Walking the walk: Translation of Scientific Findings to Improve Locomotor Recovery Post-stroke

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Outline

• Introduction: Interventions to improve walking function for patients post-stroke
  – What do we do?
  – What do we know?
  – How can we do what we know?

• Potential strategies for applying what we know?
  – Preliminary studies
  – Randomized controlled trials

• Application to Clinical Practice

What do we do?: Treatment of Patients Post-Stroke

COORDINATION

STRENGTH

FLEXIBILITY

SPASTICITY

BALANCE

Locomotion

What do we do?: Treatment of Patients Post-Stroke

COORDINATION

STRENGTH

SPASTICITY

FLEXIBILITY

BALANCE

Wheelchair Transfers Locomotion Standing Stairs
What do we do?: Treatment of Patients Post-Stroke

COORDINATION  FLEXIBILITY  BALANCE

STRENGTH  SPASTICITY

Wheelchair  Transfers  Locomotion  Standing  Stairs

What do we do?: Distribution of Physical Therapy Activities

• Derived from outpatient observations (Moore et al, 2010, Stroke)
• Similar in inpatient stroke rehabilitation (Bernhardt et al 2004)

Practice of multiple activities to improve multiple impairments/functional limitations

What do we do? Other priorities driving rehabilitation interventions

• Minimize excessive abnormal behaviors/limit spasticity (Bobath 1990) – limit effort/intensity of exercise
• Treatment through levels of progression as capable

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What do we know?: Principles of Neuroplasticity

• Animal/human studies have identified specific factors that influence neuroplasticity (Kleim and Jones 2008)
  1. Use it or lose it*
  2. Use it and improve it*
  3. Specificity Matters
  4. Repetition Matters
  5. Intensity Matters
  6. Time Matters
  7. Salience Matters
  8. Age Matters
  9. Transference
  10. Interference
What do we know?: Principles of Neuroplasticity

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8. Age Matters
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What do we know?: Contributions of specificity to improve walking function

- Stepping practice is related to improvements in stepping performance
  - animals: Deleon 1998, 1999

- Non-stepping practice
  - Balance training improves balance, minimally affects walking (Hui-Chan et al 2009)
  - Strength training improves strength, . . . (Patten et al 2004; Jayaraman et al 2013)

What do we know?: Contributions of amount and intensity improve walking function

- Amount of practice
  - Animal studies - Cha et al 2007
  - Clinical practice - 200-800 steps/session in stroke/SCI; Lang et al 2009, Moore et al 2010

- Clinical practice: 200-800 steps/session in stroke/SCI - Lang et al 2009, Moore et al 2010

**Dose** vs **Response**

- A: Stepping activity during clinical PT
- B: Stepping activity during intensive LT
- C: A daily stepping practice during PT/IL
What do we know?: Principles of Neuroplasticity

- Contributions of **amount** and **intensity** improve walking function
  - Amount of practice
    - Animal studies – Cha et al 2007
    - Clinical practice: 200-800 steps/session in stroke/SCI - Lang et al 2009, Moore et al 2010

- Intensity of practice
  - Faster stepping training improves performance vs slow training
  - Higher stepping intensities improves performance (Hornby et al 2008, Holleran et al 2015 JNPT)
  - Clinical practice: 2.8 min/5% time in aerobic intensity zone (Mackay and Makrides 2003)

What else do we know? Caveats of available research

- Just forward treadmill training without high-intensity doesn’t improve outcome better than non-walking exercise (Duncan et al 2011)

- Forward treadmill training does not:
  - improve balance function in patients post-stroke (Macko et al 2005)
  - improve community activities (Macko et al 2008)

- One size (strategy) doesn’t fit all
  - Non ambulatory patients perform better with treadmill training (DON’T NECESSARILY NEED BWS) – Ada et al 2010
  - Ambulatory patients perform better overground (Combs et al 2013)

- “Principles” don’t address concept of errors and variability

Contribution of errors and variability of locomotor practice??

- Perfect practice doesn’t necessarily make perfect!! – Guidance Hypothesis

- Augmenting errors during learning may enhance magnitude/accelerate learning (Bastian 2006, Reisman et al 2010)

- Greater errors associated with variable contexts
  - Task/environmental variability
    - Shah et al 2012 - Forward vs variable treadmill training
    - van den Brand et al 2012- Forward treadmill vs Overground/stairs

- What should be variable? How much? When?
How can we apply what we know?

- Maximize practice of goal-specific, attainable tasks – what does that mean?
- Practice tasks that may accomplish multiple goals
- May need to compromise certain “tenets”
  - Intensity – how much of a risk (Pang et al 2013)?
  - Progression – do I need to progress stepwise (Horn et al 2005)?

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- Potential strategies for applying what we know?
  - Preliminary studies
  - Randomized controlled trials
Preliminary Study

- **Feasibility and Potential Efficacy of High Intensity Stepping Training in Variable Contexts in Subacute and Chronic Stroke**

- **Subjects:**
  - 25 individuals post single, unilateral supratentorial stroke
  - 18-75 years old
  - MMSE score ≥23/30
  - Moderate assistance or better to ambulate < 0.9 m/s self-selected walking speed
  - 10 w/ chronic stroke (> 6 mo, all ambulatory, avg duration = 41.2 mo)
  - 12 w/ subacute stroke (1-6 mo, **3 non-ambulatory**, avg duration = 3.2 mo)

(Holleran et al, 2014)

Methods: Design and Outcomes

- **Testing (un-blinded):**
  - BSL, 4 week (MID), 8 week (POST), 3 month follow-up (F/U)
  - Chronic subjects received pre-BSL 1 month prior

- **Locomotor outcomes:**
  - Daily stepping activity (within and outside of training session)
  - Gait speed (Self-selected & fastest speed)
  - 6MWT
  - Gait kinematics & spatiotemporal symmetry
  - Peak VO2, gait efficiency and economy

- **Non-locomotor outcomes**
  - 5X sit-to-stand (time/kinematics/kinetics)
  - Berg Balance Scale

Methods: Intervention

- 36-40 1hour training sessions over 8-10 weeks
- Continuous monitoring of stepping activity, HR, Borg RPE
- **Protocol:**
  - Week1-2: All forward treadmill training
    - Maximize speed/repetition/CV intensity
  - Weeks 3-8: Variable task, environment, and multi-directional stepping
    - Half treadmill: 25% speed training, 25% dynamic balance
    - Half overground: 25% speed/balance, 25% stairs

- **Priorities of training**
  - Focus only on reciprocal stepping
  - High aerobic intensity (70-80% heart rate reserve, up to 18 RPE)
  - Challenge enhanced with error augmentation, variable task practice and environmental context
Challenging Biomechanical Subcomponents of Walking

- Weight bearing/propulsion
  - Guidance/Assist as needed – weight support, slow speeds
  - Error Augmentation –
    - Reduce weight support/assist as tolerated
    - Increase speed, propulsive demands/add weighted vest

- Leg swing
  - Guidance/Assist as needed – manual/elastic assistance
  - Error Augmentation – elastic resistance, leg weights, stepping over obstacles

- Medial-lateral/anterior-posterior stability
  - Guidance/Assist as needed – stabilize trunk, assistive devices
  - Error Augmentation – balance perturbations

Primary locomotor outcomes

- Daily stepping activity
  - Per day prior to, during and following training (post and follow-up)
  - Stepping activity during training (ave = 2873 steps per session, ~4000 during only treadmill training)
Primary locomotor outcomes

- **Gait velocity:**
  - SSV: chronic = 0.23 m/s; subacute = 0.33 m/s (Effect size -1.34-1.64)
  - FV: chronic = 0.38 m/s; subacute = 0.54 m/s (ES: 1.53-1.62)
  - Recent published changes = 0.18 m/s (Ada et al 2003; different inclusion), subacute ~0.25 m/s (LEAPS)

- **Six minute walk test:**
  - chronic = 90 m; (Ada et al 2003 ~60 m)
  - subacute = 144 m; recent ~80 m (LEAPS)

- 33-50% reduction in O₂ cost (ES: 0.62-1.08)

- No relation between initial walking status and improvements
Non-locomotor outcomes

- Five times sit-to-stand improvements
  - 25% chronic
  - 40% subacute

- Berg Balance Scale
  - 6 pts chronic
  - 8 pts subacute (~21 pts in non-ambulatory subjects)

Randomized Controlled Trial: 
Very Intensive Early Walking post-Stroke (VIEWS)

- Subjects:
  - Subacute (1-6 months post-stroke)
  - Ages 18-75
  - Single, unilateral supratentorial stroke
  - Follows 3-step commands or MMSE ≥ 23
  - Moderate assistance or better to ambulate < 0.9 m/s self-selected walking speed
  - Blocked stratification for walking speed prior to randomization

- Outcomes (blinded)
  - Primary: self-selected and fastest walking speeds, 6 min walk test
  - Secondary: 5X sit-to-stand, Berg Balance Scale

(VIEWS: Design)

Experimental

- Focused stepping training
- High aerobic intensity (70-80%HRR)
- Skilled variable task practice on treadmill and overground
- No concurrent physical therapy

Control

- Multiple activities, limited practice of any single task (Lang et al 2009, Moore et al 2010)
  - Walking: 500-1000 steps/session
  - Balance: 12 reps/session
  - Strength: ~50 repetitions
  - Passive ROM - ~10 reps
  - Transfers: ~10 reps
- 30-40%HRR
- Concurrent physical therapy
VIEWS: Results

- **Total recruitment**
  - 15 experimental, 17 control
  - No significant differences in age, duration post-stroke, or baseline walking function

- **Duration**
  - 36-40 1 hour training sessions over 8-10 weeks
  - Similar number of therapy sessions between groups
  - Differences in stepping practice
    - 2358±860 vs 948±489 steps/session
    - 4046±2596 vs 2572±1689 steps/day throughout training

VIEWS: Results

- **Results: primary measures**
  - Significant differences in improvements (p < 0.01)
    - Self-selected velocity (0.27±0.22 vs 0.09±0.09 m/s)
    - Fastest possible velocity (0.28±0.20 vs 0.11±0.15 m/s)
    - 6 min walk test (114±111 vs 29±32 m)
  - Amount of practice related to improvements in walking!

VIEWS: Results

- **Results: secondary measures**
  - No difference in Berg Balance Scale (~8 pt improvement)
  - No difference in 5X sit-to-stand between groups

- **Tasks practiced in control PT, not in experimental**

Knowledge Translation Strategies

Jennifer Moore PT, DHS, NCS
Clinical Practice Leader, Neurologic Physical Therapy
Rehabilitation Institute of Chicago
Knowledge Translation (KT)

“the dynamic and iterative process that includes the synthesis, dissemination, exchange and ethically sound application of knowledge to improve health, provide more effective health services and products, and strengthen the health care system.”

Evidence-Based Practice (EBP)

“integration of the best research evidence with clinical expertise and patient values and circumstances to make clinical decisions.”

EBP vs. KT

Coordinated process between all stakeholders
The Challenge of Knowledge Translation (KT)

- > 17 years for evidence to be used in clinical practice (Morris, 2011)

- KT is multi-faceted (Strauss, 2009)
  - Patient
  - Individual Clinician
  - Organizational leaders/stakeholders
  - Political
  - Economic

Clinical Application of Gait Training

Project objectives

- Identify barriers to providing intensive gait training in inpatient rehabilitation
- Implement KT interventions targeting the identified barriers
- Monitor clinician behavior change
- Determine the impact of new practice on patient outcomes

Specific goal:
- maximize the number of steps
- achieve high aerobic intensity with 70-85% HR Max

Facilitators

- Organizational context:
  - Inpatient rehabilitation unit in an academic rehabilitation hospital
- Stakeholder involvement:
  - Initially implemented in “ability lab”
  - Stakeholder involvement:
    - Clinicians: 8 primary physical therapists, nursing staff, 2 rehabilitation aides
    - Researchers: 1 PI (opinion leader) and 3 research PTs
    - Leadership: Allied Health and Nursing Managers, Directors (allied health and medical), Executive Leadership Team

- Social context:
  - Initially funding through internal, leadership driven context (Henry B Betts award)
  - Vision of leadership to integrate research with clinical practice
Facilitators

- Economic:
  - Henry B Betts award provides a bonus to the “winning” team (initial incentive)
  - Potential for improved reimbursement with better outcomes
  - Success on “new floor” indicates success in new hospital; translated to other floors

- Political: all stakeholders engaged

- Individual facilitators:
  - Clinicians on floor knew expectation of integration of research
  - Patients expected a “novel” treatment

Barriers

Discussions between researchers, administrators, clinicians:

- Knowledge of application of intervention:
  - General application
  - Medically complex patients
  - Very impaired patients

- Cultural differences:
  - Difficulty in focusing the majority of sessions on gait training
  - Concern about providing other important interventions

- Logistics:
  - Scheduling (staffing, outside appointments, etc)
  - Readiness for PT when session starts (toileting, dressed, etc)
  - Time lost setting patients up in equipment
  - Streamlined documentation

Tailored KT Interventions

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<tr>
<th>Barrier</th>
<th>KT Intervention</th>
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<tr>
<td>Knowledge</td>
<td>Education sessions</td>
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<td>Case study presentations by clinicians</td>
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<td>1:1 mentoring</td>
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<td>Facilitation</td>
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<tr>
<td>Current culture</td>
<td>Dose that allowed for family training and other interventions</td>
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<td></td>
<td>Added more time for rehabilitation aide</td>
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<td>OT increased transfer interventions</td>
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<td></td>
<td>Reporting of outcome measures and intervention in team conference</td>
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<tr>
<td>Logistics</td>
<td>Determine scheduling mechanism</td>
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<td>Coordinated with nursing to ensure pt ready for treatment</td>
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<td></td>
<td>Rehab aide training in setting patients up</td>
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<td>EMR modified for streamlined documentation</td>
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Monitor Use

- Understanding of the evidence, application and interpretation
  - Case study reports
  - Reporting in team conference

- Positive attitude toward utilization

- Documentation audits

- Utilization of standardized measures / adherence to standardized practices
Evaluate Outcomes at Various Levels

- Patient
  - Improvement in functional outcome
  - Length of stay
  - Satisfaction

- Clinician
  - Changes in decision-making
  - Efficiency
  - Satisfaction

- Organizational or process level
  - Overall patient outcomes
  - Reimbursement

Sustain Knowledge Use

- Integrate into routine clinical practices
  - Reporting in team conferences
  - Mandatory documentation
  - Journal and education inservice topics

- Leadership
  - Support clinicians to act as facilitators
  - Interviewing strategies to hire clinicians likely to adopt practice
  - Provide feedback to clinicians related to adherence
  - Clear vision for practice

- Financial supports
  - Include OM and intervention utilization as component of merit increases
  - Allow some “protected time” for new staff to learn practices
  - Send staff to CEU courses related to measurement and gait training

Key Components of this Project

- Leadership support
- Stakeholder engagement
- Tailored KT interventions to address barriers
- Vision of research, clinician and hospital leadership

Clinical implementation of high-intensity stepping interventions during the treatment of patients with subacute stroke

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Rehabilitation Institute of Chicago
Sensory Motor Performance Program
cholleran@ric.org
Content

- Amount of practice in clinical environment
- Efficacy of focused intensive stepping in research environment
  - Effects on walking and non-walking outcomes
- Feasibility and preliminary efficacy sub-acute inpatient stepping program

Contemporary Practice

- Dose and intensity
  - Conventional rehabilitation
    - 400-800 steps per session (Lang 2009, Moore 2010)
    - 2.8 min in aerobic heart rate zone (Mackay-Lyons 2001, Makrides 2002)
  - Research environment
    - Forward stepping ~ 4000
    - Variable stepping ~ 3000
    - Up to 85% HR maximum

Effects on non-locomotor behaviors

Straube et al 2014
- Five times sit-to-stand decrease
  - 25% chronic
  - 40% subacute
- Berg Balance Scale
  - 6 pts chronic,
  - 8 pts subacute (~21 pts non-ambulatory)

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Clinical Application

- Scientific understandings build basis for structuring an inpatient program
- 2 Inpatient floors with combined research activities
- Support from management and leadership
- Interdisciplinary coordinated team (research and clinical staff)
Study Sample and Design

- Retrospective data analysis
  - Implementation of stepping program over 16 month period
- Inclusion
  - Initial diagnosis of stroke (<6 months)
  - 18-89 years of age
- Exclusion
  - Pregnant
  - HIV or AIDS
  - Lower extremity fracture or amputation

Implementation

- Physical Therapy Staff
  - Prioritizing walking
  - Perform outcome measurements
- Occupational Therapy
  - Continuing to address transfers
- Therapy Aides
  - Assist with increased stepping under PT guidance (groups and assist with more dependent patients)
  - Additional staff for stepwatches
- Nursing/PCT Staff
  - Consistently ready for therapy
  - Carry over of transfers
- Administrative Support
  - Scheduling extra PT time
  - Group scheduling
- Research Support
  - Assist with gathering data
  - Providing and downloading stepwatches

Implementation - Intervention

- Prioritization of Stepping during clinical PT
  - Stepping practice
    - Stepping in multiple directions, obstacles, stairs, uneven/compliant surfaces, curbs
    - Extra PT sessions assisted by aide (group therapy)
  - Intensity
    - 60-85% HRR, 14-17 RPE
    - Document every 5 minutes
  - Treadmill and overground with or without BWS
  - Transfers performed as part of weekly assessments or during family training as necessary

Implementation - Stepwatch

- StepWatch3™
  - Worn 7:30 am to 5:00 pm
  - Paretic leg
  - Downloaded by clinical staff and de-identified to match information from medical chart
Implementation - Environment

Equipment
- 4 Treadmills with BWS
- Use of two inpatient floors
  - Overhead trolley
  - Lite gait
  - Rifton tram
  - Hoyer lift
- Stairmaster

Data Extraction

Extracted by clinical staff and de-identified for research staff analysis
- Demographic Information
  - Gender
  - Age
  - Duration post-stroke
  - Lesion side
  - Type (ischemic/hemorrhagic)
  - Adverse events during length of stay
  - Distribution

Data Extraction

- Training parameters
  - Peak HR & duration
  - Peak RPE & duration
- Outcome assessments (Admit and D/C)
  - 6 MWT
  - FIM (Bed, Toilet, Walk, Combined Motor, Combined Cognitive)
  - BERG balance scale
  - 10 MWT
  - PASS
- Stepping Activity

Data Analysis

- Nonparametric data distribution
  - Demographic, training and admission data with primary and secondary measures at discharge and change scores (medians and IQR's)
  - Spearman’s correlation $\alpha = 0.0005$ with 100 comparisons
- Stepwise multiple linear regression
  - Estimate contributions of independent predictors to outcomes
  - Hierarchical linear regression
- Conditional logistic regression
  - Independent predictors to d/c location and walking function
Results - Demographics

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<thead>
<tr>
<th>Demographics</th>
<th>Median (IQR; N) or N (%)</th>
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<tr>
<td>age</td>
<td>64 (55-75; 201)</td>
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<tr>
<td>gender: male/female</td>
<td>114/87</td>
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<tr>
<td>lesion location: right</td>
<td>74 (39%)</td>
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<tr>
<td>left</td>
<td>88 (44%)</td>
</tr>
<tr>
<td>bilateral</td>
<td>32 (17%)</td>
</tr>
<tr>
<td>lesion distribution: cortical</td>
<td>98 (49%)</td>
</tr>
<tr>
<td>subcortical</td>
<td>32 (16%)</td>
</tr>
<tr>
<td>subtentorial</td>
<td>21 (15%)</td>
</tr>
<tr>
<td>multiple/unknown</td>
<td>40 (20%)</td>
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<tr>
<td>lesion type: ischemic</td>
<td>142 (71%)</td>
</tr>
<tr>
<td>hemorrhagic/unknown</td>
<td>59 (29%)</td>
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<tr>
<td>duration post-stroke</td>
<td>13 (8-25; 201)</td>
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<tr>
<td>Charlson Comorbidity Index</td>
<td>1 (0-3; 201)</td>
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Results - Baseline Characteristics

- 80% of patients (n=161) admitted < 30 days post-stroke
- 15 between 60-180 days post-stroke
- >80% of patients presented with severe deficits
- 6MWT (LoA≤4) was required with 79% of patients

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<td>Paretic leg strength</td>
<td>1 (0-3; 177)</td>
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<tr>
<td>6 min walk test (m)</td>
<td>15 (3.0-67)</td>
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<tr>
<td>6 min level of assistance</td>
<td>3 (2-4)</td>
</tr>
<tr>
<td>Berg Balance Scale</td>
<td>5 (4-22)</td>
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<tr>
<td>FIM-Bed mobility</td>
<td>2 (1-3)</td>
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<tr>
<td>FIM-Toilet transfers</td>
<td>2 (1-3)</td>
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<td>FIM-Walk</td>
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Results - PT Interventions

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<tr>
<td>length of stay (days)</td>
<td>28 (21-35; 201)</td>
</tr>
<tr>
<td>PT sessions/day</td>
<td>1.1 (0.94-1.3; 201)</td>
</tr>
<tr>
<td>PT min/session (min)</td>
<td>54 (52-56; 201)</td>
</tr>
<tr>
<td>peak HR/session (% max)</td>
<td>70 (62-76; 161)</td>
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<tr>
<td>peak RPE/session</td>
<td>16 (15-17; 160)</td>
</tr>
<tr>
<td>mean % session RPE &gt; 13</td>
<td>38 (31-44; 157)</td>
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<tr>
<td>daily stepping (steps/day)</td>
<td>1516 (594-2645; 201)</td>
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Results - Outcome Measures

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<thead>
<tr>
<th>Outcome measures</th>
<th>Admission</th>
<th>Discharge</th>
<th>N (%)</th>
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<tr>
<td>6 min walk test (m)</td>
<td>15 (3.0-67)</td>
<td>146 (44-281)</td>
<td>166 (83)</td>
</tr>
<tr>
<td>6 min level of assistance</td>
<td>3 (2-4)</td>
<td>5 (4-5)</td>
<td>166 (83)</td>
</tr>
<tr>
<td>Berg Balance Scale</td>
<td>5 (4-22)</td>
<td>34 (13-46)</td>
<td>173 (86)</td>
</tr>
<tr>
<td>FIM-Bed mobility</td>
<td>2 (1-3)</td>
<td>5 (3-5)</td>
<td>201 (100)</td>
</tr>
<tr>
<td>FIM-Toilet transfers</td>
<td>2 (1-3)</td>
<td>4 (3-5)</td>
<td>201 (100)</td>
</tr>
<tr>
<td>FIM-Walk</td>
<td>1 (1-2)</td>
<td>4 (3-5)</td>
<td>201 (100)</td>
</tr>
</tbody>
</table>
### Results - Outcome Measures

<table>
<thead>
<tr>
<th>Outcome measures</th>
<th>Admission</th>
<th>Discharge</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 min walk test (m)</td>
<td>15 (3.0-67)</td>
<td>146 (44-281)</td>
<td>166 (83)</td>
</tr>
<tr>
<td>6 min level of assistance</td>
<td>3 (2-4)</td>
<td>5 (4-5)</td>
<td>166 (83)</td>
</tr>
<tr>
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<td>5 (4-22)</td>
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<td>2 (1-3)</td>
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<td>2 (1-3)</td>
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</tr>
<tr>
<td>FIM-Walk</td>
<td>1 (1-2)</td>
<td>4 (3-5)</td>
<td>201 (100)</td>
</tr>
</tbody>
</table>

### Results - Stepping Activity

#### A) Stepping activity on 8th day of admission

<table>
<thead>
<tr>
<th>LoA</th>
<th>Steps/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>212 (145-340)</td>
</tr>
<tr>
<td>2</td>
<td>482 (429-506)</td>
</tr>
<tr>
<td>3</td>
<td>419 (369-615)</td>
</tr>
<tr>
<td>4</td>
<td>1016 (539-2010)</td>
</tr>
<tr>
<td>5</td>
<td>2053 (1293-2880)</td>
</tr>
<tr>
<td>&gt;6</td>
<td>4471 (3253-4619)</td>
</tr>
</tbody>
</table>

#### B) Stepping activity 5 days before discharge

<table>
<thead>
<tr>
<th>LoA</th>
<th>Steps/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100 (70-166)</td>
</tr>
<tr>
<td>2</td>
<td>200 (150-250)</td>
</tr>
<tr>
<td>3</td>
<td>300 (225-375)</td>
</tr>
<tr>
<td>4</td>
<td>400 (300-500)</td>
</tr>
<tr>
<td>5</td>
<td>500 (400-600)</td>
</tr>
<tr>
<td>&gt;6</td>
<td>600 (500-700)</td>
</tr>
</tbody>
</table>

#### C) Daily stepping activity during length of stay

- Patient within 25th percentile
- Patient within 75th percentile
- Median and interquartile range

### Results - Correlations

#### A. Discharge 6 min walk test

- $r=0.87$

#### B. Change 6 min walk test

- $r=0.85$

### Results - Stepping and Initial LoA

<table>
<thead>
<tr>
<th>Admission LoA</th>
<th>DC LoA 1</th>
<th>DC LoA 2</th>
<th>DC LoA 3</th>
<th>DC LoA 4</th>
<th>DC LoA 5</th>
<th>Steps/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 (7.7)</td>
<td>1 (2.6)</td>
<td>1 (2.7)</td>
<td>-</td>
<td>-</td>
<td>212 (145-340)</td>
</tr>
<tr>
<td>2</td>
<td>6 (23)</td>
<td>7 (18)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>482 (429-506)</td>
</tr>
<tr>
<td>3</td>
<td>8 (31)</td>
<td>7 (18)</td>
<td>3 (8.1)</td>
<td>-</td>
<td>-</td>
<td>419 (369-615)</td>
</tr>
<tr>
<td>4</td>
<td>1 (3.8)</td>
<td>6 (15)</td>
<td>6 (16)</td>
<td>1 (2.9)</td>
<td>-</td>
<td>1016 (539-2010)</td>
</tr>
<tr>
<td>5</td>
<td>9 (35)</td>
<td>18 (46)</td>
<td>26 (70)</td>
<td>29 (85)</td>
<td>29 (78)</td>
<td>2053 (1293-2880)</td>
</tr>
<tr>
<td>&gt;6</td>
<td>-</td>
<td>-</td>
<td>1 (2.7)</td>
<td>4 (12)</td>
<td>8 (22)</td>
<td>4471 (3253-4619)</td>
</tr>
</tbody>
</table>
Stepwise logistic regression

- CGA or better
- Steps
- Admit 6MWT

Stepwise logistic regression

- D/C home or other
- CGA or better
- Admit 6MWT

Stepwise logistic regression

- D/C home or other
- Steps
- Admit 6MWT

Discussion

- Stepping
  - 1516 steps/days, 5-6 x greater
  - Intensity - 38% of session
- Adverse events echo normative data (cite)
- Correlations echo other data (cite) with stepping demonstrating highest correlation to outcomes
  - Locomotor and non-locomotor
- Stepping activity possible predictor of LoA at discharge and discharge location (home vs other facility)
- Limitations
  - No control group
  - No long-term follow up
Conclusions

• Large amounts of focused, repeated stepping practice in patients with sub-acute stroke is feasible

• Effects on locomotor behaviors

• Effects on non-locomotor behaviors

• Stepping as possible predictor of discharge from IP rehab

• Future direction – assess efficacy

Acknowledgements

• Personnel
  – William Rymer, MD, PhD
  – Elliot Roth, MD
  – Catherine Kinnaird, MS
  – Michael Lewek, PT, PhD
  – Patrick Hennessy, MPT, NCS
  – Carey Holleran, MPT, DHS, NCS
  – Abi Leddy, DPT, MSCI, NCS
  – Kristan Leech DPT

• 9th floor PT staff
  – Nicole Williams DPT
  – Ryan Pelo DPT
  – Raquel Santiago DPT
  – Mike Klonowski DPT, PCS

Thank you and Questions?

Thank you!