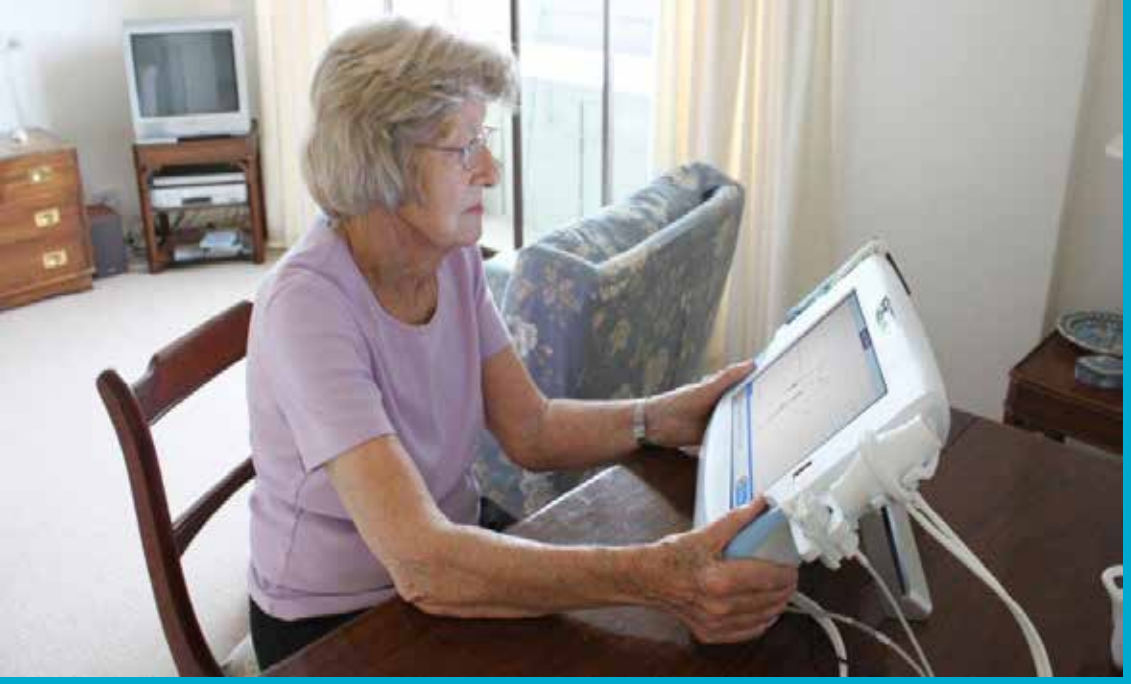

FUNDED by the Australian Government Telehealth Pilots Program

Robust evidence for the Impact of at-home Telemonitoring for Chronic Disease Management

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HEALTH AND BIOSECURITY FLAGSHIP
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The problem we are addressing!

An ageing population, doubling of those > 65 and quadrupling of those > 85 in 40 years

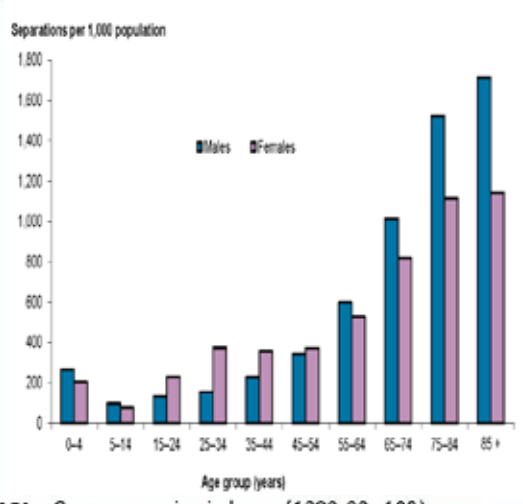
As the population ages the burden of chronic disease increases. Almost 50% of those > 65 have two or more chronic conditions.

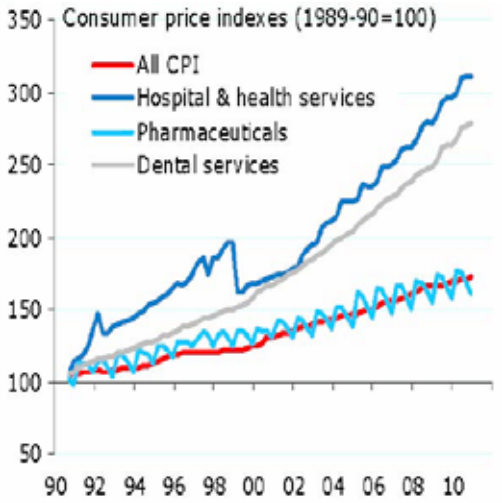
As the population ages the incidence of hospital admissions increase dramatically

Hospital costs have doubled over the last 10 years and are increasing at > x3 CPI

Health is now the largest employer in many developed countries – we cannot continue to increase the health workforce!

Models of care are changing worldwide with a larger focus on self management and team based coordinated care





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**

Clinical Evidence for benefits of telehealth

Clinical Evidence for the benefits of telehealth

- Telehealth Services for the management of chronic disease in the community are now no longer “Bleeding edge”, but are yet to be deployed in a large scale in Australia, despite their demonstrated success, as summarised below;
  - 15% reduction in A&E Visits
  - 20% reduction in emergency admissions
  - 14% reduction in elective admissions
  - 14% reduction in bed days
  - 8% reduction in tariff costs and
  - 45% reduction in mortality rates

UK Department of Health: Whole System Demonstrator Programme Headline Findings Dec 2011.

The USA Veterans Administration

- The Veterans Health Administration (VHA) is one of the world leaders in using telehealth to promote independent living for its patient population. The VHA's model uses a care coordinator who supports and monitors a panel of 100–150 patients, with a focus on empowering patients to take roles in self-management.
- Routine analysis of data obtained for quality and performance purposes from a cohort of 17,025 CCHT patients shows the benefits of a 25% reduction in numbers of bed days of care, 19% reduction in numbers of hospital admissions, and mean satisfaction score rating of 86% after enrolment into the program.
- The cost of CCHT is $1,600 per patient per annum, substantially less than other NIC programs and nursing home care.
- VHA's experience is that an enterprise-wide home telehealth implementation is an appropriate and cost-effective way of managing chronic care patients in both urban and rural settings.

Addendum:

The US Department of Veterans Affairs announced that 690,000 US veterans received care in the 2014 fiscal year via telehealth, with 2 million telehealth visits scheduled.

That means that 12 percent of all veterans enrolled in VA programs received telehealth care of some kind in 2014.

- http://mobihealthnews.com/37325/telehealth-served-12-percent-of-va-covered-veterans-in-2014/

Why has Australia been so slow in large scale adoption of telehealth?

- State and Commonwealth demarcation of responsibility!
  - States manage hospitals
  - Commonwealth responsible for primary and aged care
- Those that pay and those that benefit are not aligned
- Medicare only comfortable funding interactions between providers and payers – hence the focus on video conferencing!
- During the decade during which hospital costs have doubled, healthcare budgets are strained leading to limited capacity for new initiatives
- Many clinicians not supportive of new models of care based on telehealth
- No policy initiatives or sustained funding to establish a national market
- The fee for service model stifles innovations and inhibits a focus on outcomes rather that process
- A view that patients are not ready or capable – *not true!*
- A view that there is insufficient evidence to support telehealth – *not true!*

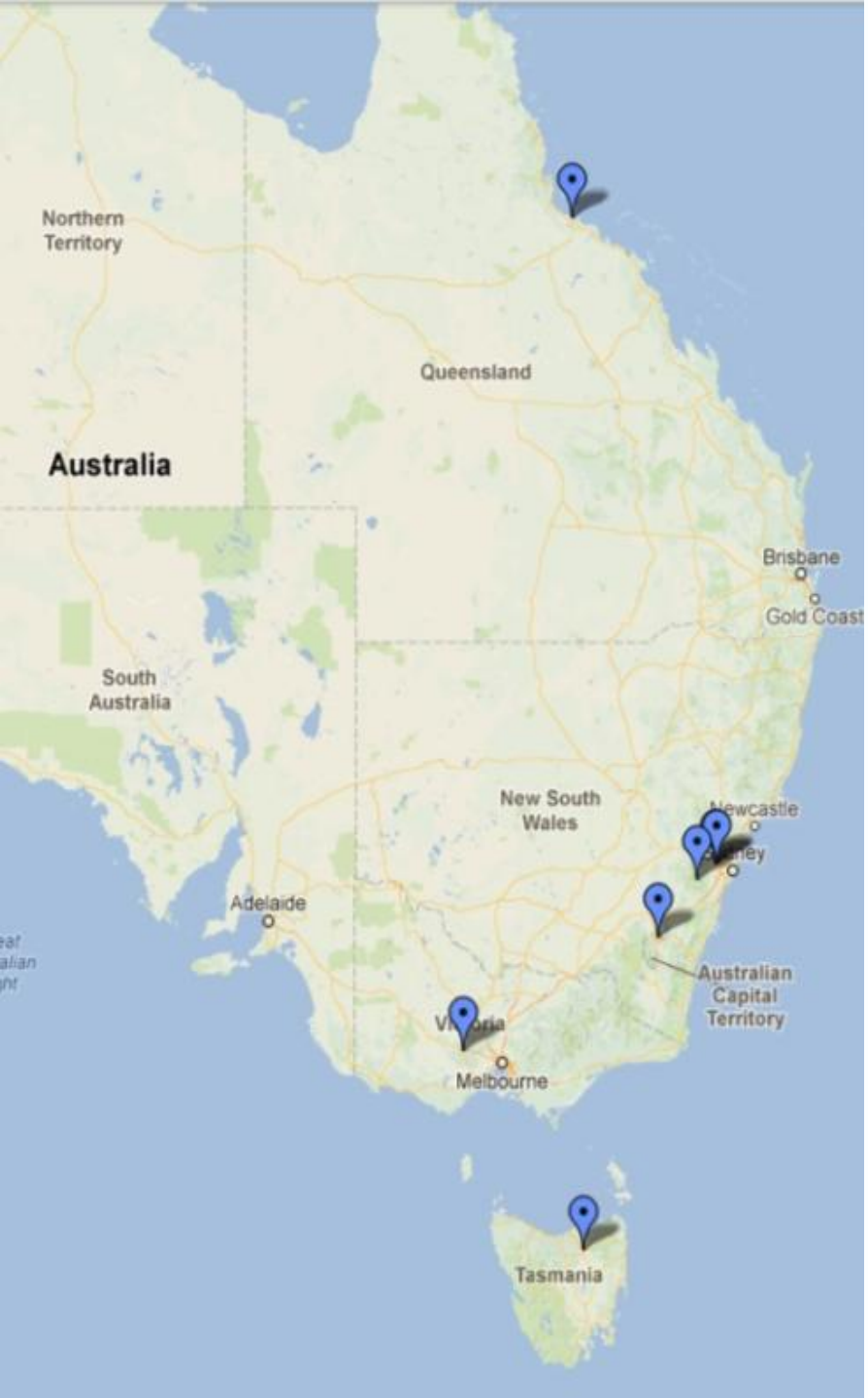
Funded by the Australian Government under the National Telehealth Pilots Program

The CSIRO National Telehealth Trial

NBN Telehealth Pilot Program
CSIRO Telehealth Project

Summary

- CSIRO was lead organisation
- Six clinical partners and three industry partners
- Total project size >$6m ($3.02m from DOHA/DBCDE Pilot Program)
- Six (6) Trial sites in Five (5) states and territories
- Focus on Chronic Disease Management (CDM) in the Community
- Six different models of care represented
- Trial duration 18 months – ended 30th Dec 2014



CSIRO NBN Telehealth Trial – 6*

Sites

- Townsville
- Penrith
- Nepean Blue Mountains / ARV
- Canberra and ACT
- Ballarat and the Grampians
- Launceston / Northern Tasmania

Number of patients at each site

- 25 Test Patients
- 50 Control Patients

Total

- 150 Test patients
- 300 Control Patients

Trial Design

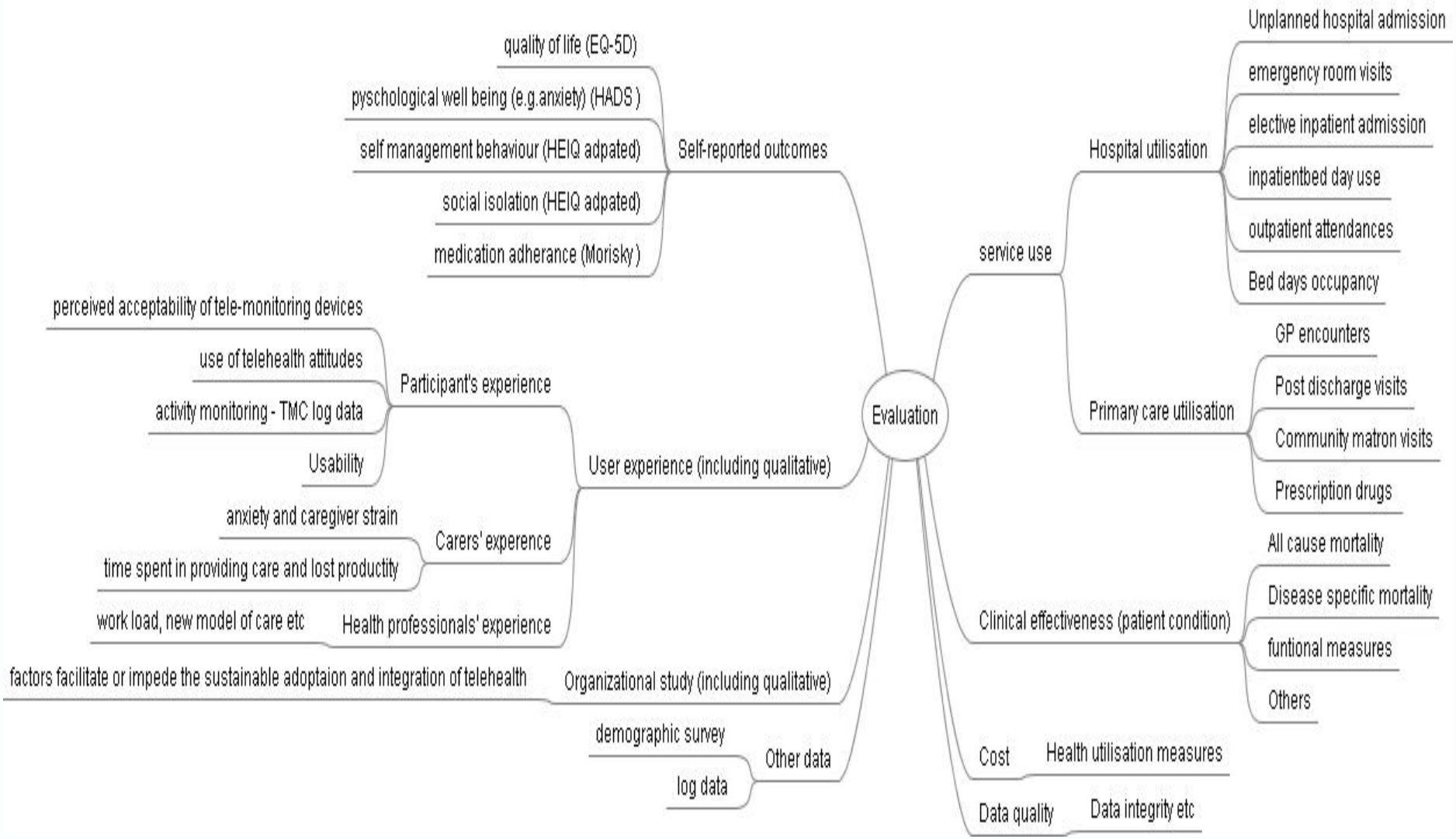
- Case Matched controls
- Before-After-Control-Impact (BACI)

* One site was decommissioned

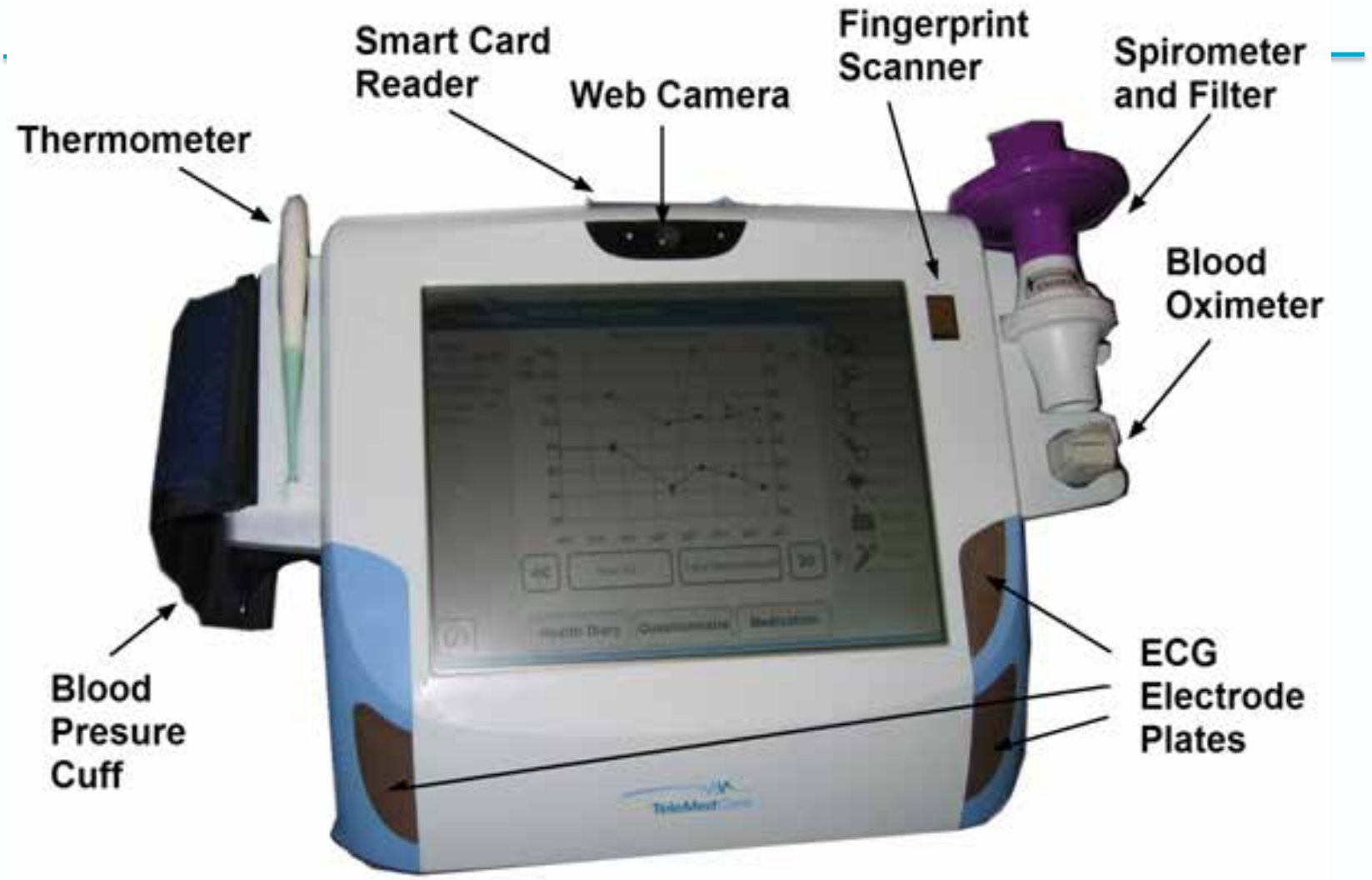
Key objectives of the CSIRO trial

- Identify and model the impact of introducing telehealth services into existing 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

Evaluation Framework



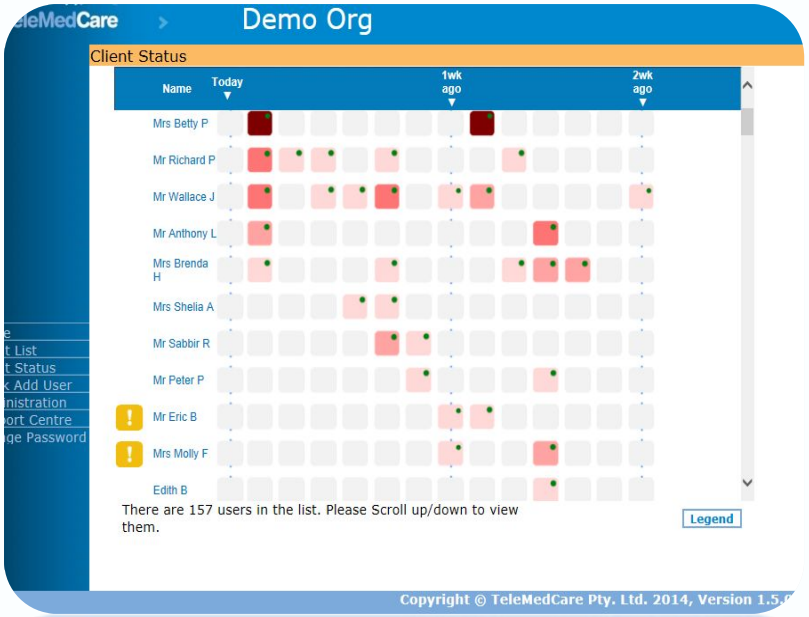
Telemedcare Clinical Monitoring Unit



Telehealth Services Provided by the Clinical Monitoring Unit

- Vital Signs (provided as appropriate to patient's clinical condition)
  - Non Invasive BP (Auscultatory and Oscillometric)
  - Pulse Oximetry
  - Single lead ECG
  - Blood Glucometer (separate device)
  - Spirometry (FEV_1, VC, PEF)
  - Body Temperature
  - Body Weight
- Communications
  - Messaging
  - Video Conferencing
- Questionnaires
  - Large range of Clinical and Wellness questionnaires to choose from

Telemedcare Online Health Portal.

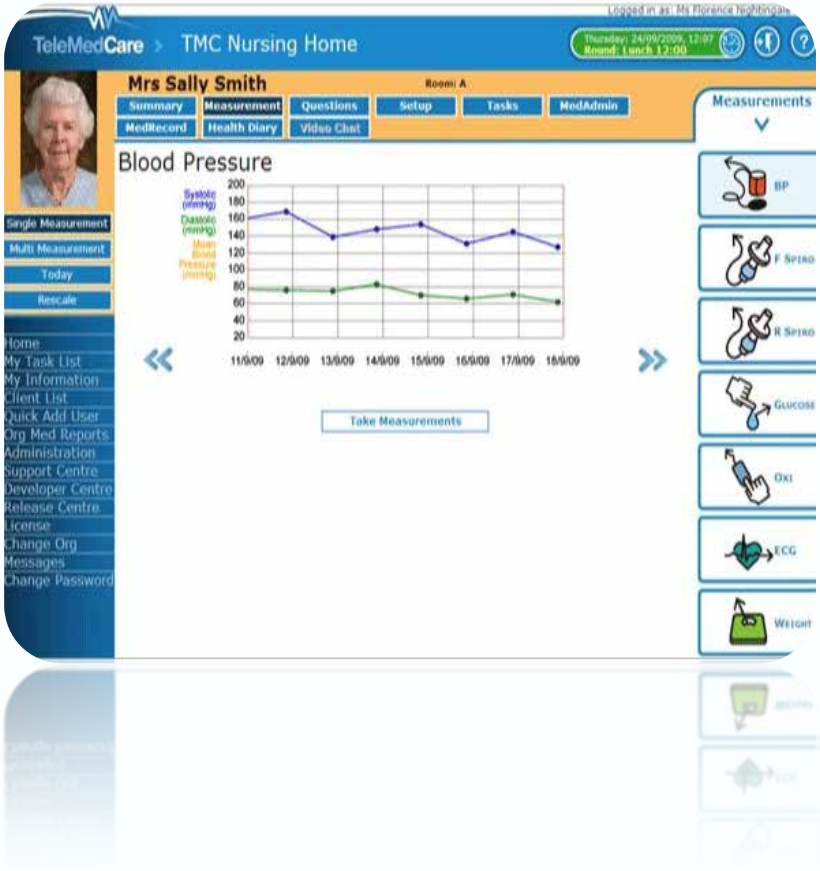


- Operates over a secure VPN and can be accessed from any browser
- Clinicians can set alerts and alarms either globally or for individual patients
- Reports can be generated automatically on alerts and alarms or can be scheduled periodically

Online Health Portal

An integrated enterprise level service

- Accessible from any device, anywhere
- Secure, operates through a VPN
- Enterprise level service delivery and management
- View latest measurements and trends
- Global and patient specific alerts and alarms
- Automated patient risk stratification
- Generate and send clinical measurement reports
- Patient triage system.
- Possible Integration with patient management software and EHRs via HL7 API



Alternative for the Home –
The Personal Health Monitor

PHM TABLET +
3/4G Internet

BT BASE UNIT
(shown without wired
Peripherals, NIBP,
PulseOximeter, BT)

Glucometer

Weight Scale

Easy ECG

Alternative for the Home:
The TMC Home Hub and its peripherals!

BT BASE UNIT
(shown without wired Peripherals, NIBP, PulseOximeter, BT)

Glucometer

Weight Scale

Easy ECG

The CSIRO National Trial – user perspectives

YOU TUBE Video Clip at URL below

https://www.youtube.com/watch?v=72-xat2gjHg

Selection Criteria for Test and Control Patients

Criteria	Type	Description
Age	Inclusion	50 years old and over at consent.
Cognitive capacity	Inclusion	Abbreviated Mental Test (AMT) score > 7.
Unplanned acute admissions	Inclusion	A rate of unplanned acute admission with the required principal diagnosis code(s) indicated below: a) > 2 in the last 12 months, or b) > 4 in the previous 5 years.
ICD-10-AM principal diagnosis code(s) for each unplanned acute admission	Inclusion	Code(s) for each unplanned acute admission indicate a diagnosis for one or more of the following chronic conditions: a) Chronic Obstructive Pulmonary Disease (J41 – J44, J47 and J20, with secondary diagnosis of J41-J44, J47), b) Coronary Artery Disease (I20 – I25), c) Hypertensive Diseases (I10 – I15, I11.9. Note: Hypertensive Heart Failure (I11.0) is included in Congestive Heart Failure), d) Congestive Heart Failure (I11.0, I50, J81), e) Diabetes (E10-E14), f) Asthma (J45).

Example of case matching of Control patients with Test patients

TEST/CONTROL	AGE	GENDER	MAJOR DIAGNOSIS	SEIFA[1] INDEX FOR POSTCODE	STRENGTH OF MATCH Perfect Match=0
TEST	54	M	COPD	1023	
CONTROL 1	56	M	COPD	1025	1.68[2]
CONTROL 2	54	F	HD	1022	2.16[3]
WEIGHTS	0.2	1	1	0.16	

- 1 SEIFA 2011 Socio-Economic Indexes for Areas.
  SEIFA provides measures of socio-economic conditions by geographic area[25]

- 2 $|54-56| \times 0.2 + 1 \times 0 + 1 \times 0 + |1023-1015| \times 0.16 = 1.68$
  3 $|54-54| \times 0.2 + 1 \times 1 + 1 \times 1 + |1023-1022| \times 0.16 = 2.16$

Final Numbers

Total enrolled
N=287

	ACT	NSW	QLD	TAS	VIC	TOTAL
Test	16	16	26	29	26	**113**
Control	23	13	29	60	49	**174**

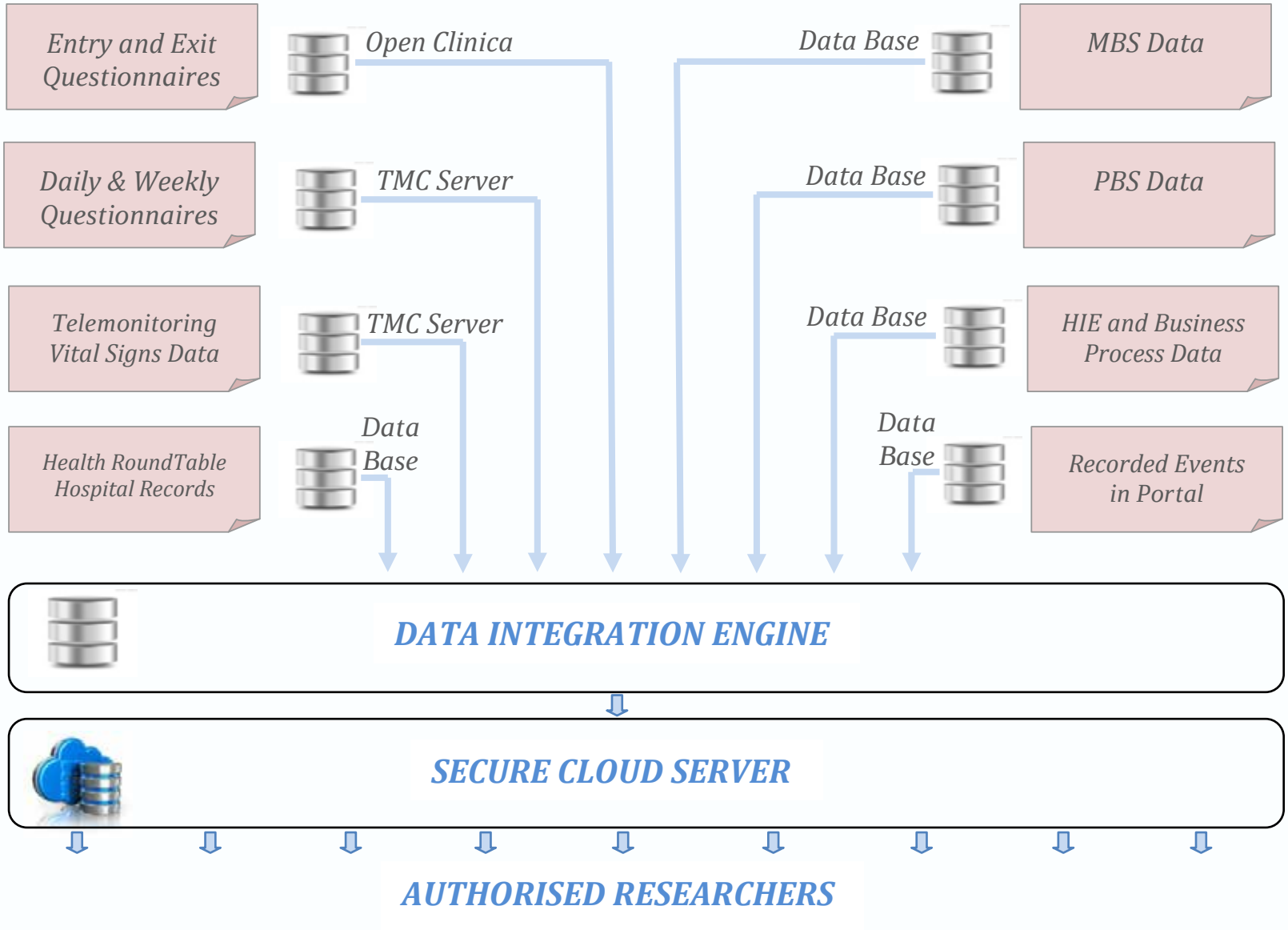
Demographics	TEST	CONTROL
Age (mean ± SD)	71 ±9.2	72±9.5
% Male	65	56
BMI (mean± SD)	30.6±8	28.0±7

Data Analysed	
Test	**Control**
100	137

Data Resources available for the study

- Pharmaceutical Benefits Scheme (PBS) Data from Department of Human Services(DHS)
- Medical Benefits Scheme (MBS) Data from DHS
- Telemedcare Vital signs data and adherence logs
- Health RoundTable Hospital Data
- Recorded events in Trial portal
- HIE and Business Analytics data
  - Questionnaires and structured interviews

Integration of multiple data sources



- **Results**
  Patient acceptability, useability

Patient responses to User and Satisfaction Survey - Telemonitoring equipment

ITEM	% Agreed or strongly agreed N=56
COMPLEXITY	
· TMC* easy to use	87.5
· I sometimes find the TMC system frustrating to use	32.1
· Instructions on the TMC are easy to understand and follow	83.9
· Using the TMC system is cumbersome	19.6
· I needed to learn a lot of things before I could get going with the TMC	23.2
· I found the TMC unnecessarily complex	7.1
· I think that I would need the support of a technical person to be able to use the TMC	12.5
· I feel very confident using the TMC	85.7
· I find the various functions in the TMC are well integrated	83.9
COMPATIBILITY	
· TMC is a tool that would be easy to incorporate into my daily routine	80.4
· The TMC fits right into the way I like to manage my health	76.8
· Using the TMC fits well with my lifestyle	71.4

Patient responses to User Satisfaction Survey – Telemonitoring service

ITEM – USER SATISFACTION RESPONSES	% positive (e.g. agree/satisfied and strongly agreed/very satisfied) N=49
EMPOWERMENT EXPERIENCE	
Daily monitoring of my vital signs has improved my knowledge about the nature of my health condition	69.4
Daily monitoring of my vital signs has improved my knowledge about the symptoms I should watch for	77.6
Daily monitoring of my vital signs has improved my knowledge about the way I can better manage my health condition	59.2
As a result of using the telemonitoring service, I have involved more in monitoring my health condition	79.6
As a result of using the telemonitoring service, I have been able to better manage my health condition	61.2
As a result of using the telemonitoring service, I feel more secure about my health condition	69.4
As a result of using the telemonitoring service, I have improved my self-care	71.4
EXPERIENCE WITH TELEHEALTH NURSE	
How do you feel about the service provided by the telemonitoring nurse in terms of the time given to you by the telemonitoring nurse	87.8
How do you feel about the service provided by the telemonitoring nurse in terms of contacting you when there is a need to discuss your measurement	79.2
How do you feel about the service provided by the telemonitoring nurse in terms of helping you to understand your conditions	77.1
In an overall and general sense, how satisfied are you with the telemonitoring service you received from the telemonitoring nurse?	75.0

Patient responses to User Satisfaction Survey – Telemonitoring service

ITEM – USER SATISFACTION RESPONSES	% positive (e.g. agree/satisfied and strongly agreed/very satisfied) N=49
OBSERVABILITY	
The effects of monitoring my health using the telemonitoring service are apparent to others	38.8
I would recommend using the telemonitoring service to other people	89.8
OVERALL SATISFACTION	
Overall how satisfied are you with the telemonitoring service?	89.6
Would you like to continue using the telemonitoring service after the trial?	57.1
OTHER EXPERIENCE	
Talking to telemonitoring nurse over the phone makes me worry about my condition	4.1
Seeing my vital signs everyday has made me anxious about my chronic condition	12.2
How often has your GP referred to your measurements during your visits?	12.2
Telemonitoring has improved my communication with my GPs	34.7
How satisfied are you with your internet connection?	73.5

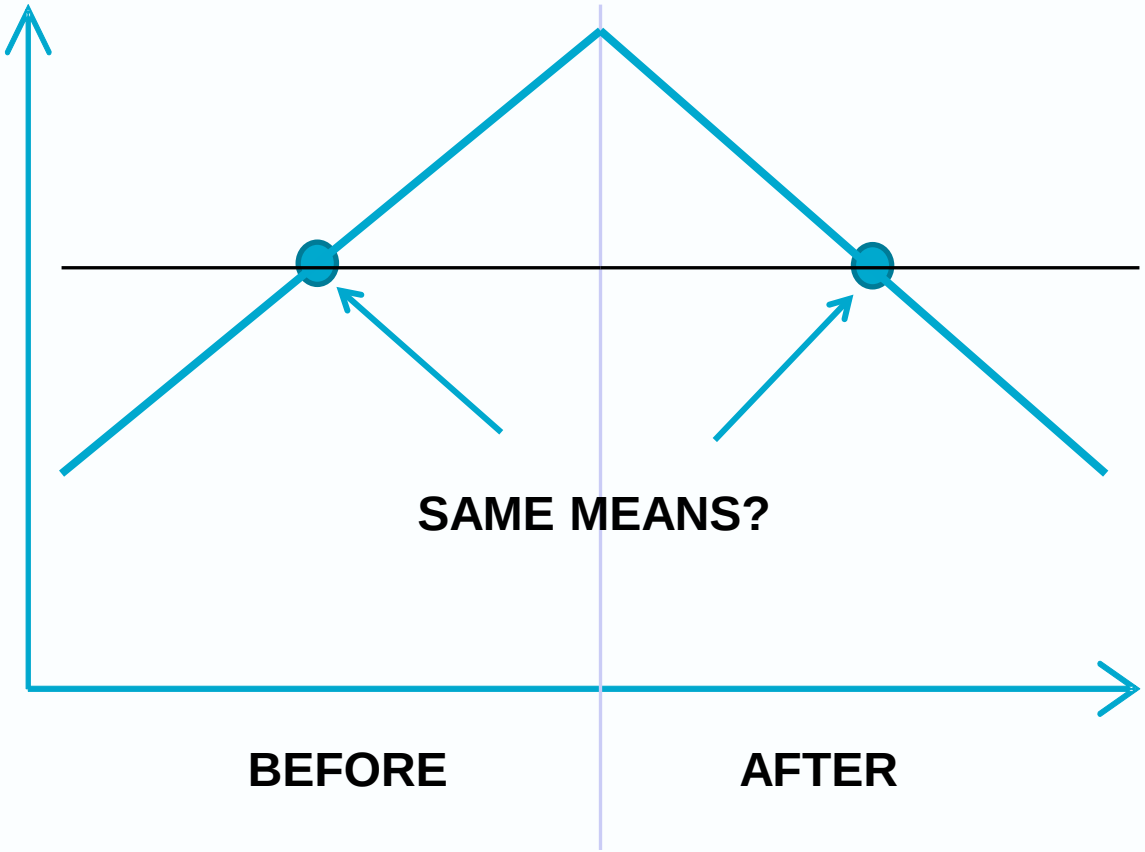
Patience compliance with measurement and questionnaire schedule

Item of Activity Location: (All sites)	Number of Scheduled Items	Number of Items Completed	% Compliance
VITAL SIGNS MEASUREMENT			
Blood Pressure	30,679	20,551	66.99%
ECG	30,327	19,817	65.34%
Pulse Oximetry	30,834	20,216	65.56%
Blood Glucose	12,464	8,739	70.11%
Spirometry	20,692	10,876	52.56%
Body Temperature	27,297	17,143	62.80%
Body Weight	25,122	14,124	56.22%
Average Compliance (Measurements)	**177,416**	**111,466**	**62.83%**
CLINICAL QUESTIONNAIRES			
CHF (Daily)	12,139	6,179	50.90%
COPD (Daily)	8,679	4,335	49.95%
Quality of Life EQ5D (Weekly)	3,761	2,235	59.43%
Mental Health K10 (Monthly)	943	534	56.63%
Living With and Managing Medical Conditions (HeiQ)	919	621	67.57%
Medications Adherence	208	93	44.71%
Average Compliance (Questionnaires)	**26,649**	**13,997**	**52.52%**

CSIRO

- **Impact of Telemonitoring on**
  Use of Medical Services (MBS)
  Number of admissions to Hospital
  Length of Stay
  Mortality

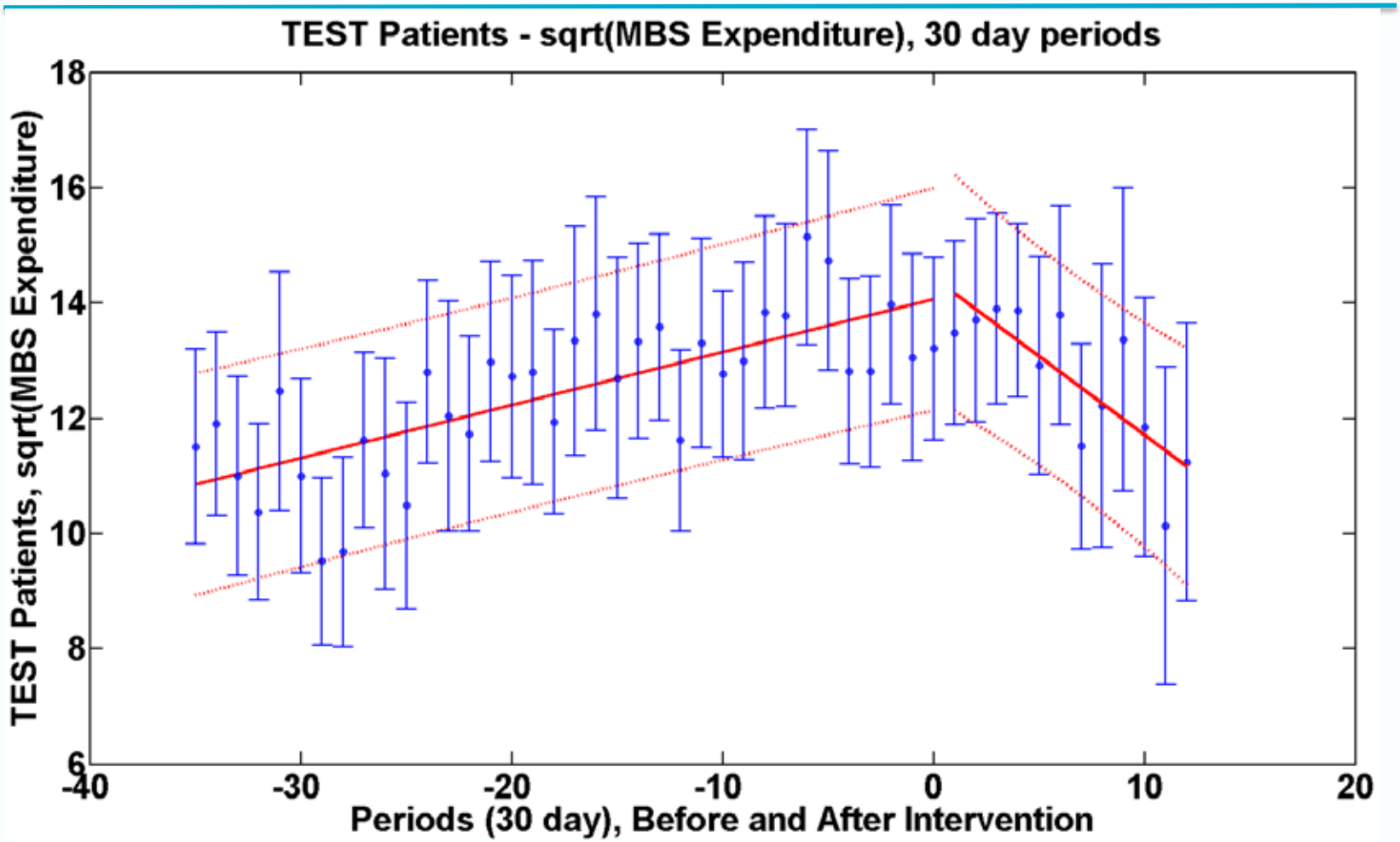
Why you cant use simple Before and After statistics when data is time varying!



Time series analysis of data

- In this method we used 30 day intervals for MBS and PBS analysis and 100 day intervals for number of admissions and length of stay.
- All data were time aligned so that the time interval “0” represented the day when telemonitoring commenced, and 0 to -35 is the period of 36 x 30 days BEFORE the intervention and 1 to 12 represents the 12 x 30 days AFTER the intervention.
- The disadvantage of this method is that the effects of seasonal variations cannot be assessed and indeed are minimised because of averaging effects. This method however emphasises that the intervention is the first order effect that we are seeking to analyse.

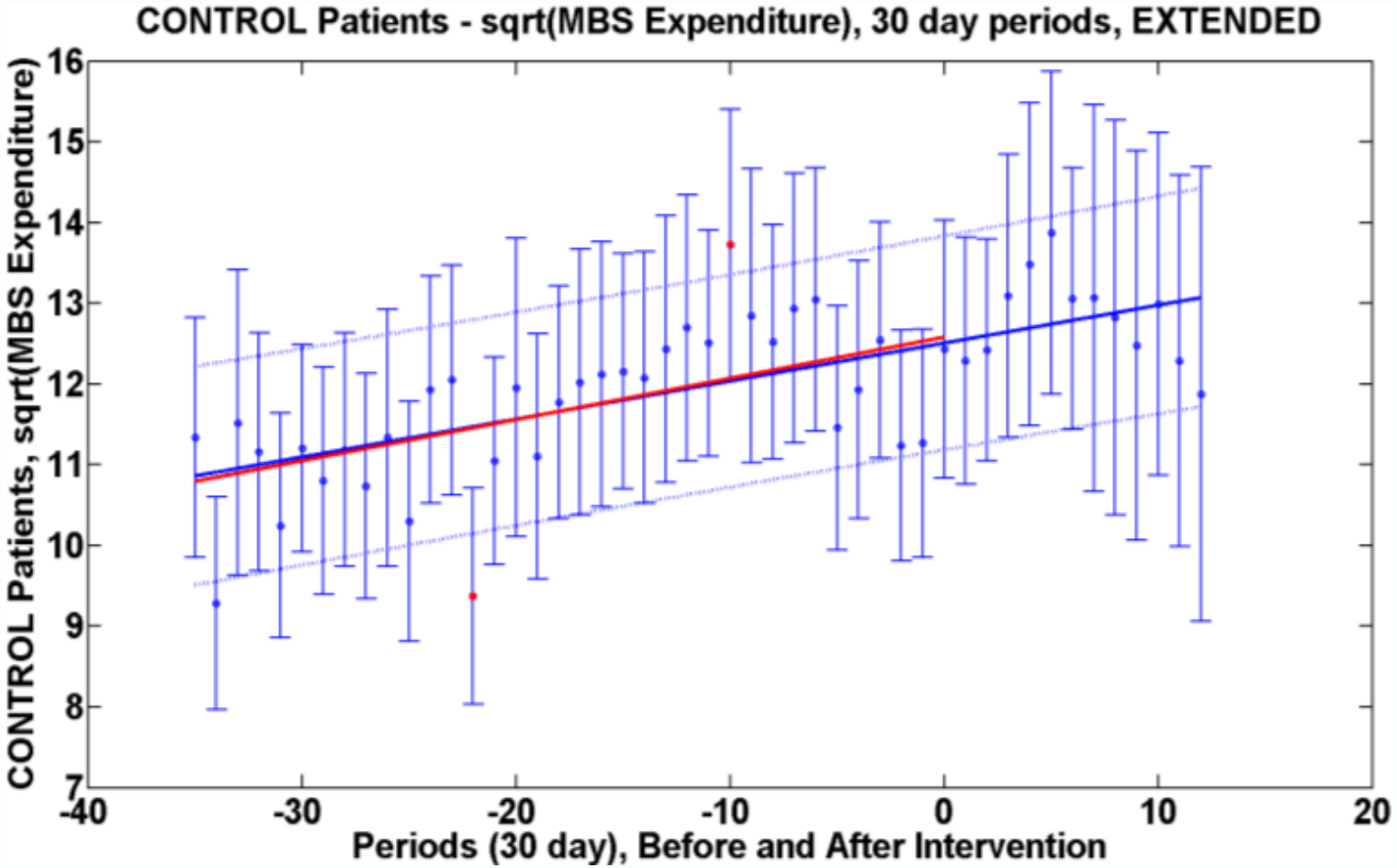
Time Series Analysis of Total MBS Item Costs – for TEST patients



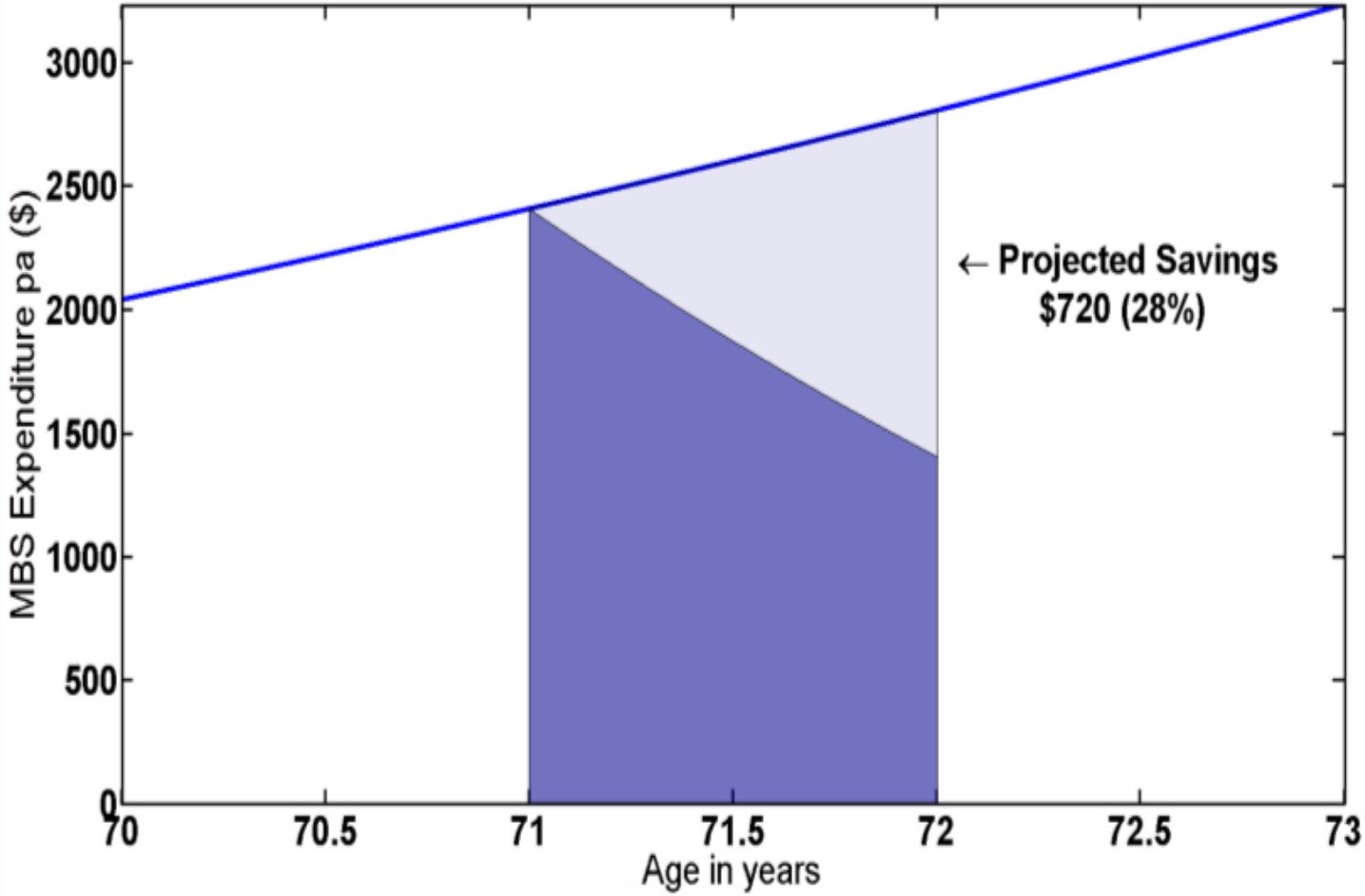
Linear regression and anocova analysis for sqrt(MBS expenditure) – All patients

	BEFORE	AFTER		BEFORE	AFTER
	Slope	Slope	Sig	Intercept	Intercept
CONTROL	0.05098	-0.03953	0.1	12.58	12.98
	(0.0293, 0.0727)	(-0.1305, 0.0515)		(12.13, 13.02)	(12.29, 13.66)
TEST	0.0919	-0.2729	<0.001**	14.06	14.44
	(0.0625, 0.1213)	(-0.4236, -0.1222)		(13.47, 14.66)	(13.33, 15.55)
P	0.0268*	0.009**			
DIFF (Control - Test)	-0.9446	3.916	0.1025	-55.38	-30.91
	(-2.073, 0.1839)	(-3.251, 11.08)		(-78.71, -32.05)	(-83.66, 21.84)

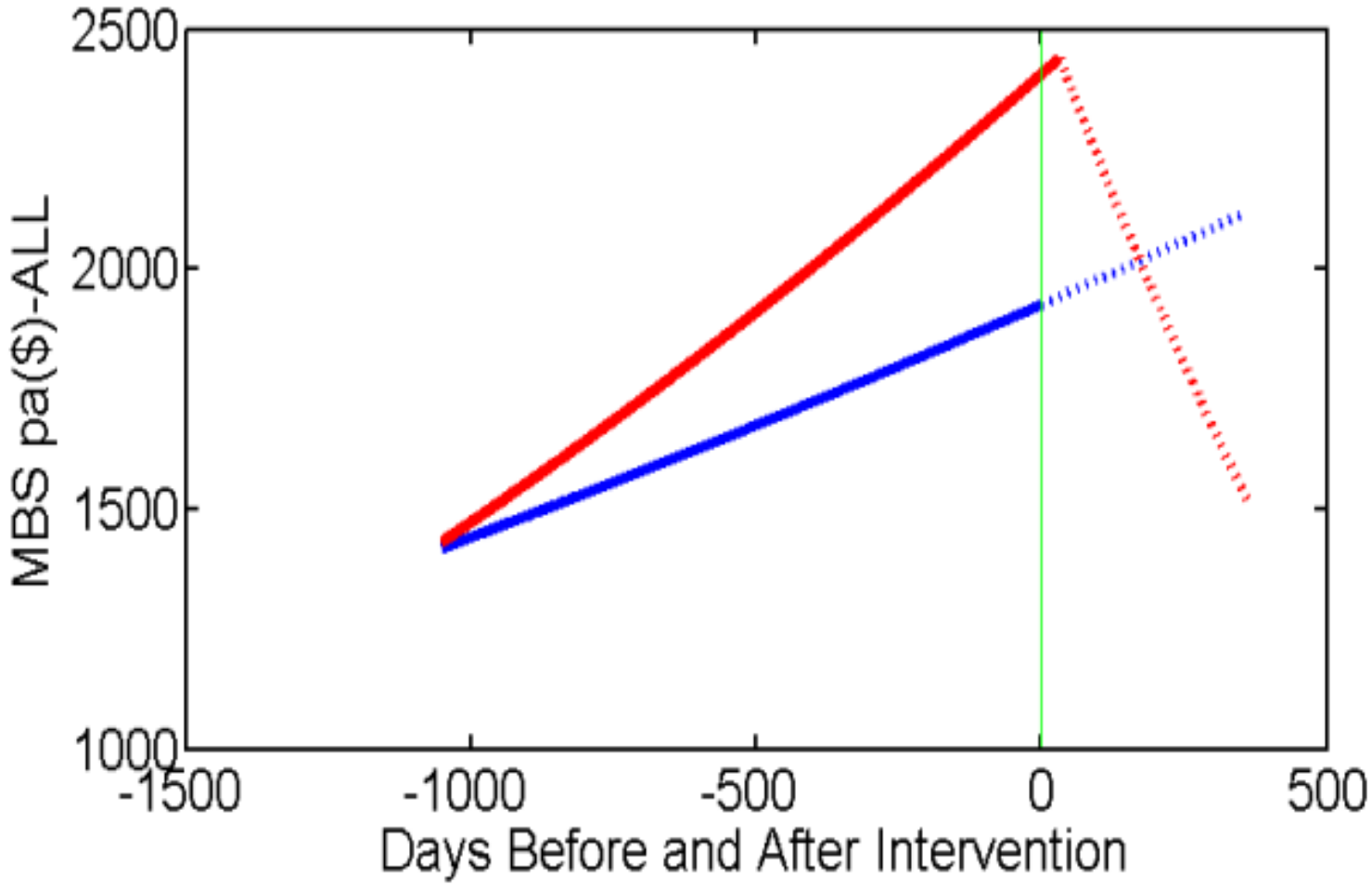
Using ANCOVA to test Before and After for Control subjects



Estimate of impact of telemonitoring on MBS expenditure



Model based time course for MBS expenditure for Test and Control subjects



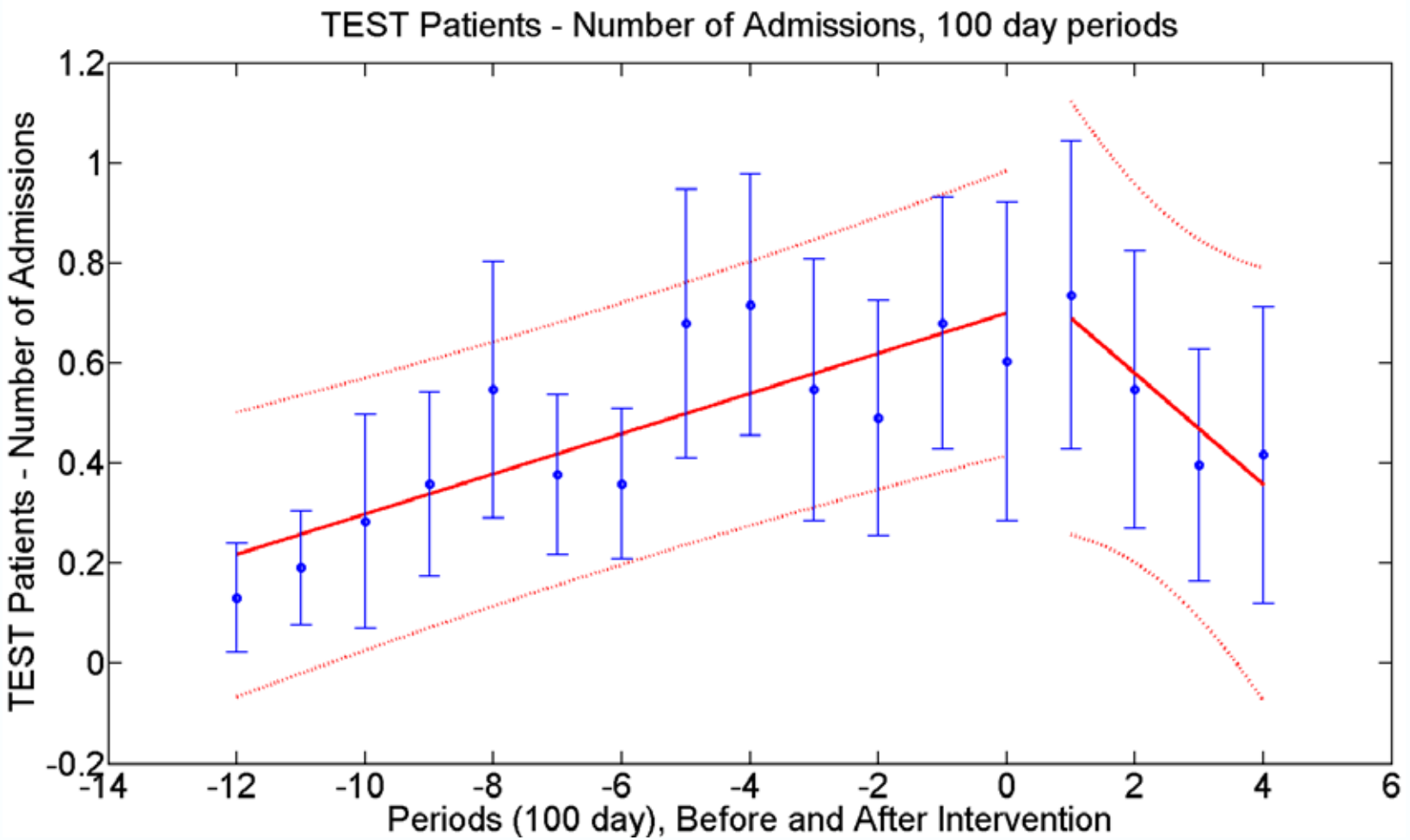
Estimates of MBS costs and savings one year before and one year after the intervention

PATIENT COHORT	Rate of MBS Expenditure at start of Intervention	Predicted Rate of MBS Expenditure at Year +1 (Without Intervention)	Estimated Rate of MBS Expenditure at Year +1 (With Intervention)	% Reduction in rate of MBS expenditure over one year	Predicted Annual Cost of MBS items after Intervention	Actual Annual Cost of MBS items after Intervention	Savings in MBS Expenses over one year	% Savings in MBS expenses over one year
All patients (N=100)	$2,405	$2,803	$1,504	**46.3**	$2,602	$1,991	**$611**	**23.5**
Male patients only (N=67)	$2,267	$2,623	$1,401	**46.6**	$2,444	$1,914	**$529**	**21.7**
Female patients only (N=33)	$2,381	$2,611	$1,477	**43.5**	$2,495	$2,001	**$495**	**19.8**
Patients with Cardiac disease as their primary diagnosis (N=50)	$2,491	$2,951	$1,562	**47.1**	$2,719	$1,915	**$804**	**29.6**
Patients with Respiratory disease as their primary diagnosis (N=30)	$2,165	$2,454	$1,296	**47.2**	$2,308	$1,899	**$409**	**17.7**
Patients with Diabetes as their primary diagnosis (N=20)	$2,615	$3,046	$1,755	**42.4**	$2,828	$2,344	**$484**	**17.1**
Patients managed in a community setting (N=62)	$2,460	$2,788	$1,269	**54.5**	$2,623	$1,975	**$648**	**24.7**
Patients managed in a hospital setting (N=38)	$2,320	$2,752	$1,768	**35.7**	$2,534	$1,969	**$564**	**22.3**

Impact of Telemonitoring on

Rates of hospitalisation
Length of stay
Mortality

Time Series Analysis of Number of Admissions– for TEST patients



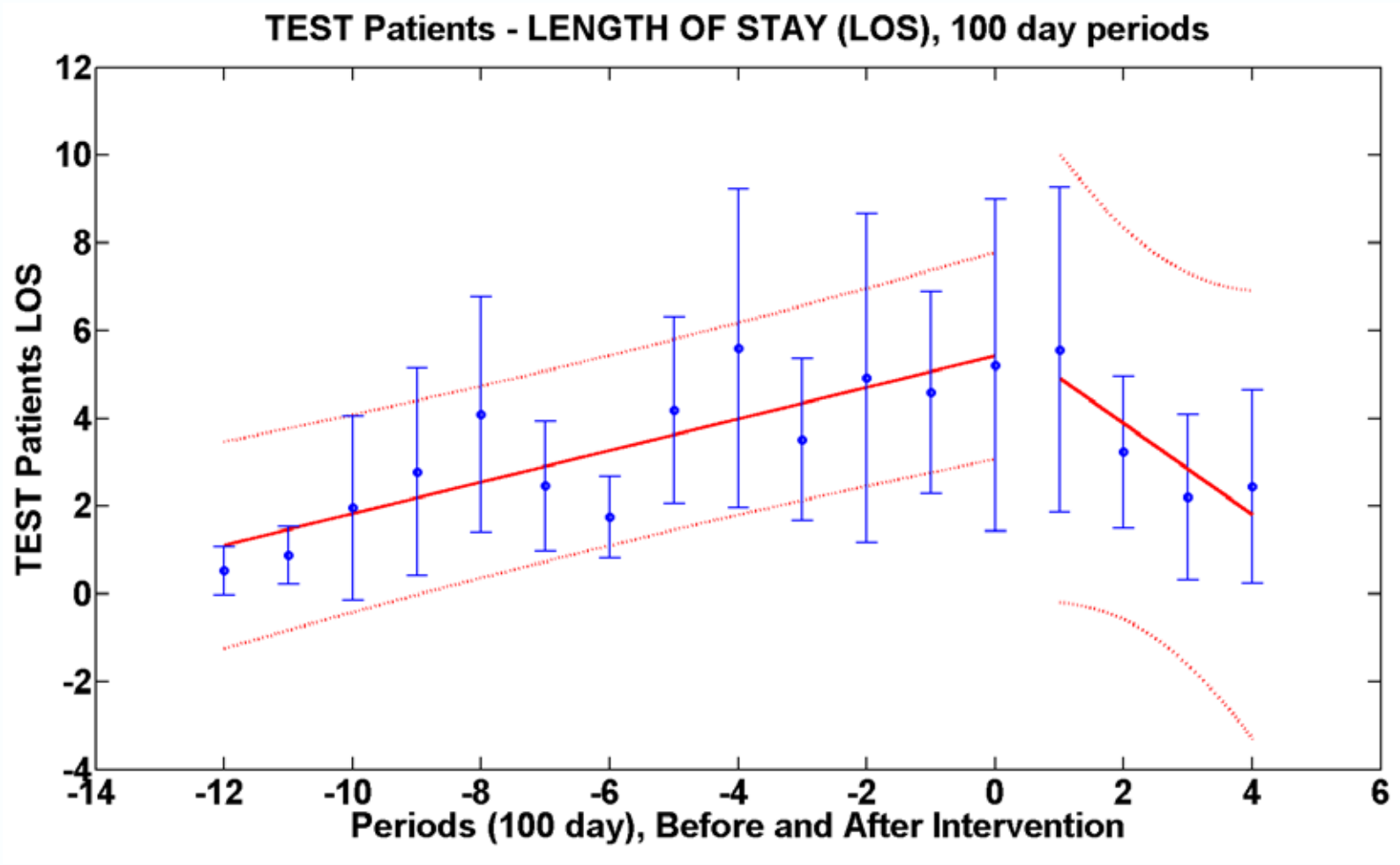
Impact of Telemonitoring on Number of Hospital Admissions

Rate of Admissions at start of Intervention (N/annum)	Predicted Rate at Year +1 (N/annum)	Estimated Rate at Year +1 (N/annum)	% Change in Rate	Predicted Number Admissions in Year after Intervention (N/annum)	Actual Number Admissions in Year after Intervention (N/annum)	Reduction in Number Admissions over one year (N/annum)	% Change in Number Admissions over one year
2.55	3.09	1.45	**53.2%**	2.82	1.82	**1.00**	**35.7%**
2.55	3.09	1.45	**53.2%**	2.82	2.15	**0.67**	**23.8%**

Estimates based on linear regressions provided in previous slides, using two different methods. Second method considers delayed onset of effect of intervention

Conclusion: **0.67 < Reduction in admissions < 1.00** per annum

Time Series Analysis of Length of Stay – for TEST patients



Impact of Telemonitoring on Length of Stay (LOS)

Rate of LOS at start of Intervention (days)	Estimated Rate of LOS one year after, without intervention (days)	Estimated Rate of LOS one year after intervention (days)	% Change in Rate of LOS	Predicted LOS over one year without Intervention (days)	Estimated LOS in Year after Intervention (days)	Estimated reduction in LOS over one year (days)	% Change in LOS over one year
19.8	24.6	6.0	**75.7%**	22.2	12.9	**9.3**	**41.9%**
19.8	24.6	7.9	**67.9%**	22.2	14.7	**7.5**	**33.8%**

Estimates based on linear regressions provided in previous slides, using two different methods. Second method considers delayed onset of effect of intervention

Conclusion: **7.5 < Reduction in Length of Stay < 9.3 days** per annum

Mortality data using different data sources

	Source Master Register	Source Master Register			Source Master Register + Ryerson Index		
	All	Test	Control	Control (Matched)*	Test	Control	Control (Matched)*
Number (N)	1429	57	77	57	100	137	100
Number of Deaths	251	5	13	9	8	16	9.5
Crude Death Rate	17. 6%	8.8%	16.9%	15.8%	8.00 %	11.7%	9.5
% Reduction in Deaths relative to controls	50.1%		**48.0%**	**44.5%**		31.5%	15.8%

* Test patients can have either one or two matched controls. If both matched controls die, this is counted as 1 death. If only one of the two matched controls dies, this is counted as 0.5 deaths. If a Test patient has only one Control and that Control dies, that is counted as 1 death.

Note: Ryerson index of published death notices – Less Reliable
Master Register checked against Births, Deaths and Marriages Register

Conclusion: **44.5% < Reduction in Mortality < 48.0%** over the year

Summary of Results of Telehealth Trial

- **Rate** of expenditure on medical services fell by **46%**
  - Savings over the first year was **24%**
- **Rate** of unscheduled admissions to hospital fell by **53.2%**
  - Reduced number of admissions over one year **24-36%**
- **Rate** of length of stay fell by **70-76%**
  - Reduced length of stay over first year **34-42%** (7.5-9.3 days)
- **Mortality** was reduced by **45-48%**
- **> 83%** user acceptance and use of telemonitoring technology
- **> 89%** of clinicians would recommend telemonitoring services to other patients

Impact of Telemonitoring on

Health Economics and Return on Investment

Health economics of Aged Care

The Numbers - Aged Care Cost Per Year:

Home health monitoring	$US1,600 /year ($2,550 in Aust)
In Home Nursing Visitation	$US13,121 /year
Nursing Home	$US77,745 /year

Source – US Veterans Health Administration (VHA)

The Numbers: Health Care Cost Per Day:

Telecare	$3.46 /day
Telehealth	$7.14 /day
Acute Hospital Bed	>$967.00 /day

Source - Feros Care (Aust) – Telehealth Care Pilot Program

Estimated Potential Return on Investment

- **Minimum estimated Costs / month for telehealth management of chronically ill patient**

· Capital costs averaging $1324 amortised over 4 years at 7% pa	$35 /month
· Internet costs (3/4G data costs, 10MB monthly plan)	$5 /month
· Monitoring, hosting and maintenance @ $70/month	$70 /month
· Nurse coordination (100 patients / clinical care coordinator, $4 /day / patient)	$120 / month
TOTAL	$230/month

- **ANNUAL COST ESTIMATE** **$2,760 pa ($7.40/day)**
- **ANNUAL SAVINGS ESTIMATES**

· Savings in MBS and PBS Costs (from CSIRO trial)	$1000 pa
· Reduced LOS, averaging 7.5 bed days @ $2,051 / day	>$15,383 pa
· Reduced demand on community nurses (Reduction of one visit / week @ $60 /visit)	$2880 pa

TOTAL SAVINGS **$19,263 pa**

ESTIMATED ROI = 5.98

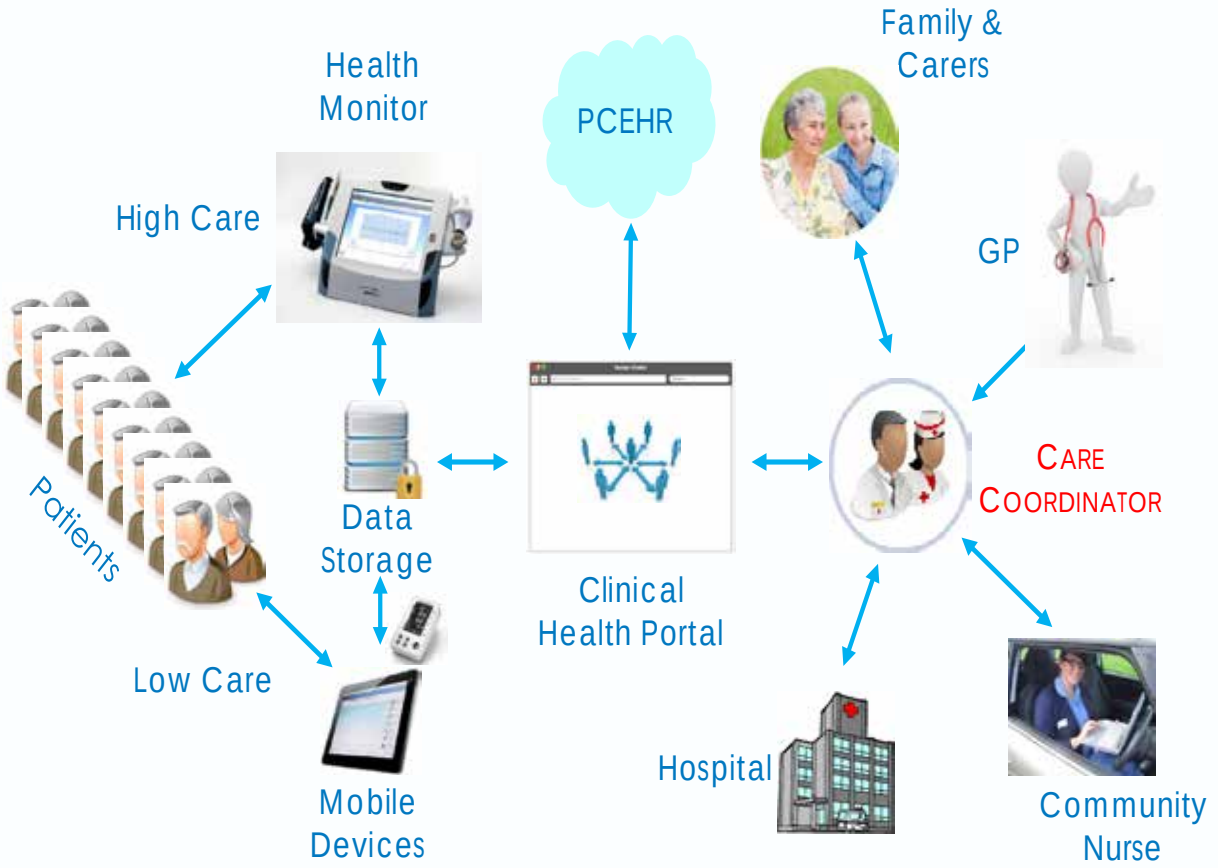
(4.9 without involvement of community nurse)

Some conclusions

- Cost savings and improved healthcare outcomes are evident through reduced hospitalisation and hospital LOS, reduced MBS costs and small reductions in PBS costs
- Part if not all local costs of implementing telehealth can be saved through increased case loads and more efficient use of clinical staff
- The process of implementing a telehealth service is relatively straight forward, providing there is sufficient clinical buy-in and a capacity for organisational change
- High level of acceptance by community nurses and patients despite entrenched workplace cultures in some sites leading to slower uptake
- Despite strenuous efforts by the project team, very poor participation and buy-in by GPs
- The critical role of Clinical Care Coordinators in any telehealth program

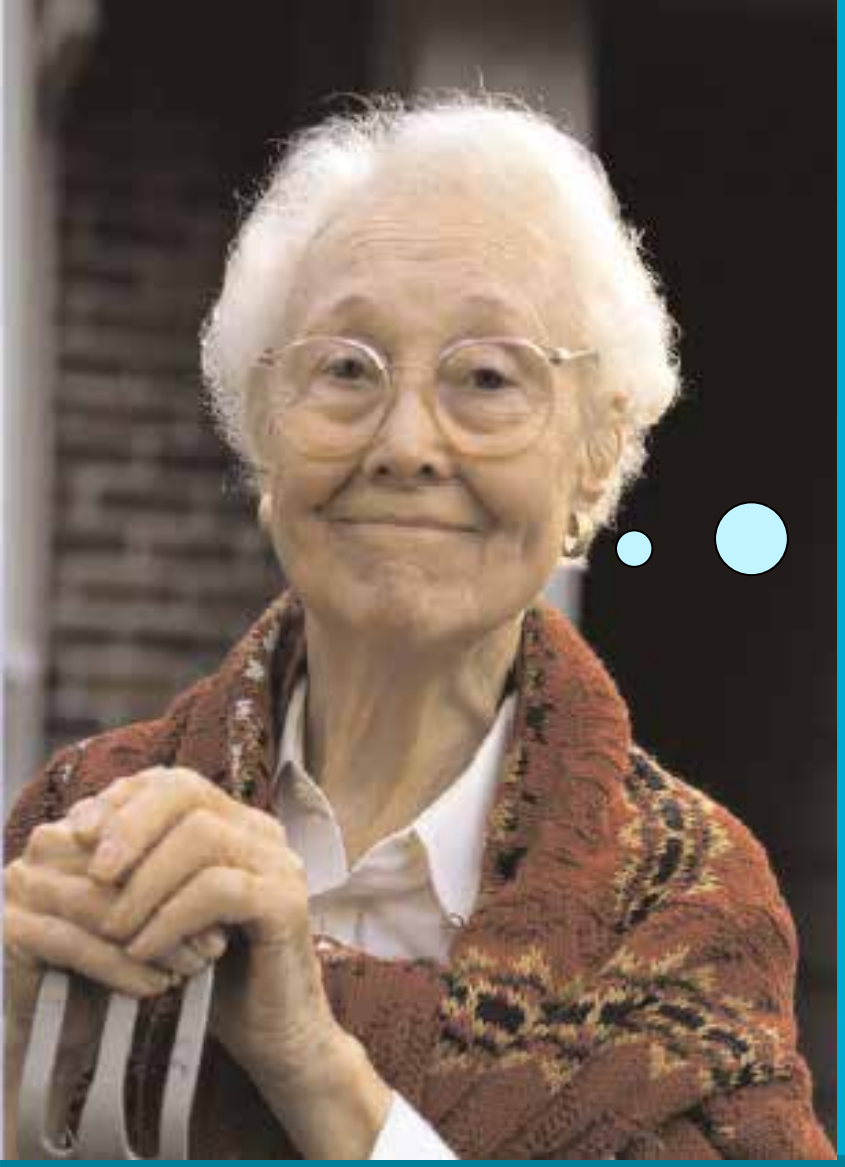
Clinical Triage and Care Coordination

Objectives of clinical triage is not to ***deliver*** care but to ***coordinate and orchestrate*** the provision of timely and effective care by the patient's normal care giver ie GP or community nurse, to avoid an exacerbation of the patients chronic condition and unnecessary hospitalisation



The New Shape of Healthcare?

- More than 1.6 m patients in Australia aged >65 with 2 or more chronic conditions will be managed at home with a range of appropriate telecare, smart assistive technologies and telehealth services. More effective early discharge and Hospital in the Home.
- Clinical care of patients in residential care facilities or nursing homes (>217,000) will greatly improve through the deployment of electronic medications management systems and telehealth
- Excellent clinical care coordination supported by intelligent risk stratification and predictive analytics will ensure that the right care is delivered at the right time to the right person to greatly reduce unnecessary hospitalisation
- Vital signs and questionnaire data from at-home telemonitoring will be integrated with the PCEHR to form an important part of a universal electronic health record available anywhere and anytime.
- Mobile community nurses will be supported by a range of smart telehealth systems to improve efficiency, reduce travel and improve patient healthcare outcomes
- At home telemonitoring of vital signs will become routinely accepted by clinicians as an essential part of managing chronic disease in the community
- This will come to pass within the next 5-10 years!



ANY QUESTIONS?

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