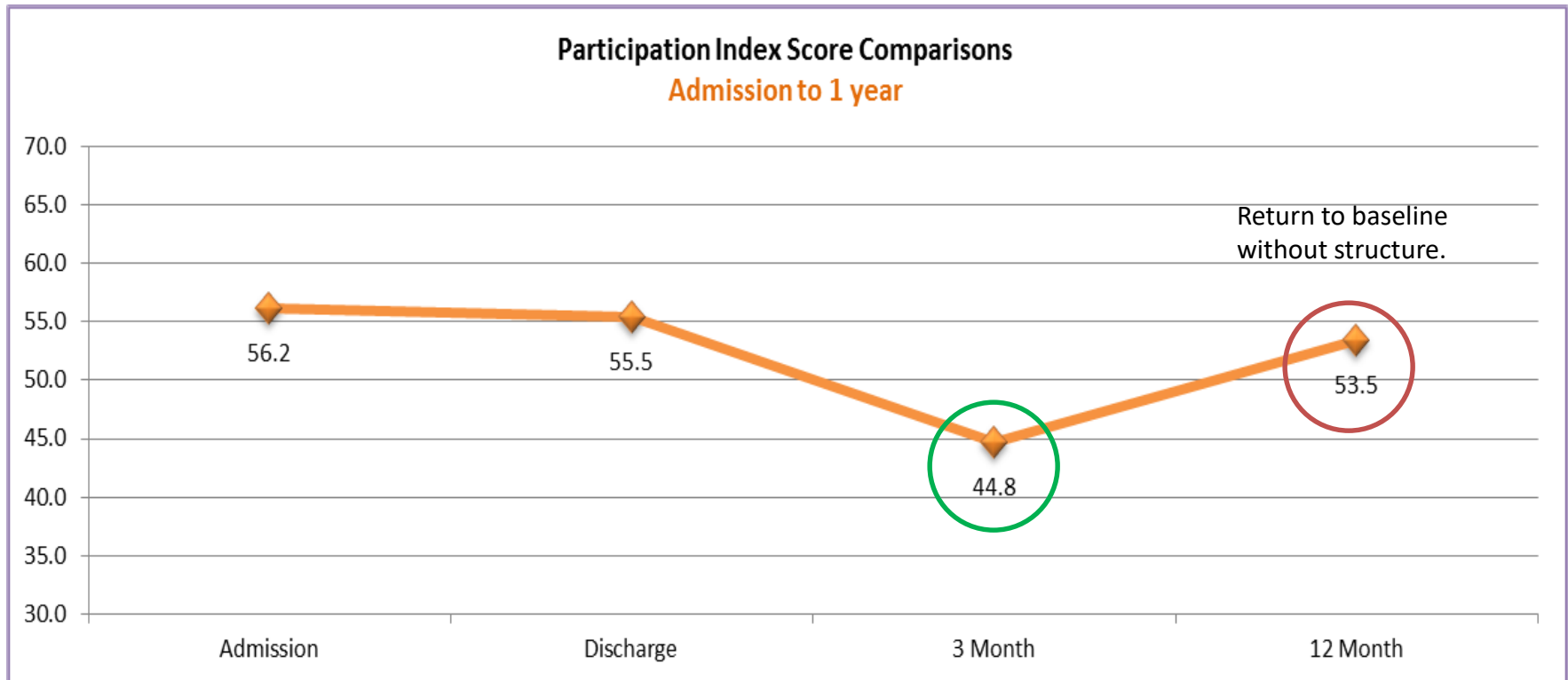
Lewis & Horn, 2022

Outcomes – 1 year post discharge



Goal: an individual will continue to maintain their gains; the graph demonstrates that phenomenon with appropriate care for the appropriate length of time.

Treatment Efficacy – Prevention with Supported Living



Goal: Individuals that are greater than 4 years post injury typically require ongoing supports and services, and tend to do better with continued structure. Without the structure and support, the individuals are at risk for decline in function (in this graph, higher score indicates greater disability)

Research and Analytics: Finding new things.

Research 2013

Horn, GJ & Lewis, FD (2013). Analysis of Post-Hospital Neurological Rehabilitation Outcomes (abstract). *The Journal of Head Trauma Rehabilitation*, 28(5), 25 (#0057).

Horn, G.J. & Lewis, F.D. (2013). Analysis of post-hospital neurological rehabilitation outcomes. Paper presented to the *North American Brain Injury Society (NABIS) Annual Meeting*, September 20, 2013 - Technology Lecture Series.

Lewis, F.D. & Horn, G.J. (2013). Functional impact of depression on traumatic brain injury outcomes. Presented at the *Special Operations Medicine Conference*, Tampa, FL.

Lewis, F.D. & Horn, G.J. (2013). Traumatic Brain Injury: Analysis of functional deficits and post-hospital rehabilitation outcomes. *Journal of Special Operations Medicine*, 13 (3), 56-61.

Research 2014-2015

Horn, G.J. & Lewis, F.D. (2014). A Model of Care for Neurological Rehabilitation. *AANLCP – Journal of Nurse Life Care Planning*, 14 (3), 681-691.

Horn, G.J., Lewis, F.D., Russell, R., & Harding, V. (2014). Pediatric Neurorehabilitation: post-hospital outcome comparisons. Accepted by the *World Congress 2014*.

Horn, G.J. & Lewis, F.D. (2014). Functional impact of anxiety on traumatic brain injury outcomes. Presented at the 91st American Congress of Rehabilitation Medicine, October 2014, Toronto, Canada. Published abstract in the *Archives of Physical Medicine & Rehabilitation*.

Lewis, F.D. & Horn, G.J. (2014). Post-hospital Brain Injury Rehabilitation: Comparison of neurobehavioral intensity and neurorehabilitation outcomes. Presented at the 91st American Congress of Rehabilitation Medicine, October 2014, Toronto, Canada. Published abstract in the *Archives of Physical Medicine & Rehabilitation*.

Russell, R., Horn, G.J., Lewis, F.D. & Harding, V. (2014). Pediatric Neurorehabilitation: post-hospital outcome comparisons. Paper presented at *2014 Research Symposium for Master's in Public Health*, Benedictine University, College of Education and Health Services, Lisle, IL.

Lewis, F.D. & Horn, G.J. (2015). Neurologic Continuum of Care: Evidence-based Model of Post-hospital System of Care. *Neurorehabilitation* (Accepted January 19, 2015; Spring, 2015 release).

Research 2016-2017

Horn, GJ, Lewis, FD & Malec, JF (2016). Rehabilitation Modeling: Using the Rasch Analysis for evidenced-based care, *Archives of Physical Medicine and Rehabilitation*. (Presented at the American Congress of Rehabilitation Medicine – Chicago, Illinois).

Horn, GJ, Lewis, FD & Pipitone, J (2017). Clinical challenges of craniopharyngioma: Neurobehavioral sequelae and complex outcomes. *Neurologic Disorders and Therapeutics*, 1(2), 1-5.

Lewis, FD, Horn, GJ & Russell, R. (2017). Examination of Post-Hospital Residential Brain Injury Rehabilitation Outcomes Across the Age Spectrum. *International Journal of Physical Medicine & Rehabilitation*, 5(1), 1-6.

Lewis, FD, Horn, GJ & Russell, R. (2017). Impact of Chronicity on Outcomes Following Post-Hospital Residential Brain Injury Rehabilitation: Application of Multivariate Statistics and Rasch Analysis. *Open Journal of Statistics*, 7, 254-263.

Lewis, FD & Horn, GJ (2017). Depression following traumatic brain injury: Impact on post-hospital residential rehabilitation outcomes. *NeuroRehabilitation*, 40, 401–410.

Malec, JF & Keene, J (2016). Post-Inpatient Brain Injury Rehabilitation Outcomes: Report from the National OutcomeInfo Database. *Journal of Neurotrauma*, 33, 1371–1379.

Research 2018-2023

Lewis, FD & Horn, GJ (2018). Traumatic brain injury and Cerebral vascular accident: Applications of Rasch Analysis to examine differences in disability and outcome in post-hospital rehabilitation. *Open Journal of Statistics*, 8, 670-683.

Horn, GJ, Lewis, FD, Malec, J, Papadimitriou, C, Kersten, P, O'Donoghue, CR, Meixner, C, Harding, V. (2019). Diversity of Outcomes: From person-centered to international rehabilitation perspectives. 4 hour workshop presented at the American Congress of Rehabilitation Medicine, Education Institute, Chicago, IL United States.

Lewis, FD & Horn, GJ (2019). Prediction of functional outcome in post-hospital brain injury rehabilitation. *Journal of Behavioral and Brain Science*, 9, 406-416.

Horn, GJ & Lewis, FD (2022). Residential Rehabilitation: Return on investment one year after discharge. 99th ACRM Annual Conference, Chicago, IL.

Lewis, FD & Horn, GJ (2023). Comparison of TBI and CVA Outcomes: Durability of gains following post-hospital neurological rehabilitation. *Neurorehabilitation* (Accepted).

Rasch Analysis Application

Bond T, Fox C. (2007). Applying the Rasch Model: Fundamental Measurement in the Human Sciences (2nd Ed.). Mahwah, NJ: LEA.

Grimby, G., Tennant, A. & Tesio, L. (2012). The use of raw scores from ordinal scales: time to end malpractice? Journal of Rehabilitation Medicine, 44(2), 97.

Malec JF, Hammond FM, Giacino JT, Whyte J, Wright J. (2012). A structured interview to improve the reliability and psychometric integrity of the Disability Rating Scale. Archives of Physical Medicine and Rehabilitation, 93, 1603-8.

Malec, J.F. & Lezak, M.D. (2008). Manual for the Mayo-Portland Adaptability Inventory (MPAI-4) for adults, children, and adolescents. Santa Clara, CA: The Center for Outcome Measurement in Brain Injury.

Merbitz, C., Morris, J., & Grip, J.C. (1989). Ordinal scales and foundations of misinference. Archives of Physical Medicine and Rehabilitation, 70(4), 308-312.

Tesio, L. (2003). Measuring behaviours and perceptions: Rasch analysis as a tool for rehabilitation research . Journal of Rehabilitation Medicine, 35, 105–115.

Questions



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