UNSW SYDNEY

2021 Annual Report

Tyree Foundation Institute of Health Engineering (Tyree IHealthE)

Acknowledgment Of Country

Tyree Foundation Institute of Health Engineering would like to acknowledge the Bedegal people that are the Traditional Custodians of the lands on which the Institute stands. We pay respect to Elders past and present, and extend that respect to other First Nations people. We celebrate the diversity of Aboriginal cultures and languages across Australia.

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Tyree Foundation Institute of Health Engineering

Connecting unmet needs with co-designed innovations

Challenge, opportunity and progress

I am proud to deliver this Annual Report, providing an overview of the achievements of Tyree IHealthE over the course of its first year of operations.

The COVID-19 pandemic, in particular the second wave of the virus that triggered an extended period of social restrictions throughout 2021, presented us with challenges. It limited our ability to engage with clinicians and patients, and to spread the word about Tyree IHealthE with health administrators, industry representatives and the community at large.

But it also presented us with a powerful and completely unexpected opportunity to collaborate on the rapid delivery of digital health solutions to support COVID-19 management in the community, to establish the processes and partnerships that would streamline the implementation of those solutions, and to see the difference they made to the health and wellbeing of patients, and the efficiencies of the health system. I would also like to acknowledge the enthusiasm for opportunities for cross-faculty collaboration, with leadership and support from Professor Stephen Foster, Dean, UNSW Engineering, and Professor Vlado Perkovic, Dean, UNSW Medicine and Health.

The TeleClinical Care COVID-19 (TCC-COVID) remote monitoring platform (Connected Health: in the pandemic, p25) served as an exemplar project for Tyree IHealthE in its first year, providing clear evidence of what we can achieve with partners, while also generating experiences and insights that have allowed us to revisit our assumptions and refine our ways of working.

Despite the limitations of the pandemic, and the necessary focus on the development and deployment of TCC-COVID, Tyree IHealthE has continued to expand on its education initiatives (Educational opportunities, p18), to develop its network of collaborators (Interdisciplinary Strengths, p10) and to implement the processes that will ensure a disciplined approach to innovation in the years ahead (Innovation Enablers, p12 and Translation Outcomes, p16).

Perhaps our greatest achievement, however, has been to attract a diverse and highly credentialed team of like-minded individuals to the common goal of developing technological solutions that genuinely meet the needs of patients and clinicians in the Australian health system. We are excited by what we have achieved so far, and by what lies ahead. And we acknowledge, without reservation, that none of this would have been possible without the generous support of the Tyree Foundation.

Scientia Professor Nigel Lovell
Director, Tyree IHealthE
Head of the UNSW Graduate School of Biomedical Engineering

An extraordinary vision

We are very grateful for the contribution that the Sir William Tyree Foundation has made to our organisation to enable the work that we do.

The partnership between the Tyree Foundation and IHealthE
The generous gift from the Sir William Tyree Foundation (Tyree Foundation) has enabled Tyree IHealthE to embark on research and flagship projects to improve patient outcomes, offer earlier diagnoses, provide more targeted therapies, and deliver remote care. The incredible support enables Tyree IHealthE to develop and deliver innovative and economical health technologies, connecting unmet needs with co-designed innovation.

Tyree Foundation Board Chair Robbie Fennell shared at the launch of Tyree IHealthE that the vision for the Institute stems from her father, Sir William Tyree OBE. Sir William saw the incredible potential of blending the skills of medicine and engineering and this became the purpose of the Foundation he established which is to **"invest in Australian Universities and Institutions by focusing on education and research in both medical science and engineering to improve Australia for future generations."** It is this sentiment that underpins the work of Tyree IHealthE and will enable multidisciplinary projects to succeed and support emerging researchers in biomedical engineering.

Who was Sir William Tyree OBE?
Sir William Tyree OBE was a visionary engineer and technology pioneer with a big heart. His lasting philosophy was: An investment in education is an investment in Australia. UNSW Sydney is proud to have had a long history with Sir William and he is considered one of the University's most distinguished alumnus. A graduate of the Sydney Technical College, Sir William was awarded a Doctor in Science, honoris causa, in October 1986 for his contribution to the profession of engineering and to UNSW.

Sir William was a founding member of the School of Electrical Engineering and Computer Science committee in 1968 and was also instrumental in establishing a number of firsts in education at UNSW including the Tyree Chair in Electrical Power Engineering and a graduate program in Engineering, to name a few. Sir William's philanthropic support has been widespread - but the Foundation has been particularly generous to UNSW by establishing the state-of-the-art Tyree Energy Technologies Building, providing of a large number of scholarships, and through establishing Tyree IHealthE.

Cameron Perrett, Sir William Tyree Foundation; Dr Peter Tyree AM, Sir William Tyree Foundation; David Ward, Sir William Tyree Foundation; David McNeil, Sir William Tyree Foundation; Keian Barnard, Sir William Tyree Foundation; Robbie Fennell, Chair, Sir William Tyree Foundation; Emeritus Professor Ian Webster AO, Director, Sir William Tyree Foundation; Ralph Waters, Sir William Tyree Foundation and Andrew Thorpe, Sir William Tyree Foundation. Photo: Richard Freeman.

Building the foundation

Despite the disruption of the pandemic's second wave, Tyree IHealthE has made significant progress in its first full year of operations. A core team of researchers, administrators and communications experts has been recruited, keeping pace with strategic milestones, driving outstanding achievements in research, education and network-building, and establishing the processes and opportunities that will support successful collaboration and innovation in the years ahead.

"For me, there are lots of highlights since our launch in December 2020. The first is the runs on the board that we've been getting in the Connected Health area. It just so happened that COVID-19 came along and tipped the balance towards the need for more remote monitoring and greater acceptance of tele-care, so the successes in the Connected Health area have been fantastic. I think the other thing is that we're starting to get the underpinning systems in place. I'm a systems nerd. I love making sure that we are approaching our activities systematically, doing them in a way that gives them a strong foundation on which to grow. I think we're really starting to bed down some of these activities now, including the SCIMIT process, the co-design processes, and the development of the hub concepts. I'm really pleased with this progress."

Professor Laura Poole-Warren AM
Deputy Director, Tyree IHealthE

The Tyree IHealthE team

Recruitment was a priority for Tyree IHealthE in its first year, and was identified as one of the organisation's strategic milestones. Founders Nigel Lovell and Laura Poole-Warren have successfully gathered around them a team representing considerable professional expertise in translational research, strategic operations and communications.

Scientia Professor Nigel Lovell

Director

Scientia Professor Lovell is the Head of the Graduate School of Biomedical Engineering, working in the areas of bionics, telehealth, biosignal processing and physiological modelling. Nigel has authored 300+ journal papers and been awarded over $100 million in research and development funding. Over his career he has mentored 70 PhD students and delivered more than 150 keynote presentations. He is a Fellow of seven learned academies throughout the world.

As the Director of Tyree IHealthE, Nigel is responsible for delivering on the Institute's vision, creating a transformational engine of discovery, innovation and healthcare translation.

Professor Laura Poole-Warren AM

Deputy Director

Professor Poole-Warren AM leads a research group focused on improving interfaces between biomedical devices and tissues. Laura has held various leadership roles including recent appointments as co-chair of the Australian Brain Alliance, and the Frontier Technology Clinical-Academic Group of Maridulu Budyari Gumal (also known as the Sydney Partnership for Health, Education, Research and Enterprise or SPHERE). She is a Fellow of four learned academies and in January 2020 was honoured as a Member of the Order of Australia (AM) for service to Biomedical Engineering and Education.

As the Deputy Director of Tyree IHealthE, Laura is responsible for the development of translational research and education strategy, integrated with end-user engagement, as well as matters relating to governance and operational excellence. She also deputises for the Director on all matters.

Gemma Ashton

Chief Operations Officer

Gemma Ashton is a program-operations professional with more than 15 years' experience delivering strategic initiatives in the higher education sector. Her work has had a special focus on health research and education. Prior to joining Tyree IHealthE, Gemma was the Program Manager at the Charles Perkins Centre, a multidisciplinary research centre committed to improving global health. In her role there, she led the implementation of strategies to support collaborative, solution-focused research, and managed partnerships with industry and government collaborators.

As Chief Operations Officer, Gemma is responsible for the financial and administrative operations of Tyree IHealthE and driving new opportunities for collaboration and commercialisation with external stakeholders.

Jacqueline Wells

Senior Project Officer

Jacqueline Wells is a marketing and communications professional, with experience in developing digital communication strategies, stakeholder engagement programs, and managing large strategic events. With a background in social sciences and digital communications, Jacqueline is especially interested in the potential for better communication around health technology and innovation. She has over 10 years' experience working in higher education; prior to joining Tyree IHealthE she managed the Digital Health and Informatics Network (DHIN) at The University of Sydney, where she ran a virtual network for researchers in digital health.

As Senior Project Officer, Jacqueline supports outreach activities, stakeholder engagement initiatives, and manages the Tyree IHealthE communications channels.

Brice Lenfant

Project Officer

Brice Lenfant is an IT professional with extensive experience implementing, customising, and scaling up digital platforms in the education sector. With a background in Contract Law and IT Project Management, Brice has held various positions in education, including as a lecturer in Mongolia, and a Student Hall Manager in New Zealand. Prior to joining Tyree IHealthE, he was a Digital Systems Specialist at the Catholic Education Office in Canberra where he rolled out cloud-based education software in 56 schools and six colleges across NSW and ACT.

As a Project Officer for Tyree IHealthE, Brice coordinates technical projects and ensures the development of clinical applications and solutions in an agile environment.

Tyree IHealthE committees

Steering Committee

The Tyree IHealthE Steering Committee has oversight of the Institute's operations and oversees the implementation of the Tyree IHealthE strategy. The Steering Committee meets four times a year.

Chair

Emeritus Professor Ian Webster AO
Director, Sir William Tyree Foundation

Steering Committee members

Lisa Altman
Director, Strategy, Innovation and Improvement, South Eastern Sydney Local Health District

Professor Guangzhao Mao
Head of School, Chemical Engineering, Faculty of Engineering

Professor Mark Parsons
Professor Medicine & Neurology, UNSW South Western Sydney Clinical School, South Western Sydney Local Health District

Professor Anushka Patel
Vice Principal Director and Chief Scientist, The George Institute for Global Health

Professor Klaus Schindhelm
Graduate School of Biomedical Engineering, Faculty of Engineering

Associate Professor Adrienne Torda
Associate Dean, Education & Innovation, Faculty of Medicine

Professor John Watson
Emeritus Professor, Faculty of Medicine

Knowledge Translation Advisory Committee

The Knowledge Translation Advisory Committee advises on the appropriate translation of clinical and biomedical engineering research to commercial technologies and/or clinical practice. The Knowledge Translation Advisory Committee meets twice a year.

Chair

Professor Chris Roberts AO
Visiting Professor, UNSW. Ex-CEO, Cochlear Ltd.

Knowledge Translation Advisory Committee members

Dr Dan Grant
Managing Director and CEO at MTPConnect

Bronwyn Le Grice
Founder and Managing Director, ANDHealth

Dr George Margelis
Independent Chair, Aged Care Industry Information Technology Council

Professor John Parker
Founder and CEO at Saluda Medical

Leanne Wells
CEO, Consumers Health Forum of Australia

Professor Klaus Schindhelm

Professor of Biomedical Engineering,
Tyree IHealthE Steering Committee member

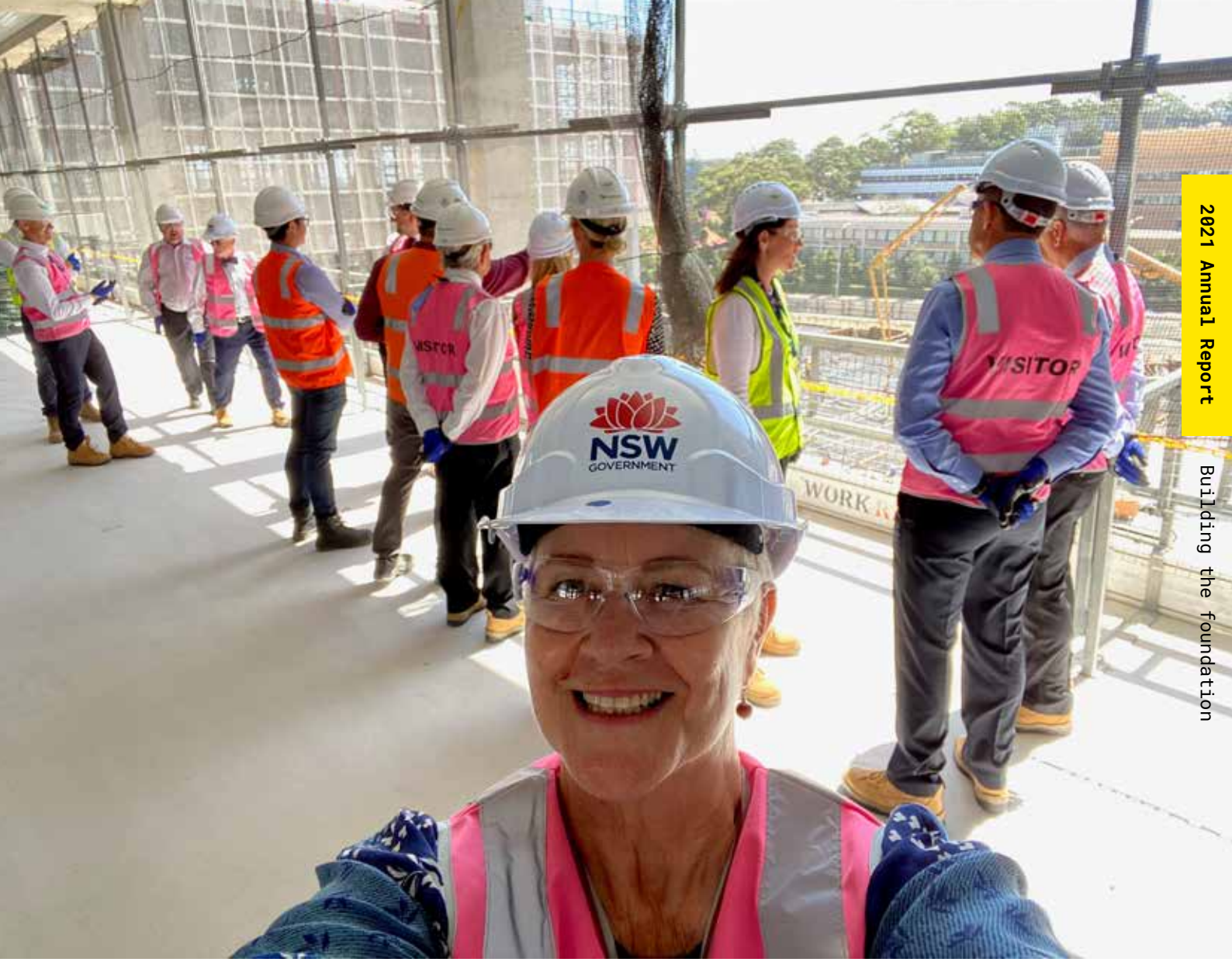
As a student at UNSW in the 1970s, with an emerging expertise in 'reaction engineering', Klaus Schindhelm assumed he was heading towards a career in the chemical industry: passing raw materials through pipes, extracting products of value, eliminating the resultant waste. Instead, he was approached by Peter Farrell, then a Senior Lecturer in the UNSW School of Chemical Engineering and later founder of medical device company ResMed, who encouraged him to undertake an undergraduate thesis, and later a PhD, in artificial kidneys. His ensuing career in biomedical engineering saw him establish the Graduate School of Biomedical Engineering and maintain his professorial position at the University while also joining Peter at ResMed, holding a range of significant positions including VP Product Development, Senior Vice President of Global Operations, Senior Vice President of Global Applied Research and Chief Research Officer.

What do you think it takes to succeed in research translation?

I really got an education in research translation at ResMed. I was a full professor when I started there, but the commercial experience at ResMed taught me just as much, if not more, as my previous 20 years in academia had taught me, and it was an incredibly valuable education. I am not a clinician. I never will be, and I never pretend to be. But if I am working on a project in a medical specialty such as cardiology, I make sure I can stand in front of the world's best specialists and use their language, have a discussion with them about their problems. If I am working in some area of neurology, I'll be able to do that again, because I've done my homework. That is how, as a technologist, as an engineer, you can work in the medical world as a true developmental partner, rather than just as a contractor. In essence, that is what IHealthE is enabling. It is a mechanism for engineers to partner in the true translation of health concepts through technology.

Where do you think Tyree IHealthE will be, five or 10 years from now?

I hope that we will have established the five pillars of Tyree IHealthE, and that we will have created an engine in each of those pillars that can drive innovation, that can effectively take solutions to unmet needs and pursue them to an end that makes them useful in health care. And the key to that is to make sure they are 'patient-centric', in other words, that they are genuinely good for the patient. Whether they are products or treatments or processes, it is about taking these things and moving them forward in a way that makes them useful in a commercial or clinical or patient-centric way, and that does not blow out costs.



Interdisciplinary strengths

Building on the capabilities and credibility of UNSW Engineering and UNSW Medicine and Health, Tyree IHealthE is an interdisciplinary hub of healthcare translation that will directly and significantly address both the health needs of our ageing population, and the broader need for Australia to develop its capacity for innovation.

It bridges the gaps between patient need, clinical practice, research activity and solution development, ensuring that projects are relevant and viable, and ready to be implemented into cost-effective, everyday practice.

Tapping into the resources of the UNSW community

The Tyree IHealthE team has used this first year to take stock of related activities already taking place across the University, and to connect with relevant stakeholders to ensure that efforts are bolstered rather than duplicated. To date, Tyree IHealthE has:

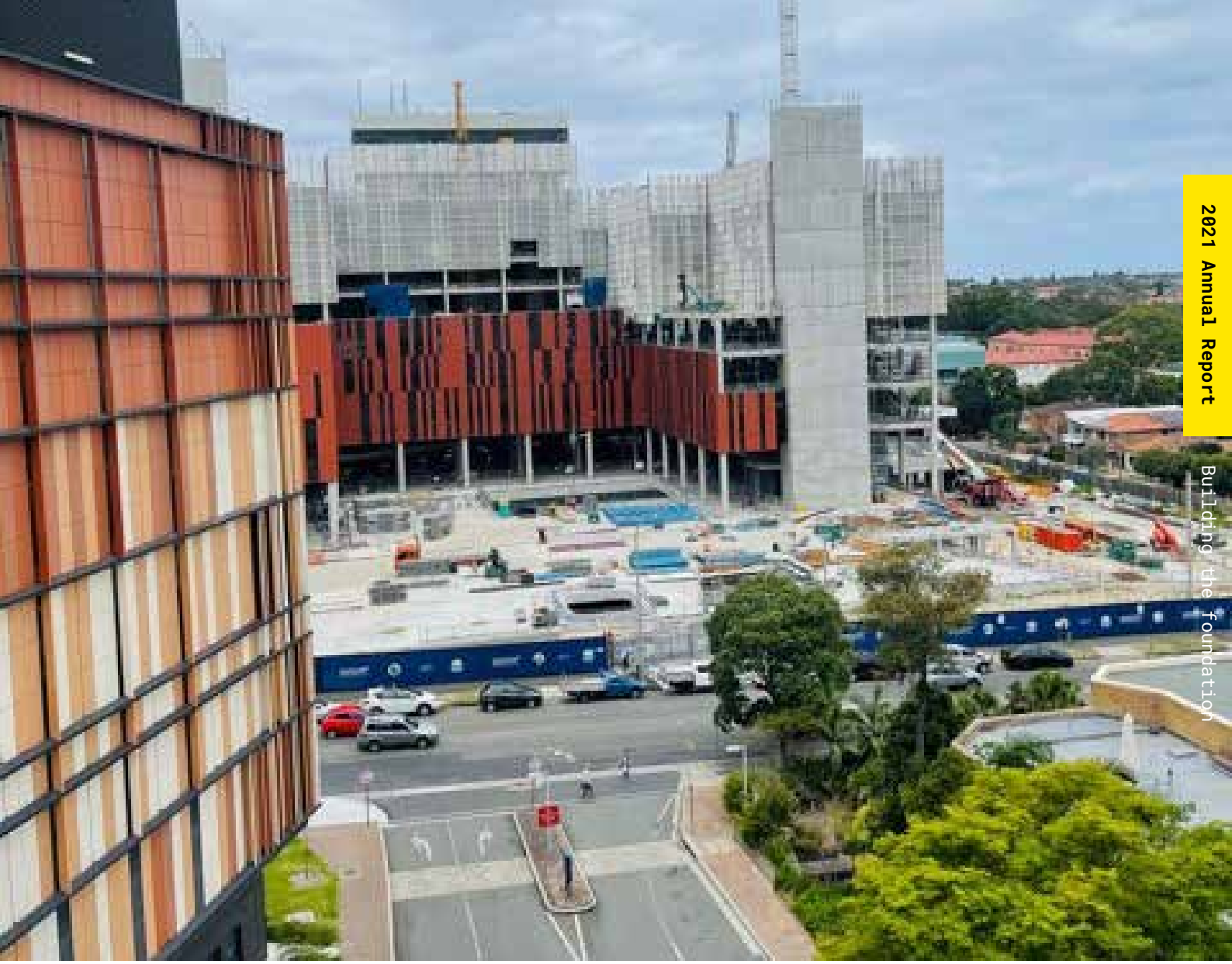
- Established regular meetings with the Dean of UNSW Medicine and Health and the Dean of Engineering and agreed for all future Tyree IHealthE grants to be developed collaboratively with both faculties;
- Led a symposium with the UNSW School of Chemical Engineering to discuss the potential for collaboration and engagement, with future symposia planned with the School of Computer Science and Engineering, the School of Electrical Engineering and Telecommunications, and UNSW Medicine and Health;
- Presented to a meeting of UNSW Medicine and Health senior faculty staff including the heads of all clinical schools and medical research institutes.

The team is also currently organising an event to be hosted jointly by Tyree IHealthE and the UNSW Ageing Futures Institute. Entitled *How can biomedical innovations fulfil unmet needs in ageing?*, it will be held in early 2022.

Establishing a network of external partners

Throughout 2021, Tyree IHealthE has pursued networking and outreach activities as a matter of priority. The aim is to develop a thriving community of interdisciplinary, inter-organisational collaborators, committed to early-stage consultation and co-design, and united in their aim to deliver tangible benefits to patients and the health system. So far, Tyree IHealthE has:

- Presented to a Randwick Health and Innovation Precinct Collaboration Committee, generating follow-up meetings with the Sydney Children's Hospital Network, Victor Chang Cardiovascular Research Institute, and the Cardiac and Vascular Health Clinical Academic Group of Maridulu Budyari Gumal (SPHERE);
- Delivered presentations to professional groups including the Diabetes, Obesity and Metabolic Disease Clinical Academic Group of Maridulu Budyari Gumal (SPHERE);
- Represented Tyree IHealthE at events including the Randwick Health and Innovation Precinct Virtual Care Workshop and the South Eastern Sydney Local Health District (LHD) Strategy Planning Day;
- Co-sponsored the 2021 e-Seminar Series of the Australian Society of Biomedical Machine Learning.



Innovation enablers

To achieve its aim of being a centre of innovation and translation, Tyree IHealthE must establish formal structures and processes that will help identify the unmet needs of the health system and the community, and support the development of relevant and viable solutions.

Clinical co-design hubs: spaces for community engagement

Identifying those needs and beginning to scope a response to them requires meaningful engagement with clinicians and patients. This year, the Tyree IHealthE team has developed a plan to establish three co-design hubs within the Randwick Health and Innovation Precinct's Health Translation Hub. The hubs will provide clinicians and the community at large with a space and an opportunity to raise issues, discuss gaps, workshop ideas and provide feedback on the solutions being developed by the Tyree IHealthE team and its partners.

1 Assistive Tech Hub

Building on an educational initiative from the Graduate School of Biomedical Engineering, the Assistive Tech Hub will see people with disability engaging with Tyree IHealthE teams to co-create life-changing assistive technology. Located in a patient and consumer-facing space of the Health Translation Hub, the area will be staffed by an engineer and an occupational therapist, and will encourage community drop-ins. Solutions with commercial prospects will be progressed into accelerator programs by Tyree IHealthE partner Remarkable, an organisation dedicated to start-ups using technology to drive inclusion for people with disabilities.

2 Connected Health Hub

Also occupying a patient and consumer-facing space within the Health Translation Hub, the Connected Health Hub will operate like a 'Genius Bar' for digital health. Community members will be able to explore the products and programs on offer, upload relevant apps to their own smartphones, and get training in how to use apps, wearables and other personal devices to monitor and manage their own health and wellness. The feedback provided by community members will help Tyree IHealthE refine solutions and improve user experiences.

3 Neural Rehab Hub

A priority for the Sydney Children's Hospital, the Neural Rehab Hub will create a space for clinicians and engineers to work together with families to support the needs of children with complex brain injuries or disease. The hub will leverage the funding support for neuroscience recently received by the Sydney Children's Hospital at Randwick.

"The Assistive Tech Hub started life as an initiative led by A/Prof Lauren Kark, Deputy Head of the Graduate School of Biomedical Engineering. Put very simply, the idea was to bring multidisciplinary teams of engineering students together with people with disabilities to design things that could meet their needs. It is a regular, ongoing engagement, so it's a great way to make sure the iterative process of design is always taking into account what the user needs. Essentially, it's a beautiful model for what we aim to achieve at Tyree IHealthE: including both patients and clinicians in the process of solution design, and engaging with people who may be very close to the coalface of the problem."

Professor Laura Poole-Warren AM
Deputy Director, Tyree IHealthE

"SCIMIT is a tried and proven process for getting hospital clinicians and researchers together to identify unmet needs and develop solutions that work. Essentially, it's a 'design control' approach: you take an idea, you make sure it's okay, and then you think about all the elements you need to make it happen, including the regulatory issues and the business models. In 2021, we selected three Catalyst project teams for access to the GAITS software. It will be my job to walk through the SCIMIT process with them, all of them excellent researchers and outstanding clinicians, and to get them to think differently about what they're doing so that, hopefully, they can develop their ideas into projects that have genuine translational meaning for health care."

Professor Klaus Schindhelm
Professor of Biomedical Engineering

SCIMIT: a systematic innovation pathway

Moving transformative new solutions towards implementation requires the detail and discipline of the structured innovation process provided by the Sydney Consortia for Improving Medicine with Innovation and Technology (SCIMIT), the local version of the internationally recognised CIMIT process originating out of Boston.

A core component of CIMIT is the Guidance and Impact Tracking System (GAITS), a platform that supports the assessment of commercialisation processes. In 2021, Tyree IHealthE was granted access to a number of GAITS licenses by MTPConnect, Australia's growth centre for the medical technologies, biotechnologies and pharmaceuticals sectors.

Those licenses will be made available to three of the five winners of the inaugural Catalyst Awards. Klaus Schindhelm (page 15) will mentor project teams through the SCIMIT process.

2021 Catalyst Awards

In 2021, Tyree IHealthE launched the Catalyst Awards, an initiative designed to champion collaborative research teams working on solutions with genuine translational potential. The inaugural Catalyst Awards focussed on Connected Health and featured projects that were using technology and data systems to support patient needs in a holistic way.

The five winners (listed) reflect principles of co-design, prioritising end-user engagement, and demonstrating strong collaboration with clinical researchers. In addition to valuable seed-funding, they will be supported through the innovation process over the next 12 months by the Tyree IHealthE team and their partners from the HealthHatchery at Maridulu Budyari Gumal (SPHERE).

Winners of the 2021 Catalyst Awards

Dr Sebastiano Barbieri (CI), Dr Belinda Parmenter, Kelly McLeod, Professor Louisa Jorm: *Improving Exercise Physiology Outcomes through Reinforcement Learning*.

"Thanks to the Catalyst Award I will be able to strengthen my collaborations with clinical partners interested in applications of machine learning in health, and to extend the impact of my project beyond academic outcomes."

Dr Sebastiano Barbieri

Dr Matthew Brodie (CI), Professor Arun Krishnan: *Accelerating Non-Invasive Treatment of Motor Impairment*.

"The Catalyst Award has enabled me to bring together a talented team of engineers and clinicians towards improving the lives of people with peripheral neuropathy. Importantly is has provided access to experienced mentoring in medical device development for the team."

Dr Matthew Brodie

Dr Peter Brown (CI), Dr Elizabeth Brown, Tom Kulaga: *A Smart Mouthguard for Sleep Monitoring*.

"The Catalyst Award will provide vital funding that will establish the link, both digital and physical, between the patient monitoring systems and the connected wider health network."

Dr Peter Brown

Dr Hamid Alinejad-Rokny (CI), Associate Professor Tony Roscioli, Ali Afrasiabi: Aletheia: *A Novel Artificial Intelligence Tool for Highly Accurate NGS-based Clinical Genetic Analysis*.

"The Catalyst Awards will enable our project to develop a novel AI-based analytical tool for improving the accuracy of genetic profiling which is an important part of connected health and a fundamental step in personalised medicine."

Dr Hamid Alinejad-Rokny

Dr Michael Stevens (CI), Dr Reza Argha, Professor Daniel Chan, Dr Ying Xu: *Guardian Angels - Unobtrusive Fall Detection for Persons Living With Dementia*.

"The Catalyst Award will enable our team to start the translation process for our non-invasive fall detection technology, and improve the quality of life of those living in aged care facilities."

Dr Michael Stevens

Translation outcomes

The Randwick Health and Innovation Precinct development, currently under construction, will ultimately be the home for Tyree IHealthE, alongside many of its partners including the Prince of Wales Hospital, the Sydney Children's Hospital and South Eastern Sydney Local Health District (LHD). In particular, Tyree IHealthE will have a presence in the Acute Services Building and the Health Translation Hub.

Almost 200 representatives from across all the organisations involved meet regularly in a variety of working groups to consider how best to lay the groundwork for effective collaboration. Among them are Tyree IHealthE's Nigel Lovell, who has a place in the Virtual Care Working Group, and Laura Poole-Warren who sits on the Operations Steering Group.

The connections between individuals and organisations, already being established informally as part of Precinct planning processes, will be further encouraged by initiatives including secondment programs and grant partnerships – and by the development of a single sign-on digital network that provides users with seamless access to computer systems across the Precinct.

These provisions pave the way for the Precinct to serve as a testbed for digital health innovation:

Tyree IHealthE will engage with patients and clinicians to remotely collect and fuse data from a variety of devices including wearables, implantables (such as pacemakers and defibrillators) and unobtrusive sensors;

Those data will be linked with data from the electronic medical records maintained by hospital partners and other partners in the community including GPs and pharmacies;

The linked data will be developed into longitudinal health models that reveal the evolution of the health and wellness of a patient;

Predictive analytics will be applied to these longitudinal data trends to target health resources to those most in need and to prevent costly hospital readmissions;

Connectivity results in new models of care and health service delivery, improving the overall quality of care for patients, and reducing healthcare costs.

The multidisciplinary environment and co-design process fostered by Tyree IHealthE allows for a vast range of innovations to be developed, trialled and evaluated. If successful, they can be swiftly implemented into everyday practice with Precinct partners.

Lisa Altman

Director of Strategy, Innovation and Improvement,
South Eastern Sydney LHD

Working across the three pillars of her South Eastern Sydney LHD directorate, Lisa Altman oversees everything from the development of real-time patient data dashboards for clinicians to the investigation and implementation of research-driven clinical improvements to improve patient outcomes. She also represents the South Eastern Sydney LHD in the ongoing development of the Randwick Health and Innovation Precinct. It's that aspect of her role that sees her working closely with the Tyree IHealthE team.

Why is Tyree IHealthE important to the South Eastern Sydney LHD?

There are two really clear reasons. The first is that we are partners in the Randwick Health and Innovation Precinct and, for me, it's crucial to be collaborating with Tyree IHealthE because they sit at the intersection of the health and the academic spaces. The second reason is that tele-clinical care or TCC, which has come out of a partnership between the Tyree IHealthE biomedical engineering team and South Eastern Sydney LHD clinicians, is what we're looking at as a foundational platform for dealing with some of the biggest challenges we face now around the growing demands of chronic disease and an ageing population.

What is the value of the TCC platform to South Eastern Sydney LHD?

The exciting thing about TCC from my perspective is that we have had the opportunity to jointly develop the solution, and jointly develop the roadmap. That makes it much more valuable than any off-the-shelf products we could get. Commercial vendors might pay lip service to tailoring and customising the product, but it's nothing like the really collaborative partnership that we've had.

What are the challenges ahead for the further implementation and commercialisation of the TCC product?

One of the silver linings of the COVID-19 experience is that we've been able to test at scale. We've now cleared a lot of the hurdles and streamlined the process and, in collaboration with Tyree IHealthE, we've significantly improved the product. Now we're thinking about how we can take this from being a product used for COVID-19 in the acute sense, to COVID-19 as an endemic disease, alongside other chronic diseases. Using the TCC platform in that way will require further changes, particularly to the back-end and the reporting and performance metrics. We're having those conversations now.

"Tyree IHealthE has available to it incredible resources. In particular, we have the incredible resource of the top-quality students that we have within our grasp to educate. Medical technology will create a different wealth base for the country. Australia has been very, very successful in doing that with companies like Cochlear and ResMed and others, but we've got the ability to do even better with the highly educated workforce of the future".

Professor Klaus Schindhelm
Professor of Biomedical Engineering

Educational opportunities

Tyree IHealthE is committed to ensuring that the next generation of engineers and clinicians are exposed to interdisciplinary and translational thinking and processes as students.

It's a commitment designed to embed an innovation culture in the workforce of the future, speeding the translation of research discoveries into products and services that improve the lives of patients, and strengthening the development of a medical technology sector that will make a significant contribution to the Australian economy.

To date, the Tyree IHealthE team have directly supported more than 25 theses, including PhDs, Engineering Honours, and Individual Learning Plan projects. They've also engaged undergraduate and postgraduate students in Vertically Integrated Projects (VIPs): ambitious, long-term, multidisciplinary projects led by UNSW researchers.

In the future, the opening of the Randwick Health Innovation Precinct will see educational opportunities multiply. Additionally, plans are being developed for undergraduates and postgraduates to contribute to the work of the proposed Clinical Co-Design Hubs.

Dr Praveen Indraratna

TCC, PhD student

As a trainee cardiologist, Dr Praveen Indraratna was struck by the profound impact he could have on patients, responding to life-threatening situations, and discharging them within just a matter of days. In 2017, he began looking for a PhD project that would allow him the opportunity to have a similarly immediate and tangible impact. He joined the TCC team, under the supervision of A/Prof Sze-Yuan Ooi, Cardiologist at Prince of Wales Hospital.

What have you learned from being part of this collaborative team?

This is a model of care that could work across different specialisations, across different age groups, across hospitalised patients and outpatients - there is really limitless potential. Clinicians from every speciality should be looking at this and thinking about how they could collaborate with biomedical and software engineers to come up with solutions for their patients. It's great for us to see that what we, as clinicians, think of as an idea - purely an idea - can be made into a tangible product. It's really amazing what the technical team can do.

How has this experience impacted on you, professionally and personally?

It's been very rewarding to be involved in something genuinely unique. A lot of doctors take a well-trodden path. Digital health is something brand new. It's something that enables you to help hundreds of patients in the time that you would otherwise help just one or two. It's had a great impact on me, being involved in a completely different model of care and a completely different way of treating patients than I would otherwise have had exposure to.

What do you hope the legacy of the TCC project will be?

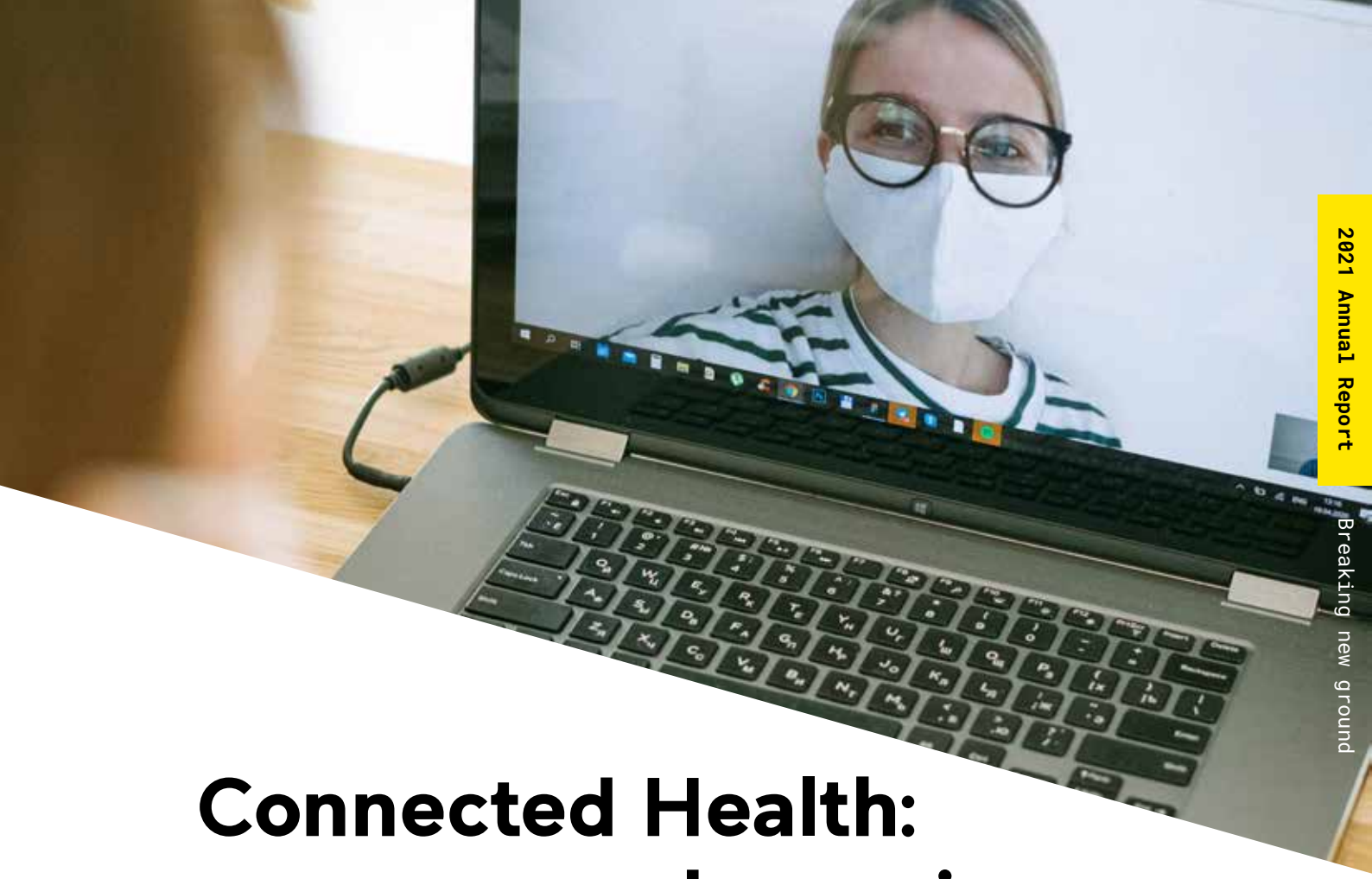
I hope that in 10 or 20 years' time, every patient that comes through the hospital could be considered for some sort of digital health model of care, whether they've got diabetes, kidney disease, cancer, mental health conditions – whatever the cause may be. I hope that it's just a mainstream model of care, in the same way that drugs and surgery are standard models of care. I hope that in the future, people will look back and say, 'You know that cardiac trial? That was where it started, and now our whole hospital, our whole district, perhaps even our whole nation, is using a model of care based on that'.

Breaking new ground

In its first year of operations, Tyree IHealthE has forged ahead with the delivery of breakthrough innovations, not least in response to the overwhelming demands of the pandemic. Along the way, it has identified the stakeholders, developed the partnerships and refined the processes that will aid collaboration, ease implementation, and underpin future successes.

"It's actually a pretty formidable step to go from idea generation to solution. How do I build that? How do I get it tested? Then where do I go from there? I'm still not sure that I know - but the thing is, I don't need to know. I just need to be a clinician, and think like a clinician, and be in a room with the people who have expertise in the solution-building. That's what Tyree IHealthE brings. It brings the opportunity for a clinician to say, 'I have a good idea and I want you guys to help me turn that idea into a solution, and turn that solution into an evidence-based implementation'. I can tell you, I couldn't do it by myself! It's thanks to Nigel and the team that we've been able to build what we have built. Everyone has their strengths, and it's about pulling together a team that can take all of those different strengths and utilise them to their maximum."

A/Prof Sze-Yuan Ooi
Connected Health, Clinical Lead



Connected Health: progress and promise

The Connected Health pillar has been the proving ground for Tyree IHealthE operations in 2021. 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 Sze-Yuan Ooi and Nigel Lovell, had anticipated that this 'remote monitoring' would produce efficiencies in the health system, reducing waiting room congestion for clinicians while improving the comfort of patients who were no longer hauled out of their homes for routine clinical visits. What they 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.

Connected Health: 2021 at a glance

- TCC-COVID was successfully trialled and then translated into clinical practice, adopted by the South Eastern Sydney LHD and deployed to all hospitals in the district. Discussions to implement TCC-COVID across other LHDs are ongoing.
- Two pilot studies for TCC-Heart Failure and TCC-Rehab generated valuable insights that were subsequently applied to the design and development of new clinical trials for TCC-Cardiac and TCC-Stroke.
- A large-scale clinical trial commenced for TCC-Cardiac, a product designed to remotely monitor vital signs, and improve the delivery of a behavioural and exercise program for the prevention of recurrent cardiovascular events. The work was funded by a $2 million grant from the NSW Health Translational Research Grant Scheme, and patient recruitment is currently underway across a dozen NSW hospitals.
- A clinical trial has begun for TCC-Stroke, a product that aims to better manage stroke patients by detecting early onset of atrial fibrillation using a deep-learning algorithm. It also tracks medication usage and adherence through a collaboration with Webstercare, Australia's largest supplier of polypharmacy medications. It is funded by a $1.7 million NHMRC Medical Research Future Fund grant.
- Tyree IHealthE was named as the lead collaborator of the new Research Hub for Connected Sensors in Health, awarded $5 million as part of the Australian Research Council (ARC) Industry Transformation Research Program. The Hub, which includes 20 industry partners, has also attracted $5 million in industry funding as well as other cash support.
- The integration of TCC has been progressed. New bidirectional data feeds have been established with Cerner, the electronic medical record (EMR) system managed by NSW Health. Additionally, TCC data are now connected to the NSW Health Patient Flow Portal which supports the state-wide management of resources.
- A close association has been fostered with the eHealth NSW human-centred design team, with more than $500,000 in funding secured through the South Eastern Sydney LHD for the development of additional TCC modules addressing mental health, gestational diabetes, chronic obstructive pulmonary disease (COPD), aged care and post-surgical rehabilitation.
- A business case is being developed for TCC start-up 'Apostele', with plans for the team to participate in accelerator programs and secure external investment in 2022.

A/Prof Sze-Yuan Ooi

Connected Health, Clinical Lead

For close to a decade, cardiologist A/Prof Sze-Yuan Ooi was responsible for implanting cardiac devices in as many as 300 patients a year. He was also responsible for tracking the performance of those devices, typically via a remote monitoring device that flashed intermittently on patients' bedside tables while feeding information back to the clinical team. The device was hugely beneficial from a clinical standpoint, but often a source of stress for patients who worried about the possible significance of every flash. Now, Sze-Yuan aims to help bridge the gap between the patient experience and the technical solutions put forward by 'awesome engineering' through his contributions to the IHealthE Connected Health program.

What excites you about IHealthE?

I remember the first time I had a tour of Biomedical and Mechanical Engineering; I was absolutely blown away. Their capabilities, the equipment, the technology and knowhow - it was next level! It's great that IHealthE is bringing patients, clinicians and health care administrators together with researchers and engineers and all their awesome ideas. There's an enormous amount that we can learn from each other.

What progress have you seen in the TCC program since it began?

We've come a long way. We built an app, trialled it and showed that it reduced cardiac readmissions by 50 per cent. Then the pandemic happened. From a technical point of view, that's had a positive effect in that now there's general acceptability of what we're doing, and everyone is saying 'Well, of course, this makes sense!'. Our early results and the shift in acceptance of tele-health has facilitated wider engagement in our activities and future plans.

What processes have you put in place for engaging with clinicians?

We are working closely with the clinicians to build a uniform process that enables us to understand the clinicians' point of view, that communicates to them what an app may or may not be able to offer them, and that considers what needs to happen for the app to be embedded in their usual clinical flow. There have been lots of learnings through TCC-Cardiac and TCC-COVID. We have developed a fairly detailed process that builds in all those thoughts and requirements from the outset, so the tech team have got something solid they can then build from.

What goals have you got for TCC into the future?

Ultimately, we want to make this very modular. At the moment, we've been very disease-specific, but patients don't always have one specific disease, and they don't necessarily have the same needs as another person with the same disease. The TCC model encompasses many different functionalities, different types of physiological measurements, medication compliance, exercise programs, psychological supports, and educational resources – so instead of having an app for heart failure patients and an app for people with COVID-19 – we want to have one app that clinicians can use to prescribe the functionality their patient requires, in the same way they prescribe medications. It's personalised medicine, but in the form of a personalised app to address the individual patient's conditions and needs.

What are your ambitions for the Connected Health program?

Connected Health is about breaking down the silos in health. Currently, we're all discrete entities. The hospital system is separate to my private consulting room system. The GPs are all separate. Patients don't even have information about themselves. So what we have now is 'disconnected health'. By itself, TCC remote monitoring is a great solution for supporting patients, but really it's just a small piece of the grander ambition of breaking down all those silos and having an integrated digital system, with appropriate privacy and security, where anyone in a patient's care stratosphere is able to access the information they need. Imagine how much better the patient's care and outcomes would be if everyone who was looking after them was on the same page!

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 TCC team that their product's remote monitoring capacity could be of use.

Sze-Yuan Ooi approached a colleague at Prince of Wales Hospital and put the team and the technology at his 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.

In the first wave of the virus, TCC-COVID was used by a limited number of patients willing to take part in a clinical trial. When the second wave arrived in 2021, the TCC team moved quickly to negotiate with the Therapeutic Goods Association (TGA) to have the app approved for widespread implementation across the South Eastern Sydney LHD.

TCC-COVID: 2021 at a glance

The app has been rolled out to over 2,000 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.

Dr Kristen Overton

Staff Specialist in Infectious Diseases, Prince of Wales Hospital, Randwick. Acting Clinical Director, COVID Community Management Centre, South Eastern Sydney LHD

Kristen Overton was involved in establishing COVID-19 testing clinics at the start of the pandemic in 2020, and is currently Acting Clinical Director of the South Eastern Sydney LHD Community Management Centre where she oversees a district-wide model of assessment and care for COVID-positive patients, aided by TCC-COVID.

How do you reflect on the contribution you and your colleagues have made throughout the pandemic?

I think a huge, diverse group of people across the hospital and the University have worked amazingly well together to deal with this ever-changing situation, and come up with new and innovative ways to do the best we could when things were shockingly busy and crazy and sad in the hospital system.

How did the partnership with IHealthE and TCC-COVID come about?

In March last year, my Head of Department, Associate Professor Jeffrey Post, was walking through the corridors when Sze-Yuan Ooi approached him and said: 'Let us know what we can do to help'. Jeff's answer was: 'We need an app. Speak to Kristen; she'll need an app.' That's how I met Sze-Yuan and Nigel and the whole TCC team. They dropped everything they were working on to create the TCC-COVID app, built around the questions I wanted and the parameters I needed. At our peak, we had over a thousand patients with COVID-19 in the district and I just didn't have enough staff to call them every day. The app meant we could manage patients at scale and really focus on those who were in need of medical care.

What do you think will be the ongoing role of TCC-COVID?

Now that people are vaccinated, we have lots of low to moderate risk patients who really don't need that much intervention. They just need to feel supported, and to have a mechanism they can use to reach out for care. The app has a button that says, 'I'm feeling worse' and if they press that, someone will call them within 30 minutes. I have never before worked with a cohort of patients in the community who were so anxious. Just being able to reassure them that they were safe was so, so helpful.

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	Professor Chun Wang, Professor Nigel Lovell, Professor 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, Professor 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.	Professor Ken Butcher, A/Prof Sze-Yuan Ooi, Professor Nigel Lovell, Professor 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	Professor 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	Professor 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	Professor Nigel Lovell, A/Prof Sze-Yuan Ooi	2020-2021
$211,000	UNSW Research Infrastructure Scheme	Connected Health Network Lab (CHaNL)	Professor 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

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