# Chatbots in Mental Health

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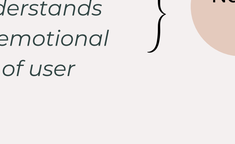
## Background

Rates of mental illness have increased rapidly worldwide[13], causing the demand for support to outstrip the supply of mental health services. According to the World Health Organisation, **up to 55% of individuals** in developed countries struggling with mental health **cannot access appropriate support services[6].**

*Predicted cost of mental illness is $16 trillion globally between 2011 - 2030[6]*



*29% of individuals have mental health issues in their lifetime[11]*

Current support options

Face to face therapy

Synchronous telehealth

Asynchronous telehealth

Conversational bots

One solution to the shortfall of mental health services lies in mobile apps using conversational bots. These **Chatbots** are complex computer programs that interact and converse with human users, allowing the **delivery of text-therapy**. This could significantly improve the accessibility and effectiveness of mental health support[4].

## How do Chatbots work?

There are **two main types** of Chatbots currently used in mental health services worldwide[4]:

### Artificial-Intelligence powered Chatbots

- Understands and responds using Machine Learning, AI and Natural Language Processing
- Builds rapport by enabling users to control dialogue and responds to a wider array of inputs





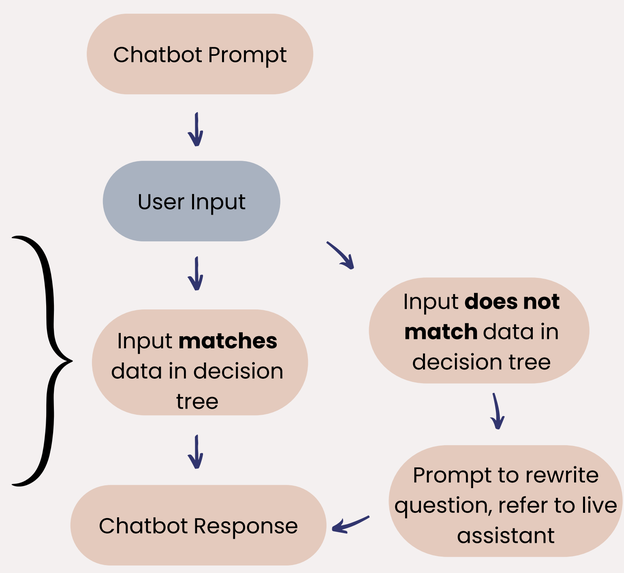
*Adapted from Wysa*




### Decision tree/ Keyword Chatbots

- Uses predefined rules and a vast data bank to generate responses
- Simple, accurate and secure


*Adapted from Otis*




## Problems with Chatbots

### *Safety*

- Safety risks of Chatbots include **misunderstanding**, **mistreatment** and provision of **false information**[5]
- **Lack rapid response to emergencies**, only 23% responded adequately to suicidal ideations[10]
- Responses **can be shallow and/or confusing**[2], and struggle to provide **meaningful social support**[7]

### *Privacy*

- Literature demonstrates that **health apps can lack privacy and security**[9]
- In Australia, digital health apps are *likely* bound by Federal Privacy Legislation through the **Privacy Act of 1988**, however this **requires clarification**[18]
- Australian privacy policies are **insufficiently enforced** in relation to products originating in other jurisdictions (Commonly America)[18]

### *Regulations*

- There is **no standard method** to evaluate safety of Chatbots[1]
- Therapeutic Goods Administration (TGA) regulations currently exclude digital health products that follow clinical guidelines, resulting in **most mental health chatbots remaining completely unregulated in Australia**[19]
- **No regulatory body** is clearly identified as responsible[8]

### *Limited human element*

- Limited conversational ability - responses can be **shallow and/or confusing**[2]
- **Interpersonal relationship** is biggest predictor of treatment effectiveness - Chatbots can struggle to **provide meaningful social support**[7]

## Effectiveness of Chatbots

### Perception by users

Review by Abd-Alrazaq et al (2021) **collated 37 studies**[2]:
•Unique features of Chatbots: real-time feedback, weekly summary and continuous data collection
•High **usefulness** and **ease of use**
•Satisfaction with **confidentiality**, **objectivity** and **anonymity**
•Sense of **accountability**
•24/7 access improved **accessibility**[12]

### Clinical evidence

Meta-analysis by Abd-Alrazaq et al (2020) **collated 12 clinical trials**[3],
•Improvements in depression, distress, stress and acrophobia
•But evidence was **considered weak** due to the lack of studies and high estimated risk of bias

Other clinical trials also show improvements in **wellbeing** and **mood**[12,15,16], **disclosure** of **information**[17], and symptoms of **anxiety**[14]

Overall, most studies have focused on **acceptability and usability**, while evidence for **improvements in clinical outcomes is lacking**

## What's needed?

- Improvements in **linguistic capabilities** of Chatbots to ensure **appropriate responses**, particularly in emergency situations
- **Further research** into Chatbots to confirm effectiveness regarding **clinical outcomes**
- **Review and clarification** of **privacy** and **regulation laws** surrounding mental health Chatbots in Australia
- Development of **standards for evaluation**

## Takeaways

- Chatbots could be a solution to the shortage of global mental health support for mental health sufferers
- Chatbots have high usability and acceptability, but inconclusive clinical effectiveness
- Wide array of problems need resolution for future growth of Chatbots - particularly data privacy and regulation
- Technology improvements, further research and standardization in evaluation are important next steps

References

1. La Trobe University, VIC
2. Lyf Support, VIC
3. Digital Health CRC, NSW

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Australian Government Department of Industry, Science and Resources
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# The Ethical Application of AI in Health: A Desktop Review

*Tamara Marwood[1], Professor James Boyd[1], Dr. Urooj R. Khan[1], S. Jade Barclay[2], Kirsten Jackson[3]*

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## BACKGROUND

The increased use of Artificial Intelligence (AI) techniques requires research organisations, ethics committees and data custodians to be able to assess the ethical and privacy implications of AI applications, which may differ from ethical models and regulation typically seen employed in health research and clinical health services in Australia.

- AI is being used and will be applied to a greater extent in the health sector in future.
- AI has benefits for the health sector and the users of the health sector.
- Governments and researchers agree that regulatory agencies and institutions need to formulate guidelines and policies regarding the ethical use of AI models for Australia's health sector.

## What available frameworks enable the ethical use of AI in health in Australia?

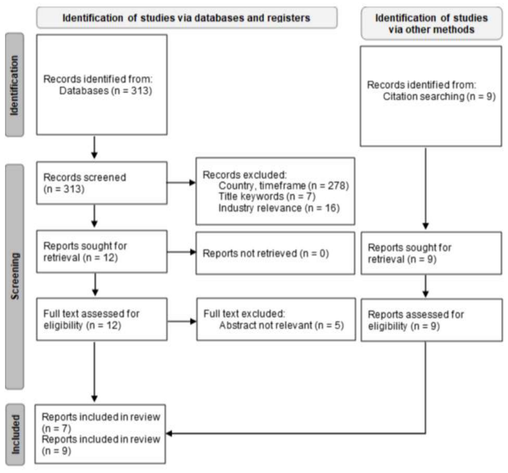
*AI-specific ethical frameworks have limited adoption in the Australian healthcare sector.*

*Governments, peak bodies, and researchers are aware of the challenges, and are starting to develop frameworks that can assess the ethical application of AI models in health.*

## METHOD

This desktop review of ethical frameworks for AI in health identifies and critiques:

1) existing frameworks, policy documents, guidelines and other resources for the ethical application of AI in healthcare;
2) key organisations or academics in Australia and the frameworks and resources they have developed; and
3) the ethical and privacy implications of AI in health. Scopus, Public Health Database, Web of Science, Emerald Insight, and ProQuest were searched to identify relevant papers and studies published in since 2018.



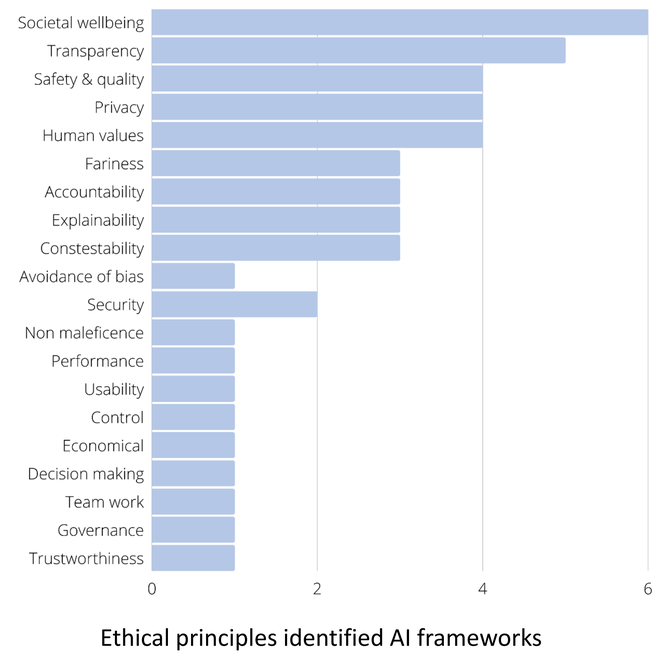

A total of sixteen papers were reviewed.

Seven research papers were identified: two papers on proposed ethical frameworks for AI health systems and five literature reviews assessing AI ethical health system frameworks in both research and clinical health settings.

Nine papers from grey literature were reviewed, including six AI ethical frameworks in general domains, one framework for clinical healthcare, one roadmap to the implementation of AI in healthcare (which included a section on ethical frameworks) and one roadmap to Australia establishing standards for AI internationally, across domains.

## REVIEW OF ETHICAL FRAMEWORKS & GUIDELINES

| Framework | Authors | Domain | Status | Health application | Stages in AI lifecycle | Stakeholders considered | Method to assess AI model | Case study or application | Governance |
|---|---|---|---|---|---|---|---|---|---|
| **Governance Model of AI in Healthcare (GMAIH)** | Researchers | Health | Recommended | Clinical and research | Introduction stage - health service review of AI products in market. Deployment stage. Integration. | Software developers, government agencies, health services, medical professional bodies, and patient interest groups. | None | None | Clinical governance committee (internal) |
| **The Translational Evaluation of Healthcare AI (TEHAI)** | Researchers | Health | Recommended | Clinical and research | Development, deployment and discernment. | Software developers, health services. | Uses three main components - capability, adoption and utility to assess AI systems - applied during different phases of an AI model and has a workflow model for healthcare service. A score card system is provided to assess each component. | None | None |
| **Standards of Practice for Artificial Intelligence in Clinical Radiology (RANZCR)** | Peak body | Health | In practice | Clinical | Development, deployment and monitoring. | Patients, clinical teams. | Five standards and indicators, and on-going audits. | Requires further research | Reporting incidents to regulatory authorities - Therapeutic Goods Administration in Australia. The practice must establish an appropriate governance body (or bodies) to oversee the deployment and use of ML and AI at the practice. |
| **Australia's Artificial Intelligence Ethics Framework** | Government | All | In practice | Clinical | Design, data and modelling; development and validation; deployment monitoring and refinement. | The humans impacted. | Not provided | Yes - no health case studies 2 x Banking 1 x Insurance 1 x Telco 2 x Tech | Not identified |
| **PwC Responsible AI Toolkit** | Corporation | All | Unclear | N/A | Strategy, planning, development, deployment, monitoring and reporting. | Board members, customers, and regulators. | Not provided | Not provided | Not identified |
| **NSW Government AI Policy and Assurance Framework** | Government | All | In practice | N/A | Used at all major points of an AI project's lifecycle – from start to finish, and monitoring. | Users of the framework and community. | Risk assessment spectrum | Not provided | AI peak body review |
| **Roadmap for AI in Healthcare for Australia (the AAAiH Roadmap)** | Peak body | All | In practice | N/A | Planning and design, data collection and processing, as well as model building; deployment, operation. | All organisations and individuals involved in, or affected by, AI systems. | Not provided | Not provided | Not identified |




Ethical principles identified AI frameworks

Most ethical guidelines for the application of AI systems in healthcare consist of high-level principles, with few detailed actual-use cases in clinical healthcare, and even fewer in healthcare research. Within Australia, only one ethical framework was identified as operating in healthcare for clinical radiology practices and hospital departments. Of the ethical frameworks in this review, only three of the seven frameworks provided methods used to assess AI models.

## CHALLENGES & RECOMMENDATIONS

### Technology (with limited uptake within the health sector)

**Recommendation:** Apply a 'proposed' ethical framework or governance model within a health care setting.

### Relationship between stakeholders & the AI lifecycle

**Recommendation:** Ensure the safety and quality of AI will require the involvement of consumers, clinicians and AI experts in the co-design of AI, and training in the safe use of AI.

### Inconsistency with ethical principles and application of AI system

**Recommendation:** Case studies of the application of the recently launched NSW Government AI Policy and Assurance Framework & Ethical Principles for the use of AI in Medicine & Standards of Practice for Clinical Radiology.

### Regulation & governance

**Recommendation:** Clinical and health research organisations may consider applying the existing guidelines and methods to assess an AI model to establish an internal governance body.

## CONCLUSION

All frameworks proposed a set of principles intended to provide guidance about the application of AI across the AI lifecycle that are applicable to many industry domains in Australia. Governments and researchers concur that regulatory agencies and institutions will need to formulate guidelines and policies regarding the use of AI models for Australia's health sector[2]. Despite the complexity and concerns of applying ethical AI frameworks to healthcare, there are roadmaps towards developing ethical AI frameworks in Australian industry and the healthcare sector specifically.

Available frameworks do not adequately enable users to assess the ethical use of AI modelling techniques in healthcare. Governments, peak bodies and researchers are aware of the challenges and are starting to develop frameworks that can assess the ethical application of AI models in health.

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# Professional Accountability, Trust and Data-Driven Decision Making in Health Care

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## INTRODUCTION:

There is growing consensus that patient experience and outcome measures are an important element of good quality health care (Gilburt, Rose and Slade, 2008; Kilbourne *et al.*, 2018).

**We know** that outcome and performance indicators can be used to assess nation-wide performance and can reveal gaps in practice and standards of procedure – such as time to treatment, inflection rates, readmission and so on. (Williams *et al.*, 2016). These data are valuable in designing clinical decision support systems (CDSS).

**Patients are in a unique position to report meaningful information about their illnesses, experiences of treatment and quality of life.**

**Industry Hypothesis:** Better understanding of patient experiences and outcomes could enhance the delivery of health care on many levels including:

- The therapeutic relationship (Micro)
- Information sharing or 'benchmarking' across clinical teams and between healthcare settings (Meso)
- Policy and administrative levels - where decisions on funding and resource allocation occur (Macro) (Williams *et al.*, 2016)

**My (Bioethical) Hypothesis:** Clinicians *have a moral obligation* to work with patients to achieve the experiences and outcomes that matter to them; this is central to promoting patient autonomy. Measuring patient experiences and outcomes offers an opportunity to ensure professional accountability and build trust across the health care system. Thus, we have an obligation to collect data with Patient Reported Measures (PRMs).


(Illustration by Jill Dawson & Phillip Saunders – Dawson, J. et al., (2010) 'The Routine Use of Patient Reported Outcome Measures in Healthcare Settings', *BMJ,* 340, Available at: https://doi.org/10.1136/bmj.c186 )

## THE PRICKLY PROBLEM:

### STAKEHOLDERS HAVE CONFLICTING PERCEPTIONS OF WHAT IS A GOOD EXPERIENCE OR OUTCOME.

What matters to patients may differ to what matters to clinicians, administrators, carers, and policy makers.

It is also highly likely that two people with the same illness, who are given the same treatment will report different experiences and outcomes that are influenced by not only their characteristics such as age or gender, but also their values, beliefs and cultural attitudes.

Consider these two reviews (pictured right) about the same clinician – one positive and one negative, both highlight their different perceptions of the experience of note taking in the consultation.

While these reviews consist of free text as opposed to formal PRMs, which offer the benefit of guided data collection, through pre-determined questions, statements and fields for answers, nonetheless, these reviews demonstrate that patients seeking services from the same clinician can have conflicting ideas or perceptions about the quality of their interaction. This matters, because without solving the issue of conflicting stakeholder perceptions, clinicians and others may be weary about the reliability of patient-reported data.

★☆☆☆☆ Staff 1 Punctuality 1 Helpfulness 1 Knowledge 1

Dr. [redacted] would be one of the rudest people i have ever dealt with, regardless of his occupation. If I felt bad before our meeting, i felt 10 times worse after it. He fired off insults at me like "i guess you have a big gut" and "do you shave your head because you're going bald" which i found totally unprofessional. The consultation consisted of him asking me some generic questions - one sentence at a time so he could bang away on his keyboard - and not one slither of advise or even an opinion to help me. The only time he came to life was when recommending that i go and see his mate the "life coach". I have now given up on the idea of treating my mental health issues as this has been such an awful experience.

4 Helpful? Flag

★★★★½ Staff 5 Punctuality 3 Helpfulness 5 Knowledge 5

Dr [redacted] was very professional in my session with him. He was extremely thorough, kind and professional. Took detailed notes about my history and conditions. He got straight to the point and wasted no time and made the most of our session.

0 Helpful? Flag

(Reviews publicly available online from www.ratemds.com. Name and date redacted for privacy.)

## KEY ETHICAL ISSUES:

### Data Accuracy and Reliability

The data produced using PRMs must be trusted if it is to become actionable.

### Transparency and Trust

Patients need to know how their data will be stored, managed and used.

### Privacy and Informed Consent

Patients need to have their private information protected and to understand how PRMs work in order to give informed consent.

### Equity and Accessibility

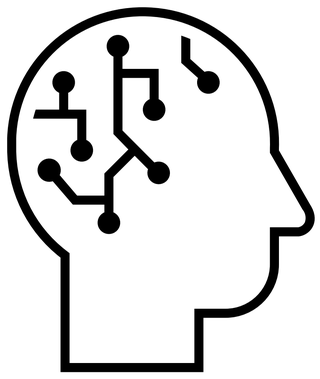
PRMs must be designed and delivered in a way that create minimal barriers – language, disability, and disease burden must be factored in.

### System Barriers

PRMs must not create additional burden on an already strained system. Appropriate scaffolding is needed to support 'time poor' clinicians in using patient-reported data.

### Bias

The influence of bias in the design and use of PRMs must be mitigated, to ensure what is collected does not reproduce inequalities or create data poverty.



## APPLYING THIS TO MENTAL HEALTH

In Australia, government mandated outcomes reporting has been in place for mental health for 22 years (since 2000), but has this led to improved patient experiences and outcomes? The 2021 National Study of Mental Health and Wellbeing (ABS 2022a) estimated that over 2 in 5 (43.7%) Australians aged 16–85 had experienced a mental disorder during their lifetime, up from 20% in 2018, and 18% in 2014-15.

This suggests that mental health is a growing public health issue. It has low health outcomes, works with some of the most vulnerable patients, and has variation of quality of care across public and private providers. Because of this, it presents as a significant case study for the effectiveness or actionability of PRMs in creating better experiences and outcomes for patients.

### Anticipated Challenges:

**#1 Challenging field to measure:** Mental health typically has lower outcomes and patient experience can be influenced by mental ill-health

**#2 Disparate views in the field:** Disputes on what is considered a successful outcome/experience and what/how/when to measure (e.g., ADM vs. CBT in treatment of depression, measure during treatment, post discharge, outpatient only etc)

**#3 Systemic issues:** Clinicians are overwhelmed by demand, meaning no time to spend with patient-reported data

**#4 Clinician apprehensiveness:** How will the data collected characterize professional capabilities/performance?

**#5 Patient apprehensiveness:** Mental Health treatment often ongoing (management rather than cure), how will patient-reported data impact their relationship with treating clinician/clinical teams?

## Interdisciplinary Review:

**Discipline:** Bioethics & Philosophy

**Discipline:** Health, Science and Medicine

**Key Literature:** Respecting Autonomy Without Disclosing Information (Walker 2013); Informed Consent and Clinician Accountability (Clarke and Oakley, 2007)

**Key Literature:** Australian Commission on Safety and Quality in Health Care PROMS Literature Review (Williams *et al.,* 2016)

**Method:** Snowball Referencing and General Search (Monash Library Database and Google Scholar)

**Identified:** 434 books, journal articles and reports (academic and grey literature)

**Literature reviewed:** (n= 93)
**Pending review:** (n= 341)

## Acknowledgments:

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# In-Depth Consumer and Carer Co-Design of Mental Health Monitoring Technologies

Bronwin Patrickson, Mike Muster, Dan Thorpe, Niranjan Bidargaddi

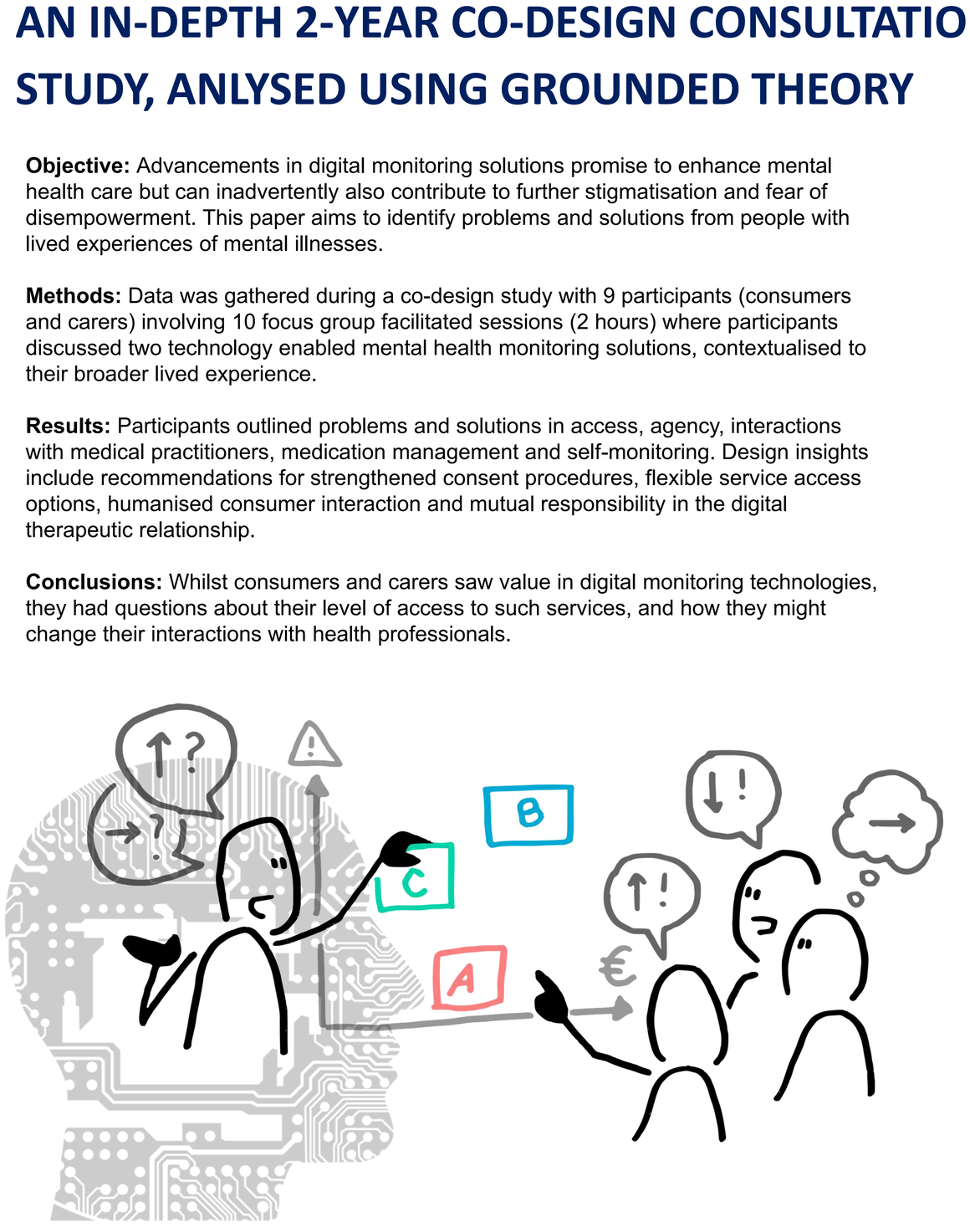
## AN IN-DEPTH 2-YEAR CO-DESIGN CONSULTATION STUDY, ANLYSED USING GROUNDED THEORY

**Objective:** Advancements in digital monitoring solutions promise to enhance mental health care but can inadvertently also contribute to further stigmatisation and fear of disempowerment. This paper aims to identify problems and solutions from people with lived experiences of mental illnesses.

**Methods:** Data was gathered during a co-design study with 9 participants (consumers and carers) involving 10 focus group facilitated sessions (2 hours) where participants discussed two technology enabled mental health monitoring solutions, contextualised to their broader lived experience.

**Results:** Participants outlined problems and solutions in access, agency, interactions with medical practitioners, medication management and self-monitoring. Design insights include recommendations for strengthened consent procedures, flexible service access options, humanised consumer interaction and mutual responsibility in the digital therapeutic relationship.

**Conclusions:** Whilst consumers and carers saw value in digital monitoring technologies, they had questions about their level of access to such services, and how they might change their interactions with health professionals.





### In-Depth Co-Design

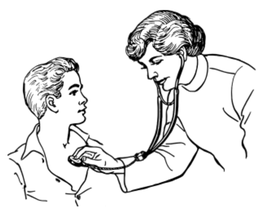
An in-depth co-design approach explores beyond mere usefulness to investigate lifestyle, context and lived experience drawing from normative theory, ethnography and phenomenology. In its most optimal form, this broader consultation leads to results that capture the best aspects of consumer input – like acceptability, utility, and novelty – also tempered by professional insights (Trischler et al. 2018).

## PROBLEM THEMES

**AGENCY**
*(Consumer) "I was initially forcibly medicated in a locked ward, and the psychiatrist did afterwards apologise, acknowledge it wasn't necessary and that he was overworked and couldn't be bothered negotiating with somebody who was thoroughly manic."*

**ACCESS** (to clinician of choice)
*(Consumer) "I didn't get diagnosed until I'd been in a severe manic episode … for about 11 weeks…and I had a doctor (GP) tell me that I had bipolar, and then he gave me a script for, like, 60 Valium, and that's all I got. . So it wasn't until I started seeing my newer psychiatrist in the last two and a half years and was put on Lithium that I really had any treatment that was adequate for what I needed."*

**ACCESS** (to different options)
*(Carer) "I think that Zoom has been great in lots of ways….But I think you should be given the choice whether you want to do it via Zoom, via phone, or whether you want to go into the GP. But I also feel that this has been an opportunity maybe for people to have a greater understanding of what it's like to be isolated."*



**INTERACTIONS WITH MEDICAL PROFESSIONALS**
*(Consumer) "Medication-wise, I've had a doctor who's very clear that I'm in control what I put in my body."*

**MEDICATION MANAGEMENT**
*(Consumer) "The actual range of side effects has never been discussed with me on any drug that I've had. You've got to look up the internet ,,,which can be quite an excessive list… with some drugs."*

**SELF-MONITORING**

*(Consumer) "Yes, I make my own medication adjustments. This is after I've been taught how to… and so that this really enables me to minimise my medication and minimise the side effects."*

*(Carer) "I monitored [in a] diary, and that was something that the Occupational Therapist set up for her, but she was quite willing for me to be involved in that…they would discuss it and work out the medication really from what she was diagnosing. That worked well."*

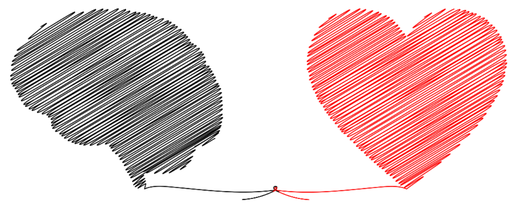
## SOLUTION THEMES

**Adaptability & Flexibility**


**Optimising the Record**

**Humanising the Record**

**Enhancing the Digital Therapeutic Relationship**



**Strong consent setting procedures to support consumer and carer engagement alike in the consumers' recovery journey.**

### AI2: AN EXAMPLE APPLICATION


## DIGITAL SERVICES CAN'T REPLACE THE THERAPEUTIC RELATIONSHIP – BUT WITH IN-DEPTH CONSUMER AND CARER INPUT THEY CAN ENHANCE IT

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# SAMSON (Safety and Adherence to Medication and Self-care advice in ONcology) Enhancing medication adherence among people with cancer

**Thu Ha Dang** [1,2,3] Abdur Rahim Mohamad Forkan[1] Nilmini Wickramasinghe[1,4] Prem Prakash Jayaraman[1] Kate Burbury[2,5] Penelope Schofield[1,2,5]

## BACKGROUND

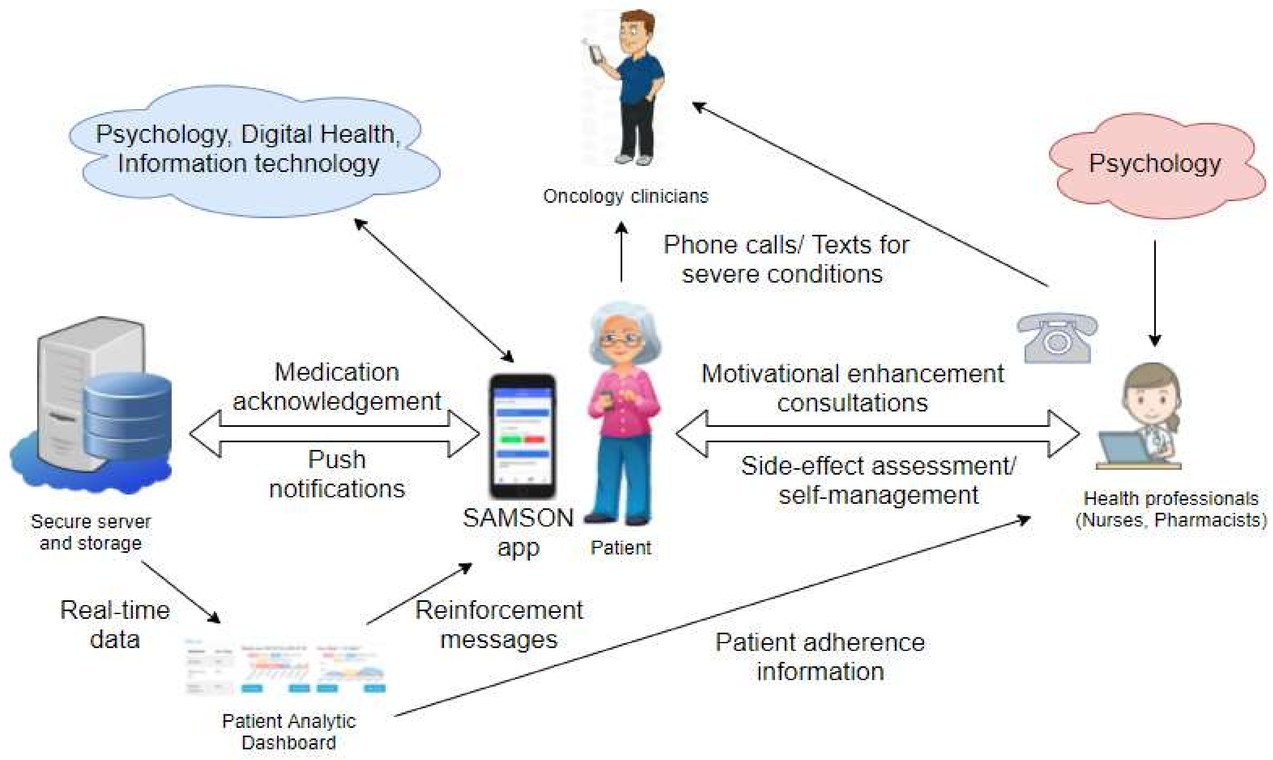
250,000 Australians per year are admitted to hospitals for medication-related issues including 'treatment non-adherence', costing $1.4 billion [1]. Medication adherence (MA) is "the extent to which patients take their medication as recommended by their health care provider"[2]. Medication non-adherence impedes health outcomes and increases costs. Medication adherence for cancer treatments can be as low as 20% and often gets worse over time[3].

Barriers to medication adherence require multi-dimensional interventions[4,5]. Digital solutions can support complex interventions and are increasingly accepted by patients [5]. Oral anti-cancer medication adherence improves most with multi-component interventions involving collective adherence strategies (patient education, reminders, self-monitoring, reinforcement, and supportive counseling), especially patient-tailored interventions [5].

This project uses technology to deliver multi-component, individualised, user-friendly interventions via SAMSON (Safety and Adherence to Medication and Self-care advice in ONcology). SAMSON is a novel patient-centred, comprehensive digital medication adherence solution for people with chronic illnesses.

## CO-DESIGN SAMSON

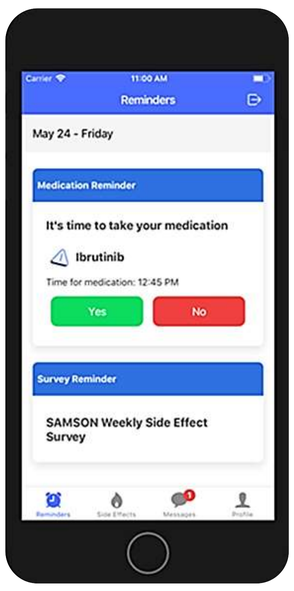
In this project, a co-design approach [6], applying the Design Science Research Method (DSRM) [7,8] is used. This approach involves patients and health professionals throughout the whole process of developing and evaluating the MA intervention solution [6]. The iterative co-design approach focuses on the **patients' challenges and issues** to develop designing solutions to enhance the **desirability, acceptability, and usability** of the MA intervention. The SAMSON solutions comprises: 1. **a mobile health app** involving individually tailored smartphone alerts and real-time advice for side-effect self-management, and 2. **a health professional teleconsultation platform** using established behavioural change approaches that help promote adherence and side-effect self-management.




How SAMSON works

SAMSON solution targets the cognitive, behavioural and affective aspects of MA to form good MA behaviours and provides ongoing daily adherence support for the long-term maintenance of established behaviours. **SAMSON mobile app** provides the patient with scheduled tailored reminder push notifications and symptom surveys. Medical data collected from the patient is analysed by the mobile system in real-time to provide in-time reinforcement to the patient, and clinical data to the care team. Based on this analysed information, **health professionals provide ongoing adherence support via teleconsultations**, using established patient-centred and behavioural change approaches to promote adherence and strengthen the patient's side-effect self-management skills.

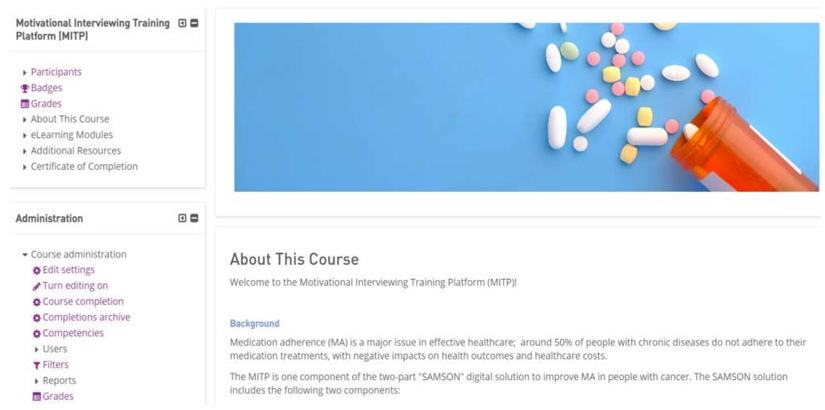
## Component 1 - SAMSON mobile app




Key features:

- Smartphone app & web portal
- Automated Reminder
- Logged side-effects
- Self-care advice
- Analytics dashboard
- Medication information

## Component 2 – Online Motivational Interviewing Training Platform (MITP)

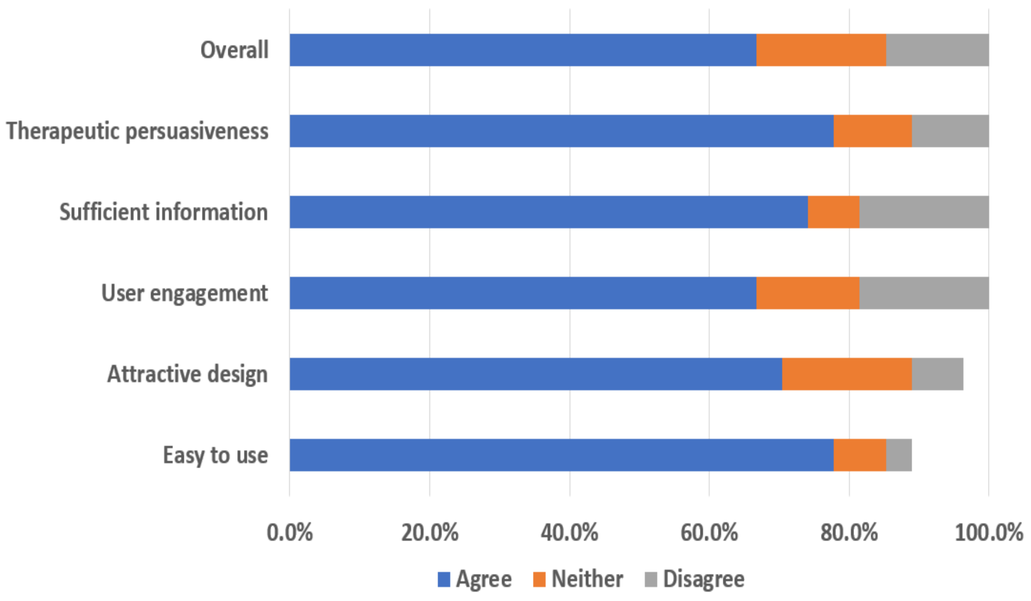



Key features:

- Monitoring & motivating patients' adherence
- Improving self-management skills
- In-time support to patients
- Educating on diseases, treatment & medication adherence
- Enhancing the patient-provider relationship

## SAMSON MOBILE APP USER-TESTING RESULTS

### Quantitative surveys




Patients' rating of the SAMSON mobile app (n=27)

### Qualitative in-depth interviews

**Helpful app, which can remind, support and inform**

*"It (the SAMSON app) does its job, so it's good… **It's a very neat app** in this in the sense there's no extra stuff. **It's just exactly just what it needs to do**. That's all so yeah, it's pretty good." [P7]*

**Possible barriers**

*"I think an app like that (SAMSON app) for my father **who's in his 80s**, I couldn't see it being used, he'd see it as a nuisance." [P9]*

**Desire for refinement and healthcare connections**

*"…to have something like that (two-way SMS feature) on the app (SAMSON) would be good because you could get almost feedback a lot quicker." [P10]*

## CONCLUSION

SAMSON is one of the **first digital medication adherence (MA) solutions** synchronised with available clinical care in oncology. The platform is evidence-based, theory-based, and co-designed, and rigorously tested. Initial results indicate that the SAMSON is acceptable and clinically feasible for both patients and clinicians. Future studies will validate SAMSON's acceptability, usability, and potential effect on MA. SAMSON may help reduce the number of hospitalisations resulting from poor MA, and in turn, ease the burden on Australia's health budget and hospital system.

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# Estimating value from CDSS before use

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## {predictNMB}

**Estimate when and where a model-guided strategy would outperform a treat-all or treat-none approach**

## BACKGROUND

- Clinical prediction models are used in healthcare settings to guide treatment decisions. But may not be effective at reducing healthcare burden or costs when implemented.
- The value of clinical decision support systems (CDSS) is often measured after implementation. But cost savings are possible if estimates were made before investment.
- These estimates can be used to compare between models, interventions or factors relating to the target healthcare setting.

## METHODS

- To better inform decisions regarding the development and implementation of model-guided care, we developed an R package, predictNMB, to simulate and evaluate model-guided care.
- Users can evaluate hypothetical changes to the model, the effectiveness and cost of care being guided, and the prevalence of the event.
- Models are evaluated in terms of Net Monetary Benefit (NMB), with built-in summary and visualisation methods help communicate results to stakeholders and decision makers.

## Main features

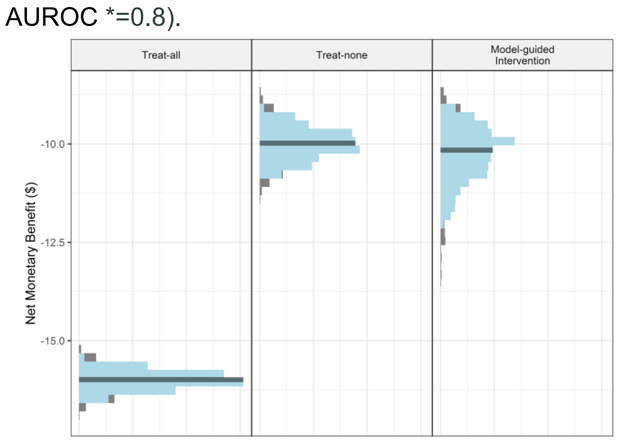
- R package to estimate when and where a model-guided strategy would outperform treat-all or treat-none guidelines.
- Evaluation of the Net Monetary Benefit (a monetary value that encompasses both healthcare costs and patient outcomes).
- Evaluate a range of hypothetical scenarios to further evaluate the model-guided approaches (prevalence of outcome, treatments available, and model performance).
- Allows user to evaluate how a CDSS that guides the allocation of an intervention may perform before its implementation.
- Enables decision makers to better prioritise the development CDSS to areas that maximise value-based care.
- The software is freely available with guides and examples online.


## PRACTICAL EXAMPLE

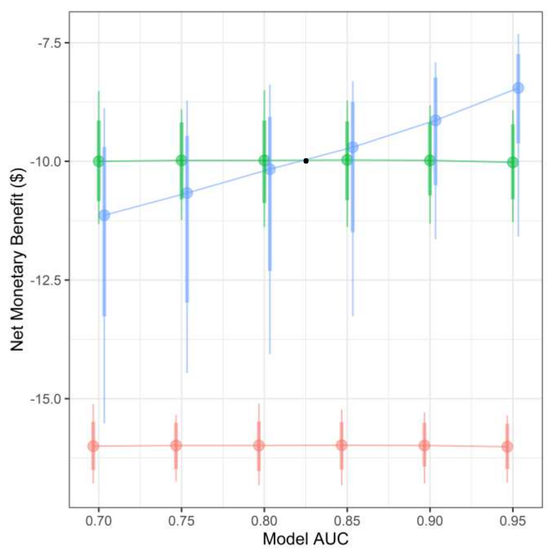
For a hospital to evaluate how they should be allocating the pressure injury (PI) prevention interventions, they can compare potential models before implementation.

**Questions that can be answered using predictNMB:**

- Is the treating only the high-risk group (model-guided intervention) better than a treat-all or treat-none strategy in my patient population (prevalence =10%) and with my model performance (model AUROC *=0.8).

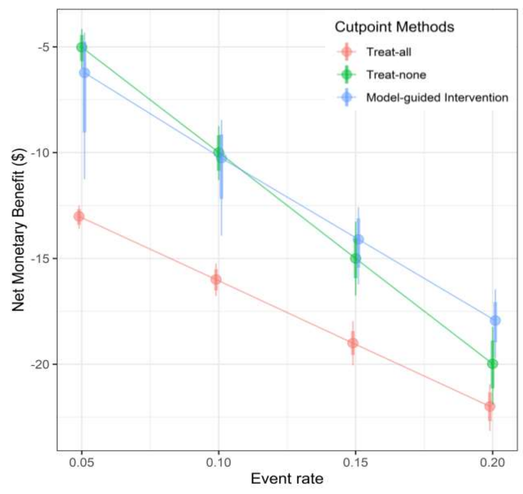



- What is the relative benefit of the model-guided intervention as the **model performance** (AUROC) improves? At what AUROC does my model outperform a treat-all/none strategy?
  - Only when the blue line crosses over the green line, does the model-guided intervention provide the best NMB (AUC > 0.82).

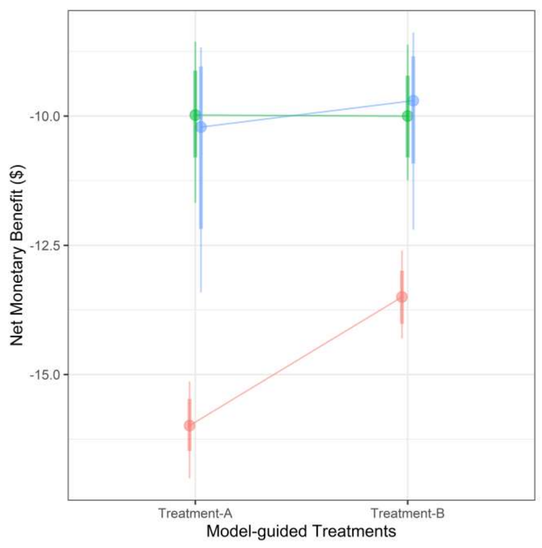



**Cost of pressure injury (PI): $ 100**
**Cost of PI prevention: $ 10**
**Effectiveness of intervention: 40%**

- What is the relative benefit of using the model-guided intervention as the **rate of the pressure injuries** increases in different hospitals or wards?




- What is the relative benefit of using the model-guided intervention when the rate of injuries remains the same, but the **cost and effectiveness of the intervention** is different (cost=$7 and effectiveness=35% reduction)?




*AUROC = Area Under the Receiver Operating Characteristic

## CONCLUSION

The use of predictNMB may improve hospital resource allocation and orient future CDSS towards value-based care. This approach is applicable to any clinical prediction model, diagnostic or prognostic, where the outcomes of possible classifications can be costed.

## TRANSLATION & IMPACT

The predictNMB R package is available at rwparsons.github.io/predictNMB/. You can use this to better inform decisions regarding the development and implementation of model-guided care within your specific healthcare settings. It can also be used when developing clinical prediction models to better direct efforts to address healthcare challenges where model-guided care is most likely to be cost-effective.

# Adopting CDSS in healthcare: combining theory with practice

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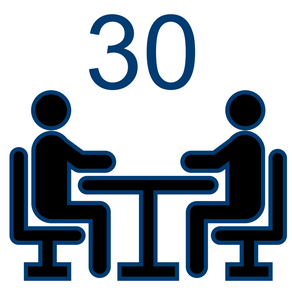
## BACKGROUND

- Clinical decision support systems (CDSS) are increasingly indispensable to the high-quality, safe and efficient healthcare delivery in Australia, particularly within acute care settings like hospitals
- Inappropriate use and sub-optimal uptake of these tools can and do waste valuable healthcare resources, investment and intellectual labour [2]
- The implementation process and the mechanisms for success or failure of CDSS uptake are multi-factorial; given the complex organization of health services and systems [3,4]

> **"Knowledge of theories, models and frameworks (TMF) from the field of implementation science may assist in providing translational guidance for CDSS implementation."**

- This international study explores how implementation science TMFs are applied across a range of digital health settings to identify active translation factors to promote the uptake of digital innovations in healthcare

## METHOD




### Semi-structured Interviews

were conducted with healthcare workers, health services researchers, and implementation scientists to investigate the use of TMFs when implementing or evaluating CDSS interventions in healthcare settings

## RESULTS

Interviews conducted thus far have identified the following key factors:

**Co-design**

"For implementation…when it comes to digital health is that if it's codesigned, it makes -the implementation is just so much easier"

**Use a systems approach**

"Implementation… involves looking at what's being done in the system, the problems to implementation and the solutions for implementation"

Healthcare workers

Implementation scientists

Health services researchers

**Context matters**

"The solution must fit into the systems current values, fits or trends"

## TRANSLATION & IMPACT

- Interview data will inform a series of workshops to identify the most important translational factors influencing the implementation and evaluation of CDSS use in healthcare settings
- Study's findings may be used to extend the application of current TMFs or provide stand alone guidance to healthcare and related stakeholders to facilitate effective and sustainable CDSS adoption

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