Game-Based Stroke TeleRehabilitation: Challenges in Scaling to National Clinical Trails

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Overview

- UCI StrokeNet team
- Challenges of Stroke Rehabilitation, Telerehabilitation and Games
- Developing, demonstrating and deploying Game-Based Stroke Telerehabilitation systems
- UCI Stroke Telerehab system and environment
- Further scaling challenges
- Conclusions
- ClinicalTrials.gov: NCT02360488
UCI StrokeNet team

- Steve Cramer, MD (PI): Neurology, Anatomy & Neurobiology, and Physical Medicine & Rehabilitation, UCI School of Medicine; NINDS StrokeNet Exec. Committee

- Lucy Dodakian (OTR/L), Allison McKenzie (DPT), Jill See (PT), Jutta Heckhausen (Psych. & Soc. Beh.), Vu Le (software dev), and others.

- Collaborators and patient recruitment at eight national StrokeNet hospitals
# StrokeNet Clinical Trial Partner Sites

<table>
<thead>
<tr>
<th>Parent StrokeNet RCC</th>
<th>Study Site</th>
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<tr>
<td>Los Angeles Southern California</td>
<td>University of California, Irvine</td>
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<tr>
<td>Northwest Stroke Trials Network</td>
<td>Harborview Medical Center</td>
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<td>Chicago Stroke Trials Consortium</td>
<td>Rehabilitation Institute of Chicago</td>
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<td>Cleveland Regional Coordinating Center</td>
<td>MetroHealth Rehabilitation Institute of Ohio</td>
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<td>Emory Rehabilitation Hospital</td>
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<td>South Carolina Collaborative Alliance for Stroke Trials</td>
<td>MUSC Center for Rehabilitation Research in Neurological Conditions</td>
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<td>Stroke Trials Network of Columbia and Cornell</td>
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<td>New England Regional Coordinating Center</td>
<td>Spaulding Rehabilitation Hospital</td>
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About me:
Research Director, UCI IVECG

- Focused on producing Computer Games and Game-Based Virtual Worlds since 2005 for:
  - Academic research (National Science Foundation)
    - GBVW as Decentralized Activity Systems (2008-12)
  - Industrial training (Intel—Semi.Fab, “NDA”—drug discovery)
  - K-12th STEAM education (Discovery Science Center, San Francisco Symphony)
  - Defense (USNavy, Northrop-Grumman—C2/C3CB) and Healthcare (NINDS-stroke; UCI ICTS-asthma)
  - International R&D partnerships (SKorea, UK)
Recent Project: SFSKids.org – Informal Classical Music Learning Game Environment
Challenges of Stroke Rehabilitation, Telerehabilitation and Games
Stroke and Stroke Rehabilitation

- Approx. 800K/yr. stroke survivors in US, ~65% with persistent motor control impairments.
- Unassisted motor control recovery is partial.
- Clinical rehabilitation focuses on activities of daily living (ADLs) via occupational therapy.
- Most therapy requires at-home, iterative practice.
- Approx. 33% of all stroke patients experience clinical depression.
- Low rates of therapeutic compliance.
Stroke Telerehabilitation

Research Question: How best to utilize computer games and networked information technology to deliver personalized stroke rehabilitation therapy and assessment to patients at home?
UCI Stroke Telerehabilitation

- **Goal:** Provide *low-cost* rehabilitation capabilities and stroke prevention education for at-home usage.
- **Goal:** *Minimize complexity* of support system feature and interaction, and *enable fun* user experience.
- **Goal:** Supporting (remote) *therapists and physicians*: building on not replacing modern rehabilitation.
- **Goal:** Utilize *standardized* stroke/motor control *outcome measures*, education and patient assessments.
- **Goal:** Insure patient *safety, non-inferiority*, and HIPPA *privacy and data security* compliance.
Game-Based Stroke Rehabilitation and Telerehabilitation: *Translational Challenges*

- Many promising demonstration projects.
  - Games provide *intrinsic motivation* for activity/play, but
  - Most research to date are singular case studies of technology development; some without stroke patients.

- Few clinical assessments, few/no recovered ability assessments or validation after sustained post game-play intervention.
Identify theory/model underlying motor control impairment, neuroplasticity and recovery.

Identify what motor control circuits or therapeutic movements addressed.

Identify mapping for patient-specific impairments or rehabilitation plan via differentiated game play.
Developing, Demonstrating and Deploying Game-Based Stroke Telerehabilitation systems
UCI Stroke Telerehabilitation system and environment

- Upper extremity motor control *game console*
  - 9 types of movement interaction *devices*
  - 8 kinds of *upper extremity movements*, and 96 standard motor control rehabilitation exercises
  - 25 *mini-games* addressing different motor control tasks.
  - Open to improvements, extensions, repurposing, including anything that can be transduced, then measured and trained.

- Therapist UI/UX support system environment
  - Clinical trial management system infrastructure
UCI Stroke Telerehabilitation game console
Stroke Telerehabilitation game console and a sample game (for dial rotation movement)

Motor control devices: Game console buttons (large, small), continuous dial, Myo armband, touchpad, joystick, WiiMote, PS Eye, finger pressure force sensor.

All devices integrated to act like PC mouse/keyboard inputs.

35 consoles currently deployed in nationwide clinical trial.
Extension candidate: AR Stroke Rehab Game Interface

(a) 1st person view, (b) functional tasks with high ecology and affordance, (c) mirror neural activation, (d) embodied action observation/priming, (e) explicit motor imagery, (f) playful interaction experience and (g) safety.
Extension candidate: PC versus AR stroke rehabilitation game play UI/UX efficacy

Control Panel: Patient Itinerary

UC IRVINE TELEREHABILITATION STROKE STUDY

Choose An Activity
- Decreased proximal strength
- Decreased distal strength
- Decreased grip strength
- Exercises
- Games
  - Flappy Bird
  - Targeting
- Decreased pinch strength
- Decreased prox motor control
- Decreased distal motor control
- Decreased fine motor control
- Other

VuTest (TR Group)
Supervised Session #1
10/5/2015

Start Time: 10:00am

Video Chat - Review (10/10 minutes)

Exercises (10/10 minutes)
- 3 Transfer Object (75)
- 8 Skier Horiz ABD w/Tubing (99)
- Elbow Extension (52)

Games (10/10 minutes)
- Bubble Pop
- Cut the Rope

Anything (10/10 minutes)
- All Finger Ext (33)
- Targeting

Break (10/10 minutes)

Current Itinerary for VuTest

Uploaded

Total timer: 80 minutes
- Video Chat: 10 minutes
- 3 Transfer Object (75): 2 minutes
- 8 Skier Horiz ABD w/Tubing (99): 3 minutes
- Elbow Extension (52): 5 minutes
- Bubble Pop: 5 minutes [PS Move]
- Cut the Rope: 5 minutes [PS Move]
- All Finger Ext (33): 5 minutes
- Targeting: 5 minutes [squeeze]
- Rest: 10 minutes
- Fingers MP Ext Stretch (57): 5 minutes
- MP Ext IP Flex (59): 5 minutes
- Flappy Bird: 10 minutes [Buttons]
- Button Presses: 5 minutes [Buttons]
- DIP Extension Stretch (58): 5 minutes

Copy To...
Email To...
Upload
TR Group
Supervised Session #1
10/5/2015
Total time: 80 Minutes

- Video Chat
  - 10 minutes

- 73. Transfer Object
  - 2 minutes

Exercise #73: Transfer Object

Grasp and hold object with one hand. Transfer object to other hand. Reverse. Use objects of different shapes, sizes, and weight.

- 99. Bilateral Shoulder Horizontal Abduction With Tubing
  - 3 minutes

Exercise #99: Bilateral Shoulder Horizontal Abduction With Tubing

Hold hands with palms facing in and arms extended. Keep arms straight while pulling both arms out to the sides, squeezing shoulder blades together.

- 52. Bilateral Elbow Flexion
## Control Panel: Patient Survey Assessment

### UC Irvine Telerehabilitation Stroke Study

### O.P.S.

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### Patient Satisfaction

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Further stroke telerehabilitation scaling challenges

- Improve, extend, repurpose game console and/or environment.
- Persistent, *social multi-patient* therapeutic game play
  - Socialize telerehab and peer engagement play
  - Enable communication (text+*Emoji* chat) with peers
  - Enable cooperative, coordinative, and collaborative game play.
- How best to support *thousands* of stroke patients?
- How best to take advantage of multi-timezone support for patients needing 24 hours rehabilitation care.
Conclusions

- Game-based stroke telerehabilitation is rapidly evolving and large opportunity area for research that translates into clinical practice.
  - Focus to date is stroke, but can extended to other chronic disease management: diabetes, obesity, dementia, medication compliance.
- Stroke telerehabilitation system and environment are scalable, personalized, fun to use in therapeutic care and participatory.
- Game-based stroke telerehabilitation can be deployed with international research or clinical practice partners.
Acknowledgements

- NIH/NINDS
- ClinicalTrails.gov: NCT02360488, Telerehabilitation in the Home Versus Therapy In-Clinic for Patients With Stroke An Assessor-blind, Randomized, Non-inferiority Trial