



UNSW
SYDNEY



**Tyree Foundation Institute
of Health Engineering**



Connected Health

Tyree Foundation Institute of Health Engineering

Connecting unmet needs with co-designed innovations

The Sir William Tyree Foundation Institute of Health Engineering (Tyree IHealthE) at the University of New South Wales, Sydney focuses on interdisciplinary research that brings the key players together in a supportive and collaborative environment. By investing in innovative and cross-functional ways of working, Tyree IHealthE leverages a range of skills and disciplines to ensure that clinicians, and patient needs, remain at the core of health technology solutions.

Connected Health utilises technologies to support patients outside the clinical setting. Our innovations will promote healthy ageing, improve chronic disease management, and enhance access of care for rural patients.

What is co-designed health?

Engage with
healthcare
professionals to
determine unmet
clinical needs

Users, practitioners,
technologists and other
stakeholders **work
collaboratively** to
design solutions

**Co-designed
Health**

Connected Health: progress and promise

The Connected Health pillar has been the proving ground for Tyree Operations in 2021, one of the five pillars in the institute's overarching research strategy. The development, trial and implementation of Tele-Clinical Care (TCC) solutions, successful products in their own right, have also generated valuable lessons in research translation including how to engage with clinicians and patients, who to include in the innovation ecosystem, and what to consider for the successful implementation of new solutions in a busy and burdened health system.

TCC apps give patients a way of keeping track of their own health while feeding key information through to their clinicians for assessment. The TCC team, led by A/Prof Sze-Yuan Ooi and myself, had anticipated that this 'remote monitoring' would produce efficiencies in the health system, reducing waiting room congestion for clinicians while improving the care and comfort of patients who were no longer hauled out of their homes for routine clinical visits. What we weren't anticipating was the impact it would have on patient wellbeing. In the case of TCC-Cardiac trials, patients became more aware of their health and much better at managing their own self-care, including taking medication regularly. And, anecdotally, South Eastern Sydney LHD teams found that TCC-COVID helped relieve anxiety among COVID-19 patients, who felt safer and more supported with the app in hand.

To date, the TCC architecture has been used to develop a series of disease-specific apps. In the future, the team hopes to develop a more modular product that can be customised to suit the health needs of any patient, and the clinical practices of any provider or healthcare setting.

In this way, TCC will be making progress towards the ultimate goal of Connected Health: an integrated digital system in which anyone involved in the care of a patient can have quick and easy access to the tools and information they need to support that patient's health – including the patient themselves.

Scientia Professor Nigel Lovell

Director, Tyree IHealthE

Head of the UNSW Graduate School of Biomedical Engineering



Connected Health Leads

Clinical Lead

Associate Professor Sze-Yuan Ooi

Sze-Yuan is a clinician researcher with extensive clinical experience and expertise in the fields of coronary intervention and cardiac device implantation, including novel implantable cardiac device and remote monitoring technologies. He is a Staff Specialist at the Prince of Wales Hospital and is the current Director of the Coronary Care Unit. Sze-Yuan held the position of Research Fellow in Cardiology at the Institute for Cardiovascular Research in Leeds, England from 2003 to 2005. His research interests include the pathogenesis of coronary atherosclerosis and the role of inflammation, coronary physiology, novel assessments of and modulation of the coronary microcirculation, new device technology and telehealth. Sze-Yuan has been awarded over \$14.6M in research funding over the last 5 years, \$1.89M as CIA. He has published over 30 papers in peer-reviewed journals. Sze-Yuan holds a Conjoint Associate Professor position with UNSW Sydney.



Academic Lead

Dr Beena Ahmed

Dr Beena Ahmed is a Senior Lecturer in the School of Electrical Engineering and Telecommunications at UNSW Sydney. Her research is applied in nature, integrating cross-disciplinary principles from healthcare, speech processing and computer science using collaborations across all fields. She has led the application of novel machine learning techniques to clinical domains with severely unbalanced datasets. She has pioneered the use of machine learning to detect pronunciation errors in disordered speech and predict the risk of dementia from speech. Beena has also worked on developing novel algorithms to quantify the complexity of the sleep electroencephalogram and detect the presence of sleep disorders such as insomnia to assist clinicians in the diagnosis process. She has also worked on using machine learning to predict mental stress levels using signals collected from minimally invasive physiological sensors (e.g., heart rate, skin conductance) and then used the output in biofeedback games to help users self-regulate their stress levels. She has also developed novel methods to identify cancerous fluorescence lifetime images. She has received \$6+ million in funding, both local and internationally, and published over 80 career publications. She is also the founder of Say66, where she has translated her research to provide an automated speech therapy system for children with speech disorders.



Engaging with industry

Connected Health at Tyree IHealthE engages with a range of external partners, including Local Health Districts, NSW Ministry of Health, medical device and cloud-based data management companies. Tyree IHealthE also partners with the NSW Office for Health and Medical Research to leverage their capabilities in delivering innovative solutions in medical technology.

The primary enabler of activity is our **Connected Health Network Laboratory (CHANL)** which uses our principals of co-design to develop new biomedical technologies and facilitate the provision of a suite of software-based solutions to address the future sustainability of the healthcare budget.

Our work to date has been highly successful in terms of systems development and clinical trials, for instance, the TeleClinical Care (TCC) remote monitoring solution for COVID-positive patients (TCC-COVID) developed by this laboratory was successfully translated into clinical practice, and large-scale clinical trials for our solutions in cardiac rehabilitation (TCC-CARDIAC) and stroke (TCC-STROKE) are currently underway.

CHANL provides an important government resource, offering a framework for solutions to the major challenges of health system economics associated with the ageing population and the proliferation of technologies. It is a resource for clinicians at the interface of provision of health services to an ever expanding patient pool, who can see better ways to address this need and care for patients through low-cost information technology. It will become a resource for industry, by providing clinician-driven, market-tested software technology solutions to biomedical challenges for commercialisation to markets, locally and worldwide.

Connected Health Network Laboratory team

Dr Peter Brown | Postdoctoral fellow

Zhuoying Li | Back end software engineer

Stephen Ong | Front end software engineer

Uzzal Biswas | Technical support

Brice Lenfant | Project Officer (Connected Health)

Recruiting Feb 2022 | Front end software engineer

Recruiting Feb 2022 | Back end software engineer

Capabilities in Connected Health

Capability	Expertise in	Our people
Signal, Information and Machine Intelligence Lab	• Non-intrusive health monitoring via audio signals • Machine learning and pattern classification • Disordered speech monitoring • Analyses of EEG, ECG, heart rate, respiratory rate, skin conductance, • Behavioural analyses • Biomedical signal processing • Voice biometrics	Dr Beena Ahmed School of Electrical Engineering and Telecommunications
Making a Smart Assessment of Mental State	• State-of-the-art speech-based assessment of depression via smartphone • World leaders in automatic voice analysis	Professor Julien Epps School of Electrical Engineering and Telecommunications
Clinical Machine Learning	• Working at the intersection of medicine and computing, bringing together doctors, pharmacists, mathematicians, software engineers and computer scientists • State-of-the-art technologies and the use of large clinical practice datasets • Fully validated solutions and technology that is cost-effective and safe • Ability to understand clinical decision making and the challenges in translating machine learning techniques into clinical practice	Associate Professor Blanca Gallego Luxan Centre for Big Data Research in Health



Capabilities in Connected Health

Capability	Expertise in	Our people
Big Data Analytics	• Data science, data analytics, biostatistics, epidemiology and bioinformatics • Ethical, legal and policy frameworks relevant to using health big data • Secure management, sharing, curation and stewardship of health big data • Developing and delivering training in health data analytics • Communicating complex research findings through multiple modalities, including data visualisation, technical reports, plain-English briefings, multimedia products and social media	Professor Louisa Jorm Centre for Big Data Research in Health
Microbiome Data Analytics for Biomarker Discovery	• Expertise in deep profiling of the human microbiome documented in high impact outputs • Documented capacity to perform multi-omics strategies • Long-term experience with the handling and extraction of a range of clinical samples	Dr Nadeem Kaakoush Microbiome Interactions Group, School of Medical Sciences
Managing Chronic Disease and Wellness Using Telehealth Technologies	• Access to patient clinics and study groups • Active presence in the Randwick Health Zone, including close involvement in the design of a Virtual Care Centre planned for the new Prince of Wales Hospital (POWH) • Engagement of clinicians and stakeholders to promote user-centric systems design • Decades of experience in medical device regulatory approvals (TGA/FDA/CE) and development of health-authority-compliant software architectures	Scientia Professor Nigel Lovell Graduate School of Biomedical Engineering, Tyree IHealthE
Predictive analytics for managing disease	• Expertise in biosignal processing and closed loop control of biological systems • Using machine and deep learning techniques to predict and manage chronic disease • Leader in predictive analytics for feature extraction and disease classification	Dr Reza Argha Graduate School of Biomedical Engineering

Connected Health in the Pandemic

When the COVID-19 virus emerged at the start of 2020, highly infectious and with no immediate vaccine or treatment solutions available, it was obvious to the team that their product's remote monitoring capacity could be of use.

Associate Professor Sze-Yuan Ooi approached a colleague at Prince of Wales Hospital and put the team and the technology at their disposal. Within a month, informed by a coalition of infectious disease and respiratory specialists, the TCC team had developed TCC-COVID, an app that allowed clinicians to monitor symptoms in COVID-positive patients, limiting the spread of the virus by supporting those with mild to moderate risk to be cared for at home, while enabling them to respond quickly to those who showed signs of deterioration.

TCC Covid at a glance



The app has been rolled out to over 3600 patients in the South Eastern Sydney LHD



More than 150 clinicians and medical students have been trained and supported to staff the remote monitoring platform.



The app has been translated into five languages to support its implementation in LHDs across Sydney



Discussions to implement the app in health districts across NSW and the ACT are ongoing.

2021 Successful Grants in Connected Health

Amount	Awarded by	Awarded for	Applicant(s)	Date
\$5,000,000 (plus matching industry funds)	Australian Research Council Industrial Transformation Research Program	Connected Sensors for Health	Prof Chun Wang, Prof Nigel Lovell, Prof Justin Gooding et al.	2021-2026
\$1,900,000	NSW Health Translational Research Grants Scheme (TRGS)	TeleClinical Care (TCC) CARDIAC - clinical trial	A/Prof Sze-Yuan Ooi, Prof Nigel Lovell et al.	2021-2022
\$1,700,000	National Health & Medical Research Council / Cardiovascular Health Mission (MRFF)	TeleClinical Care (TCC) STROKE: A randomised controlled trial of a comprehensive smartphone application-centric model of care to improve outcomes in stroke patients	Prof Ken Butcher, A/Prof Sze-Yuan Ooi, Prof Nigel Lovell, Prof Kim Delbaere et al.	2021-2023
\$560,000	South Eastern Sydney Local Health District and NSW eHealth	TeleClinical Care (TCC) module development (Gestational Diabetes, Chronic Obstructive Pulmonary Disease, Mental Health, Cardiac Rehabilitation) and Cerner EMR integration	Prof Nigel Lovell, A/Prof Sze-Yuan Ooi, et al.	2021-2022
\$540,000	National Health & Medical Research Council / Cardiovascular Health Mission (MRFF)	CardiacAI: Deep learning to predict and prevent secondary cardiovascular events	Dr Blanca Gallego Luxan et al.	2022-2024
\$455,000	iMOVE CRC	Healthy Heads in Trucks and Sheds (supporting mental health and wellness of transport workers) - app development	Prof Nigel Lovell	2021
\$450,000	Australian Research Council/Discovery Early Career Researcher Award (DECRA)	Deciphering molecular genetic mechanisms underlying chromatin interactions	Dr Hamid Alinejad-Rokny	2022-2024
\$211,500	South Eastern Sydney Local Health District	TeleClinical Care – COVID (TCC-COVID) app and system for managing COVID-19 positive patients in their home	Prof Nigel Lovell, A/Prof Sze-Yuan Ooi	2020-2021
\$211,000	UNSW Research Infrastructure Scheme	Connected Health Network Lab (CHaNL)	Prof Nigel Lovell, Dr Peter Brown et al.	2022-2024
\$50,000	Royal Hospital for Women NICU	TeleClinical Care (TCC module development (pre-term babies)	Dr Peter Brown et al.	2021-2022
\$30,000	UNSW Cardiac Metabolic and Vascular Theme award	A novel online tool to diagnose double diabetes using biomarkers	Dr Jennifer Snaith et al.	2021-2022
\$30,000	UNSW Cardiac Metabolic and Vascular Theme award	Telehealth system for chronic kidney disease	Dr Ria Arnold et al.	2021-2022



Tyree Foundation Institute of Health Engineering

Gemma Ashton

Chief Operations Officer
Tyree Foundation Institute of Health Engineering (Tyree IHealthE)
Faculty of Engineering
UNSW Sydney
P: +61 9348 0473
E: g.ashton@unsw.edu.au

W: www.ihealthe.unsw.edu.au
E: IHealthE@unsw.edu.au



@TyreeIHealthE

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Contact us