The Impact of Mobile Health (mHealth) Technology on Family Caregiver’s Burden Levels and an Assessment of Variation in mHealth Tool Use

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U.S. Veterans Health Administration
International Digital Health and Care Congress
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Presentation Overview

- Background and Impetus for this Research
- Study Purpose
- Significance of this Research
- Methods
- Results & Key Findings
- Scope and Limitations
- Discussion of Results
- Future Research Recommendations
Impetus for the Research
Joint Investigation of the U.S. Department of Veterans Affairs (VA) & George Washington University (GWU)

Over 2 million U.S. Vets Returning from War – Many Seriously Injured

Costs Escalating

- Expensive Drug Process in FDA
- Utilization of expensive newer technologies
- Increased salary demands from medical workers
- The aging population

High Rates of Stress & Burden

CAREGIVER BURNOUT.
Help and Prevention

VA’s Family Caregiver Program

Mobile Health’s Potential

VA Family Caregiver Mobile Health Pilot

Get connected! mobilehealth.va.gov
VA Family Caregiver Program

- July of 2012 there were 4,501 Caregivers enrolled, today there are over 10,000 enrolled

- Caregivers receive a stipend from the VA of ~USD1,500 per month to provide in home healthcare support to Veterans

- Program provides training, counseling and respite care to support the Caregivers

- Program is staffed by VA Caregiver Support Coordinators who make quarterly home visits

- Veterans in the program are from post 9/11 wars and have sustained severe physical and emotional injuries from require caregiving services
Study Purpose

- Contribute to the evidence base regarding the effectiveness of technology-based solutions, specifically mHealth tools, in reducing Family Caregiver burden

- Describe the relative use of the mHealth apps and the factors that predict this use in a medically complex Caregiver-Care Recipient population
Related Research

- Technology-based Caregiver interventions studies have shown mixed results in reducing Caregiver burden/stress
  - Caregivers report the need for access to more health information and ways to communicate with providers
  - mHealth interventions in this study are designed to support Caregivers
  - mHealth interventions have not been studied in the Caregiver population and this study is the first to do so

- Many mHealth studies are limited, many poorly designed with small sample sizes
  - Unclear what factors influence use of mHealth and if it is the same as factors driving other Consumer Health Technologies
  - This study is the first to identify factors driving mHealth use in this Caregiver/Veteran population
What Caregivers want from Technology

Significance of the Research

Finding ways to reduce Caregiver burden is important:
- Caregivers provide USD450 billion in uncompensated care in U.S. annually
- Caregivers prevent /delay institutionalization of care recipients
- High rates of burnout reduce Caregivers’ ability to provide care

Understanding which mHealth apps are most commonly used by Caregivers and their Veterans, along with factors that influence their use, is important to future mHealth implementation decisions
**Study Design**

**Zarit Burden Study**
- Quasi-experimental pretest/posttest design with a nonrandomized control group

<table>
<thead>
<tr>
<th>Treatment Group</th>
<th>O X O (N=620)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Group</td>
<td>O O (N=2,274)</td>
</tr>
</tbody>
</table>

O = Measurement  
X = mHealth Intervention

**mHealth Use Study**
- Prospective Cohort Study Design (3 months)

**Exposed Group**
- Received mHealth Intervention
- N=881

**Subset**
- Completed Research Surveys
- N=577

Predict mHealth App Use

**Designed as an “intention to treat” study by including in the analysis patients who received the intervention but may not have used it**
Zarit Burden Study Research Question

Will VA Family Caregivers and their supported patients receiving a suite of caregiver-driven mHealth apps on an iPad® have a significantly different change in measured caregiver burden levels at the end of the 3 month study period, as compared with a measured control group that did not receive the intervention, after adjusting for pre-study burden levels and other covariates?

\[ H_0: \bar{Y}_1 = \bar{Y}_2 \]
\[ H_a: \bar{Y}_1 \neq \bar{Y}_2 \]

\( \bar{Y}_1 \) represents the Primary Study group’s mean change in Zarit Burden scores after adjusting for covariates

\( \bar{Y}_2 \) represents the control group’s mean change in Zarit Burden Scores after adjusting for covariates
mHealth Use Study Research Question

What is the relative use of the mHealth apps provided to the treatment group, and what are the characteristics of the Caregivers and Veterans that predict their use?

When outcome = App Use versus Non-Use

Logit = α + β₁x₁ + βₖxₖ  (Logistic Regression Model)

Logit = natural logarithm (ln) of the odds of Y, α = the Y intercept, x = a categorical or continuous predictor variable, β = the slope parameter

H₀: β₁...βₖ = 0  Hₐ: β₁...βₖ ≠ 0

When outcome = Frequency of App Use

Log(Y) = α + β₁ₓ₁ + β₂x₂ + βₖxₖ  (Negative Binomial Model)

Y = represents the frequency of use of the mHealth apps, x = represents predictor variables, β = Slope variable

H₀: β₁...βₖ = 0  Hₐ: β₁...βₖ ≠ 0
Intervention

- iPad loaded with a suite of mobile health apps designed to support Caregivers
- Intervention was only available to study participants
- Initial App concepts were created based on needs identified by Caregiver focus groups
- Specific App design sessions & usability sessions were then held with follow-up Caregiver/Veteran focus groups
- Support included: Quick Start guide, Help desk, website with FAQs, monthly newsletter
- Logging on to apps required Dept of Defense (DoD) supplied credentials
mHealth Apps

Launchpad: Container for all study apps

Summary of Care: Provides access to health care record

Notifications: Sets medication reminders

Rx Refill: Refill prescriptions

Journal: Diary

Care4Caregivers: Caregiver Support

PTSD Coach: PTSD Support

Pain Coach: Pain Support
Summary of Care

Displays data from VA’s electronic medical record

Display includes: demographics, diagnoses, surgeries, lab results, medications, radiology reports, consults, and future clinic appointments

Screenshots: (top) shows listing of patient contact information, medical diagnoses; (bottom) shows graphical display of laboratory results
Prescription Refill

Displays a listing of active medications with their refill status and provides the ability to submit a request for a refill.

Screenshot shows active meds, clicking on right arrow will provide detailed information on medications.
Journal

Enables users to record daily events, communications, mood, pain, vitals, diet and exercise.

Screenshot: (Left) selector for specifying the event to be recorded – choices include communication log, mood, pain, vitals, diet, exercise and assessments; (Right) demonstrates the calendar and scale for recording information on mood.
VA Pain Coach

Provides tools to help manage pain.

Provides pain management education along with a monthly and daily pain dietary and tools for setting, tracking and sharing goals.

Screenshots: (Left) shows main screen: choices include Learn, Self Assessment, Manage and Goals; (Right) is the selector for inputting data on monthly and daily pain, viewing pain graph, generated pain reports, and scheduling reminders to retake pain assessments.
Care4Caregiver

Provides information about the emotional consequences of caregiving and techniques for building resilience and managing stress.

The Zarit Burden inventory (12 questions) was incorporated into the app for burden self-assessment and tracking.

Information about Caregiver support resources is also provided.

Screenshots: (Left) is main screen, choices include Learn, Self-Assessment, Manage and Find Support; (Right) Assessment tool.
VA PTSD Coach

Screening tool for assessing and tracking Post Traumatic Stress Disorder (PTSD) symptoms

Enables symptom tracking

Provides tools for PTSD management and information on support services

Screenshots: (Top) is main screen; choices include Learn, Self-Assessment, Manage, and Find Support. (Bottom) select the symptom being experienced for information on how to manage the symptom
Theoretical Framework for Studies

- **Zarit Burden Study:** Sorenson Expanded Stress Process Model
  - The mHealth intervention provides assistance and support to Caregivers resulting in an amelioration of stressors and changing the Caregivers’ appraisal of their situation

- **mHealth Use Study:** Unified theory of acceptance and use of technology (UTAUT)
  - The perceived usefulness of the mHealth apps and their ease of use will drive utilization
Zarit Burden Study Data Collection

- Zarit Burden Inventory administered quarterly during home visits by VA staff & recorded in Electronic Health Record (EHR)
- Zarit Burden Scores extracted from EHR using text mining
- VA Administrative Databases used as covariate data source

Study Start Date = June 1, 2013 or Day iPad Received

Look back 6 months from study start date and extract most proximal Zarit Burden Score

Study End Date
September 18, 2013

Look forward 6 months after study end date and extract most proximal Zarit Burden Score

If post study Zarit is not found, select last Zarit after study start date
mHeath Use Study Data Collection

- App use was tracked and sent to backend database
  - Metrics collected: user, app used, time, duration of use

- VA administrative databases were used as source for predictor variables

- Survey data was collected by asking participants to complete the surveys on the iPads

- If surveys were not completed within 2 weeks of receiving the iPad, participants were contacted and asked to complete on iPad or via a telephone interview
Outcome Variables

- Zarit Burden Study: Change in Zarit Burden Score
  - 4 question Zarit screening score extracted from EMR

- mHealth Use Study: App Use
  - At least one use of the mHealth apps
  - Frequency of use of the mHealth apps for those who have used
  - App use was measured for each app individually and for the group of seven study mHealth apps
Zarit Burden Study Statistical Analysis

- General Linearized Model (GLM) used to assess differences between control and treatment groups in the outcome variable Zarit burden change scores

- Covariates included:
  - Pretest Zarit burden scores – adjusts for regression toward the mean
  - Variables derived from VA administrative databases that were statistically different between treatment and control groups – used to compensate for nonrandom control

- Post hoc analysis performed on the treatment group to assess differences in Zarit burden change scores by category of app use after controlling for pretest Zarit burden scores
mHealth Study Statistical Analysis

- **Logistic Regression Model** used to understand the factors that predict at least one use of the apps
- **Negative Binomial Model** used to understand the factors that predict incremental increases in app use

A parsimonious set of predictor variables created from VA administrative databases and survey data for that subset of study participants completing the research surveys:

- **Caregiver Characteristics Survey**
  - Questions derived from 2009 National Alliance for Caregiving Survey
- **Caregiver Preparedness Survey**
  - “Overall, how well prepared do you think you are to care for your Veteran”
- **Zarit Caregiver Burden screening survey (self-administered)**
  - Total score was used
Results
Study Participant Selection

Family Caregivers Enrolled in VA Family Caregiver Program Sent Invitation to Participate in VA mHealth Pilot (4,501)

- Did Not Agree to Participate (3,456)
- Agreed to Participate (1,045)

Agreed to Participate (1,045)

- Confirmed Shipping Address and Still Enrolled as of May 2013 (881)

- Receive the iPad/mHealth Intervention

- Found a Pre and Posttest Zarit Burden Score in the Electronic Medical Record

ZARIT BURDEN STUDY CONTROL GROUP (2,274)

ZARIT BURDEN STUDY TREATMENT GROUP (620)

mHEALTH USE STUDY TREATMENT GROUP (881)

- Consent to Participate in Research Study & Complete Research Surveys

SUBSET COMPLETING SURVEYS (577)
## Caregivers Receiving mHealth Intervention Compared with other Caregiver Groups

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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</tr>
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<tbody>
<tr>
<td>Gender Female</td>
<td>66%</td>
<td>96%</td>
<td>95%</td>
</tr>
<tr>
<td>Caregiver Age</td>
<td>48</td>
<td></td>
<td>40</td>
</tr>
<tr>
<td>Caregiver = Spouse</td>
<td>5%</td>
<td>70%</td>
<td>91%</td>
</tr>
<tr>
<td>Duration of Caregiving</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Less than 1 year</td>
<td>31%</td>
<td>4%</td>
<td>59% (&gt; 4)</td>
</tr>
<tr>
<td>- More than 5 years</td>
<td>31%</td>
<td>56%</td>
<td></td>
</tr>
<tr>
<td>Choice in Caregiving = No</td>
<td>43%</td>
<td>67%</td>
<td>36%</td>
</tr>
<tr>
<td>Hours of Caregiving &gt; 40</td>
<td>13%</td>
<td>43%</td>
<td>66%</td>
</tr>
<tr>
<td>Burden Level = High</td>
<td>9%</td>
<td>30%</td>
<td>27%</td>
</tr>
<tr>
<td>Emotional Stress = Extreme</td>
<td>31%</td>
<td>68%</td>
<td>16%</td>
</tr>
<tr>
<td>Physical Strain = High</td>
<td>8%</td>
<td>9%</td>
<td>12%</td>
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</table>
## Other Study Group Characteristics (N=881)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
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<tbody>
<tr>
<td>Veteran Age</td>
<td>40 years</td>
</tr>
<tr>
<td>Veterans Male</td>
<td>96%</td>
</tr>
<tr>
<td>Veterans &gt; 80 percent service connected</td>
<td>85%</td>
</tr>
<tr>
<td>Average days in Caregiver Program</td>
<td>529</td>
</tr>
<tr>
<td>Percent living in rural area</td>
<td>40%</td>
</tr>
<tr>
<td>Percent receiving polytrauma care</td>
<td>16%</td>
</tr>
<tr>
<td>Percent with Traumatic Brain Injury (TBI) diagnosis</td>
<td>30%</td>
</tr>
<tr>
<td>Percent with PTSD diagnosis</td>
<td>68%</td>
</tr>
<tr>
<td>Percent with other mental health diagnosis</td>
<td>22%</td>
</tr>
<tr>
<td>Percent with other medical diagnosis</td>
<td>17%</td>
</tr>
<tr>
<td>Percent with Spinal Cord Injury</td>
<td>9%</td>
</tr>
</tbody>
</table>
Outcome Variable: Zarit Burden Change Scores

- Pretest and Posttest Zarit burden scores were obtained from the VA’s electronic medical record for 69% of the control group and 70% of the treatment group.
**Dependent Variable: Zarit Burden Change Score Distribution**

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Variable</th>
<th>Mean</th>
<th>Std Dev</th>
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<tbody>
<tr>
<td>Control</td>
<td>2274</td>
<td>Zarit Change</td>
<td>-0.061</td>
<td>2.962</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pretest Zarit Score</td>
<td>5.422</td>
<td>3.521</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Posttest Zarit Score</td>
<td>5.360</td>
<td>3.584</td>
</tr>
<tr>
<td>Treatment</td>
<td>620</td>
<td>Zarit Change</td>
<td>-0.009</td>
<td>2.922</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pretest Zarit Score</td>
<td>5.672</td>
<td>3.630</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Posttest Zarit Score</td>
<td>5.662</td>
<td>3.582</td>
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</table>
### GLM Covariates (Continuous)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Control</th>
<th></th>
<th>Treatment</th>
<th></th>
<th>Pr &gt; χ²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>STD</td>
<td>Mean</td>
<td>STD</td>
<td></td>
</tr>
<tr>
<td>Ancillary Visits</td>
<td>7.26</td>
<td>9.23</td>
<td>5.18</td>
<td>6.02</td>
<td>&lt; .0001</td>
</tr>
<tr>
<td>Medical Visits</td>
<td>2.44</td>
<td>3.09</td>
<td>1.89</td>
<td>2.12</td>
<td>&lt; .0001</td>
</tr>
<tr>
<td>Days in program</td>
<td>522.50</td>
<td>117.17</td>
<td>532.86</td>
<td>118.58</td>
<td>.0502</td>
</tr>
<tr>
<td>Veteran Age</td>
<td>37.77</td>
<td>9.18</td>
<td>39.58</td>
<td>9.40</td>
<td>&lt; .0001</td>
</tr>
</tbody>
</table>
## GLM Covariates (Categorical)

<table>
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<tr>
<th>Variable</th>
<th>Level</th>
<th>Control</th>
<th>Treatment</th>
<th>Chi-Square</th>
<th>Pr &gt; $\chi^2$</th>
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<tbody>
<tr>
<td>Vet Service Connected %</td>
<td>&lt; 80%</td>
<td>9.42</td>
<td>14.80</td>
<td>.0001</td>
<td></td>
</tr>
<tr>
<td>Vet A&amp;A</td>
<td>No</td>
<td>89.12</td>
<td>94.02</td>
<td>.0003</td>
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</tr>
<tr>
<td>Vet Marital Status</td>
<td>Divorced</td>
<td>6.65</td>
<td>4.86</td>
<td>.0002</td>
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<tr>
<td></td>
<td>Married</td>
<td>78.55</td>
<td>86.06</td>
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<tr>
<td>Branch of Service</td>
<td>Air Force</td>
<td>6.54</td>
<td>4.10</td>
<td>.0316</td>
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<tr>
<td></td>
<td>Army</td>
<td>73.11</td>
<td>78.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Marines</td>
<td>13.31</td>
<td>10.58</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Navy/Coast Guard</td>
<td>7.05</td>
<td>7.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relationship</td>
<td>Parent</td>
<td>14.78</td>
<td>7.59</td>
<td>&lt; 0.0001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spouse</td>
<td>81.70</td>
<td>90.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caregiver Gender</td>
<td>Female</td>
<td>92.74</td>
<td>95.63</td>
<td>0.0105</td>
<td></td>
</tr>
</tbody>
</table>
Checking GLM Model Assumptions

- Equality of variance across groups
  - Levine Test $F(1,2892) = .09, P =0.760$
  - Hypothesis of equal variances could not be rejected

- Homogeneity of regression slopes
  - Ran GLM model for each quantitative variable against dependent variable and tested the significance of the interaction terms
  - No interaction terms were significant

- GLM regression diagnostics indicated that the GLM model was a good fit
  - Residuals appear to be randomly distributed and display a normal distribution
Results of Zarit Burden Study

- The study was powered at the 80% level with a 2-tailed alpha < .05 to detect an absolute difference of 0.4 or more between the control and treatment groups.

- Overall F test for the GLM is significant (p < .001) and explains 17% of the variance in Zarit burden change scores.

- The factor of interest, Group, was not significant (p = .54)
  - The null hypothesis of equal means for the treatment and control groups could not be rejected.
Another research question was posed during the course of data analysis that was not originally intended to be asked in the original study.

Research question: is there a difference in Zarit burden change scores across app use groups after adjusting for pretest Zarit burden scores and the administration of the Zarit burden inventory relative to study start and end dates?

Null Hypothesis: The mean change in Zarit burden scores does not differ across app use groups.
Comparison of Zarit Change Score Across App Use Categories

A GLM model was run with the dependent variable of Zarit burden change score

Covariates included pre Zarit burden scores and two time variables to adjust for the days between when the pre and post Zarit burden inventories were administered relative to the study start and end dates

Model goodness of fit was verified as the residuals appeared random and normally distributed

<table>
<thead>
<tr>
<th>App Use</th>
<th>N</th>
<th>Mean</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Use</td>
<td>178</td>
<td>0.073</td>
<td>-0.018</td>
</tr>
<tr>
<td>Low Use (&gt; 0 and &lt;= 7)</td>
<td>141</td>
<td>-0.035</td>
<td>0.132</td>
</tr>
<tr>
<td>Medium Use (&gt; 7 and &lt;= 18)</td>
<td>146</td>
<td>-0.308</td>
<td>-0.233</td>
</tr>
<tr>
<td>High Use (&gt; 18)</td>
<td>155</td>
<td>0.200</td>
<td>0.363</td>
</tr>
<tr>
<td>Control</td>
<td>2,274</td>
<td>-0.061</td>
<td>-0.080</td>
</tr>
</tbody>
</table>
Post Hoc Analysis Results

The high use group experienced an increase in Zarit burden that was statistically different from the control group ($p=0.047$).

The medium use group experienced a decrease in Zarit burden that was borderline statistically different from the high use group ($p=0.055$).
mHealth Use Study Results
The mHealth Study group consisted of individuals who received the mHealth/iPad intervention (N=881).

A subset of the mHealth study group was used - comprised of those that received the mHealth/iPad intervention and completed the three study surveys (N=577).

Chi square analysis did not reveal any statistically significant differences in these two populations with respect to the variables derived from VA databases.
mHealth Use Study Outcome Measures

Binary Outcome – At Least One App Use

- Any Clinical App
- Notifications
- Summary of Care
- Rx Refill
- Care4Caregivers
- Journal
- VA PTSD Coach
- VA Pain Coach

mHealth Study Group (N=882)
mHealth Study Group Completing Surveys (N=577)
mHealth Study Outcome Measures

Frequency of App Use

- Any Clinical App
- Notifications
- Summary of Care
- Rx Refill
- Caregivers
- Journal
- VA PTSD Coach
- VA Pain Coach

mHealth Study Group (N=882)
mHealth Study Group Completing Surveys (N=577)
Non-Users of the mHealth Apps

30% of the Study Group and 14% of the Study Group completing the surveys did not use the mHealth Apps.

Percentage of Reported Reasons of Non-Use of the LaunchPad

- DS Login Issues: 55.21%
- App Issues: 21.88%
- Usability: 9.38%
- Misinformation: 4.17%
- Personal: 4.17%
- Language Barrier: 3.13%
- No iPad/Not a caregiver: 2.08%
Frequency Distribution App Use for those who have used the Apps at least once

Distribution represents a negative binomial distribution

Subset of treatment group that completed the surveys
## Logistic Regression Results

- **mHealth Use Study Group** (n=879)
  - H&L (p = 0.121), C-stat=0.65

- **Subset Completing Surveys** (n=533)
  - H&L (p=0.21), C-Stata=0.72

<table>
<thead>
<tr>
<th>Parameter</th>
<th>P value</th>
<th>Odds Ratio</th>
</tr>
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<tbody>
<tr>
<td>Assess Period</td>
<td>&lt;.0001</td>
<td>1.036</td>
</tr>
<tr>
<td>Vet Age</td>
<td>0.007</td>
<td>.978</td>
</tr>
<tr>
<td>Relationship Spouse</td>
<td>&lt;.0001</td>
<td>2.428</td>
</tr>
<tr>
<td>Rural vs Urban</td>
<td>0.010</td>
<td>1.514</td>
</tr>
<tr>
<td>Other Mental DX</td>
<td>0.014</td>
<td>1.629</td>
</tr>
<tr>
<td>Polytrauma No</td>
<td>0.254</td>
<td>1.260</td>
</tr>
</tbody>
</table>

<table>
<thead>
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<th>Parameter</th>
<th>P value</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assess Period</td>
<td>&lt;.570</td>
<td>1.010</td>
</tr>
<tr>
<td>Vet Age</td>
<td>0.281</td>
<td>.983</td>
</tr>
<tr>
<td>Relationship Spouse</td>
<td>0.320</td>
<td>1.591</td>
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<tr>
<td>Rural vs Urban</td>
<td>0.275</td>
<td>1.374</td>
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<td>Other Mental DX</td>
<td>0.027</td>
<td>2.602</td>
</tr>
<tr>
<td>Polytrauma</td>
<td>0.058</td>
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</tr>
<tr>
<td>Computer Preparedness</td>
<td>&lt;.0001</td>
<td>1.680</td>
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<tr>
<td>Preparedness</td>
<td>0.016</td>
<td>0.588</td>
</tr>
</tbody>
</table>
**Negative Binomial Regression Results**

- **mHealth Use Study Group (n=619)**
  - Scaled Dev = 1.09, Scaled PC = 1.19

- **Subset Completing Surveys (n=468)**
  - Scaled Dev = 1.09, Scaled PC = 1.06

<table>
<thead>
<tr>
<th>Parameter</th>
<th>P value</th>
<th>Incidence Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vet Age</td>
<td>0.07</td>
<td>1.01</td>
</tr>
<tr>
<td><strong>Relationship Spouse</strong></td>
<td>&lt;.028</td>
<td><strong>1.35</strong></td>
</tr>
<tr>
<td>Rural vs Urban</td>
<td>0.46</td>
<td>0.948</td>
</tr>
<tr>
<td>Other Mental DX</td>
<td>0.13</td>
<td>1.14</td>
</tr>
<tr>
<td>Polytrauma No</td>
<td>0.33</td>
<td>1.10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>P value</th>
<th>Incidence Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vet Age</td>
<td>0.07</td>
<td>1.01</td>
</tr>
<tr>
<td>Relationship Spouse</td>
<td>0.47</td>
<td>1.12</td>
</tr>
<tr>
<td>Rural vs Urban</td>
<td>0.68</td>
<td>0.97</td>
</tr>
<tr>
<td>Other Mental DX</td>
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<td>1.18</td>
</tr>
<tr>
<td>Polytrauma No</td>
<td>0.22</td>
<td>1.14</td>
</tr>
<tr>
<td>Computer</td>
<td>0.53</td>
<td>1.03</td>
</tr>
<tr>
<td>Preparedness</td>
<td>0.26</td>
<td>0.94</td>
</tr>
</tbody>
</table>
## Significant Predictors of App Use by Individual Clinical App

<table>
<thead>
<tr>
<th>App Name</th>
<th>Significant Predictor Var</th>
<th>P Value</th>
<th>Incidence Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Journal</td>
<td>Living Location (R vs U)</td>
<td>.023</td>
<td>0.41</td>
</tr>
<tr>
<td>Notifications</td>
<td>Veteran Age</td>
<td>.003</td>
<td>1.01</td>
</tr>
<tr>
<td></td>
<td>Polytrauma Care (Y vs N)</td>
<td>.008</td>
<td>0.32</td>
</tr>
<tr>
<td>Care4Caregives</td>
<td>Veteran Age</td>
<td>.035</td>
<td>1.01</td>
</tr>
<tr>
<td>Summary of Care</td>
<td>Other Mental Health DX (1 vs 0)</td>
<td>.001</td>
<td>1.42</td>
</tr>
<tr>
<td></td>
<td>Computer Skills</td>
<td>.033</td>
<td>1.03</td>
</tr>
<tr>
<td>Pain Coach</td>
<td>Other Mental Health Dx (y vs n)</td>
<td>.001</td>
<td>1.61</td>
</tr>
</tbody>
</table>
Key Finding from Zarit Burden Study

- The study did not observe that the mHealth intervention had a significant impact on Zarit burden change
  - This result is consistent with several other Caregiver burden technology intervention studies:
    - Pierce et. al. - Caring~Web, no effect on depression or life satisfaction scores
    - Demiris et. al. - Videophones delivering problem solving therapy no effect on anxiety, quality of life and problem-solving abilities
    - Dang et. al. - IVR intervention providing stress showed no effect on bother scores, anxiety, depression or mastery
  - The three month study period may have been too short to see a fuller effect of the mHealth intervention
Key Findings from mHealth Use Study

- Most frequently used apps were Notifications, Summary of Care, and Rx refill
  - These three apps perform the functions that surveyed U.S. National Caregivers have indicated are their most wanted††:
    1. Access to their Health Information (Summary of Care)
    2. Medication Support (Notifications and Rx Refill)

- Supports the UTAUT model of technology acceptance that the main drivers of app use are perceived usefulness and ease of use

- Care4Caregivers was a moderately used app and yet the National Caregiver survey shows coaching software as one of the least sought after technologies

- Journal app was not used as often as expected given that the function “electronic logs to track care” was in the top 3 requested functions made by Caregivers in National survey

- PTSD app was used very little; a surprising result given the number of PTSD patients in the study population

Key Findings from Bivariate Analysis

There were four principal components driving mHealth app use:

1. The amount of time and effort expended in Caregiving
   - Tier 3 (high caring effort), Veteran was receiving polytrauma care and Veteran high service-connected disability had a reduced use of the mHealth apps

2. Caregiver and Veteran mental and physical condition
   - Caregiver low preparedness, high strain was associated with increased use
   - Veterans with Mental Health Diagnoses (other than PTSD) were associated with increased use

3. Caregiver and Veteran demographics
   - Increased age of the Caregiver/Veteran decreased app use

4. Computer skills and propensity for technology adoption
   - Lower computer skills were associated with decreased app use
Key Findings from Logistic Regression Modeling

Modeled the factors that predict interest in using the mHealth Apps – using the app at least once

- Living in a rural location increased initial use by 1.5 times
  - Other studies have shown that use of eHealth tools in rural area is less than urban, due to reduced internet access
  - Providing data plans may have contributed to increased rural use

- Every one year increase in age decreased initial app use by 2%

- Spouse Caregivers were 2.4 times more likely to use the apps than non-spouse Caregivers

- Caregivers caring for Veterans with mental health conditions (other than PTSD) were 1.6 times more likely to use the apps

- Caregivers who felt less prepared for Caregiving were 40% more likely to try using the apps
Key Findings From Negative Binomial Regression Modeling

Modeled the factors that predict the incremental increases in the frequency of app use

- Given that frequency of app use is related to the user’s recurring need for the function performed by that app, these factors were most meaningfully interpreted for each app

- Living in a rural location was a negative predictor of Journal app use (IR = .41)

- Veteran age is a positive predictor of Care4caregivers and Notifications app use

- Polytrauma care is a negative predictor of Notifications app use

- A Veteran diagnosis of “Other Mental Health (not PTSD)” consistently predicts app use, both in the logistic regression models and in the Summary of Care and Pain Coach Binomial Reg models.
Study Scope and Limitations

- Scope was limited to primary Family Caregivers enrolled in the VA’s Family Caregiver program and the Veterans they cared for

- Caregiver population for this research was unique when compared to Non-VA Family Caregivers:
  - Care was for medically complex Veterans with high rates of mental illness
  - Age was younger than the average Non-VA Caregiver (40 yrs vs. 48 yrs.)
  - Predominantly female (95%) vs. Non-VA Caregivers (66%)
  - Caregivers in this study were supported by a formal VA program

- Study period was three months which may not have been long enough to detect significant changes in Caregiver burden scores resulting from the mHealth intervention
Future Research Recommendations

- A future qualitative study interviewing high and low users of the apps to determine likes and dislikes, as well as barriers to use.

- Additional apps are under development that will incorporate more personalized content and provide additional communication with the VA healthcare team.
  - The Journal app is being reworked to incorporate more of the PHR tracking functions requested by Caregivers (e.g. med history and symptom reporting).

- These new apps will present additional research opportunities to evaluate their appeal and utility for Veterans and their Caregivers.
Acknowledgements

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  - Shawn Hardenbrook, Brian Olinger, Kevin Todd and Jessica Bralley, who contributed to the Mobile Health Family Caregiver Pilot
  - Neil Evans, Gail Graham, and Robert Petzel, who provided Executive support
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- **George Washington University**
  - Gregory Shaw, *Associate Professor of Engineering Management and Systems Engineering*

*Thank you*