CSIRO Australian e-Health Research Centre

Digital Twin Powered Equitable Patient Access in Queensland Hospitals

Dr. Sankalp Khanna

CSIRO Australian e-Health Research Centre

25 March 2026

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THE AUSTRALIAN NATIONAL SCIENCE AGENCY'S DIGITAL HEALTH RESEARCH PROGRAM

What we do

We are Australia's leading national digital health research program with capabilities in precision medicine, AI, virtual care and interoperability.

How we do it

Our research develops scalable, real-world products and services to support industry, governments, and clinicians to deliver efficient and effective healthcare and health systems.

Who we are

We are recognised by health systems nationally and globally as leaders in digital health research, tool and platform development and implementation.

- Health Data Semantics & Interoperability
- Transformational Bioinformatics
- Biomedical Informatics
- Health Services
- Health System Analytics

Who we work with

- Aust Gov't health agencies
- Clinical research partnerships
- Aus and int digital health companies
- Unis
- Global standards bodies

We are Australia's first (and only) ISO 13845 certified research institute

Scope: Digital Twin for QPACH Project

The state of Queensland, Australia

- shares many challenges with WPRO nations.
- a mix of highly urbanized hubs and extremely remote, climate-vulnerable island/rural communities.

QPACH: Queensland Patient Access Coordination Hub

- State-wide patient flow control room.
- Current focus of the QPACH - real-time tracking.

Project Aim

- Develop and validate a Digital Twin that will map the inputs and outcomes to provide:
  - Predictive risk outlook
  - Scenario-based risk mitigation
- to support decision making & response planning

"A digital twin is a digital model of an intended or actual real-world physical product, system, or process (a physical twin) that serves as a digital counterpart of it for purposes such as simulation, integration, testing, monitoring, and maintenance." ... https://en.wikipedia.org/wiki/Digital_twin

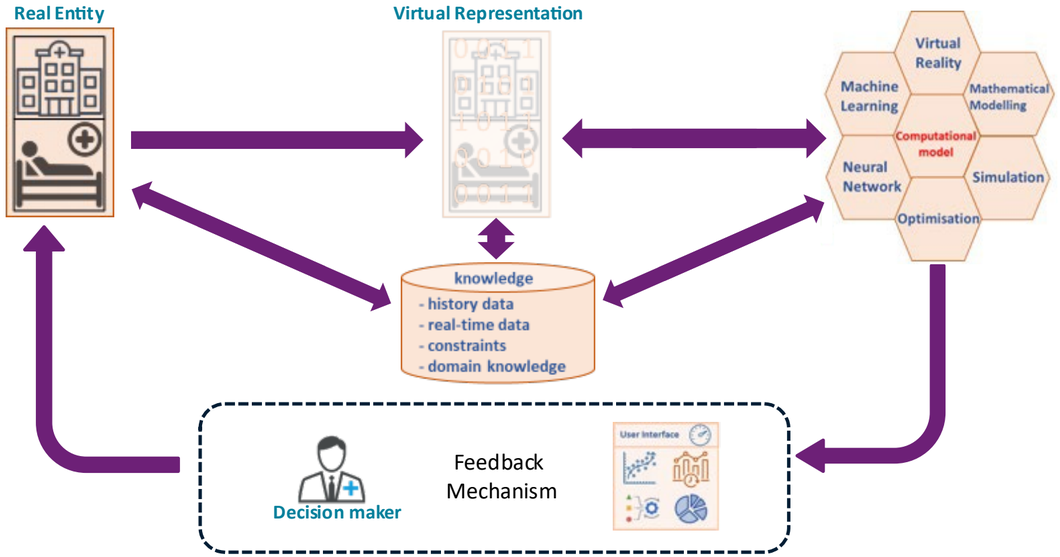

Fig: Architecture - Digital Twin for QPACH

Ref: Riahi V, Diouf I, Khanna S, Boyle J, Hassanzadeh H. Digital Twins for Clinical and Operational Decision-Making: Scoping Review. J Med Internet Res 2025;27:e55015.

Improved Demand Forecasting with ADePT

Advanced Demand Prediction Tool (ADePT)

- Based on a statistical forecasting method (SARIMAX)
- Accounts for weekly patterns, trends, and external factors
- Benefits over machine learning models:
  - Interpretability
  - Less data required
  - Simpler implementation due to fewer parameters
- Improved accuracy for smaller patient subgroups (e.g. emergency admissions)
- Accuracy is similar year-round, even during peak times

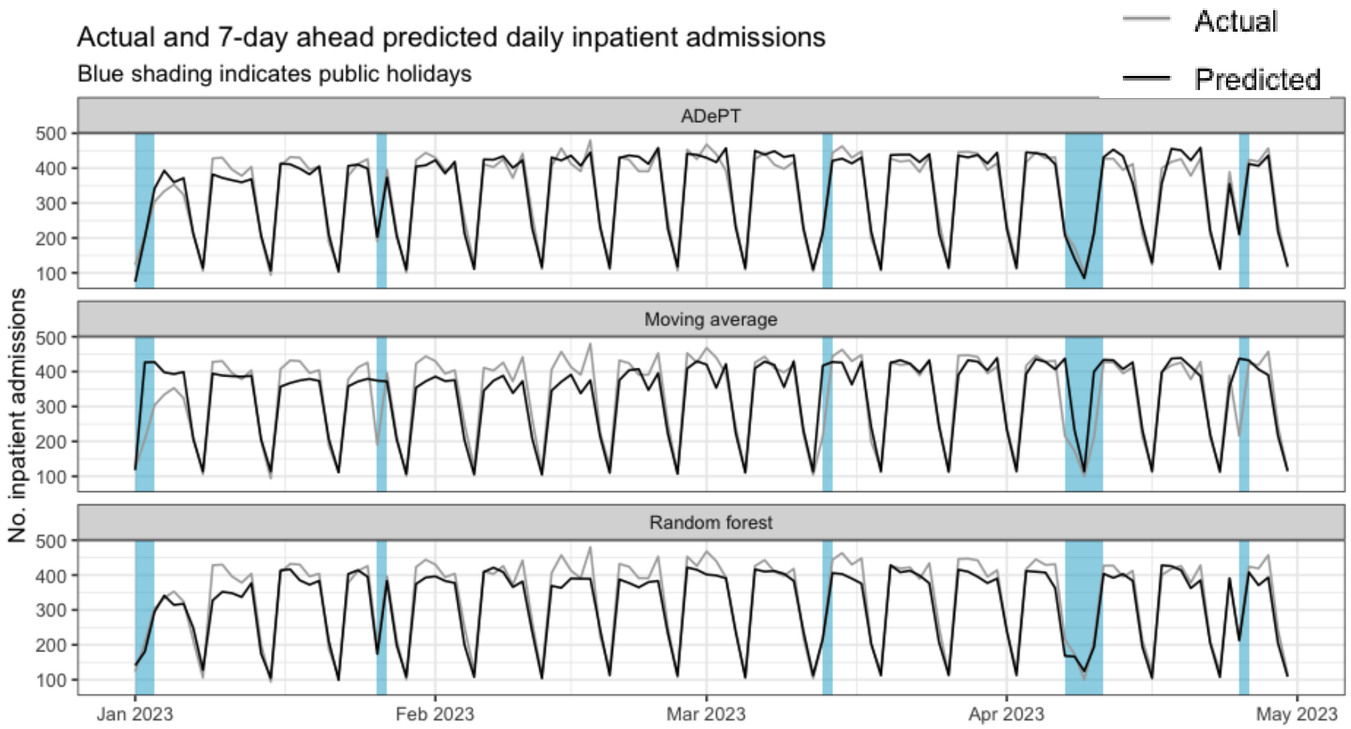

Fig: Comparing inpatient prediction performance - ADePT vs other methods

Ref: Josling G, Boyle J, Riahi V, Naumoski Z, O'Sullivan K, Jayasena R, Khanna S. Demand Prediction for Better Hospital Capacity Management. Stud Health Technol Inform. 2025 Nov 12;333:70-75.

QPACH Digital Twin : Predictive Risk Outlook

What it is:

- 7-day forecasts for ED presentations and inpatient occupancy at the hospital and HHS levels.
- Powered by a CSIRO-developed demand prediction algorithm (ADePT) with validated high-accuracy

Why it matters:

Flags periods of likely system stress for targeted interventions.

Views: Three key elements

- Table & Table-as-plot
- Max Occupancy vs Time>90% scatter
- Cumulative Net Flow (by shift) line

Fig: Predictive Risk Outlook

Simulation for Scenario Modelling

- Facility-level patient flow simulation

- To quantify the likely impact of alternative strategies

Fig: Facility level flow simulation

QPACH Digital Twin: Scenario-based Risk Mitigation

Scenarios implemented

1. Early Discharge
   a) Discharge patients 1 hour earlier
   b) Discharge patients 2 hours earlier
   c) Discharge 50% by 10am, 80% by 12pm, 100% by 2pm
   d) Discharge 35% by 11am, 70% by 2pm, 100% by 5pm
   e) Discharge 50% by 11am, 70% by 2pm, 100% by 5pm
   f) Discharge 80% by 11am
   g) Discharge 50% by 10am, 70% by 2pm, 90% by 5pm, 100% by 10pm

2. Add Available Beds

   Ability to add bed(s) to one or multiple wards in a target facility

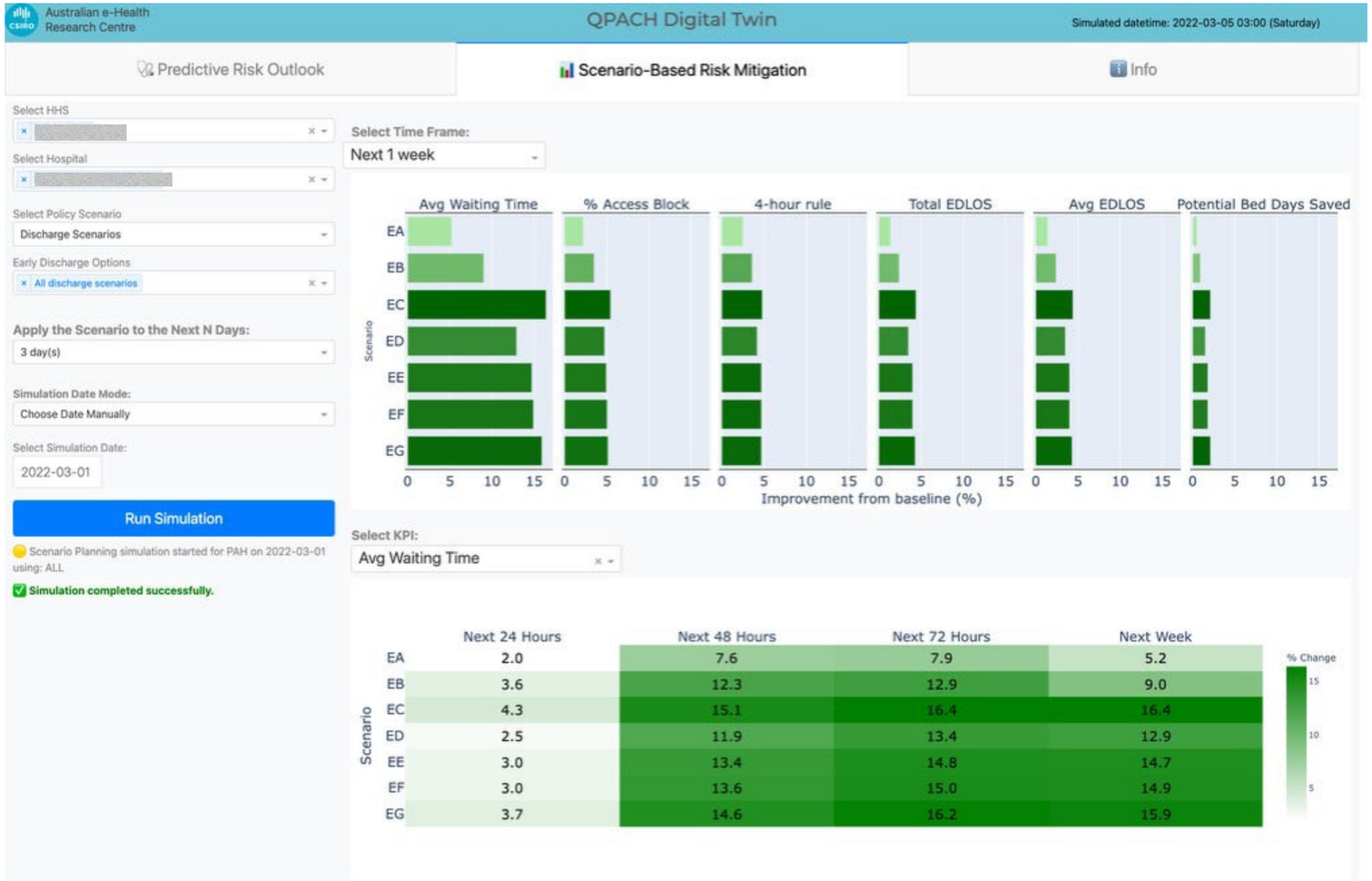

Fig: Scenario Based Risk Mitigation

Integration and Deployment Pathway

- Near-real time linked data
- Alignment with existing platforms
- Ward level to state level views
- Controlled access

Fig: Queensland Health Integration Architecture

In Summary

- Data driven approach to streamlining operations
- Predictive capacity risk identification
- Scenario based risk mitigation
- “Virtual equity” for a geographically dispersed population
- Scalable architecture – from single site to entire state
- Integration within Queensland Health environment
- Potential to add more features / models
- Codesigned with problem owners to ensure suitability

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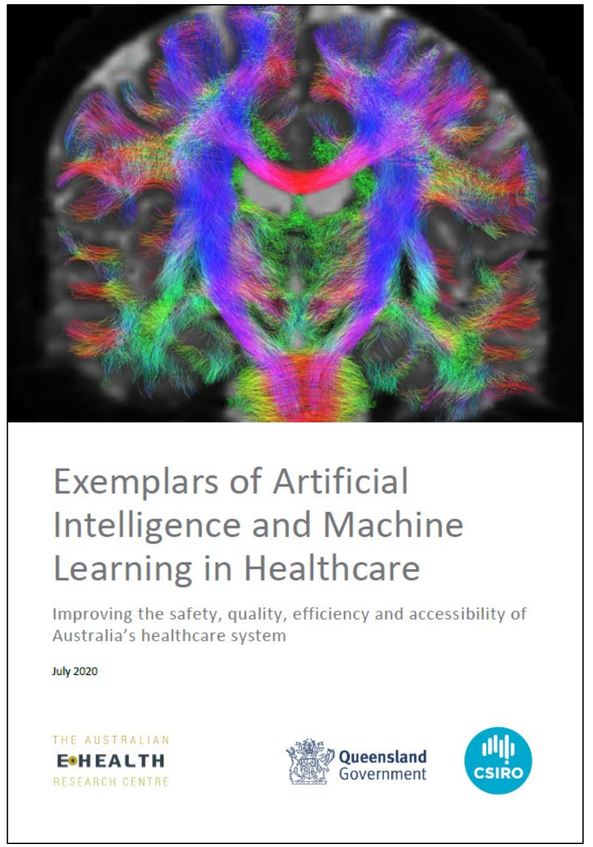
Thank you

Dr. Sankalp Khanna
Senior Principal Research Scientist
Research Team Lead – Health Intelligence
t +61 7 3253 3629
e Sankalp.Khanna@csiro.au



https://aehrc.com/ai/