Home Monitoring of Chronic Disease for Aged Care - Preliminary Results of a Multi-site National Trial of Telehealth for Management of Chronic Disease in the Home

Dr. Marlien Varnfield
AEHRC Colloquium March 2015

Contact: marlien.varnfield@csiro.au
The Healthcare Sector is Changing

Healthcare systems were historically designed to manage acute illness (infections and injury), whilst today >75% of health budget expenditure is on Chronic Disease.

Service delivery models are changing their focus from

- episodic care > continuity of care
- institutional care > community and home-based care
- individual > a multidisciplinary team approach

*Self Care, eHealth, mHealth, Telehealth and Telecare provide the means of facilitating this change!*
The Spectrum of Care

Less Complex Case → More Complex Cases

100% % Self Care 0%

Self Care

% Professional Care 100%

Professional Care

most care is shared care

HOME COMMUNITY HOSPITAL

AEHRC COLLOQUIUM 2015
The Three Pillars of Telehealth

- Improved and more efficient CASE MANAGEMENT
- Assisted SELF MANAGEMENT
- Better use of available HUMAN RESOURCES

TELEHEALTH TECHNOLOGY

• Empowering the patient
• Improved Outcomes
• Reduced Costs
Home telemonitoring project

- CSIRO is lead organisation
- Total project size $5.4m ($3.02m Telehealth Pilots Program)
- Six trial sites in five states (revised 5 Trial Sites in 5 States)
- Focus on chronic disease management in the community
- Six (revised 5) different models of care represented
- Trial duration 20 months – ends on Dec 2014
CSIRO Telehealth Trial – 6 Sites

- Launceston / Northern Tasmania
- Ballarat and the Grampians (Vic)
- Townsville (QLD)
- Canberra and ACT
- Penrith (NSW)
- Greater Western Sydney (NSW)

Trial Design

- Case Matched controls
- Before-After-Control-Impact (BACI)

Aims of Trial

- To demonstrate how Telehealth services can be successfully deployed Nationally by piloting services in different settings across five states
- To gather evidence on how Telehealth services can be scaled up to provide an alternative cost effective health service for the management of chronic disease in the community
- Development and deployment of an Automated Risk Stratification System for triaging patients according to their health status
Key objectives of the CSIRO trial

• Identify and model the impact of introducing telehealth services into existing care models for the management of chronic disease in the community.
  - Health and wellbeing outcomes
  - Socio economic outcomes
  - Acceptability and usability of telehealth services
  - Impact on patients, carers and clinicians
  - Effect of workplace culture and capacity for organizational change management

• Develop robust statistical models to automatically risk stratify patients using questionnaires and vital signs data
Our partners

<table>
<thead>
<tr>
<th>CLINICAL</th>
<th>INDUSTRY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tasmania</td>
<td>TeleMedCare</td>
</tr>
<tr>
<td>Community</td>
<td></td>
</tr>
<tr>
<td>Medicare Local</td>
<td>iiNet</td>
</tr>
<tr>
<td>Townsville-Mackay</td>
<td></td>
</tr>
<tr>
<td>Medicare Local</td>
<td>Samsung</td>
</tr>
<tr>
<td>Nepean-Blue Mountains</td>
<td></td>
</tr>
<tr>
<td>Grampians Rural Health Alliance</td>
<td></td>
</tr>
<tr>
<td>ACT Government Health</td>
<td></td>
</tr>
</tbody>
</table>
Governance Model

PO  Project Officer
CCC Clinical Care Coordinator
CTC Clinical Trial Coordinator

Trial Sites

Site 1: Canberra ACT
Site 2: Townsville QLD
Site 3: Grampians VIC
Site 4: Launceston TAS
Site 5: ARV Penrith NSW
Site 6: NBMML Penrith NSW

Research Group 1
Clinical Trial Analysis

Research Group 2
Data Architecture

Research Group 3
Data Analytics

Research Group 4
Human Factors

Ethics, Security & Privacy

Clinical Trial Information System

Project Management & Financial Control
Project Director
Project Manager

Technical Project Committee

Adverse Events & Death Review Committee

Project Management Committee
A Systems Approach to Telehealth

- Health Monitor
- Data Storage
- Mobile Devices
- PCEHR
- Clinical Health Portal
- Patient (High Care)
- Patient (Low Care)
- Family & Carers
- GP
- CARE COORDINATOR
- Community Nurse
- Hospital
- Mobile Devices
- Data Storage
- Health Monitor

AEHRC COLLOQUIUM 2015
Telemedcare Clinical Monitoring Unit
Telehealth Services Provided

• Vital Signs (provided as appropriate to patient’s clinical condition)
  - Non Invasive BP (Auscultatory and Oscillometric)
  - Pulse Oximetry
  - Single lead ECG
  - Blood Glucometer
  - Spirometry (FEV₁, VC, PEF)
  - Body Temperature
  - Body Weight

• Communications
  • Messaging
  • Video Conferencing

• Questionnaires
  • Large range of Clinical and Wellness questionnaires to choose from
ICD-10 Diagnostic Codes for subject selection

At least two unplanned admissions to hospital in the preceding year for one or more of the following chronic conditions;

Chronic Obstructive Pulmonary Disease
- J41 – J44
- J41 – J44 J47 and J20
  (only with secondary diagnosis of J41, J42, J43, J44, J47)

Coronary Artery Disease
- I20 – I25
- I20 – I25

Hypertensive Diseases
- I10, I11.9
- I10 – I15 (I11.0: Hypertensive heart failure will be included in Congestive Heart Failure)

Congestive Heart Failure
- I11.0, I50, J81
- I50, J81, I11.0

Diabetes
- E10 – E14

Asthma
- J45
The participants in this trial
(At each test site)

- 25 Test patients connected to fast broadband and supplied with home monitoring telehealth services
- 50 Control patients (case matched to Trial subjects)
- The Test patients’ usual care community nurse/carer
- Clinical Care Coordinator(s) – Review patient data and coordinate clinical management of patients
- Project Officer assisting with all non-clinical duties for trial
- Clinical Trial Coordinator (CSIRO Liaison Officer with Trial sites)
- CSIRO Research Teams
  - Project Management
  - Clinical trial execution and data analysis
  - Data management and server technologies
  - Data analytics – Risk Stratification and Decision Support
Integration of multiple data sources

- Entry and Exit Questionnaires
- Daily & Weekly Questionnaires
- Telemonitoring Vital Signs Data
- Health RoundTable Hospital Records

DATA INTEGRATION ENGINE

SECURE CLOUD SERVER

AUTHORISED RESEARCHERS
Evaluation Framework

- Quality of life (EQ-5D)
- Psychological well-being (e.g., anxiety) (HADS)
- Self-management behaviour (HEIO adapted)
- Social isolation (HEIO adapted)
- Medication adherence (Morisky)

Self-reported outcomes

- Perceived acceptability of tele-monitoring devices
- Use of telehealth attitudes
- Activity monitoring: TMC log data
- Usability
- Anxiety and caregiver strain
- Time spent in providing care and lost productivity
- Workload, new model of care etc.

Participants' experience

- Carers' experience
- Health professionals' experience

User experience (including qualitative)

- Organizational study (including qualitative)
- Demographic survey
- Other data

Other data

Service use

- Hospital utilization
  - Unplanned hospital admission
    - Emergency room visits
    - Elective inpatient admission
    - Inpatient bed day use
    - Outpatient attendances
    - Bed days occupancy
  - Primary care utilization
    - GP encounters
    - Post-discharge visits
    - Community health visits
    - Prescription drugs
    - All cause mortality
    - Disease specific mortality
    - Functional measures
    - Others

Cost

Health utilization measures

Data quality

Data integrity etc.
Research Questions

• Effect of telemonitoring on Health services utilization
  – Visit to hospital, GP, other services
• Effect of telemonitoring on patient outcomes
  – Quality of life, progression of chronic condition, well being, medication adherence
• Patients and Care Coordinators experience
  – Usability, workload, anxiety and strain
• Service implementation and deployment
  – Existing model of care, Service design, adoption and appropriation
• Cost effectiveness analysis
Challenges we had to manage...

- The study cohort changed
- The tests and controls were not recruited simultaneously
- Too few potential controls in all areas besides TAS and VIC
- Compliance with the study
- We started with RCT but were forced to change to BACI design
- Some of these problems could have been foreseen if we were able to get a pilot sample prior to planning the study
Matching control subjects to test subjects

- Perfect matching not possible given the limited number of cases
- The matching variables and associated importance weight, e.g.,

<table>
<thead>
<tr>
<th>Test/Control</th>
<th>Age</th>
<th>Gender</th>
<th>Major Diagnosis</th>
<th>SIEFA Socio-Economic Indexes for Areas</th>
<th>Strength of the match (score of 0 equal perfect match)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test</td>
<td>54</td>
<td>M</td>
<td>COPD</td>
<td>1023</td>
<td></td>
</tr>
<tr>
<td>Control 1</td>
<td>56</td>
<td>M</td>
<td>COPD</td>
<td>1015</td>
<td>1.68 #</td>
</tr>
<tr>
<td>Control 2</td>
<td>54</td>
<td>F</td>
<td>HD</td>
<td>1022</td>
<td>2.16 $</td>
</tr>
<tr>
<td>Importance weights</td>
<td>0.2</td>
<td>1</td>
<td>1</td>
<td>0.16</td>
<td></td>
</tr>
</tbody>
</table>

# $ |54 − 56| × 0.2 + 1 × 0 + 1 × 0 + |1023 − 1015| × 0.16 = 1.68
$ $ |54 − 54| × 0.2 + 1 × 1 + 1 × 1 + |1023 − 1022| × 0.16 = 2.16
At End December 2014...

Total enrolled
N=290

<table>
<thead>
<tr>
<th></th>
<th>ACT</th>
<th>NSW</th>
<th>QLD</th>
<th>TAS</th>
<th>VIC</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test</td>
<td>16</td>
<td>17</td>
<td>27</td>
<td>29</td>
<td>27</td>
<td>116</td>
</tr>
<tr>
<td>Control</td>
<td>23</td>
<td>12</td>
<td>30</td>
<td>60</td>
<td>49</td>
<td>174</td>
</tr>
</tbody>
</table>

Demographics

<table>
<thead>
<tr>
<th>Demographics</th>
<th>TEST</th>
<th>CONTROL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean ± SD)</td>
<td>71.4±9.4</td>
<td>72.5±9.4</td>
</tr>
<tr>
<td>% Male</td>
<td>64</td>
<td>56</td>
</tr>
<tr>
<td>BMI (mean± SD)</td>
<td>30.6±8</td>
<td>28.0±7</td>
</tr>
</tbody>
</table>
## Preliminary Results from BACI Analysis

Data from Aug 2014 for 30 Test patients and 46 matched control patients

<table>
<thead>
<tr>
<th>Outcome measure all on the monthly scale</th>
<th>Did the intervention correspond to a significant change point?</th>
<th>Did the intervention correspond to a significant change in outcomes for the test patients?</th>
<th>Did the intervention correspond to a greater improvement in test patients relative to the control patient?</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBS Benefit</td>
<td>Yes(**)</td>
<td>Yes(**)</td>
<td>Yes</td>
</tr>
<tr>
<td>PBS Total cost</td>
<td>Yes(**)</td>
<td>Yes(**)</td>
<td>Yes</td>
</tr>
<tr>
<td>MBS out of hospital costs</td>
<td>Yes(**)</td>
<td>Yes(**)</td>
<td>Yes</td>
</tr>
<tr>
<td>Number of hospital admissions</td>
<td>Yes(*)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Length of stay in hospital during these admission</td>
<td>Yes(*)</td>
<td>Yes(*)</td>
<td>Yes</td>
</tr>
<tr>
<td>Number of GP visits during working hours</td>
<td>Yes(**)</td>
<td>Yes(**)</td>
<td>Yes</td>
</tr>
<tr>
<td>Number of GP visits outside of working hours</td>
<td>Yes(**)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Total number of GP visits</td>
<td>Yes(**)</td>
<td>Yes(**)</td>
<td>Yes</td>
</tr>
<tr>
<td>Total number of either Specialist, Psychiatric, Allied Health visits and Procedures</td>
<td>Yes(**)</td>
<td>Yes(**)</td>
<td>Yes</td>
</tr>
<tr>
<td>Total number of tests</td>
<td>Yes(**)</td>
<td>Yes(**)</td>
<td>Yes</td>
</tr>
<tr>
<td>Total number of Laboratory tests</td>
<td>Yes(**)</td>
<td>Yes(**)</td>
<td>Yes</td>
</tr>
<tr>
<td>Number of Primary Care visits</td>
<td>Yes(**)</td>
<td>Yes(**)</td>
<td>No</td>
</tr>
</tbody>
</table>
# User perceptions - patients

<table>
<thead>
<tr>
<th>ITEM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>COMPLEXITY</strong></td>
</tr>
<tr>
<td>• TMC easy to use</td>
</tr>
<tr>
<td>• I sometimes find the TMC system frustrating to use</td>
</tr>
<tr>
<td>• Instructions on the TMC are easy to understand and follow</td>
</tr>
<tr>
<td>• Using the TMC system is cumbersome</td>
</tr>
<tr>
<td>• I needed to learn a lot of things before I could get going with the TMC</td>
</tr>
<tr>
<td>• I found the TMC unnecessarily complex</td>
</tr>
<tr>
<td>• I think that I would need the support of a technical person to be able to use the TMC</td>
</tr>
<tr>
<td>• I feel very confident using the TMC</td>
</tr>
<tr>
<td>• I find the various functions in the TMC are well integrated</td>
</tr>
<tr>
<td>ITEM</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td><strong>COMPATIBILITY</strong></td>
</tr>
<tr>
<td>• TMC is a tool that would be easy to incorporate into my daily routine</td>
</tr>
<tr>
<td>• The TMC fits right into the way I like to manage my health</td>
</tr>
<tr>
<td>• Using the TMC fits well with my lifestyle</td>
</tr>
<tr>
<td><strong>OBSERVABILITY</strong></td>
</tr>
<tr>
<td>• The effects of using the TMC are apparent to others</td>
</tr>
<tr>
<td>• <strong>I would recommend the TMC to other people</strong></td>
</tr>
<tr>
<td><strong>SATISFACTION</strong></td>
</tr>
<tr>
<td>• I would like to continue using TMC after the trial</td>
</tr>
<tr>
<td>• <strong>Overall I was satisfied with the TMC</strong></td>
</tr>
</tbody>
</table>
“This gives me a great piece of mind. I am getting to know the variations, and when I have a bad reading I take it easy. Without this thing I would just go about like normal and get myself in trouble.”

“I know the ladies behind are seeing my data and will call me if need be, it is like seeing my GP.”

“I have a lot of faith in it and I show it to my mates, it is like having a doctor at home.”
## User Perceptions - CCC

<table>
<thead>
<tr>
<th></th>
<th>Easy</th>
<th>Difficult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring patients</td>
<td>4</td>
<td>*1</td>
</tr>
<tr>
<td>Interacting with patients</td>
<td>4</td>
<td>*1</td>
</tr>
<tr>
<td>Interacting with GP’s</td>
<td>0</td>
<td>5</td>
</tr>
</tbody>
</table>

* Reason: Additional workload

<table>
<thead>
<tr>
<th></th>
<th>Agree</th>
<th>Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinician user interface easy to use</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>User interface of CSIRO portal</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Technical support</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Agree</th>
<th>Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved patients’ knowledge</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Improved how patients monitor their condition</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Improved how patients manage their condition</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Patients feel more secure about managing conditions</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Improved patients’ self-care</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Has role in improving overall quality of care</td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>
User Perceptions - CCC

Comments:
“the visual effect of seeing data reinforced their extra interest in health, especially male patients”
“early intervention when out of range vital signs detected”
“This has provided and added on the full clinical landscape of my patients where I did not have before and appointment”
“My home visits have been reduced and I am able to see more new patients and provide the support they need”
“It is extremely useful for patients as they feel confident in taking care of their own health and peace of mind that there is someone to assist them if necessary”

“Medical clinicians not interested and have a view that telemonitoring is time consuming”
“Needs to be supported by all doctors”
“Technology support – internet connection and electrical outages”
“The only limitation was time”
“At the moment there are significant limitations to this model of care. These include appropriate patient selection, developing telemed technology, clinical/political buy-in and resource allocation”
The Clinical Care Coordination Role

- Critical to the success of the telehealth service
- CCCs orchestrate the optimal response from care givers (family, community nurses, GPs etc) but DO NOT provide direct care
- Who should manage this critical care coordination role?
  - Best to be as close to the clinical coal face as possible and working closely with Local Health Districts
  - A new role for experienced community nurses?
  - Could be managed by the hospital, the LHD or the organisations providing community nursing services ie Not For Profits such as ARV, RDNS, BCS etc
  - In order to best align those that pay and those that benefit we conclude that the LHD is best placed to manage the care coordination role for all care providers in the local health district, whether private, public or not for profit. The LHD could also outsource this role to the private sector but maintain governance oversight.
Outline Risk Monitoring
Multivariate disease surveillance

• Individual patient daily risk assessment
  – Sick but stable,
  – Early signs of exacerbation of their chronic condition,
  – Acute signs of exacerbation, requires immediate attention

• Statistical significance versus clinical significance
  – very early trend detection?

• Nurse care coordinator’s role
This overview plot provides the nurse care coordinator with a snapshot of what measurement-patient combinations to examine (i.e., only look at those with red traffic signals because they indicate significant departures from the baseline measure).
Conclusions

..it’s early days yet, but

• Now that we have received all data, the research objectives of the trial will be met and will be statistically robust.
• The trial will develop a valuable resource to inform government policy and funding models.
• Understanding the differential impact of introducing telemonitoring on different models of care for CDM will be a major contribution.
• Developing robust methods for daily risk stratification will allow for more consistent and timely orchestration of clinician responses and will encourage home telemonitoring for CDM to be scaled up nationally.
Patient video
Thank you

CSIRO Team
Professor Branko Celler
Dr. Rajiv Jayasena
Dr. Marlien Varnfield
Dr. Ross Sparks
Dr. Surya Nepal
Dr. Leila Alem
Dr. Jane Li
Dr. Julian Jang-Jaccard
Mr. Simon McBride

Contact
CSIRO e-Health Research Program
+61 7 325 33603
marlien.varnfield@csiro.au
www.csiro.au/healthservices