Using Technology in Stroke Rehabilitation

Maximizing Potential, Avoiding Pitfalls

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STROKE NETWORK *of* Southeastern Ontario

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Objectives

1. Introduce Case Scenarios related to integration of technology in stroke rehabilitation settings
2. Discuss potential barriers and facilitators to integration of technology.
3. Introduce key therapeutic and organizational considerations when deciding if and how to use technology in rehabilitation
4. Use scenarios to discuss the evidence, potential benefits, challenges, and strategies to use specific technologies to help achieve Canadian Stroke Best Practice Recommendations for Rehabilitation.
5. Revisit Scenarios using the key therapeutic and organizational considerations

What do we mean by Technology

- Any devices, equipment, or systems that have been developed from the application of scientific knowledge.
- Typically require some training or special skills to use
- Costs range from inexpensive to very expensive
- Could be designed for rehabilitation, or an ‘off-the-shelf’ product
- Examples:
  - Robotics for gait training, or arm and hand movement training
  - Body Weight Supported Treadmill Systems
  - Virtual Reality and Gaming systems
  - Wearable Activity Monitors
  - Tablets and Smartphones

Scenario 1 – Virtual Reality

- It is the end of fiscal year and the stroke rehab program director asks for ideas for capital equipment.
- The unit manager recently saw a new virtual reality system designed for rehab at a conference.
- A decision needs to be made quickly or they will lose this money. So the director and manager decide to order the system.
- A few months later, the equipment is delivered and the sales person gives an inservice to all available staff.
- The system uses Green Screen technology to put the patient on the screen and have them perform reaching and balance related tasks (e.g. hitting targets, avoiding obstacles)
- The system is large and needs to be stored in a room at the end of the hallway (away from the gym)

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- The system is large and needs to be stored in a room at the end of the hallway (away from the gym)
- A well respected therapist with extensive clinical experience doubts the value of this new device, and shares his concerns freely with his colleagues
- **1 year later**, the device was used a few times by one therapist but she has since moved to another unit. The device has been pushed into a corner, behind walkers and wheelchairs.

What could have happened differently? Any hope for the future?

Scenario 2 – Activity Monitors

- A research group at Queen's has just finished a large study focused on promoting physical activity in older adults living in the community. The resarcher has offered the Rehab Team 10 **FitBit Charge** activity monitors to use with the patients in the stroke rehab program

- As a group you think this may be helpful but are not sure how to use the devices and how they can be helpful to your patients.

Do you think they could be helpful?

How would you go about trying them out?

Scenario 3 - Tablets

A family member of a recently discharged patients is an executive at a large electronics company.

She is grateful for all that was done for her father and would like to donate 3 iPAD Tablets for patients to use while on rehab.

You are the manager and appreciate the gift but are not sure how best to use the devices. For now you put them in a locked cabinet.

What should happen next?

The Knowledge Implementation Challenge

- Uptake of research-based knowledge into clinical practice is typically slow
- Similarly, the integration of new technology into practice can be challenging, often incomplete, and unsatisfactory to users
- Effective and timely adoption of potentially valuable technologies in rehab is dependent on **awareness of limitations of the technology, barriers to integration, as well as the potential benefits of the device for patient care**

Common Barriers to Integration of Technology in Rehab

- Time requirements
- Lack of knowledge/skills
- Lack of confidence ('technophobia')
- Cost
- Perceived mismatch between device capabilities and needs of patients
- Lack of belief in the therapeutic value of the device/technology
- Lack of evidence to support use of the device
- Lack of fit of device/technology with current practice
- Technical problems/complexities

Levac et al. BMC Health Services Research 2016;16:557.

Rehab Technology Assessment Criteria:
Therapeutic Considerations

Does the technology help you adhere to key principles of effective stroke rehabilitation?

Timmermans et al. J Neuroeng Rehabil 2009, 6:1.
Hochstenbach-Waelen et al.. J Neuroeng Rehabil 2012 9:52.

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Virtual Reality (VR)

Virtual Reality (VR)

- Any system that generates simulations of real or imagined environments with which participants interact using their own body movements
- Key features include immersion, feedback and interactivity
- Off the shelf gaming consoles (e.g. Wii, Kinect), wearable headsets (Oculus Rift), and Rehabilitation-specific systems (IREX)
- Can range from $ 150.00 (Wii), to > $ 500 000 (CAREN Gait system)

http://wiifit.com

http://www.basic.rms-dev.com/caren

VR – What is the evidence? (CSBPR) 2015

- ***Upper limb rehab***: *VR, including both immersive technologies (e.g. head mounted) and non-immersive technologies (e.g. Wii gaming devices) can be used as adjunct tools to other rehabilitation therapies as a means to provide additional opportunities for engagement, feedback, repetition, intensity and task-oriented training (Evidence Level: Early-Level A; Late-Level A).*

- ***Lower limb, balance and mobility rehab***: *VR training could be considered as an adjunct to conventional gait training (Evidence Level A)*

VR can increase amount/intensity of practice in upper limb

Brunner et al. BMC Neurology (2016) 16:219
DOI 10.1186/s12883-016-0740-y

BMC Neurology

RESEARCH ARTICLE Open Access

Is upper limb virtual reality training more intensive than conventional training for patients in the subacute phase after stroke? An analysis of treatment intensity and content

Iris Brunner[1,2*], Jan Sture Skouen[1,2], Håkon Hofstad[2], Jörg Aßmus[3], Frank Becker[4,5], Hanne Pallesen[6], Liselot Thijs[7] and Geert Verheyden[8]

VR and UE training intensity study

- Rehab Inpatients ≤ 3 months post stroke
- Randomized to additional VR training or additional Conventional UE Therapy
- VR Training – YouGlove VR system

http://yourehab.com/our-products/yougrabber/

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VR and UE training intensity

- Rehab Inpatients ≤ 3 months post stroke
- Randomized to additional VR training or additional Conventional UE Therapy (CT)
- VR Training – YouGlove VR system
- Patients in VR group more active with their paretic arm than conventional group
- Difference most profound in severe patients

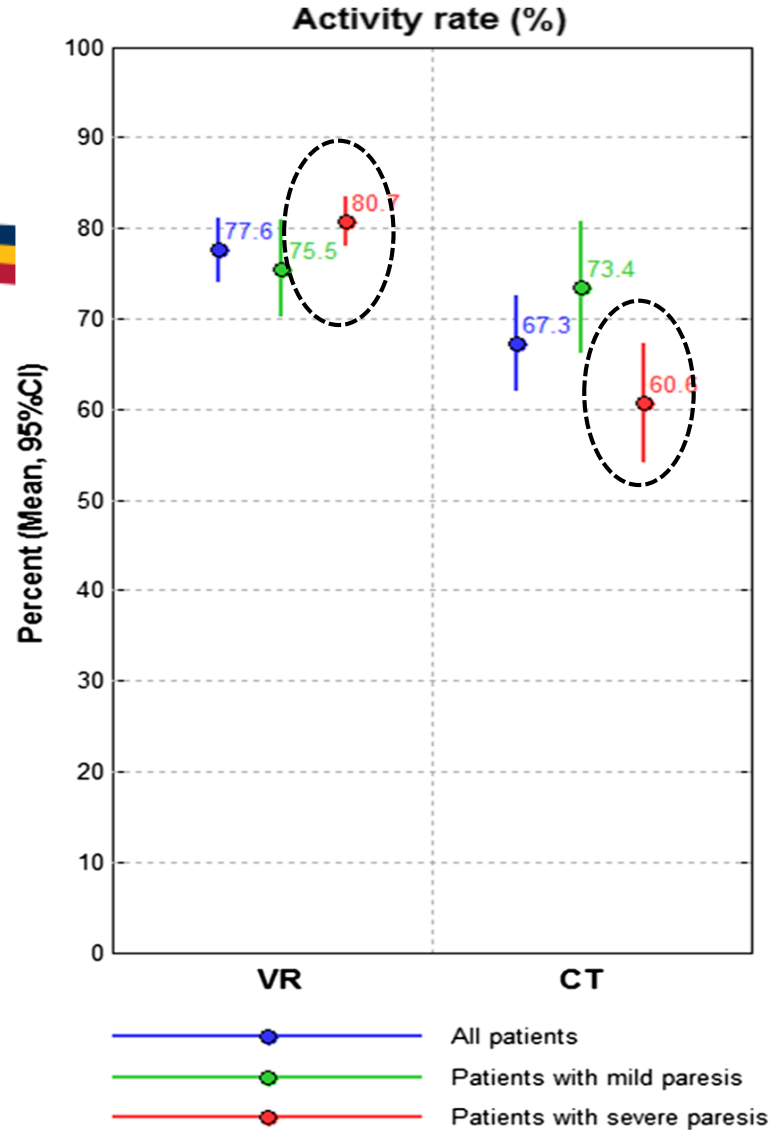

Fig. 1 Activity rate for VR and conventional training (CT) for all patients (blue), patients with mild to moderate (green) and severe (red) paresis

Brunner et al. BMC Neurology (2016) 16:219
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VR: What is the evidence (cont'd)

- VR can help increase rehab intensity (Bruner et al 2016)
- Many individuals enjoy and are motivated by VR
- Wii-based UE practice as effective as other options - EVREST (Saposnik 2016)
  – Additional Wii Practice (UE focused) = Additional UE-task-focused practice
- However, implementation can still be a challenge
- Major barriers: Confidence, knowledge, and comfort with technology (Levac et al., 2016)

- If lack of knowledge, confidence, and comfort with the technology…

Would training therapists help with adoption of VR?

Levac et al. BMC Health Services Research (2016) 16:557
DOI 10.1186/s12913-016-1807-6

BMC Health Services Research

RESEARCH ARTICLE Open Access

A knowledge translation intervention to enhance clinical application of a virtual reality system in stroke rehabilitation

Danielle Levac[1*], Stephanie M. N. Glegg[2], Heidi Sveistrup[3], Heather Colquhoun[4], Patricia A. Miller[5], Hillel Finestone[6], Vincent DePaul[7], Jocelyn E. Harris[8] and Diana Velikonja[9,10]

VR Knowledge Translation Study

- **Purpose:** To develop and to evaluate a knowledge translation (KT) intervention that incorporated an online module and experiential practice to train PTs and OTs in Virtual Reality implementation for stroke rehabilitation.
- Participant: 6 PTs, 5 OTs from 2 urban hospitals
- Interested but inexperienced in using VR
- System – IREX VR
  - Gesture recognition and green screen technology
  - Patient sees themselves on the screen moving, tries to hit targets, avoid obstacles
- Training and follow up over 1 year period
- Outcomes: Knowledge level, self-efficacy, and self-reported use at 1 year

Description of Training

Training included:

1. E-learning modules
2. Hands-on sessions (x 3) with experienced user
3. Experiential Learning – tried with 4 patients
4. Email reminders/use tips
5. Mentorship – with offsite clinician

http://www.gesturetekhealth.com/node/27

OSN VR KT study - Results

- Pre-training, Therapists (n=11) had little knowledge or experience in VR but had positive attitudes and expectations re. it's potential value
- Following KT intervention, participants improved:
  - knowledge level regarding how to use the VR system
  - self-confidence in their ability to use the system
- At the end of training, 9 therapists indicated that they intended to use the VR system and 2 therapists indicated they did not intend to use the system
- Use at 1 year: 2 out of 9 therapists used it, and only 2x, and 1x each
- Remained hopeful they would use it, but barriers cited for not using
  - Lack of time
  - Caseload factors –volume and wrong type of patient for system
  - Inability to train fine motor skills with the device (OTs)

Barriers to using VR system: Pre and Post Training

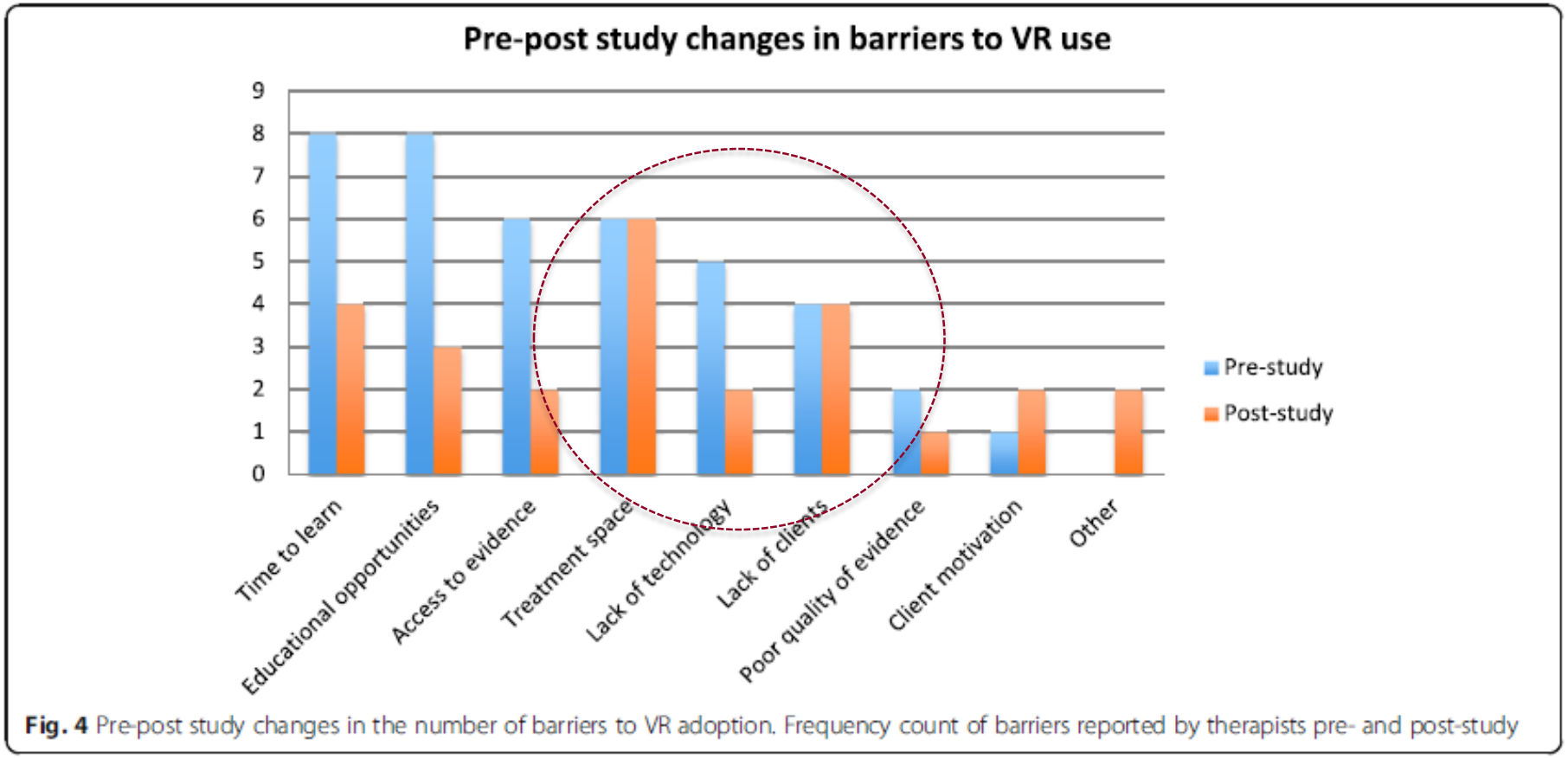

Fig. 4 Pre-post study changes in the number of barriers to VR adoption. Frequency count of barriers reported by therapists pre- and post-study

Levac *et al. BMC Health Services Research* (2016) 16:557
DOI 10.1186/s12913-016-1807-6

If knowledge, confidence and intention increased – why didn't therapists use this VR system

- Most common barriers
  - Time to transport Pt, set up, use
  - Space – away from common treatment areas
  - Technical issues/reliability
    - Frequent problems with software
    - Unable to quickly resolve problems
  - Games not ideally suited to address all patient goals
    - Finer motor, grasp and release
    - Early static standing type activities

Proportion of respondents by letter grade rating

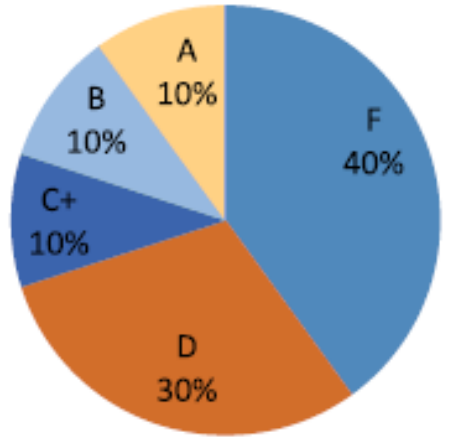

Fig. 5 System Usability Scale ratings. An A grade corresponds to a percentile score above 80. A score of 68 is a C grade and scores below 51 correspond to a grade of F

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VR: Summary

- Evidence supports using VR as an adjunct to traditional therapy
- Some key benefits include motivation and engagement of patients

However:

- Not all VR systems are the same
- Not all patients appropriate for all systems
- Technical and environmental (space) issues can become major barrier even if device is seen as potentially helpful

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- **Scenario 1 Update:**
  - At the end of the study, the VR Unit was still sitting mostly inactive
  - Therapists still hopeful they will use it, however nature of device makes it challenging to incorporate into practice on the specific unit with its current population

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- ❑ ~~Promote patient independence, autonomy and self-management~~
- ✓ Motivate patients to practice and challenge themselves
- ✓ Provide patients with feedback about their performance
- ○ Promote remediation, not just compensation when possible
- ○ Have evidence that device is **as** ~~or more~~ effective than traditional approaches

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Organizational and technical considerations - VR

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Wearable Activity Monitors

Scenario 3 – Wearable Activity Monitors

- A research group at Queen's has just finished a large study focused on promoting physical activity in older adults living in the community. The researcher has offered the rehab team ten **FitBit Charge** activity monitors to use with the patients in the stroke rehab program

- As a group you think this may be helpful but are not sure how to use the devices and how they can be helpful to your patients.

Do you think they could be helpful?

How would you go about trying them out?

Wearable Activity Monitors

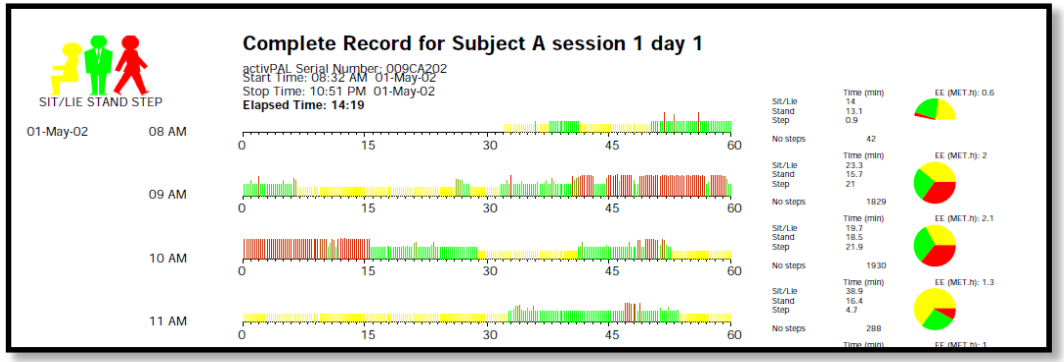
Wearable Activity Monitor (AM):

A device for monitoring, recording and interpreting physical activity/fitness-related metrics including:

- » Time spent in certain activities (e.g. sitting vs walking),
- » intensity of activity (sedentary vs vigourous activity),
- » distance walked or run
- » Heartrate (some devices)
- » quality of sleep (some devices)

https://www.bhphotovideo.com/c/product/1105928-REG/fitbit_fb404bkl_large_charge_sleep_activity_tracker.html

- Increasingly common in popular society
- Many devices target healthy populations (e.g. FitBit)
- Some developed for rehab populations (e.g. ActivPAL, Stepwatch)
- Can give real-time feedback or summary of activity patterns



http://www.paltech.plus.com/examples

AMs: What does the evidence say? CSBPR 2015

- **No specific recommendations that refer to Activity Monitors in CSBPR**

- However, may help facilitate other recommendations:
  - 3.vi. *It is recommended that patients be given opportunities to repeat rehabilitation techniques learned in therapy and implement them while supervised by stroke rehabilitation nurses (Evidence Level C).*
  - 3.vii. *Therapy should include repetitive and intense use of novel tasks that challenge the patient to acquire the necessary skills needed to perform functional tasks and activities (Evidence Level A).*
  - *To ensure long-term maintenance of health benefits, a planned transition from structured **aerobic exercise** to more **self-directed physical activity** at home or in the community should be implemented. (Evidence Level: Early-Level A; Late Level A).*

Activity Monitors to track and promote Physical Activity

- When used with goal setting, activity monitors help increase activity levels in **non-stroke** populations (e.g. older adults, people with obesity)
- Do activity monitors help increase walking activity in stroke rehab?

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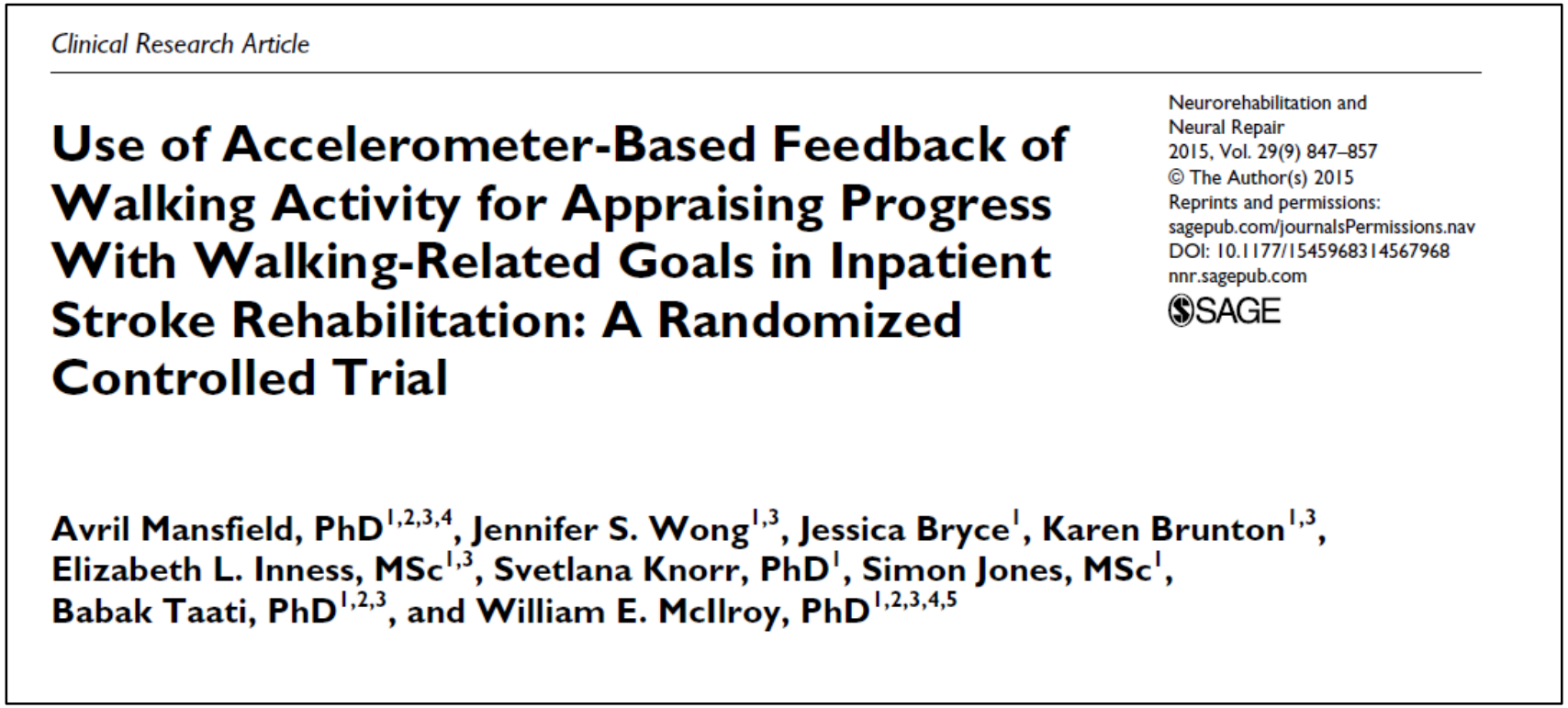

Clinical Research Article

Use of Accelerometer-Based Feedback of Walking Activity for Appraising Progress With Walking-Related Goals in Inpatient Stroke Rehabilitation: A Randomized Controlled Trial

Neurorehabilitation and Neural Repair
2015, Vol. 29(9) 847–857
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sagepub.com/journalsPermissions.nav
DOI: 10.1177/1545968314567968
nnr.sagepub.com
SAGE

Avril Mansfield, PhD[1,2,3,4], Jennifer S. Wong[1,3], Jessica Bryce[1], Karen Brunton[1,3], Elizabeth L. Inness, MSc[1,3], Svetlana Knorr, PhD[1], Simon Jones, MSc[1], Babak Taati, PhD[1,2,3], and William E. McIlroy, PhD[1,2,3,4,5]

Activity Monitor Feedback Study – Mansfield et al. 2015

- **Purpose:** To determine the effect of providing activity monitor based feedback on walking activity and other measures of walking recovery
- **Participants:** Ambulatory adults (n=57) on stroke rehab unit
- **Methods:** All wore custom activity monitor (on ankle)

  Randomized to Feedback or No-Feedback group
  - Feedback Group:
    - Therapist provided daily report of patient walking (i.e. step #, cadence, pattern)
    - Encouraged to use info during patient-therapist interactions
  - Outcomes:
    - Average steps/day throughout rehab
    - Gait speed at discharge

Activity Monitor Feedback Study – Mansfield et al. 2015

- **Results:**
  - The feedback group did not take more steps than control group

  However
  - Feedback group had higher cadence (number of steps/minute) and increased gait speed more than No-feedback control

While patients may or may not increase walking activity, there still seems to be some benefit to tracking and giving walking-related feedback using wearable activity monitors

Activity Monitors: Considerations

Step Count Accuracy:

- Activity monitors use accelerometers to record movements
- Computer algorithms are designed to recognize which movements are steps/walking (among other activities)
  - Some devices not designed to recognize slow, asymmetrical movements and step patterns as walking
- Wearing device on ankle or leg may be more accurate than waist on slow walkers
- FitBit has been shown to accurately detect steps in older adults and individuals with stroke – however is somewhat more accurate at ankle)

Self-monitoring capabilities:

- Commercial devices have step count display, and can be monitored by patients in real time, others (ActivPAL, Actigraph) require therapist to download information and give to patients in summary report)

Heart Rate monitoring (for aerobic monitoring)

- Some devices, including FitBit Charge, include heart rate monitor (if worn on wrist)

(DePaul et al. Unpublished 2015;
Simpson et al. J Rehabil Med. 2015;47:830-5;
Fulk et al. Phys Ther 2014;94:222-229.)

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Tablets and Smartphones

Scenario 3 - Tablets

A family member of a recently discharged patient is an executive at a large electronics company.

She is grateful for all that was done for her father and would like to donate 3 iPAD Tablets for patients to use while on rehab.

You are the manager and appreciate the gift but are not sure how best to use the devices. For now you put them in a locked cabinet.

What should happen next?

Tablets and Smartphones

- Any portable, lightweight personal computing device
- Not rehab specific
- Usually touch screen
- Has capacity to load and use apps
- Camera, video, audio recorder and playback
- Typically can access internet

e.g. Apple iPAD, Google, Android tablets and phones

Tablets & smartphones: What is the evidence? (CSBPR 2015)

Only one recommendation specifically mentions tablets and smartphones

- *Treatment to improve functional **communication** can include language therapy focusing on:*
  - *use of non-verbal strategies, assistive devices and technology (e.g., **I-Pads, Tablets, other computer-guided therapies)** which may be incorporated to improve communication (Evidence Level C)*
  - *use of computerized language therapy to enhance benefits of other therapies (Evidence Level C)*

Smart Phones and Tablets – Communication Aides

- Expressive Aphasia/Dysarthria

  Augmentative and Alternative Communication covers a large range of techniques which support or replace spoken communication. In the following list, AAC means the iPad app speaks for you instead of helping you to improve your speech.

  – **E.g. SmallTalk Aphasia App**

    - designed for people with aphasia, provides a vocabulary of pictures and videos that talk in a natural human voice.

  Therapeutic apps helps patient practice their speech

  National Aphasia Association has a list of Aphasia Apps

  http://www.aphasia.org/aphasia-resources/aphasia-apps/

Stroke Apps

- StrokeWise – website that identifies multiple smartphone and tablet apps that are available for patients with stroke
- Mostly communication focused

http://www.strokewise.info/2011/10/ipad-apps-people-who-have-had-strokes.html

Tablets & smartphones: What is the evidence? (CSBPR 2015)

Rhythmic auditory stimulation *(RAS) could be considered for improving gait parameters in stroke patients, including gait velocity, cadence, stride length and gait symmetry (Evidence Level A).*

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- Shown to improve gait speed, cadence, stride length, and symmetry in patients with stroke

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- **Patient's smartphone can be used to deliver RAS using apps that play specific rhythm (e.g. metronome), identify and select songs with specific tempos, or adjust the tempo of patient's favourite songs**

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Tablets & smartphones: What is the evidence? (CSBPR 2015)

__Mental Practice__ could be considered as an adjunct to lower extremity motor retraining (Evidence Level A)

Malouin et al., Frontiers Human Neuroscience 2013
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Mental Practice could be considered as an adjunct to lower extremity motor retraining (Evidence Level A)

- **Mental practice** is the symbolic rehearsal of a physical activity in the absence of any gross muscular movements. Opportunity to practice without movement.
- Guided imagery of upper extremity activity with hemi-limb, lower limb movement, and/or walking
- When added to physical practice, can improve motor and functional recovery after stroke – is under utilized in clinical practice

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- **Recorded scripts of specific tasks, with video or photo examples of movements, can be added to phone/tablet and used by patients between therapy sessions**

Malouin et al., Frontiers Human Neuroscience 2013
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Tablets & smartphones: What is the evidence? (CSBPR 2015)

*Therapists should consider supplementary training programs aimed at increasing the active movement and functional use of the affected arm **between** therapy sessions (Early Evidence Level B; Late—Evidence Level C)*

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- **GRASP program with pictures and videos can be uploaded onto tablets to help guide patients in independent or family-supervised practice**

GRASP

Graded
Repetitive
Arm
Supplementary
Program

Tablets & smartphones: What is the evidence? (CSBPR 2015)

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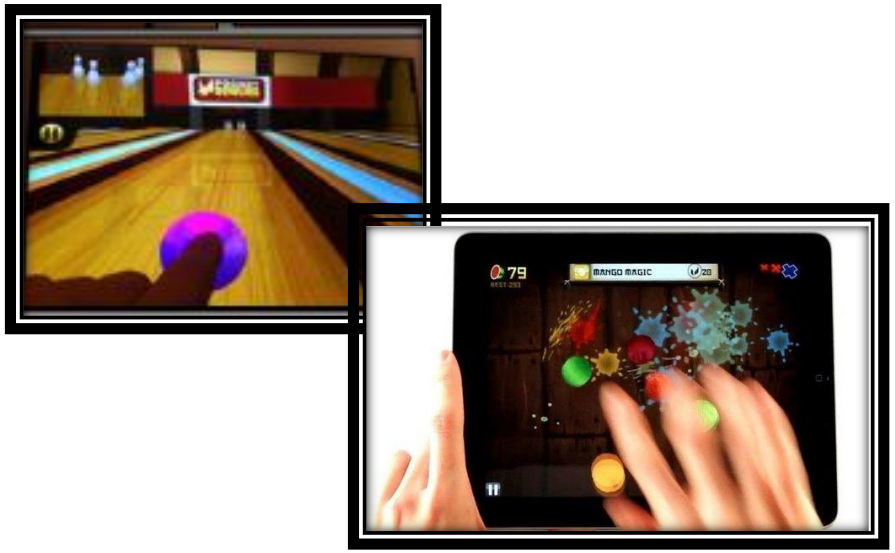
- GRASP program with pictures and videos can be uploaded onto tablets to help guide patients in independent or family-supervised practice
- **Rehab-Let Study: Uses non-rehab apps that challenge fine motor skills, and dexterity in patients with stroke**
  - **Tapping, pinching, swiping**



Rand et al. Trials (2015) 16:277

Rehab Technology Assessment Criteria:
Therapeutic Considerations

Does the technology help you adhere to key principles of effective stroke rehabilitation?

The technology should:

- ❑ Promote patient-centred approach to addressing needs and goals
- ❑ Facilitate intensive, repetitive, meaningful task-oriented practice
- ❑ Facilitate challenging, progressive, scalable practice/activities
- ❑ Allow variability of practice
- ❑ Promote patient independence, and autonomy
- ❑ Facilitate independent or family assisted practice *outside* of therapy sessions
- ❑ Motivate patients to practice and challenge themselves
- ❑ Provide patients with feedback about their performance
- ❑ Promote remediation, not just compensation when possible
- ❑ Facilitate adherence to other specific strategies demonstrated to be effective (e.g. mental practice)
- ❑ Have evidence that device is as, or more effective than traditional approaches

Therapeutic Considerations – Tablets and Smartphones

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Rehab Technology Assessment Criteria:
Organizational and technical considerations

The technology should be:

- ❑ Easy for therapy staff to learn
- ❑ Quick and easy to start and adjust settings
- ❑ Should not take *more* time than standard therapy
- ❑ Should make it possible to treat more than one patient at a time
- ❑ Function reliably and have accessible tech support
- ❑ Adaptable to between-patient differences, within-patient changes
- ❑ Adjustable to various task-related variables
- ❑ Provide clear feedback and instructions to patients
- ❑ Able to measure, track and document patient progression
- ❑ Portable and/or can be used in typical therapy areas
- ❑ May be used independently by patients
- ❑ Meets infection control guidelines (e.g. can be cleaned and shared)
- ❑ Meets privacy guidelines (e.g. storing personal info on devices)

Tablets and Smartphones

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Steps toward Successful Implementation of Technology

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(adapted from Hochstenbach et al, 2012

Steps to successful implementation

Selection | Orientation | Insight | Acceptance | Change | Retention

Phase 1 – Technology Selection

- Engage staff early, and at all stages of purchasing technology
  - Identifying the need/problem
  - How the device will help address the need/problem
  - Selection and trial of device
  - Identify how to integrate device into current practice patterns

(adapted from Hochstenbach et al, 2012

Steps to successful implementation

Selection | Orientation | Insight | Acceptance | Change | Retention

- **Phase 2: Orientation**
  - Make sure staff are aware of the new device without infringing on therapy time
  - Provide info about potential benefits, added value and advantages for therapists, and patients
  - Acknowledge/address emotional barriers to technology
    e.g. Fear that technology could replace therapy staff
  - Acknowledge/address lack of *'belief'* in potential benefit

- **Phase 3 – Insight**
  - Provide time to train, and info for therapists re. the device
  - Pilot equipment device with Innovators – they can be champions to encourage others (e.g. early adopters, early majority)

(adapted from Hochstenbach et al, 2012

Steps to successful implementation (cont'd)

Selection | Orientation | Insight | **Acceptance** | Change | Retention

- **Phase 4 – Acceptance**
  - Ensure device fits with current vision of stroke rehab
  - Therapists should be convinced of added value and effectiveness
    - Case presentations/experiences of patients on the unit
    - Feedback from patients
  - Evidence that device makes it easier to treat patients simultaneously
  - Acknowledge that certain aspects of therapy could/should be automated
  - Device should be "ready to go", quick start up, easy to use,
  - Housed in area close most therapy activities

    Avoid separate room if possible – can be used anywhere

(adapted from Hochstenbach et al, 2012

Steps to successful implementation (cont'd)

Selection | Orientation | Insight | Acceptance | **Change** | Retention

- **Phase 5 Change**
  - Create possibilities for all therapists to try/practice with technology
  - Time for group practice
  - Make it easy for questions to be answered (e.g. onsite 'expert', company, experienced users (offsite))
  - Address bugs/malfunctions quickly – assign champion with the time to identify and carry through on problems

(adapted from Hochstenbach et al, 2012

Steps to successful implementation (cont'd)

Selection | Orientation | Insight | Acceptance | Change | **Retention**

Phase 6 – Retention of Change

- Incorporation of the technology into existing practices and the organization
- Include in protocols/best practices if appropriate
- Maintain regularly with other equipment, address problems promptly, new staff trained on it, regular training/problem solving
- Avoid the "**Irreplaceable Expert**" – One person who knows everything about the device, and does all that needs to be done including treating patients for other therapists. What happens if that person leaves?

(adapted from Hochstenbach et al, 2012

Use of Technology in Stroke Rehabilitation: Summary

In this session we:

- Discussed potential barriers to implementation of technology in rehabilitation settings
- Introduced decision making strategies for selection, and planning for use of technology in rehabilitation
- Discussed evidence related to 3 specific technologies and ways that they may be used to facilitate best practice rehabilitation care
- Summarized steps for successful selection, implementation and maintenance of technology in stroke rehabilitation settings from team and managers perspective

Questions and Discussion?

STROKE NETWORK *of* Southeastern Ontario

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