Evolution of TeleRehabilitation for Rural Veterans
Then, Now, Next
Charles E. Levy, MD

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Point of View

- PMRS Chief
  - Leader of the mTBI team
- Director of clinical telerehabilitation programs
  - Low ADL Monitoring Program (LAMP)
  - Rural Veterans Tele Rehabilitation Initiative (RVTRI)
- Associate Director of CINDRR
- RRD Investigator
  - Virtual Environments for Therapeutic Solutions
Telehealth assumptions:

- Care that involves distant talking heads usually can be performed successfully by televideo.
- With adequate IT infrastructure, talking head care can be exported from the medical center to the community clinic.
- These interactions often require a health care facilitator and occasionally specialized equipment.
How is Rehabilitation Different?

- Rehabilitation often requires:
  - Active participation
  - Physical Exercise
  - Home Practice
Text-based systems (c., 2002)

Office of Telehealth Service
Care Coordination/Home Telehealth (CCHT) Programs
*Disease Management Protocols* on commercial home messaging devices.
*Standardized but not personalized.*
Text Based TeleRehabilitation: Low ADL Monitoring Program (LAMP)

- 2002 VISN-8 Community Care Coordination Service (CCCS) 2 year clinical demonstration project
- 2004: NF/SG VHS funded PM&RS Telerehabilitation Care Coordination Home Telehealth program
- Based on work of William Mann, et al.
- Functional decline in elders may be attenuated through the provision of assistive technology and adaptive equipment (W.C. Mann et al., 1995; W.C. Mann et al., 2001; W.C. Mann et al., 1999)
Purpose and practice

- To preserve home independence for frail elders
- Home Assessment, and equipment provision.
- Daily remote monitoring of health and functional status via home massing device or computer, phone or tablet
- Encourage self-management of chronic illnesses
- Referrals for additional VA and community services
- Continuous care coordination and support
Bathroom Modifications
Exterior Modifications
Tech Options

Home Messaging Device Interface
- VA Provided
- Low –Tech (POTS)
- Closed Disease Management Protocols with branching tree logic questions – no variability
- One way prescribed communication

Web-enabled Interface (Computer, tablet, phone)
- VA and Veteran provided
- Higher tech (internet connection)
- Veterans log in through secure URL
- Flexible DMP with two way text communication
Remote Monitoring Technology

Health Buddy

- Messaging and monitoring device
Remote Monitoring Technology

- Computers with internet capability
- Secure custom disease management protocol completed and submitted by veteran and/or caregiver
Remote Monitoring Technology

 Barclay, Myron

Computers with internet capability (cont.)

 Secure two-way asynchronous free text messaging

G: on 06/05/06 at 17:21 wrote

I believe pt for strength training on an out patient basis is an excellent idea. I have been mentioning it to the various doctors but no one seems to listen. To me the longer we put it off the longer the journey back cause it is really getting bad when three healthy firemen have as much rouble as they did getting me up. A combo of pt and possible water exercise taking the weight off the rest my body couldn't hurt if we could find out who needs to write the consult and could do it before I wind up having an accident I can't recover from. THANKS for catching what I've been saying. I have no broken bones yet but anyone who looks at me would describe me as a bloody train wreck.

Kathy Horn on 06/05/06 at 17:20 wrote

Oh my gosh!!!!!!
Are you sure you didn't do more than just cut your leg? Is there any chance that you may have fractured something? I placed the consult for wheelchair clinic for you to be evaluated for a scooter a few weeks, so that might be one solution, at least for outside activities. What about physical therapy here on an outpatient basis for strength training? Just let me know what you think.
35 y.o. Woman, S/P MVA

- Frontal skull fx
- Subdural hematomas
- 11 days in coma
- Left optic nerve damage
- Separation of left shoulder
- Deficits in executive function, memory, judgment, impulse control
LAMP Interventions

- Functional and home assessment
  - Rolling laundry cart, filing system, labeled bins
- Cognitive Cues
  - Palm Pilot
  - Daily Dialogue
- Care Coordination
How has your mood been since you last checked in?

**yes** | **no** : Are you having More Pain than Usual or any New Pain?

if yes, How would you rate your pain on a scale of 1-10, 10 being the worst pain imaginable? | **none**

**yes** | **no** : Are you taking all of your prescribed medications?

If you did not take a prescribed medication(s) let us know why.

**yes** | **no** : Did you keep all of your Palm Pilot appointments since you last checked in?

If you missed some appointments, let us know why?
Customizable DMP
(Daily Dialogue)

yes | no : Did you program your Palm Pilot for the upcoming day?

If you have had any problems following your daily child care routine please tell us about them.

What type of fun activities did you do with your children today?

Which of the following household tasks have you completed since you last checked in? (check if yes)

- Laundry
- Grocery list
- Clean the house
- Make a meal

Have you completed any other household tasks since you last checked in?

yes | no : Have you felt productive since you last checked in?

If you would like us to report anything to your Primary Care Physician, let us know in this space.

If you would like us to report anything to your Mental Health Provider, please let us know in this space.

If you have any comments, questions or other needs please let us know about them in this space.

For health or benefits related information, Contact VA
For page errors and accessibility problems only, Contact Webmaster
### Outcomes

#### Table 3. Comparison of Healthcare Expenditures for LAMP (n = 115) and MCG (n = 115) One-year Pre-enrollment and One-Year Post-enrollment

<table>
<thead>
<tr>
<th></th>
<th>TOTAL SUM</th>
<th>BDOC</th>
<th>CLINIC</th>
<th>ER</th>
<th>NHCU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-enroll days/visits</td>
<td>$2,767,712.90</td>
<td>$1,494,483</td>
<td>$1,162,211</td>
<td>$23,842</td>
<td>$87,177</td>
</tr>
<tr>
<td>Post-enroll days/visits</td>
<td>$2,812,250.50</td>
<td>$690,215</td>
<td>$2,053,015</td>
<td>$24,257</td>
<td>$44,763</td>
</tr>
<tr>
<td>Difference in costs pre-post</td>
<td>+$44,537.60</td>
<td>-$804,268</td>
<td>+$890,814</td>
<td>+$415</td>
<td>-$42,414</td>
</tr>
<tr>
<td>Difference in days/visits pre-post</td>
<td>-826</td>
<td>8,728</td>
<td>-8</td>
<td>-116</td>
<td></td>
</tr>
</tbody>
</table>

#### LAMP

<table>
<thead>
<tr>
<th></th>
<th>TOTAL SUM</th>
<th>BDOC</th>
<th>CLINIC</th>
<th>ER</th>
<th>NHCU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-enroll days/visits</td>
<td>$2,055,283.60</td>
<td>$1,231,656</td>
<td>$642,052</td>
<td>$16,908</td>
<td>$164,668</td>
</tr>
<tr>
<td>Post-enroll days/visits</td>
<td>$1,578,459.30</td>
<td>$553,924</td>
<td>$862,510</td>
<td>$12,826</td>
<td>$149,198</td>
</tr>
<tr>
<td>Difference in costs pre-post</td>
<td>-$476,824.30</td>
<td>-$677,732</td>
<td>+$220,458</td>
<td>-$4,082</td>
<td>-$15,470</td>
</tr>
<tr>
<td>Difference in days/visits pre-post</td>
<td>-744</td>
<td>-157</td>
<td>-4</td>
<td>-4</td>
<td></td>
</tr>
</tbody>
</table>

#### MCG

1) Bendixen RM, Horn K, Levy CE: Using telerehabilitation to support elders with chronic illnesses in their homes. Topics in Geriatric Rehabilitation 2007;23:47-51
3) Bendixen RM, Levy CE, Olive ES, Kobb RF, Mann WC. Cost Effectiveness of a telerehabilitation program to support chronically ill and disabled elders in their homes. Telemedicine and e-health 2009: 15:31-38
Rural Veterans TeleRehabilitation Initiative (RVTRI)

To enable access to high quality rehabilitation to rural veterans via telehealth.

- Rural Veterans TeleRehabilitation Initiative: VA ORH: 9.09-10.10
- Rural Veterans TeleRehabilitation Initiative II: VA ORH 10.10-9.11
- X08-FY12Q1-S5-P00058. Rural Veteran's TeleRehabilitation Initiative Expansion, Proliferation and Dissemination Project. VA ORH
- Rural Veteran’s TeleRehabilitation Initiative Expansion, Proliferation and Dissemination Project: Respiration, Eating and Swallowing Program (RVTRI-RESP) 2014, 2015
- Rural Veterans TeleRehabilitation Initiative: Creative Arts Therapy Project. VA Office of Rural health No8-FY14Q3-S0-P01219 2014, 2015
- Rural Veterans Supported Employment Initiative (Lisa Ottomanelli, Director; Levyco-Director) 2014, 2015
- Breast Cancer Rehabilitation Initiative, VISN 8 Transformational Innovation Grant
Effects of physical therapy delivery via home video telerehabilitation on functional and health-related quality of life outcomes

- Retrospective pre-post design, n = 26
- Average length of participation was 99.2 ± 43.3 d
- 15.2 ± 6.0 therapeutic sessions

Charles E. Levy, Erin Silverman, Huanguang Jia, Meghan Geiss, David Omura,
Patient Characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex: Male</td>
<td>92.3</td>
</tr>
<tr>
<td>Age</td>
<td></td>
</tr>
<tr>
<td>≤64 yr</td>
<td>69.2</td>
</tr>
<tr>
<td>&gt;64 yr</td>
<td>30.8</td>
</tr>
<tr>
<td>Patients by Home ZIP Codes</td>
<td></td>
</tr>
<tr>
<td>Rural Patients</td>
<td>57.7</td>
</tr>
<tr>
<td>Nonrural Patients</td>
<td>42.3</td>
</tr>
<tr>
<td>Major Medical Diagnosis</td>
<td></td>
</tr>
<tr>
<td>Musculoskeletal</td>
<td>80.8</td>
</tr>
<tr>
<td>Multiple Sclerosis</td>
<td>15.4</td>
</tr>
<tr>
<td>Stroke</td>
<td>3.8</td>
</tr>
<tr>
<td>Types of Physical Therapy Provided</td>
<td></td>
</tr>
<tr>
<td>General Strengthening Program</td>
<td>26.9</td>
</tr>
<tr>
<td>Lumbar Stabilization Program</td>
<td>38.5</td>
</tr>
<tr>
<td>Scapular Stabilization</td>
<td>34.6</td>
</tr>
</tbody>
</table>
# Results: Satisfaction

Patient satisfaction. Number of respondents for satisfaction survey was 25 for all items except item number 12, which had 24 respondents.

<table>
<thead>
<tr>
<th>Satisfaction Item and Response Category</th>
<th>Level of Satisfaction, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1. Length of time for 1st appointment*</td>
<td>0</td>
</tr>
<tr>
<td>2. Waiting minutes to see telehealth provider†</td>
<td>23</td>
</tr>
<tr>
<td>3. Time spent with your specialist*</td>
<td>0</td>
</tr>
<tr>
<td>4. Your providers’ personal manner‡</td>
<td>0</td>
</tr>
<tr>
<td>5. Your privacy was respected*</td>
<td>0</td>
</tr>
<tr>
<td>6. Come back to this clinic for additional care§</td>
<td>0</td>
</tr>
<tr>
<td>7. Equipment operation was explained*</td>
<td>0</td>
</tr>
<tr>
<td>8. Satisfied with video quality*</td>
<td>0</td>
</tr>
<tr>
<td>9. Satisfied with audio quality*</td>
<td>0</td>
</tr>
<tr>
<td>10. Understanding your specialist*</td>
<td>0</td>
</tr>
<tr>
<td>11. Overall telehealth experience*</td>
<td>0</td>
</tr>
<tr>
<td>12. Future use of telehealth again for medical care§</td>
<td>25</td>
</tr>
</tbody>
</table>

*1 = not, 2 = somewhat, 3 = satisfied, 4 = very satisfied.
†1 = 1–5, 2 = 6–15, 3 = 16–30, 4 = 31–45, 5 ≥ 45 (minutes).
‡1 = poor, 2 = fair, 3 = good, 4 = very good, 5 = excellent.
§1 = no opinion, 2 = strongly disagree, 3 = disagree, 4 = agree, 5 = strongly agree.
†§1 = yes, 2 = no.
N/A = not applicable.
Visits and Travel

<table>
<thead>
<tr>
<th>Table 2.</th>
<th>Patient visits, travel, and potential cost avoidance.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Visit, Travel, And Potential Cost Avoidance</strong></td>
<td><strong>Mean ± SD</strong></td>
</tr>
<tr>
<td>Average Time with RVTRI (d)</td>
<td>99.2 ± 43.3</td>
</tr>
<tr>
<td>Average Number of Sessions Received</td>
<td>15.2 ± 6.0</td>
</tr>
<tr>
<td>Average Number of Telerehabilitation Sessions Received</td>
<td>11.3 ± 5.9</td>
</tr>
<tr>
<td>Average Number of Face-To-Face Sessions Received</td>
<td>3.9 ± 2.6</td>
</tr>
<tr>
<td>Average Roundtrip Miles Per Visit Saved*</td>
<td>179.8 ± 182.7</td>
</tr>
<tr>
<td>Average Total Number of Miles Saved†</td>
<td>2,774.7 ± 3,197.4</td>
</tr>
<tr>
<td>Average Total Driving Hours Saved</td>
<td>46.3 ± 53.3</td>
</tr>
<tr>
<td>Average Travel Expense Saved ($)‡</td>
<td>1,151.50 ± 1,326.90</td>
</tr>
</tbody>
</table>

*Roundtrip mileage from patients’ home residence to closest local Department of Veterans Affairs (VA) hospital for each visit.
†Roundtrip miles per visit × number of telerehabilitation sessions received through RVTRI program.
‡Total number of miles saved × $0.415 (per mile travel reimbursement rate to eligible Veterans by VA for 2010–2011).
RVTRI = Rural Veterans TeleRehabilitation Initiative, SD = standard deviation.
## Change in status

<table>
<thead>
<tr>
<th>Measure</th>
<th>Baseline</th>
<th>Discharge</th>
<th>Change Score</th>
<th>p-Value*</th>
<th>r Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>VR-12 (n = 23)</td>
<td>35.8 ± 8.5</td>
<td>39.7 ± 9.8</td>
<td>3.8 ± 7.1</td>
<td>0.02</td>
<td>0.42</td>
</tr>
<tr>
<td>FIM (n = 26)</td>
<td>107.2 ± 23.7</td>
<td>114.7 ± 15.7</td>
<td>7.6 ± 13.6</td>
<td>&lt;0.001</td>
<td>0.63</td>
</tr>
<tr>
<td>Quick DASH (n = 19)</td>
<td>40.0 ± 19.4</td>
<td>36.8 ± 22.3</td>
<td>−3.1 ± 14.4</td>
<td>0.35</td>
<td>−0.22</td>
</tr>
<tr>
<td>MoCA (n = 16)</td>
<td>23.7 ± 3.8</td>
<td>26.2 ± 4.4</td>
<td>2.5 ± 3.9</td>
<td>0.01</td>
<td>0.44</td>
</tr>
<tr>
<td>2MWT (n = 13)</td>
<td>319.4 ± 182.2</td>
<td>392.9 ± 240.7</td>
<td>73.5 ± 86.7</td>
<td>0.006</td>
<td>0.73</td>
</tr>
</tbody>
</table>

*p-Values were results from Wilcoxon signed-rank tests comparing baseline score and follow-up score for each measurement. Bold indicates significance.

2MWT = 2-minute walk test, FIM = Functional Independence Measure, MoCA = Montreal Cognitive Assessment, VR-12 = Veterans RAND 12-Item Health Survey.
RVTRI Uniques & Encounters

NF/SG VHS
Fiscal Year 2016 - In Home CVT

- Physical Therapy
- Creative Arts
- Occupational Therapy
- Recreation Therapy

Encounters
Uniques
Strategies to maximize useful signal in low bandwidth environments:

- Vary the parameters:
  - Frame Rate
  - Resolution
  - Color
  - Cropping
  - Spatial data extraction Via Kinect

Tan KK, Narayanan AS, Koh GC, Kyaw kk, Hoenig HM
Development of telerehabilitation application with designated consultation categories, JRRD, Volume 51, Number 9, 2014, Pages 1383–1396
Enhanced Therapy: Virtual Reality therapy delivered via Telehealth
Virtual Environments for Therapeutic Solutions (VETS) mTBI/PTSD Phase II. VA RR&D 1I01RX000339-01A3.

Levy CE¹, Lok B², Marsiske M³, Halan S², Chen W², Lehman L¹, Silverman E¹, Christie J¹, Myers K¹.

¹VA Center of Innovation on Disability and Rehabilitation Research, ²Computer and Information Science and Engineering Department, ³College of Engineering, University of Florida, Department of Clinical and Health Psychology, University of Florida

This work was supported by: 1) CDMRP/DoD Concept Award: Design of Effective therapeutic interventions for Mild TBI/PTSD using interactive Virtual World Environments, 9.15.08-9.14.09; 2) Development of Virtual Humans for PTSD and mTBI: Rehabilitation Outcomes Research Center: 9.1.10-9.1.11
mTBI/PTSD Impairments

- Memory
- Attention
- Irritability
The Therapist Joins the Veteran in V-Mart

- The Veteran and the therapist sign on to a secure, encrypted URL from their own device.
- They are connected by live streaming video while in the virtual world, via web-cameras.
- The therapist controls multiple aspects of the experience at the outset, and can make adjustments on the fly.
Simple and Complex Cognitive challenges

**Simple:**
- Determine Sodium or calorie Content (read label)
- Finding a product (visual search)
- Determining least expensive of two products (direct comparison)

**Complex**
- Compute unit pricing where units are not displayed on the label
- Determine the most economical low sodium soup where the one with least sodium is not least expensive
Prolonged Exposure Therapy in V-Mart

Treatment Components

- Education
- Breathing

- Imaginal Exposure: Revisiting the traumatic memory with the goal of processing and reducing emotional distress (Virtual Viet Nam, Virtual Iraq, Virtual Afghanistan)

- In Vivo Exposure: Real world practice in approaching safe situations that trigger emotional distress (V-Mart).
On the Horizon: Extending therapy gym to the home

- Beyond activity monitoring
- Connected Instrumented Exercise Equipment
Stuff that wasn’t covered

 бю Apps: Annie Text Messaging
 бю Apps Concussion Coach, TBI Coach
 бю Other related projects RVSETI, Breast Cancer Rehabilitation Initiative
 бю Other VA practices: Home evals, TBI second Level Evals, Seating and Positioning Clinics, Amputee Clinics
Questions?