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Smarter Safer Homes: Beyond The Results

Lessons Learnt from Implementing Smart Home Technology in the Homes of Older Adults

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- What is Smarter Safer Homes?
- The DACS Trial – A Smart Home RCT
- Challenges Experienced
- Lessons Learned
- Potential Barriers to Implementation

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What is Smarter Safer Homes?

Sensor-Based in-home Monitoring System

Data Collection
- Ambient Sensors
- No sound or images recorded
- Not real-time or live-monitored

Distributed Sensors

Sensor Type	Location
Motion, Humidity, Light, Temperature & Vibration	Corner of each room
Electricity Sensor	Wall outlets (e.g. toaster/kettle)
Accelerometers or Door Sensors	Front Door and Fridge
Sleep Sensor	Under Mattress
Chair Pressure Sensor	***Discontinued***

Data Analysis
- Aggregation of Sensor Data
- AI analytics

Objective estimate of functional performance across multiple domains.

Activity of Daily Living (ADL) Domains	
• Mobility	• Transfers
• Dressing	• Personal Care/Hygiene
• Meal Prep	• Social Score
• Sleep	• Overall "Objective ADL" Score

Data Presentation
- Tablet App
- Web App

Data Visualisation

Portal	View	Traffic Light System	Comparison to Individual Baseline
Client	Individual Summary	Expected	< 1 SD from mean
Provider	List view - multiple clients	Unexpected	1-2 SD from mean
Family	Client controls data visibility	Very Unexpected	> 2 SD from mean

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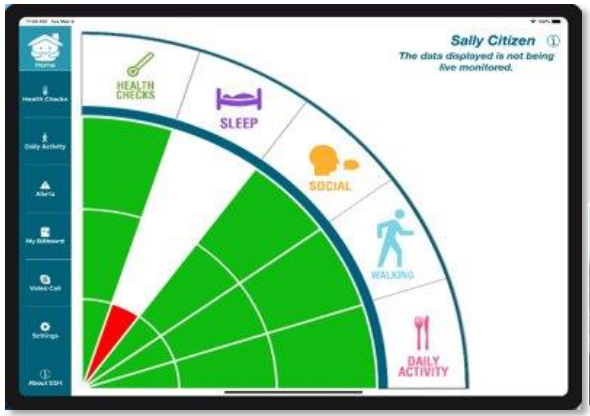
Data presented to highlight deviations from an individual “baseline activity profile” in each functional domain



Client Portal

Family Portal

Name	ADL Score	Meal Preparation	Dressing	Hygiene	Transfer	Mobility
User 0462, Demo						
User 0344, Demo						
User 0066, Demo						
User 0552, Demo						

Provider Portal

(monitored 1x/day on weekdays only)

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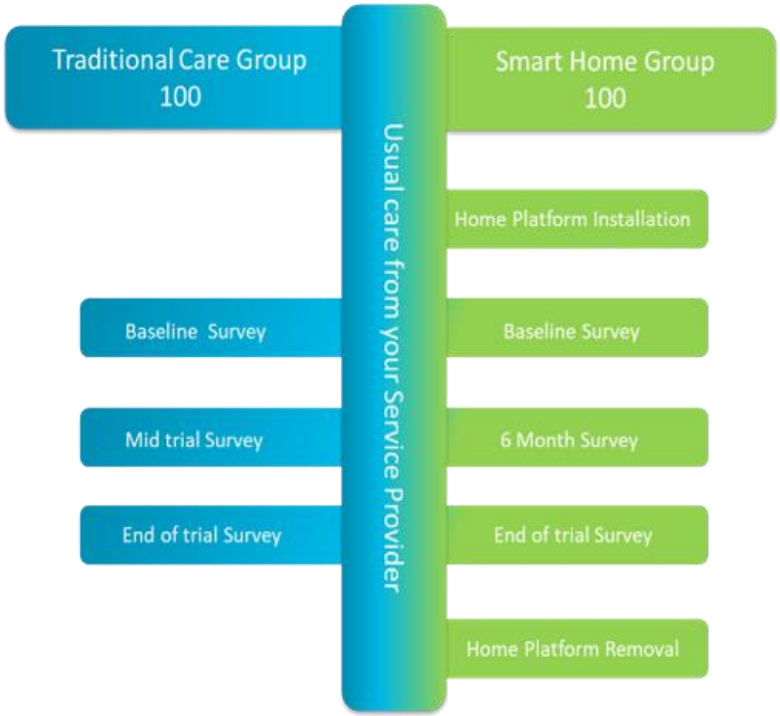
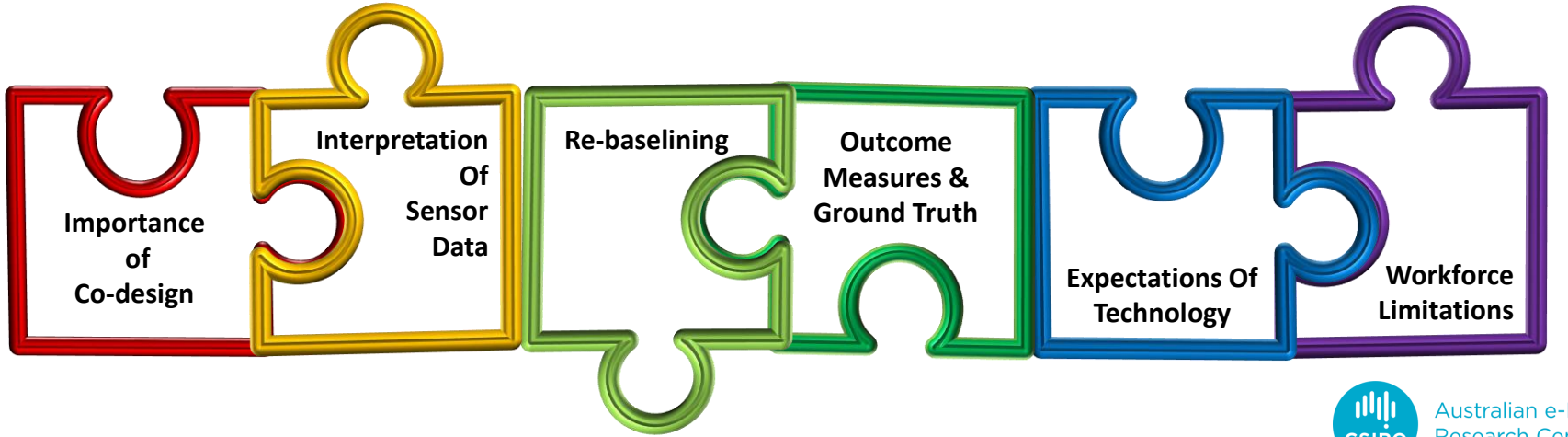
Dementia and Aged Care (DACS) Smart Home Trial

- Randomised Control Trial
- 195 participants
- 3 Aged Care Service Providers
- Monitored over 12 months
- 98 smart homes installed with sensors
- 97 controls

At commencement it was the only large scale Australian study using smart home systems to monitor function in older adults



Challenges and Lessons Learnt



Challenges

- Prepare for lots of questions from Privacy and Ethics
- Initial "big brother" reaction to 24/7 monitoring of health & lifestyle data
- Privacy risks associated with collection of sensitive data
- Balancing act between potential benefits and risks of monitoring
- Preserve privacy where possible (participants were reassured that there was no audio or video)
- Vulnerable populations & cognitive impairment = careful consideration of assessment of capacity and how to collect consent

- Things take longer than you expect in a community setting – budget extra time
- There are lots of things you can't control (e.g. internet connectivity)
- Need for reliable, durable and well designed technology (e.g. chair sensors were reliable in the lab but not in the home environment
- Aim for consistency and quality of the things you can control
- Prepare for the unexpected and have contingency plans

- Battery Life, Reliability, Sensitivity, Validity
- Need for consistent installation, regular tech support and regular maintenance (to ensure data quality and avoid missing data). Inconsistencies of relying on contractors
- Multiple occupancy dwellings, visitors and pets
- Importance of validation, feasibility testing, prototyping and iterative re-design
- It's easer to make changes early (difficult during an RCT)

- Trajectories of ageing
- Background functional decline (non-linear and only loosely associated with age)
- Multiple comorbidities
- Multi-factorial "Geriatric Syndromes"
- Complex Correlations
- Impact on hypotheses, outcome measure choices and data interpretation
- Involve statistician early
- May need large numbers and long follow up

- The Aged Care system is complex and is often counterintuitive
- Understand the systemic barriers and limitations of the system (e.g. workforce, funding, waitlists)
- Understand what "usual care" looks like
- Check your assumptions about how the system works
- Consider the impact of systemic limitation on your hypotheses and outcomes

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Re-baselining
- Gradual deterioration of older adults
- Moving target
- ? Rolling baselines
- ? Triggers for re-baselining

Interpretation of Sensor Data
- How do aged care providers interpret data? Further study to understand and measure this.
- Who is monitoring? What is their skillset?
- Need for Training, Support & development of protocols and workflows
- Context dependent data visualisation
- Trend-data VS Traffic Lights

Outcome Measures and Ground Truth
- Collect outcomes from all end users including service provider & family carers
- Importance of Qualitative data
- Balance between enough ground truth information and having too information
- (e.g. participant diaries a good source of ground truth but needed to be ceased due to associate risk management)
- Sensitivity of outcomes measures
- Statistician involvement

Importance of Multi-Disciplinary Research Team

Importance of Co-design
- Co-design with all potential end-users
- Older adults engaged minimally with the platform
- Co-design for usability AND Engagement

Communicate Expectations of Monitoring Technology
- Communicating:
  - how often the system is monitoring
  - limits of monitoring
- False sense of security
- Implications for Duty of Care

Workforce Limitations
- Workforce shortages = inability to take staff away from frontline care delivery.
- Impacts of monitoring on workloads and Duty of Care
- Limited Tech literacy and tech support
- Variability in staffing mix, skills and workflows between providers

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Trajectories of Ageing

- Biological ageing = decline in functional capacity
- Functional decline is often multi-factorial
- Biological ageing only loosely associated with chronological age. Not linear or consistent
- Consider – impact on hypotheses, outcome measure choice and data interpretation.
- Are we expecting improvement OR maintenance OR slowed rate of decline?
- Impact on baselines/re-baselining – which trajectory is a participant on?

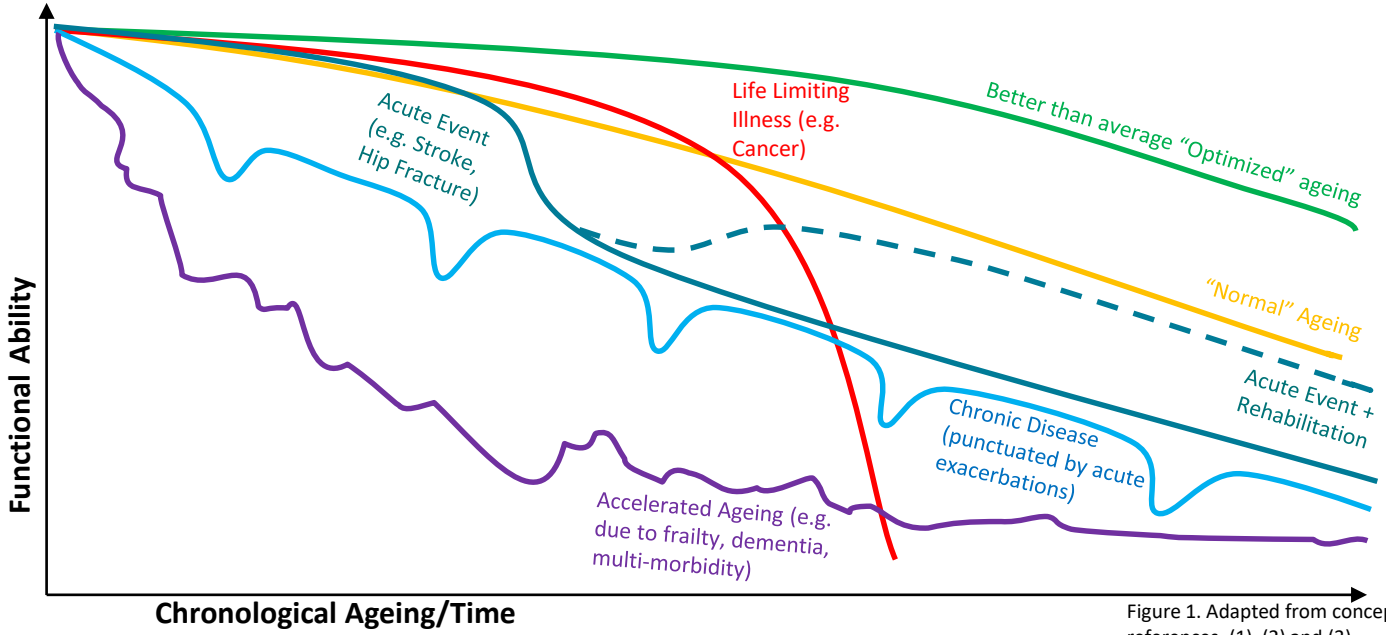
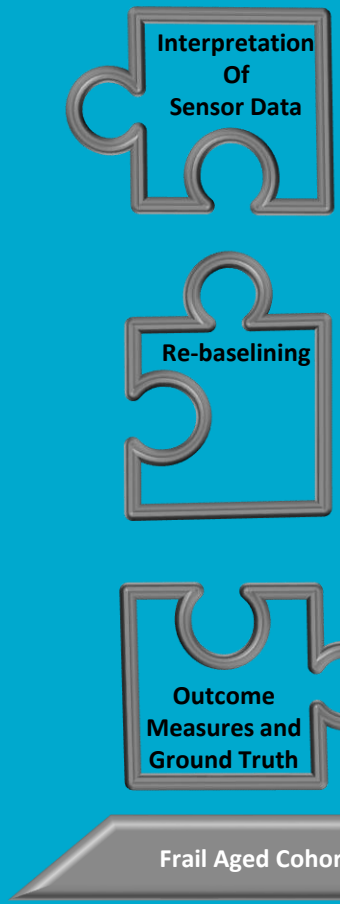


Figure 1. Adapted from concepts in references (1), (2) and (3)



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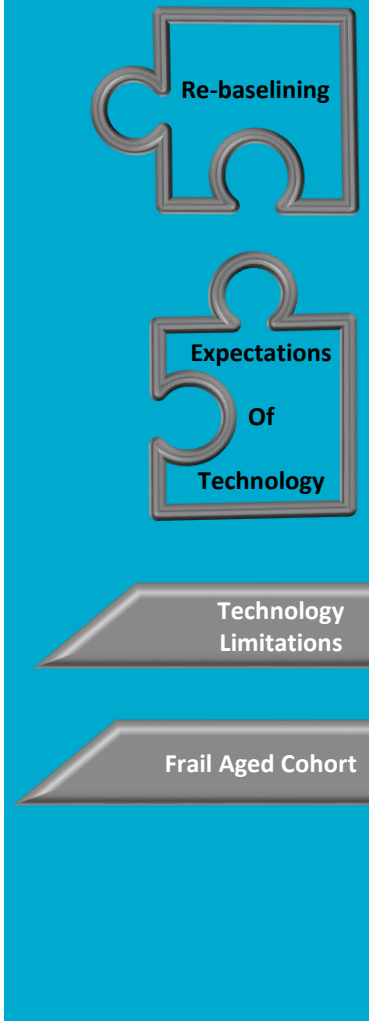
Baselines and Re-Baselining

- 21 day Baseline data collection = individualised activity patterns
- Traffic light system – subsequent data compared to established baseline
- Progressive functional decline in Older adults
- Is change in function
  - temporary or permanent?
  - Reversible?
  - Is there potential for rehabilitation/reablement?
- When is re-baselining appropriate? May be a clinical decision
- ? Rolling baselines
- ? Clinician triggered re-baselining



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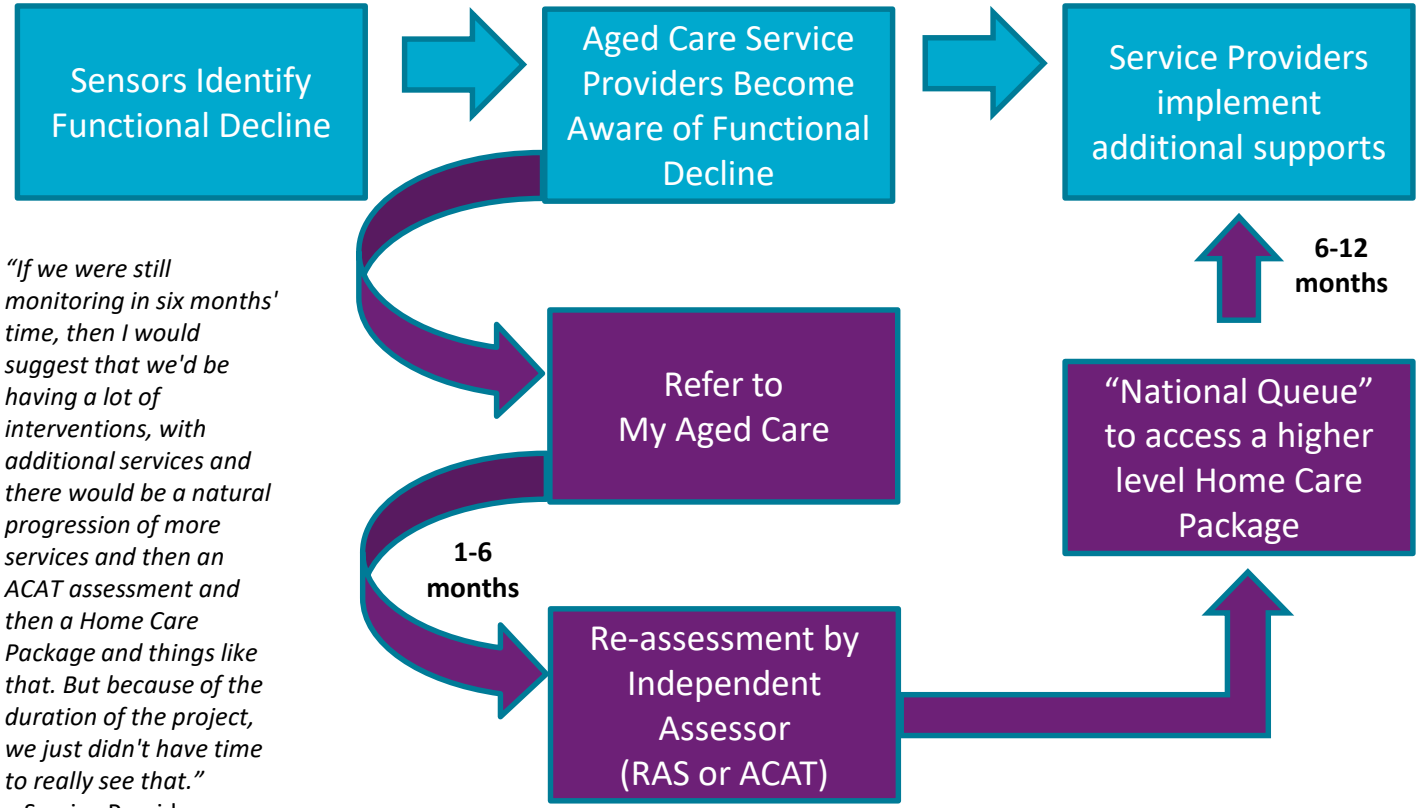
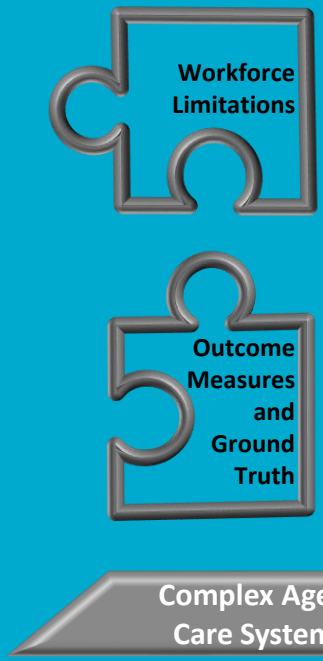
Aged Care System Complexities



"If we were still monitoring in six months' time, then I would suggest that we'd be having a lot of interventions, with additional services and there would be a natural progression of more services and then an ACAT assessment and then a Home Care Package and things like that. But because of the duration of the project, we just didn't have time to really see that."
– Service Provider



Client Expectations and Duty of Care

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24/7 Data Collection
Only monitored 5x/week
NOT Real Time
No Emergency Response

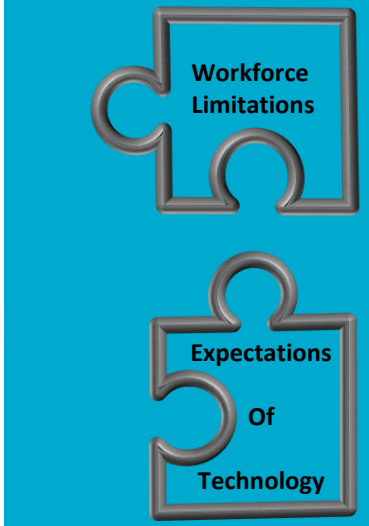
"I had a fall… and this doesn't register. I think it would be good if this registered. I was on the floor about 10 minutes and didn't have a falls monitor on at night" – Participant

"I could see that it could give a false sense of security. Even if you have 24/7 monitoring unless you have some way of alarming in case of suspected emergency." – Service Provider.

"Need for good communication of who is checking the system and when (e.g., not an emergency monitor, only checked weekdays because "Need for good communication of who is checking the system and when (e.g., not an emergency monitor, only checked weekdays because I could see that it could give a false sense of security. Even if you have 24/7 monitoring unless you have some way of alarming in case of suspected emergency." – Service Provider.

"I think people still did expect, even though they were being monitored 1x/day, 5 days/week, that people still did get the impression that if they had a fall, we'd know and we'd help them. So that that kind of stuff is important in the communication with this."– Service Provider.

?False sense of security
Duty of Care



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Interpreting Sensor Data

- Need for contextual information
- Unexpected doesn't always mean bad
- Having continuous data is NEW for aged care providers/clinicians
- Who is monitoring? Differing skillsets
- Interpretation - what should we compare to?
  - individual baseline (used in this study)
  - ? age-related normative data
  - ? optimised ageing
- Data as a trigger for "care conversations"
- Estimates of function (how confident can we be in the data)
- Threshold to act
- Data Visualisation
  - Traffic lights vs Trend Data
  - Context dependent data visualisation
- Need for further study to understand and measure how clinicians/aged care providers use the data
- Need for training and support for aged care providers and clinicians
- Need for co-design of data visualisation, protocols and workflows

Potential Barriers to Implementation

Why hasn't there been uptake of Smart Home Monitoring by Aged Care Service providers?

Some theories:

- Regular monitoring of health and function is not **currently** part of "usual care" for most people receiving Home Care
- Staff time needs to be allocated to monitor these systems and for associated follow up/actions - current aged care workforce challenges.
- Limited awareness of potential benefits
- Aged Care Funding

- Home Care Packages are consumer directed. Older adults choose which services/supports they access through their package funding.
- Need for "critical mass" of adopters "choosing" the technology for it to be feasible for aged care providers to allocate staff to monitoring, however individuals can't "choose" this options if providers don't offer monitoring.
- "Support at Home" – is new funding model due to be rolled out by the Department in 2025. It includes a new proposed service type **"digital remote monitoring**". (4) However, at present this service type is a separate service type to "Care management/Care Co-ordination".
- ? Greater benefit for non-resident family carers (who may have more capacity to provide regular monitoring) than aged care providers

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University Partners
Griffith University and Macquarie University

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References

The concepts presented in Figure 1 were adapted from concepts from figures in Ref 1, 2 and 3

References

(1) Zhang et. al. DACS: Smarter Safer Homes to Support Older People Living in Their Own Homes through Enhanced Models of Care (2022). http://aehrc.csiro.au/wp-content/uploads/2022/11/CSIRO-DACS-Report.pdf

(2) Murray S.A, McLoughlin P (2012), Illness Trajectories and Palliative Care. Implications for holistic service provision for all in the last year of life. Figure 1: Typical illness trajectories for people with progressive chronic illness.

(3) Lynn J, Adamson D (2003), Living Well at the End of Life. Figure 3: Chronic Illness in the Elderly Typically Follows 3 Trajectories

(4) Shinmura, K (2016) – Cardiac Senescence, Heart Failure and Frail: A triangle in Elderly People. Fig 1. Trajectories of health and functional decline with ageing

(4) Australian Government Department of Health, Support at Home Program Overview (2022)

Thank you

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