IMPACTS OF RESEARCH

University of Otago
Te Whare Wānanga o Otāgo
New Zealand

Division of Health Sciences
Te Wāhanga Mātau Hauora

CONTENTS

INTRODUCTION

High quality research that changes the world is what we strive for at the University of Otago Division of Health Sciences. It's also what governments around the world are asking for. They want greater accountability from researchers who must articulate how research investment benefits communities and populations. Those benefits include health, societal, cultural, economic or environmental factors at the individual, whānau and community level.

This booklet describes eight research impact case studies. They come from across the seven Schools in the Division of Health Sciences and highlight different stages of their impact journey. Each has been selected for making a meaningful contribution in a different field of research.

These researchers are improving people's health, changing local and central government policies, contributing to best practice guidelines, creating spin-off companies to commercialise research and building capability by training the next generation of scientists.

By forming meaningful relationships with stakeholders, creating strong networks with other researchers and being advocates for policy change they are achieving success.

We hope you enjoy discovering how their impact was achieved.

Professor Paul Brunton
PRO-VICE CHANCELLOR, DIVISION OF HEALTH SCIENCES

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Thank you to the 45 participants who took part in surveys and interviews for this work.
We also acknowledge the wider research teams, including those not specifically
named in these case studies.

THE DIVISION IN NUMBERS: 2014-19

THE DIVISION OF HEALTH SCIENCES HAS SEVEN SCHOOLS:

1. School of Physiotherapy
2. School of Pharmacy
3. School of Biomedical Sciences (BMS)
4. Dunedin School of Medicine (DSM)
5. University of Otago, Wellington (UOW)
6. University of Otago, Christchurch (UOC)
7. Faculty of Dentistry (DENT)

SCHOLARLY OUTPUT - ALL PUBLICATIONS

TOTAL 8,483

SCHOLARLY OUTPUT - ARTICLES ONLY

TOTAL 6,339

BOOK AND BOOK CHAPTERS

TOTAL 215

PUBLICATIONS IN TOP 10% JOURNAL PERCENTILES

TOTAL 2,872

CITATION COUNT[1]

TOTAL 109,018

FIELD-WEIGHTED CITATION IMPACT

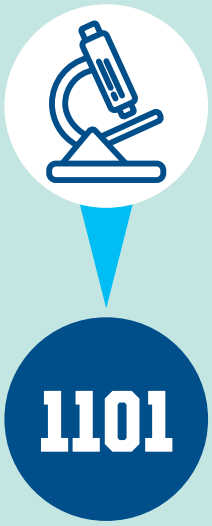
1.99 The Field-Weighted Citation Impact is nearly two times the world average.

33 of our researchers have an H index of 40 or more, characterising them as 'outstanding' scientists.[2]

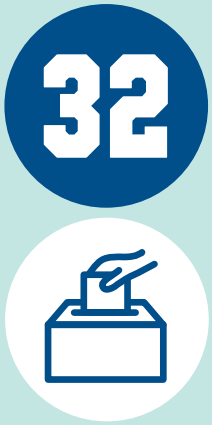
1. Scopus. Benchmarking the publication year and scholarly output (all). Division of Health Sciences 2018. Year range: 2014 to 2018. Data source: Scopus, to 19 Jul 2019.
2. Hirsch JE. An index to quantify an individual's scientific research output. Proc Natl Acad Sci U S A. 2005;102(46):16569-72.

THE DIVISION IN NUMBERS: 2014-19

NUMBER OF RESEARCHERS



FELLOWS OF THE ROYAL SOCIETY OF NEW ZEALAND



32 of the Division's staff have been elected as Fellows of the Royal Society of New Zealand

HEALTH RESEARCH COUNCIL - SIR CHARLES HERCUS RESEARCH FELLOWSHIPS

- 2019 **Khoon Lim** Orthopaedics & Musculoskeletal Medicine UOC
- 2019 **Rosie Brown** Anatomy BMS
- 2019 **Katie Douglas** Psychological Medicine UOC
- 2018 **Htin Lin Aung** Microbiology BMS
- 2018 **Hamish Jamieson** Medicine UOC
- 2018 **Sharon Leitch** General Practice and Rural Health DSM
- 2018 **Michael Pankhurst** Anatomy, BMS
- 2018 **Daniel Ribeiro** Physiotherapy
- 2017 **Tracy Melzer** Medicine UOC
- 2016 **Tania Slatter** Pathology DSM
- 2015 **Karl Iremonger** Physiology BMS

HEALTH RESEARCH COUNCIL - LILEY MEDAL

- 2017 **Jonathan Broadbent** Oral Sciences DENT

ROYAL SOCIETY OF NEW ZEALAND - JAMES COOK FELLOWSHIP

- 2019 **Hallie Buckley** Anatomy BMS
- 2018 **Tony Merriman** Biochemistry BMS
- 2015 **Antony Braithwaite** Pathology DSM

ROYAL SOCIETY OF NEW ZEALAND - RUTHERFORD DISCOVERY FELLOWSHIP

- 2019 **Olivia Faull** Pharmacy
- 2018 **Sarah Diermeier** Biochemistry BMS
- 2017 **Aniruddha Chatterjee** Pathology DSM
- 2015 **Logan Walker** Pathology UOC
- 2014 **Louise Bicknell** Pathology BMS

ROYAL SOCIETY OF NEW ZEALAND -HERCUS MEDAL

- 2018 **Brett Delahunt** Pathology and Molecular Medicine UOW
- 2014 **Parry Guilford** Biochemistry BMS

ROYAL SOCIETY OF NEW ZEALAND - DAME JOAN METGE MEDAL

- 2018 **Suzanne Pitama** Māori/Indigenous Health Institute (MIHI) UOC

ROYAL SOCIETY OF NEW ZEALAND MASON DURIE MEDAL

- 2018 **Lisa Matisoo Smith** Anatomy BMS

ROYAL SOCIETY OF NEW ZEALAND CALLAGHAN MEDAL

- 2018 **Helen Taylor** Anatomy BMS
- 2014 **Peter Dearden** Biochemistry BMS

NZ ASSOCIATION OF SCIENTISTS MARSDEN MEDAL

- 2018 **Warren Tate** Biochemistry BMS

PRIME MINISTER'S SCIENCE PRIZES

Prime Minister's Science Prize 2014
He Kainga Oranga/Housing and Health Research Programme Public Health UOW
Prime Minister's MacDiarmid Emerging Scientists Prize 2014
Karl Iremonger Physiology BMS

NATIONAL TEACHING AWARDS

Prime Minister's Supreme Award, annual Tertiary Teaching Excellence Award 2018
Faumuina Associate Professor Fa'afetai Sopoaga Va'a o Tautai
Prime Minister's Annual Tertiary Teaching Excellence Award 2015
Suzanne Pitama MIHI UOC

LIMELIGHT LEADERSHIP AWARD FROM LEADERS IN INDIGENOUS MEDICAL EDUCATION

- 2015 Suzanne Pitama MIHI UOC

THE DIVISION IN NUMBERS: 2014-19

NUMBER OF STUDENTS

HEALTH SCIENCES EFTS	2015	2016	2017	2018	2019
PhD/DClinDent	430	431	474	480	503
Masters (thesis only)	135	134	127	133	120
Other Postgraduate	683	715	754	755	786
Total	**1248**	**1280**	**1355**	**1368**	**1409**

NATIONAL AND INTERNATIONAL COLLABORATIONS

NATIONAL SCIENCE CHALLENGES - A NATIONAL INITIATIVE.

We lead two of these

Ageing Well
ageingwellchallenge.co.nz

Healthier Lives
healthierlives.co.nz

and have involvement in many others

CENTRES OF RESEARCH EXCELLENCE (CORES) - A NATIONAL INITIATIVE.

We co-lead Brain Research NZ with the University of Auckland
brnz.ac.nz

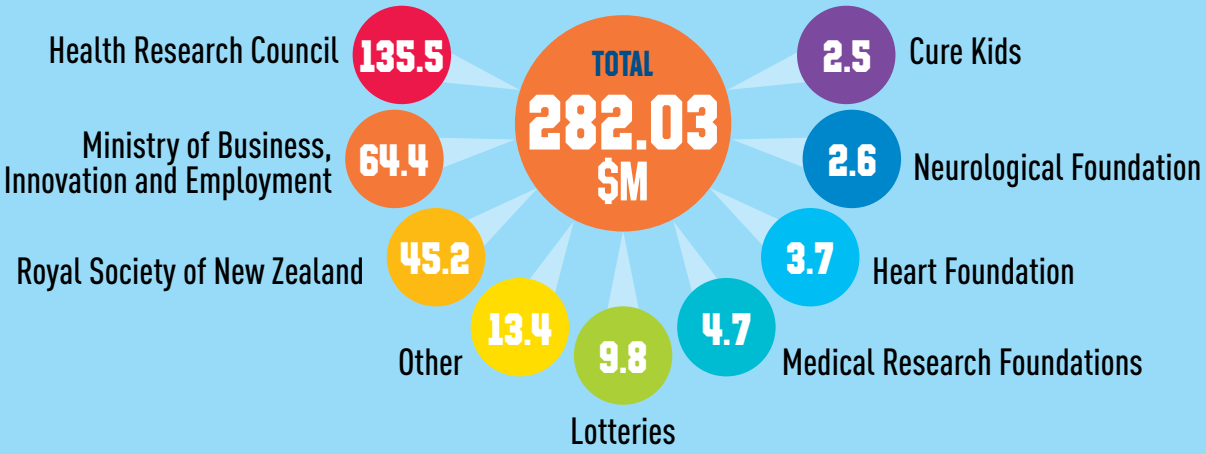
and have involvement in many others

GENOMICS AOTEAROA

We host this national science platform supporting advanced genomics research
genomics-aotearoa.org.nz

AMOUNT AND TYPE OF FUNDING SECURED

External Research funding sources 2015-18



AREAS OF RESEARCH STRENGTH IN THE DIVISION

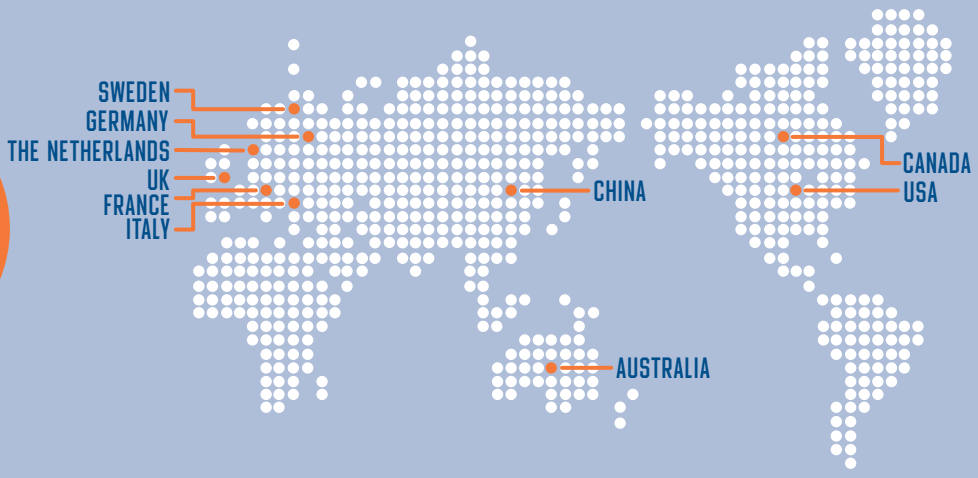
- Addiction
- Ageing
- Agriculture, plant health and disease
- Bioengineering
- Bioethics
- Biological anthropology
- Brain health
- Cancer Research at Otago
- Cardiovascular Disease at Otago
- Child Health Research at Otago
- Developmental biology
- Diabetes and obesity
- Drug discovery, formulation and delivery
- Genetics/genomics
- Global health
- Gut health
- Health disparities
- Health services research
- Housing and health
- Infectious Disease
- Inflammatory disease
- Injury prevention Research at Otago
- Lifecourse research
- Māori health
- Mental health
- Neuroendocrinology
- Oral health
- Pacific Health Research at Otago
- Public Health Research at Otago
- Suicide

THE DIVISION IN NUMBERS: 2014-19

INTERNATIONAL COLLABORATIONS

Division of Health Sciences Researchers have collaborated with researchers in **182** countries.

TOP 10 COUNTRIES



RESEARCH ARTICLE COLLABORATIONS

49.8% OF RESEARCH ARTICLES HAVE INTERNATIONAL COLLABORATION

20.8% HAVE NATIONAL COLLABORATION

25.2% HAVE INSTITUTIONAL COLLABORATION

THE TOP 10 COLLABORATING INSTITUTIONS

THE TOP COLLABORATING INSTITUTIONS ARE:

The University of Auckland • The University of Sydney
The University of Queensland • Christchurch Hospital New Zealand
The University of Melbourne • Canterbury District Health Board
University of New South Wales • Harvard University
The University of Canterbury

CASE STUDY ONE

DUNEDIN SCHOOL OF MEDICINE

THE NEW ZEALAND DRIVERS STUDY

DRIVING POLICY CHANGE

(L-R) Dr Rebecca Brookland, Dr Dorothy Begg

PARTICIPANTS INTERVIEWED FOR THE CASE STUDY

PRINCIPAL INVESTIGATOR

Dr Dorothy Begg Department of Preventive and Social Medicine (retired).

RESEARCHER

Dr Rebecca Brookland Department of Preventive and Social Medicine.

STAKEHOLDERS

Andrew Joel former Senior Education Advisor at the New Zealand Transport Agency (NZTA), currently contractor and Drive Mobile Apps product owner at the NZTA.
Jennie Gianotti former Network Behaviour Manager at the NZTA, currently Manager of Education Development at Worksafe.
Dr Simon Gianotti former Road and Sport Team Leader at the Accident Compensation Corporation (ACC), currently Injury Prevention Strategy Manager at ACC.

SUMMARY OF THE IMPACT

The work of the New Zealand Drivers Study (NZDS) has had a New Zealand and international impact. It successfully influenced policy and legislative changes along with road safety programme and campaign development. The main policy success was informing the decision to raise the minimum driving age from 15 to 16 in 2011. The forward-thinking research team achieved impact by creating relevant research questions and working closely with stakeholders and the community through meaningful engagement activities.

UNDERPINNING RESEARCH

At the time of the NZDS' establishment in 2001, motor vehicle traffic crashes were the leading cause of death and injury among young adults aged 15-25 in New Zealand[1]. The NZDS research was created to provide an evidence base to facilitate policy and programmatic change aimed at reducing the number of deaths and injuries. The research design specifically looked at aspects of the graduated driver licensing system (GDLS) – that is progression from learner licence, to restricted licence, to full licence – with the aim of determining risk factors and protective factors for crashes, injury and infringements for the participants.

The study was a prospective cohort study with the initial pilot running from 2001-04, and the main study from 2005-13. Participants were recruited to the study through Automobile Association (AA) and Vehicle Testing New Zealand (VTNZ) centres when they applied for their learner car licence, and were followed as they went through the stages of the GDLS. Māori providers who ran driver licensing courses in their communities were also consulted, and recruited new drivers to the study. In all, 3992 new drivers were recruited to the main study and completed a baseline questionnaire at the time of their learner licence test. Further interviews took place after passing the remaining two stages of GDLS. Twelve hundred parents of the youngest drivers were also interviewed at the restricted licence stage. Ongoing follow-up continued through official records (crashes, injuries, infringements).

KEY FINDINGS OF THE NZDS:

- Most parents were in favour of the GDLS, but many had poor knowledge about the restricted licence stage conditions.
- Parents can have a considerable positive influence on their adolescents' driving through ensuring compliance with the GDLS components, limiting vehicle ownership, and modelling safe driving behaviours[2].
- One dispelled myth was that young people from rural areas had more driving experience prior to obtaining their learner licence, and were therefore safer drivers. The NZDS found that pre-licence driving had no protective effect on crash involvement at the learner or restricted licence stage, and that on-road pre-licence driving was actually associated with increased crash risk[3].
- A study looking at attitudes of young drivers and parents to raising the licence age found that there was little opposition from young people to raising the driving age, and that doing so would have little impact on essential travel among adolescents in New Zealand[4].
- Driving before obtaining a licence was found to be common practice in both rural and urban Māori drivers, highlighting the need for Māori community road safety providers to address this issue[5].
- Drivers who were 'non-progressors' (did not move from a learner to restricted licence) were shown to have a reduced risk of being a traffic offender in the first 2.5 years of licensure[6].

FUNDING

The NZDS received approximately $3.9 million of funding from the following funders:

- Health Research Council
- Accident Compensation Commision
- New Zealand Road Safety Trust (now Community Road Safety Fund)
- National Safety Council
- Royal Society of New Zealand

RESEARCH SNAPSHOT

- The NZDS has produced 17 research publications (cited 143 times in publications from 20 different countries), two industry reports, and one PhD and one Masters thesis.
- Dr Begg and Emeritus Professor Langley were called on for their expertise to give a presentation on raising the minimum driver licence age to the Transport Industrial Relations Select Committee on Land Transport, Road Safety and Other Matters on 26 October 2010.
- Findings were disseminated beyond academic publication via workshops, mini-symposia and face-to-face meetings with interested stakeholders such as the NZTA, Ministry of Transport (MOT), the Dunedin City Council, community groups and iwi.
- Results were disseminated to overseas organisations considering a change to a GDLS system. For example, Dr Begg was invited to provide policy advice to Sweden, VicRoads Victoria Australia, and present to the US National Safety Council. A paper from the latter was published in the Journal of Safety Research[7].
- Dr Brookland was invited by the Royal Society (London) and the Science Advisory Council to the Prime Minister of India to present at the Commonwealth Science Conference in India in 2014.

DETAILS OF THE IMPACT

NATIONAL

POLICY AND LEGISLATION

Findings from the NZDS informed the following legislative changes wand policy documents:

- The driving age was revised on 1 August 2011 from 15 to 16[8].
- The Treasury document Regulatory Impact Statement: Safer Journeys - New Zealand's Road Safety Strategy 2010 to 2020, which discusses impacts of the minimum driving age being raised[9 p12].
- The Land Transport (Driver Licensing) Amendment Rule 2014, clause 60(1)(ca) which states that drivers can only remain on their learner or restricted car or motorcycle licence for five years to prevent 'licence pooling' (staying on the same class of licence and not progressing)[10].
- In May 2011 one study was cited by Member of Parliament Rahui Katene (Māori Party – Te Tai Tonga) in their parliamentary speech on the Land Transport (Road Safety and Other Matters) Amendment Bill[11].

CASE STUDY ONE

- Associate Minister of Transport Hon Simon Bridges' proposal to address driver licence pooling presented to the Cabinet Economic Growth and Infrastructure Committee in 2012.
- The Ministry of Transport Regulatory Impact Statement Proposal to address driver licence pooling in 2012[12].

PROGRAMMES AND CAMPAIGNS

Multiple national road safety programmes and campaigns were undertaken by NZTA, ACC and Auckland Transport as a result of the NZDS:

- The NZTA young driver programme *DRIVE*, a driving skills app and website[13].
- The NZTA and ACC commissioned a retrospective study from the NZDS to validate a theoretical model of crash risk versus a behaviour profile in order to inform the *DRIVE* programme[14].
- Findings from the study of parental attitudes in the NZDS contributed to the development of four NZTA campaigns including the *Street Talk* defensive driving course[15] and the *Safe Teen Driver* campaign to encourage parents to stay involved in their teen's driving.
- *Behind the Wheel Mangere* (funded by the NZTA, ACC and Auckland Transport) was a local driving education and social marketing programme working to reduce high crash rates among young drivers and reduce rates of unlicensed driving[16].

INTERNATIONAL

POLICY AND LEGISLATION

NZDS studies were referenced in:

Australia

- A submission to the Law Reform, Road and Community Safety Committee in Melbourne, Victoria in 2016 as part of a case study profile of GDLS in New Zealand[17].
- The document *How effective is the ACT road ready pre-licensing driver education program at changing novice driver risk-related attitudes and reducing the offence and crash involvement of novice drivers in the ACT?*"[18].

European Union

- The European Union policy document *Study on driver training, testing and medical fitness* (2017)[19].
- The European Commission Horizon 2020 project *Safety Causation, Benefits and Efficiency (SafetyCube)*, with the objective of developing an innovative road safety Decision Support System[20].

United Kingdom

- The policy document *Public Health Wales supports the introduction of graduated driving licensing (GDL) for new drivers in Great Britain*[21]. In February 2018 Prime Minister Theresa May tasked an investigation into the possibility of a GDLS in the UK, with a pilot scheme launched in Northern Ireland during 2019/2020[21].
- New Zealand was referenced as a case study in moving to a GDLS in the UK in the policy document *Getting young drivers back on the road in safety* by the Parliamentary Advisory Council for Transport Safety, UK[22].

PATHWAY TO IMPACT

CHARACTERISTICS OF THE RESEARCH

- The high quality of the NZDS research has been a key feature of the impact achieved.
  - The large data set enabled statistically-significant conclusions to be drawn when looking at smaller cohorts within the data. Cross-matching of multiple data sources provided a rich source of information.
  - Research questions were constructed carefully, including the addressing of issues specific to New Zealand legislation, myths in New Zealand around young drivers, questions that were being raised in the media, as well as looking at unmet need. Addressing research questions relevant to stakeholders and the community was considered more meaningful than solely addressing what the literature highlighted as a need. This meant that the research outcomes could be readily applied and used in practice.

"'Impact means research can be applied straight away – we're constantly looking for applied research that we can literally buy off-the-shelf."

Andrew Joel FORMER SENIOR EDUCATION ADVISOR, NEW ZEALAND TRANSPORT AGENCY

ENGAGEMENT

- Proactive engagement with the community was vital. While this required significant investment in time and money, it was considered worthwhile in order to translate the research into impact. Face-to-face meetings with community groups and iwi enabled meaningful consultation on project development and feedback on the research plans. This took place prior to commencement of the main study and continued throughout the project. A key objective of the pilot study was relationship building. Meetings took place in the participants' communities – Hawke's Bay, Gisborne, Ruatoria, Auckland, Christchurch, Dunedin and Invercargill. Through this engagement, researchers were able to recruit a good representation of rural, urban, Māori and non-Māori participants.
- Keeping in close contact with stakeholders was key to achieving impact. This was particularly important in organisations where there was relatively rapid staff turnover (for example, government agencies).

"Get out there, make sure people know who you are and what you're doing. Especially the people who are likely to be influenced or affected by your research."

Dr Dorothy Begg PRINCIPAL INVESTIGATOR, NEW ZEALAND DRIVER'S STUDY

AWARENESS OF THE POLICY ENVIRONMENT

CASE STUDY ONE

- An awareness of the policy environment and potential implications of policy change was crucial, including:
  - Taking advantage of policy windows and opportunities; for example understanding timings enabled a submission to be made prior to the driving age legislation being debated in parliament.
  - Anticipating the effect of policy changes by conducting research on this; for example, the impacts of potentially raising the driving age were anticipated by asking young people what the effects on them would be.

A TARGETED APPROACH

Stakeholders interviewed expressed their appreciation for proactive engagement and a targeted approach to research and dissemination from the NZDS researchers. Andrew Joel from the NZTA said *"They've been very approachable and eager to discuss research, and shared early findings with me. They've been very prepared to come and help speak to stakeholder gatherings or participate in workshops. It just has more impact when you have the actual researchers available to answer questions"*. Dr Simon Gianotti of ACC said *"It taught us that we had to keep refreshing our products. It also taught us how to communicate and talk to the young people, what was of relevance to them, and how to work with different age groups. It told us more about who we're trying to target, how we're trying to target them, and what would be the best way to do it."*

WHAT NEXT?

- Rebecca's driving research is continuing with a focus on improving health and wellbeing outcomes in older adults. She has a current HRC project; *NZPATHS*: *NZ Prospective Older Adult Transport and Health Study (2018-2022)*.
- Rebecca has continued her involvement in young driver research. She is:
  - Co-investigator on the *Evaluation of the Dunedin Community Driving Programme* project, a programme run by NZ Police to assist youth traffic offenders to progress through GDLS.
  - Associate Investigator on the Australian young driver *DRIVE Re-linkage* project. (DRIVE is Australian equivalent to NZDS)
  - Associate Investigator on the Australian led *The Road to Compliance: Integrating Three Theories* project.
- For the NZDS, further follow-up of crash, injury and infringement data is currently being explored.

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CASE STUDY TWO

UNIVERSITY OF OTAGO, WELLINGTON

HE KAINGA ORANGA, HOUSING AND HEALTH

IMPROVING HEALTH OUTCOMES THROUGH HOUSING POLICY CHANGE

(L-R): Professor Robyn Phipps, Associate Professor Michael Keall, Professor Chris Cunningham, Associate Professor Michael Baker, Associate Professor Nevil Pierse, Professor Julian Crane, Dr Manfred Plagmann, Professor Philippa Howden-Chapman, Jasmine Xu

PARTICIPANTS INTERVIEWED FOR THE CASE STUDY

PRINCIPAL INVESTIGATOR

Professor Philippa Howden-Chapman Director, He Kainga Oranga; Chair of WHO Housing and Health Guidelines Development Group; Director of the New Zealand Centre for Sustainable Cities

RESEARCHERS

Associate Professor Michael Keall Programme Co-director, He Kainga Oranga

Associate Professor Nevil Pierse Programme Deputy Director, He Kainga Oranga

Professor Julian Crane Programme Co-Director, He Kainga Oranga

Professor Michael Baker Programme Co-Director, He Kainga Oranga

TEAM MEMBER

Shirlee Wilton Former Research Manager, He Kainga Oranga

STAKEHOLDERS

Cheryl Davies Manager, Tū Kotahi Māori Asthma Trust

Dr Manfred Plagmann Principal Physicist, BRANZ

SUMMARY OF THE IMPACT

The He Kainga Oranga, Housing and Health research group, led by Professor Philippa Howden-Chapman at the University of Otago, Wellington, has had outstanding impact over the past two decades. Research has been directed at policy change and improving housing quality, with the ultimate goal of improving health outcomes for New Zealanders. Factors enabling success include an interdisciplinary team researching a wide range of housing and health topics, and developing close relationships with the community, including Māori. Strong leadership and a supportive and collaborative culture have also been key.

UNDERPINNING RESEARCH

The He Kainga Oranga research group has a large body of research addressing housing as a determinant of health — based on the premise that housing quality affects the health of the inhabitants. The research includes both social and environmental elements such as overcrowding and indoor air quality. Interventions for improvement include insulation, heating and injury prevention. Ethnic inequalities are also addressed through research undertaken with Māori communities. More recent studies are investigating rental properties and legislation, and homelessness.

The first significant piece of work produced by He Kainga Oranga was the *Housing, Insulation and Health Study* led by Philippa and Professor Julian Crane, who co-founded He Kainga Oranga in 1998[1]. 1350 council houses around New Zealand were retrofitted with insulation, in partnership with the Energy Efficiency and Conservation Authority/Te Tari Tiaki Pūngao (EECA). Households with at least one occupant with a chronic respiratory condition were chosen for the intervention. Results showed that occupants' health and wellbeing improved, as did household energy efficiency. The economic benefits of retrofitting insulation in New Zealand was found to have a benefit-cost ratio of 4:1.

Another important study, *The Housing, Heating and Health Study* was a randomised community trial led by Philippa and Associate Professor Nevil Pierse (2008)[2]. It investigated the effects of installing improved heating in 409 insulated households where there was a child with asthma. The study showed that indoor temperatures increased significantly and the health status of the children improved, with lower levels of asthma symptoms and sleep disturbances, as well as fewer days absence from school. In the *Evaluation of Warm Up New Zealand: Heat Smart* report, a benefit per year of $563.18 for retrofitted insulation and $4.64 for improved heating was calculated per household, due to reduction in total hospitalisations, pharmaceutical use, and mortality[3].

Nevil then worked with Associate Professor Michael Keall on the *Housing Injury Prevention Intervention (HIPI)* study, finding that simple home repairs and modifications such as putting in grab rails in bathrooms reduced the number of falls in homes by 27%[4]. A preliminary analysis of the pilot showed the benefit-cost ratio of this home remediation was 9:1.

Further key studies led by Professor Michael Baker focused on environmental health, infectious disease and housing. His research showed household crowding is the single biggest risk factor for meningococcal group-B infection[5] and rheumatic fever[6].

He Kainga Oranga have collaborated with BRANZ since their inception, and their combined research has linked aspects of building physics (such as ventilation) to health effects on occupants. BRANZ has produced a report on the role of ventilation in managing moisture inside New Zealand homes, highlighting the importance of this in creating a healthy indoor environment[7]. Philippa and Nevil are on the advisory board of the Warmer, Drier and Healthier Homes Research Programmes at BRANZ.

> *"I want people to have a better life because of the research I've done. I want people to be happier and healthier."*
>
> Associate Professor Nevil Pierse DEPUTY DIRECTOR, HE KAINGA ORANGA

CASE STUDY TWO

FUNDING

He Kainga Oranga has received over $20 million in funding since 1998. Major funders include:

- The Health Research Council (HRC), including $10 million in programme grants
- The Ministries of Business Innovation and Employment; Health; and the Environment
- Royal Society Te Aparangi
- Cure Kids
- Asthma Foundation
- Accident Compensation Corporation
- Housing New Zealand Corporation
- Hutt Mana Charitable Trust
- Lottery Health
- BRANZ

RESEARCH SNAPSHOT

The key, world-leading, papers produced by He Kainga Oranga are:

1. The housing, insulation and health study: *Effect of insulating existing houses on health inequality: cluster randomised study in the community.* This was the cover story of the BMJ in 2007[1].
2. The housing, heating and health study: *Effects of improved home heating on asthma in community dwelling children: randomised controlled trial*. Published in the BMJ in 2008[2].
3. The injury prevention study: *Home modifications to reduce injuries from falls in the home injury prevention intervention (HIPI) study: a cluster-randomised controlled trial*. Published in The Lancet in 2015[4].

The three main studies:

- Have been cited in 457 academic publications indexed by Scopus.
- Have rankings in the 98th, 84th and 97th percentiles of citations, respectively, in the field of medicine (Scopus).
- Have had 16 media mentions, including ABC News Australia.
- Have been cited 3 times in reports on the New Zealand Parliament website and 9 times in submissions to Parliament.
- Are all in the top 5% attention scores by Altmetrics.com.

An additional 63 academic publications from He Kainga Oranga have been cited 790 times by researchers in 79 countries (Scopus).

KEY REPORTS:

1. *Warming up New Zealand: Impacts of the New Zealand Insulation Fund on Metered Household Energy Use* (2011)[8].
2. *Cost benefit analysis of the Warm Up New Zealand Heat Smart Programme* (October 2011, revised July 2012)[9].
3. *The impact of retrofitted insulation and new heaters on health services utilisation and costs, pharmaceutical costs and mortality* (2011)[3].
4. *Impacts of the NZ Insulation Fund on Industry and Employment* (2011)[10].

These reports have been cited 21 times in national and 18 times in international reports, and three times in submissions to Parliament.

WORLD HEALTH ORGANISATION HOUSING AND HEALTH SOUTHERN HEMISPHERE GUIDELINES LAUNCH

The Southern Hemisphere launch of the World Health Organisation Housing and Health Guidelines was held at the University of Otago, Wellington in February 2019. The guidelines group was chaired by Professor Philippa Howden-Chapman. This event was both a celebration of the launch of the guidelines and an important step in their dissemination, as it brought together stakeholders from industry, research and politics, including Hon James Shaw, MP (Co-leader Green Party, Minister for Climate Change, Associate Minister of Statistics, Associate Minister of Finance), and Dr Ashley Bloomfield, Director General of Health. These guidelines are the first sector guidelines produced by the World Health Organisation[11].

> *" The World Health Organisation's International Housing and Health Guidelines provide important and useful advice for us to bear in mind when formulating better policy for our people. They not only show us what needs to happen to provide better futures for our citizens and their families, but they help us to decide how it should happen, and perhaps most importantly, why it needs to happen."*
>
> Hon James Shaw, MP.
> CO-LEADER GREEN PARTY, MINISTER OF CLIMATE CHANGE,
> ASSOCIATE MINISTER OF STATISTICS, ASSOCIATE MINISTER OF FINANCE[20]

DETAILS OF THE IMPACT

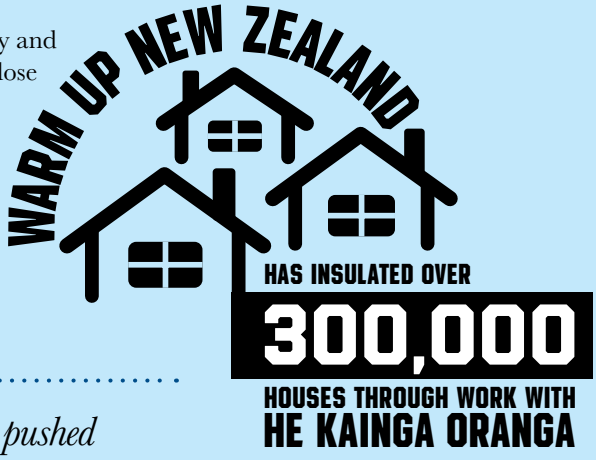
NATIONAL IMPACT

POLICY AND PROGRAMME DEVELOPMENT

- The *Rental Warrant of Fitness* programme was created through collaboration between the University of Otago and the New Zealand Green Build Council (NZGBC), in consultation with other organisations. It provides a manual and a room-by-room checklist for rental properties to ensure they are of appropriate condition[13, 14].
- *Well Homes* is a free programme run in conjunction with the Sustainability Trust, Tu Kotahi Māori Asthma Trust, and Regional Public Health, aiming to reduce crowding and to assist whānau in making their homes safe, healthy and dry[15].
- The Cross-Party *Inquiry on Homelessness* (2016) was informed by the work of He Kainga Oranga. The report's first recommendation was to roll out *Housing First* as the primary response to severe homelessness[16.] The *Housing First* programme started with $2.5 million in pilot funding with a further $63.4 million invested in 2018[17]. Through *Housing First*, 2,700 people now have permanent, warm, dry housing[18].

CASE STUDY TWO

- BRANZ and He Kainga Oranga provided extensive research input underpinning the formulation of *The Healthy Homes Guarantee Act 2017*, which came into force on 1 July 2019[19]. The Act legislates that landlords must comply with a healthy homes standard, including standards on indoor temperature, heating, insulation and drainage. New standards were announced in February 2019[20].
- The *Warm Up New Zealand* programme run by the Energy Efficiency and Conservation Authority/Te Tari Tiaki Pūngao (EECA) has spent close to one billion dollars insulating over 300,000 houses through work with He Kainga Oranga[15]. The Government has pledged another $142.5 million to cover the costs of ceiling and underfloor insulation for thousands of low-income homeowners. That investment was boosted at the start of 2019 by nearly $5 million from community organisations, councils, charitable trusts, and DHBs[20]. This additional funding has resulted in 3,200 homes being insulated as of February 2019[20].



> *" I think the great thing about this programme was it pushed governments to do something that they might not have done, in a big way".*
>
> Professor Julian Crane CO-DIRECTOR, HE KAINGA ORANGA

HEALTH AND WELLBEING

- Countless individuals, including over 10,000 research participants, as well as those who have benefitted from consequential government subsidies and minimum housing standards, have benefitted from warmer, healthier homes. Improved housing standards have also helped to address health inequalities by addressing social and environmental inequalities.

ENVIRONMENTAL

- Better housing standards reduce heating emissions, leading to impact on the environment through reduced heat loss and energy usage, thus reducing contributions to climate change.

ECONOMIC

- The cost-benefit analysis of the *Warm Up New Zealand: Heat Smart* programme had showed an estimated net benefit of $950 million[9 p iv]. Now that the programme has been rolled out and extended, it is estimated to have delivered $2 billion of benefit to New Zealand.
- Improved housing standards lead to less time off work or school due to fewer sick days, and a reduced burden on the health system.
- Improvements in housing mean that energy insecurity is reduced, as well as the cost of heating for home occupants.

Members of He Kainga Oranga (L-R): Associate Professor Nevil Pierse, Professor Philippa Howden-Chapman, Professor Julian Crane, Professor Michael Baker

PATHWAY TO IMPACT

LEADERSHIP AND TEAMWORK

- Highly accomplished leadership has been the driving force behind the success of He Kainga Oranga. This has resulted in a cohesive, high-achieving team and a culture of mutual support.
- Team meetings are a key feature of how the team work - team members share stories of what is, and what isn't working in their research and what help they need.

RESEARCH FRAMEWORK AND QUALITY

- He Kainga Oranga has a firm conviction to undertake research with a strong public health focus. They have recognised that a systematic approach is key, including addressing economic, social, environmental, and cultural issues.
- Working as an interdisciplinary team (encompassing biostatistics, public health, medicine and psychology) has enabled them to provide high-quality evidence to a wide range of research questions.
- The ability to think ahead and think strategically, including looking at overseas research and policy, has helped to produce high-quality research.

ENGAGEMENT WITH THE COMMUNITY

- He Kainga Oranga has shown a strong commitment to ongoing community engagement.
- Engagement involved research participants, the wider community, and Māori and Pasifika stakeholders. Although engagement requires investment of money and time, it means there can be a long-lasting, beneficial relationship for both parties.
- Community goodwill has been vitally important. Community partnerships have led to participant retention rates in the research studies of over 80%.

" We adopt a philosophy of what Fred Hollows said: 'there should be no survey without service' ".

Professor Philippa Howden-Chapman
DIRECTOR, HE KAINGA ORANGA

- He Kainga Oranga has had meaningful, long-term relationships with Māori researchers and Māori community organisations, and the Tū Kotahi Māori Asthma Trust in particular. Feeding back on findings enables participants to feel valued and supported.

" My big piece of advice is to develop, or establish, a meaningful relationship with Māori. If you have a Māori provider that you've done work with previously, don't just finish with that study and then only go back to them maybe five years later. It goes a long way when you nurture that relationship and you keep that relationship going."

Cheryl Davies MANAGER TŪ KOTAHI MĀORI ASTHMA TRUST

CASE STUDY TWO

TRANSLATION INTO POLICY

- A strategy used to increase the translation of He Kainga Oranga's research into policy is to present findings in the form of economic analysis reports, which provide the real-world economic benefit of implementing recommended changes[3, 9].
- Research can provide compelling evidence on issues which urgently need addressing. For example, the finding that 28,000 children were hospitalised every year with housing-preventable diseases, and 853 died within a 15-year period, is difficult for policy makers to ignore.
- Partnership with, and responsiveness to, policy makers/analysts is key to success. If a Minister wants information, then the request is prioritised.
- The team constantly engage with policy makers to ensure that their research is kept on the agenda. This means, at minimum, three-monthly meetings with research users.

> *"The real kicker to getting that impact over the line is somebody who has the ability to pick it up and make a difference, and is working in the right place to make that difference. We make a lot of noise to keep it on the agenda."*
>
> Associate Professor Nevil Pierse DEPUTY DIRECTOR, HE KAINGA ORANGA

STAKEHOLDER ENGAGEMENT

- Early and proactive stakeholder engagement has been vital, and considered the groups that may be interested in the work, and those who might be affected by potential change. Examples include community NGOs involved in housing, health, poverty or Māori development; Ministries; other government bodies (EECA, BRANZ, Housing New Zealand and Māori Boards); and visiting academics.
- Early stakeholder engagement has also been important for strengthening grant applications as it shows that researchers have thought about who to work with and what impacts may ensue.
- Relationships with stakeholders are built on mutual respect, co-ownership of the research, and an understanding that each party brings different skills to the table.
- Stakeholders are invited to participate in weekly group meetings.

CAPACITY BUILDING

- He Kainga Oranga is devoted to supporting students and nurturing new researchers. For example, Philippa has supervised an estimated 20 PhD, 14 Masters, 15 summer and 15 visiting students, many of whom have gone on to become team members.
- The team is involved in Otago University's Public Health Summer School, led by Michael Baker. The school has evolved over 12 years to become one of the largest public health summer schools in the world. 40% of attendees are government staff.

DISSEMINATION OF RESULTS

- Prior to the research there was little knowledge of housing having an impact on health, and the media has been vitally important in getting this message to the public. The team frequently issue press releases. Public interest in housing means that the researchers are often called on for comment.
- Getting the research into the WHO guidelines was key to initiating change in policy making.

WHAT NEXT?

- Nevil currently leads the *Housing First* research, with the aim of reducing the number of people sleeping rough in New Zealand streets by 90%.
- Michael Keall is leading a further injury prevention study, called *Safety on Steps.* This randomised controlled trial builds on the findings of the injury prevention study.
- He Kainga Oranga and Tu Kotahi Māori Asthma have a project called *He Tipu Manahau*, which is based around the development of affordable, good-quality housing in Wainuiomata using the concept of Ko Toku Kainga.
- *Warm Hearts* is a follow up study to *Warm Homes for Elderly New Zealanders* and is being undertaken with the support of Tū Kotahi Māori Asthma Trust. This study continues to monitor a sub-group of initial study participants, and is particularly concerned with cardiac outcomes.
- An eviction study led by Philippa is looking at understanding the experience of those who have been evicted from their homes, as well as views from other stakeholders, including the courts, social workers and community workers.

FOR MORE INFORMATION ON HE KAINGA ORANGA, SEE THEIR WEBSITE AT
www.healthyhousing.org.nz

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CASE STUDY TWO

CASE STUDY THREE

SCHOOL OF BIOMEDICAL SCIENCES

PROFESSOR PETER FINERAN

WORLD-LEADING RESEARCH IN PHAGE AND CRISPR-CAS SYSTEMS

Professor Peter Fineran

PARTICIPANTS INTERVIEWED FOR THE CASE STUDY

PRINCIPAL INVESTIGATOR

Professor Peter Fineran Department of Microbiology and Immunology, School of Biomedical Sciences

RESEARCHERS

Dr Rebekah Frampton Research Associate, Plant & Food Research
Former University of Otago PhD student

Assistant Professor Raymond Staals University of Waginengen, The Netherlands
Former University of Otago postdoctoral fellow

Associate Professor Stan Brouns University of Delft, The Netherlands

Assistant Professor Richard Scheltema University of Utrecht, The Netherlands

STAKEHOLDERS

Dr Andrew Pitman former Team Leader at Plant and Food Research
Now General Manager at the Foundation for Arable Research

Dr Sonia Whiteman Innovation Team Leader, Protect Supply at Zespri International Limited

Associate Professor Stan Brouns Delft University of Technology, The Netherlands

SUMMARY OF THE IMPACT

Professor Peter Fineran leads a research group in the Department of Microbiology and Immunology at the University of Otago. The impact of his internationally-renowned research has been to advance knowledge of how CRISPR-Cas systems are regulated, and how they work as 'molecular scissors' to cut genes. Peter has also had impacts in increasing public knowledge of science and building capability of students and scientists in the CRISPR-Cas arena. Applications to industry, as evidenced by his work on bacteriophage strategies to manage the Psa infection in kiwifruit, have also been impacted by Peter's research. Peter's success has come through high-quality research disseminated widely to the scientific community and public, as well as close collaboration with industry.

UNDERPINNING RESEARCH

Professor Peter Fineran's main research interests are the bacteriophage-resistance mechanisms of bacteria. Bacteriophages (also known as phages) are viruses which infect bacteria[1]. Bacteria have their own 'immune systems' called CRISPR-Cas, just as humans have theirs. The bacterial CRISPR-Cas systems destroy invading phages and can also prevent bacteria from acquiring antibiotic-resistance genes.

Peter's main research goal is to understand the interactions between phages and their bacterial hosts. This involves understanding how these CRISPR-Cas immune systems work, including when bacteria use this immune response, how bacteria are able to communicate with each other, and how they gain 'memory' of phage attack. Peter is also interested in the potential real-world applications of phages, such as their use as antimicrobial agents. Peter's world-leading work has shown how CRISPR-Cas systems are regulated, and how they work as 'molecular scissors' to cut genes.

CRISPR-Cas systems are used for gene editing, diagnostics, regulating gene expression and related technologies[1], with the potential for a wide variety of applications in other research, biomedical therapies, and genomic editing of organisms. Applications of genome editing are depicted below[2 p4] (Figure 1):

FIGURE 1: APPLICATION OF GENOME EDITING
(Modified from Hsu et al. 2014)

The extension of CRISPR tools into human genome editing has fundamental ethical issues, which are currently being debated amongst scientists and the public[3]. Peter has been a public figure in these discussions, such as by participating in public talks[4].

Currently, Peter is investigating the potential use of phages as a biocontrol agent against the *Pseudomonas syringae pv. actinidiae* (Psa) pathogen. Psa is a bacterium which causes kiwifruit canker. It was first discovered in New Zealand in November 2010 and in 2011 Peter started working with Zespri International Limited, the world's largest marketer of kiwifruit to develop phage-control strategies.

FUNDING

Peter's work has had over $6 million to date from a number of funders, including:

- Rutherford Discovery Fellowship and Marsden Fund, Royal Society Te Apārangi
- Zespri International Ltd.
- Tertiary Education Commission, NZ, via the Bio-Protection Centre of Research Excellence
- European Research Commission, European Union
- Ministry for Business Innovation and Employment

COLLABORATIONS

Peter has extensive collaborations – 12 national collaborators from eight organisations, and 15 international collaborators from nine institutions in six different countries.

RESEARCH SNAPSHOT

- Peter has produced 46 publications on phage and/or CRISPR-Cas systems, cited 2070 times in Scopus and averaging 46 citations per publication.
- Peter has been involved in producing documents designed to provide information to the public, such as the Royal Society fact sheet on gene editing[2].
- Peter has contributed to submissions to Government with the aim of influencing science policy, e.g. a response to the National Statement of Science Investment draft in 2014[6], and the Ministry of Business, Innovation and Employment's *The Impact of Science* in 2017[7].
- Peter has been an invited presenter at ~25 conferences (mostly international).
- Peter participates in events to engage the public in the science around CRISPR technology, including a panel discussion at the *LATE at the Museum* event at Auckland Museum, also broadcast on Radio New Zealand[4,5].
- Peter is regularly called on by the media to comment on CRISPR technologies. A recent example was the *New Zealand Geographic* in 2017[8].
- Peter has talked to Members of Parliament as part of the *Science Speaker Series* discussing CRISPR technologies.
- 12 of Peter's articles on CRISPR-Cas and phage have been cited in 58 granted patents.

RECOGNITION

Peter has received a number of international and national awards, including:

- 2019 Alexander von Humboldt Experienced Researcher Fellowship, Germany
- 2019 Fleming Prize, Microbiology Society, UK
- 2017 Genetics Society of AustralAsia Ross Crozier Medal
- 2017 Andrew Shelling Trophy, NZ
- 2015 NZ Society for Biochemistry and Molecular Biology Custom Science Award
- 2015 Thermo Fisher Scientific Award, for Excellence in Molecular Biology, NZ
- 2012 Rutherford Discovery Fellowship, Royal Society of New Zealand

DETAILS OF THE IMPACT

CASE STUDY THREE

ADVANCING KNOWLEDGE

- Peter's work has advanced scientific knowledge around the role of CRISPR-Cas defence mechanisms of bacterial populations, enabling further research and development to take place in the field.
- Through wide dissemination of his work, Peter is now recognised amongst scientists as an expert on CRISPR-Cas, increasing the reputation of the University of Otago.
- Peter's public outreach has increased knowledge of CRISPR-Cas technologies in the public domain. Due to the potential ethical implications of CRISPR technologies it is important the public is well informed and takes part in decision-making.

BUILDING CAPABILITY

- Over 50 students and staff have trained and worked in the Peter's lab in the past 10 years, expanding their knowledge and research capability. A number have gone on to run their own laboratories overseas.
- Capability development increases the potential for translation to other aspects of basic science, for example findings on the phage mechanism of Psa may be transferred to other bacterial pathogens of medical importance.
- The movement of trained staff to other institutes has enabled phage and CRISPR research to be undertaken in organisations where there was previously no capacity in this area. For example, Dr Rebekah Frampton moved from Peter's lab to Plant & Food Research, which has enabled students and technicians in the organisation to build their capability with CRISPR technology.

TRANSLATION TO APPLICATIONS

- With regard to Psa, Peter's CRISPR research is allowing the development of phage-control strategies to be tailored and applied in a more specific manner. This may ultimately lead to better crop yields and associated economic impacts. There are also potential environmental impacts as it would reduce the use of harmful agrichemicals and antibiotics, ultimately preventing antibiotic-resistance, one of the biggest threats to the world's food security[9].
- CRISPR-Cas mechanisms are now used as DNA editing tools in research environments. These tools have accelerated research into treatments for certain human genetic disorders such as sickle cell anaemia The rapidly-expanding biotechnology industry built on CRISPR-Cas genome editing now exceeds one billion US dollars, and Peter's research has broadly informed this work.

" CRISPR tools now are being applied across all different research areas of biology. So, anyone who wants to understand how any organism works, can now use CRISPR to mutate or control a particular gene. There's huge impact from that."

Professor Peter Fineran DEPARTMENT OF MICROBIOLOGY AND IMMUNOLOGY, SCHOOL OF BIOMEDICAL SCIENCES

PATHWAY TO IMPACT

CHARACTERISTICS OF THE RESEARCH

- Peter has created his own niche in the field by undertaking novel research. This has allowed him to generate impact in a highly competitive area of research.
- The research programme is highly cohesive with all projects interconnected into the theme of phage-bacterial interactions. This allows the scientists to collaborate, help each other, troubleshoot, and share what works.
- The research is scientifically excellent, making it of high value to other scientists and stakeholders. For example, 58 granted patents cite Peter's research.
- The choice of research that is applicable to multiple areas (e.g. biotechnology, agriculture, human health, society) has allowed it to have widespread actual, and potential, impact.

ENGAGEMENT

- Peter has actively sought engagement with industry. He approached the industry stakeholder Zespri after the 2010 Psa outbreak and they agreed to fund this work.
- Engagement with the public has been important for increasing understanding and awareness of the role of science in society. This engagement has provided Peter with feedback on his research, allowing him to understand different perspectives on his research, and gauge the interest in his work.
- Peter has met with kiwifruit growers to gain insight into the environment in which the research is hoped to provide impact.
- Taking media opportunities as they arise has been important for disseminating the research message.

> *"Unintended things – those won't happen if you don't engage. If you just sit in your lab, sit in your office, those doors won't open."*
>
> Professor Peter Fineran DEPARTMENT OF MICROBIOLOGY AND IMMUNOLOGY, SCHOOL OF BIOMEDICAL SCIENCES

TEAMWORK AND COLLABORATION

- Relationships with organisations that are potential avenues for delivering impact, such as Plant & Food Research and Zespri, have been prioritised.
- Peter utilises people close to the end-user (for example, Dr Sonia Whiteman from Zespri), understands their strengths and involves them in discussions, thereby creating teams of people involved in creating impact.
- Attending and presenting at conferences has been an excellent tool for keeping up to date with advances in the field and setting up new collaborations.
- Sharing lab meetings with researchers from other areas is a good way of being exposed to different research perspectives.
- Peter works with overseas groups to undertake research for which there is currently no technological capability in New Zealand. For example, collaborating with Associate Professor Richard Scheltema and Professor Albert Heck's world-leading proteomics laboratory in The Netherlands* has enabled the study of protein complexes and Cas protein complexes by mass spectrometry and crosslinking.

Dr Sonia Whiteman

*University of Ultrecht

COMMUNICATION SKILLS

- Strong communication skills have been important for building networks and relationships.
- Clear communication with end-users has been vital. This includes being honest about limitations, being open to constructive criticism and allowing end-users the opportunity to make informed decisions.
- Presenting research in a way that is understandable to a non-specialist audience is important when engaging with stakeholders and the public.

> *" Have a good story. You've got to connect with the people who are funding you, and with who it's going to make a difference to."*
>
> Dr Rebekah Frampton RESEARCH ASSOCIATE, PLANT AND FOOD RESEARCH

WHAT NEXT?

- The ultimate aim of the Psa research is to create a product to control or eliminate Psa. This will require a commercialisation process, and finding a pathway to market which may result in economic benefit for the researchers and stakeholders.
- Research will continue into understanding how CRISPR systems work and how they can be exploited. This has potential impact for understanding and halting the spread of antibiotic resistance.
- Within the team, there is opportunity to develop new diagnostic tools around CRISPR-Cas, and move into the applied space.

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CASE STUDY THREE

CASE STUDY FOUR

SCHOOL OF BIOMEDICAL SCIENCES

ASSOCIATE PROFESSOR PETER MACE

ONE STEP CLOSER TO CANCER TREATMENT

(L-R): Associate Professor Peter Mace, Sam Jamieson, Dr Anita Dunbier

PARTICIPANTS INTERVIEWED FOR THE CASE STUDY

PRINCIPAL INVESTIGATOR

Associate Professor Peter Mace Senior Lecturer, Department of Biochemistry

RESEARCHER

Sam Jamieson Senior Technician, Department of Biochemistry

STAKEHOLDER

Dr Anita Dunbier Senior Lecturer, Department of Biochemistry

SUMMARY OF THE IMPACT

Associate Professor Peter Mace is a biomedical scientist who discovered several structures of a protein with an important role in inflammation, as well as potential roles in some cancers. Impacts of Peter's research to date include building capability in students and staff, creating collaborations and advancing knowledge. Peter has achieved this by addressing knowledge gaps, trying new ideas, building relationships, and disseminating his research findings widely. Potential future impacts include using the protein as a drug target for the treatment of cancer.

UNDERPINNING RESEARCH

Associate Professor Peter Mace is a structural biologist. The wider aim of his research is to discover the 3D structure of proteins and the influence of structure on function. From his initial discovery in 2014, several structures of a protein called Tribbles have been solved[1,2]. Tribbles is encoded by the TRIB1 gene, which is important in inflammation and cancer. The Tribbles protein family is named after a small, furry creature from Star Trek that reproduce rapidly[3]. Within the cell, the protein produced from the TRIB1 gene plays diverse roles in cell development and signalling[4].

In 2013 Peter established his laboratory with funding from a Rutherford Discovery Fellowship in the Department of Biochemistry at the University of Otago. Peter initially looking at the basic biology of proteins similar to Tribbles, then investigating Tribbles sequences. There was no structural information about these proteins, so there was space in the field to research fundamental aspects of the 3D shape of these proteins and how they work. Peter found that Tribbles proteins were highly expressed in many cancers, such as breast cancer, and finding their structure and function could potentially lead to using them as a therapeutic target for drug development. Peter is leading the discovery of the structure of these proteins internationally, with several groups interested in the protein's function. Overall, Peter's research has resulted in a greater understanding of how Tribbles proteins are interacting at a cellular level, and what the consequences are of those interactions[1, 2].

Peter and his collaborators* produced the first 3D images of the Tribble-1 using the Australian Synchrotron, which uses powerful X-ray beams to image a protein's structure[5]. Peter's team discovered that Tribble-1 does not have kinase activity, but has a switch-type mechanism when it binds substrates as the active site opens up. The major implication of this is that a large pocket then becomes available where potential small molecule drugs could bind. Research has shown that Tribbles-1 promotes acute myeloid leukaemia, and suggest it could also be involved in breast cancer, so the development of a drug targeting Tribbles-1 could improve outcomes for cancer patients. Breast cancer and leukaemia have the greatest and the 10th-greatest incidence of all cancers in New Zealand, with 87.3 people and 8.8 people affected per 100 000 respectively. The annual public cost of breast cancer is $76.8 million (based on 2008 figures) and $68.5 million for leukaemia[6, 7].

Breast cancer researcher Dr Anita Dunbier, who is also in the Department of Biochemistry, collaborates with Peter to explore the connection between breast cancer and Tribbles. Peter approached Anita after he found that Tribble-1 was over-expressed in breast cancer; together they have co-supervised a PhD student Hamish McMillan whose work is focused upon understanding the protein's interactions. A key part of the project used a novel technique called Rapid Immunoprecipitation of Endogenous Proteins (RIME), enabling researchers to examine the protein in the cell in a natural situation to identify the other proteins with which it is interacting, revealing more about its function and potential role in breast cancer.

Peter is also collaborating with Dr Karen Keeshan's† laboratory to investigate the role of Tribbles proteins in leukemia. Her lab is working with mouse and human models of leukemia, which is one further step nearer to human studies. They are also developing protein reagents that specifically change levels of Tribbles proteins, which may be applicable in cancer-specific models.

* Structural work was performed with Sam Jamieson, and contributions from Yoshio Nakatani (Otago) and James Murphy (Walter and Eliza Hall Institute, Melbourne)
† University of Glasgow

After receiving additional funding from the Health Research Council (HRC), Peter continued to carry out structure determination studies and develop research capability through supervision of an assistant research fellow and senior technician in the lab, and co-supervision of PhD students.

FUNDING

- HRC, $1.13 million over 3.5 years.
- 2012 Rutherford Discovery Fellowship from the Royal Society of New Zealand, $920,000 over 5 years – generation of preliminary insight
- Lotteries Health Research – indirect funding of equipment that was integral to the research
- New Zealand Synchrotron Group (MBIE and Otago)
- Contract research income from the drug company

RESEARCH SNAPSHOT

- Peter has two academic publications on Tribbles[6, 7]. These publications have been cited in 38 academic articles from 13 different countries.
- Peter has been invited to present his research three times in the USA and three times in Europe. Conferences were organised by the Biochemical Society and European Molecular Biology Organization in Europe, and the American Society for Biochemistry and Molecular Biology in the USA (twice). Other seminars were at research institutes or companies.
- Peter spoke about his research on Channel 9 news, and articles were published on his research in the New Zealand Herald[8], the Otago Daily Times[9], and stuff.co.nz[10].
- Peter has academic collaborations with James Murphy and Isabelle Lucet (Walter and Eliza Hall Institute, Melbourne) Anita Dunbier (University of Otago) Natarjan Kannan (University of Georgia), and Alison Axtman (University of North Carolina).
- Peter is collaborating internationally with one drug and one biotechnology company.

DETAILS OF THE IMPACT

CAPACITY BUILDING

- Peter has taught biomedicine to students who go on to work in different fields. For example, Peter teaches in the Bachelor of Science programme, with students going on to a variety of science careers, and some into medicine.
- Peter also plays a major role in the Department of Biochemistry crystallography group and through this is assisting and training a wider group of researchers in synchrotron science and structural biology.
- Hamish McMillan is a PhD student of Māori descent co-supervised by Peter and Anita who won the European Society for Medical Oncology award at the NZ Society for Oncology Conference in 2018, for his talk *The Role of Pseudokinase TRIB1 in Breast Cancer*.
  He was the Elman-Poole Scholarship and Majorie McCallum travel award in 2018 to travel to the UK and learn further techniques.
- Senior technician Sam Jamieson, who is of Māori descent, now manages the structural biology resources in the department (after building experience specifically in this project), and will continue to be an integral member of the research workforce.

CASE STUDY FOUR

ECONOMIC

- Through the relationship with the drug company, the lab has been able to undertake contract work, screening samples, thus bringing income to the department to support more research.

ADVANCING KNOWLEDGE

- Discovery of the Tribbles-1 structure has advanced scientific knowledge in this area. Other research groups have gone on to use the structural findings with Tribbles-1 to draw conclusions on related Tribbles proteins, which also have roles in cancer and metabolic diseases.
- The knowledge generated has drawn attention in the wider field of pseudokinase biology, by demonstrating potential for drug targeting of this type of protein.

POTENTIAL IMPACTS

- Several industry groups are now interested in partnering with Peter to characterise Tribbles-binding drugs. This means that they are screening for compounds that bind to Tribbles-1, or will develop these compounds themselves.
- The ultimate impact that this research is working towards is that a drug will be designed and applied that targets Tribbles and reduces the burden of cancer and helps people to achieve better health outcomes.
- Through collaborations with a biotechnology company, it is hoped Peter's lab may be able to both advance compound development and aid workforce development by giving researchers at Otago experience in collaborative drug discovery.

" The work we do is at one end of the process, it might be several steps removed from getting to a patient, but I feel like if we can see how proteins work by solving their 3D structures, inherently other people who're studying those proteins are going to find they're useful. I feel like that's having impact."

Associate Professor Peter Mace
DEPARTMENT OF BIOCHEMISTRY,
SCHOOL OF BIOMEDICAL SCIENCES

PATHWAY TO IMPACT

CHARACTERISTICS OF THE RESEARCH

- Peter has identified that an important part of this research has been filling a knowledge gap of the structure of the Tribbles proteins. Interest has been created around his work as it is novel and of high quality. Novel research also helps to attract grant funding.
- Peter feels it is important that this research is of benefit to other researchers. By working with researchers looking at the function of Tribbles proteins, Peter's research is able to inform other people's research and thus broadens the opportunities for the knowledge to be translated into outcomes.
- Being prepared to try new things is important in this type of discovery research. This includes trying to come up with new analytical techniques in order to push the boundaries of novel science. However, with Peter's research he emphasizes that it is important to choose targets carefully, as this will determine what scientific route will be taken.

> *" Peter's good at finding new techniques, and I help to get them to work. You certainly have to be prepared to try a lot of new things, that seems to yield results".*
>
> Sam Jamieson SENIOR RESEARCH TECHNICIAN, DEPARTMENT OF BIOCHEMISTRY, SCHOOL OF BIOMEDICAL SCIENCES

- Understanding the problem is important, with the ability to link basic science research through to ultimate impacts, even though these may be a long way off. Anita emphasises the need to understand the clinical problem when working in healthcare. This involves talking to clinicians to gain a good understanding of current issues.

> *" If you're going for impact in the health sector, you need to be thinking about the use of your research. Make sure you understand the problem, and the clinical problem, and know what's relevant".*
>
> Dr Anita Dunbier SENIOR LECTURER, DEPARTMENT OF BIOCHEMISTRY, SCHOOL OF BIOMEDICAL SCIENCES

GRANT APPLICATIONS

- Peter feels that the process of writing grants, though sometimes laborious, is useful for developing ideas. It gets you thinking about possible impacts, and framing the research in its most impactful sense can be useful. Impact is an important component in engaging the assessment panel and saying why they should fund the research.

RELATIONSHIPS

- Building personal relationships is a key component to achieving impact. Peter has identified people to work with, for example he approached Anita, in order to collaborate, after he initially found the link between Tribbles and breast cancer. This relationship has informed his knowledge of the clinical relevance of his own work.
- Similarly, other scientists have been interested in forming relationships with Peter because of the quality of his research and because he filled a gap of knowledge in the field.

FUNDING

- Obtaining consecutive grants (firstly from the Rutherford Discovery Fellowship for the preliminary work, then from the HRC) has enabled the research to develop, whilst also funding the capability-building of staff in this research area. For example, the ongoing HRC funding received in 2015 allowed Sam to be employed as a research technician.

DISSEMINATION

- Peter has observed that people are inherently interested in science, so it is important to talk to the public through the media. Peter finds this is generally received very positively – that it helps as a fundamental science researcher to realistically consider the ultimate potential for impact.
- Conferences are important for networking and exploring new collaborations. This leads to a 'snowball effect', where researchers are able to collaborate more.

- Scientists have become more interested in the Tribbles work the more that it has been disseminated.
- Peter sees his job as providing useful information to people, so that other scientists who are studying these proteins are going to find the work useful.

WHAT NEXT?

- Further funding applications are now being considered to advance Tribbles work in leukaemia, generating reagents that can control protein levels in cells and assisting in structure-based drug design.

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CASE STUDY FOUR

CASE STUDY FIVE

SCHOOL OF PHARMACY

PROFESSOR PAULINE NORRIS

CREATING KNOWLEDGE FOR CHANGE IN MEDICINES POLICY

(L-R): Professor Pauline Norris, Dr Simon Horsburgh

PARTICIPANTS INTERVIEWED FOR THE CASE STUDY

PRINCIPAL INVESTIGATOR

Professor Pauline Norris Centre for Pacific Health (formerly School of Pharmacy)

RESEARCHER

Dr Simon Horsburgh Dunedin School of Medicine

STAKEHOLDER

Andi Shirtcliffe Chief Advisor, Pharmacy, Ministry of Health

Catherine Proffitt Manager – Strategic Planning and Performance, Pharmaceutical Management Agency (PHARMAC/Te Pātaka Whaioranga)

Sandy Bhawan Manager – Access Equity, PHARMAC/Te Pātaka Whaioranga

SUMMARY OF THE IMPACT

Professor Pauline Norris is a social pharmacy researcher who has achieved impact via advancing knowledge around social pharmacy, writing guidelines, and built academic capability in the students she works with. Pauline has achieved impact by answering research questions addressing current social issues, engaging meaningfully with stakeholders, collaborating with research partners, being adaptable, and disseminating findings in accessible ways.

> *" Working with Pauline was awesome. I think she's just amazing- she builds an impact and she's so clearly focused on trying to improve things for people. It makes you feel like your research does have meaning."*
>
> Dr Simon Horsburgh DEPARTMENT OF PREVENTIVE AND SOCIAL MEDICINE, DUNEDIN SCHOOL OF MEDICINE

UNDERPINNING RESEARCH

Professor Pauline Norris is a social pharmacy researcher who aims to understand how people access and use medicines using social science methods. Social pharmacy is an applied research discipline which investigates the overlap between the social and behavioural sciences and pharmacy practice, including understanding and improving access to, use of, medicines. Pauline has undertaken research into a variety of areas, including prescription charges, socioeconomic and ethnic variation in the use of medicines, personal medicine storage, medicine availability and funding under PHARMAC (the Pharmaceutical Management Agency/Te Pātaka Whaioranga), and people's knowledge and use of antibiotics.

PRESCRIPTION CHARGES

Pauline undertook research into prescription charges in 2012 when the government increased the co-payment for prescription medicines to $5 (for up to 20 prescriptions, after which there should be no charge) from $3. Pauline's research found that for the 10.3% of New Zealanders living in poverty, paying $5 per prescription was prohibitive and meant people went without medication, putting their health at risk[1]. PHARMAC/Te Pātaka Whaioranga data highlighted by Pauline showed 40% of New Zealanders continued to pay for 90% of their prescription items, even after they reached 20 items, resulting in unnecessary spending of $2.5 million[1]. Pauline's research highlights that affordability of medicines is an easily-modifiable barrier to accessing healthcare. Qualitative research published in 2016 showed people were forgoing prescription items, or making sacrifices such as delaying picking up medicines or reducing dosage due to cost, which comes with potential health risks[2].

SOCIOECONOMIC AND ETHNIC VARIATION IN USE OF MEDICINES

Pauline became interested in socioeconomic variation in the use of medicines once the means became available to study this - in the form of the National Health Index (NHI) numbers used on all prescriptions since 2006. *The Equity in Prescription Medicines Use* study investigated issues around medicine access, including geographic access and access to different types of drugs, using linked pharmacy data[3-7]. Part of this study investigated antibiotic use in people of different ethnicities in the Tairāwhiti (Gisborne) area[4]. It was undertaken in conjunction with Turanga Health (a Māori healthcare organisation) and Ngāti Porou Hauora (a Primary Health Organisation). The study found that antibiotic use was much lower amongst Māori, particularly in rural areas, than non-Māori. This was concerning as Māori have one of the highest documented rates of acute rheumatic fever and rheumatic heart disease in the world.

PEOPLE'S KNOWLEDGE AND USE OF ANTIBIOTICS

Pauline's research has further explored understanding of antibiotic use in New Zealand, with ethnic variation in use and perceptions addressed amongst immigrant, Māori and Samoan populations. One study involved interviews with Samoans living in New Zealand about their

understanding and reported use of antibiotics[8]. Results showed there was some confusion about antibiotic medicine. Less than 2% of participants identified the correct purpose for antibiotics, and 66% thought they were used to relieve pain. Respondents thought that a wide range of medicines were classed as antibiotics. This has implications for health practitioners, as they should not assume Samoan patients share a Western scientific understanding of antibiotics and illness[8].

PERSONAL MEDICINES STORAGE

Pauline's study on the storage of medicines looked at how people store medicines and why[9]. Results revealed people often store medicines in places where temperature and humidity are likely to affect medicine quality and that items should not be stored in kitchens and bathrooms, in bags or cars longer than strictly necessary, or in a plane's cargo hold. The authors recommended health professionals, particularly pharmacists, should emphasise the importance of correct medicine storage, and that poor storage should be considered when medicines are not achieving their desired effect.

PHARMAC/TE PĀTAKA WHAIORANGA AND MEDICINES AVAILABILITY AND FUNDING IN NEW ZEALAND

Pauline undertook research on perceptions of medicine availability and funding through PHARMAC/Te Pātaka Whaioranga[10], who make decisions on which medicines are funded in New Zealand[11]. Respondents felt PHARMAC /Te Pātaka Whaioranga constrained medicine costs effectively, was politically neutral, and resistant to lobbying. Pauline also investigated the availability of specific medicines in New Zealand, such as the breast cancer drug Herceptin[12]. Another study, undertaken with a PhD student, compared medicine availability and subsidisation in New Zealand and Finland[13].

FUNDING

- Health Research Council (HRC), (including $1 million project grant for the *Equity in Prescription Medicines* study and the current *Prescription Charges* study, a randomised controlled trial.
- Marsden Fund
- New Zealand Pharmacy Education and Research Fund
- Pauline has worked with multiple students, mainly of Māori and Pasifika descent, who have obtained Summer Studentship funding from the HRC and the University of Otago

RESEARCH SNAPSHOT

- Pauline has produced 30 research articles on the topics included in this case study, which have been cited 321 times by authors in 61 countries[14].
- Pauline's research has been featured in a broad range of New Zealand news media, including the Dominion Post, the New Zealand Herald, NewsHub, the Otago Daily Times, The Press, Radio New Zealand, stuff.co.nz, the Sunday Star Times, and the Star[15-20].

DETAILS OF THE IMPACT

ADVANCING KNOWLEDGE

- Pauline aims to increase the awareness of the public, pharmacists, and those concerned with medicine use, around social pharmacy issues such as prescription charges and medicines storage. An example of this is the *Twenty is Plenty* campaign, a two-year initiative started in 2016 by University of Otago Pharmacy students. It was designed to inform the public that they only need to pay for a maximum of twenty prescriptions per year, with any additional prescriptions being fully subsidised. The students put stickers on prescription bags, and created a Facebook page (receiving 461 likes and 454 follows)[21, 22], Twitter account and YouTube channel. The students also attended community events, such as the Otago Farmers Market, to promote the campaign.

CASE STUDY FIVE

POLICY

- According to Andi Shirtcliffe (Chief Advisor – Pharmacy at the Ministry of Health), Pauline's research on prescription charges has broadened the awareness of issues with Ministry of Health Officials, and this, in turn, has had a positive impact on advancing policy discussions. It has also enabled the co-payment policy to be referred for consideration as part of the Health and Disability System Review.
- Pauline's research underpinned a 2019 literature review by PHARMAC/Te Pātaka Whaioranga entitled *Equitable access to medicines via primary healthcare*[23] and a discussion paper *Achieving medicine access equity in Aotearoa New Zealand: towards a theory of change*[24].
- PHARMAC/Te Pātaka Whaioranga have presented the above work to stakeholders including the Ministry of Health, District Health Boards and the Health Quality and Safety Commission, Primary Health Organisations, Pacific Health providers and Māori stakeholders (such as Whānau Ora collectives) at conferences and symposiums. Sandy Bhawan (Manager – Access Equity at PHARMAC/Te Pātaka Whaioranga) has noted that the discussion document on medicine access equity is of potential use to stakeholders as it has been presented in a way that facilitates translation into policy.

> *" For us, it's so important to have those voices of communities, and having their stories told through research."*
>
> Sandy Bhawan MANAGER – ACCESS EQUITY, PHARMAC/TE PĀTAKA WHAIORANGA

GUIDELINES

- Pauline was invited onto the group adapting the National Institute for Clinical Excellence (NICE) guidelines on antibiotic resistance for New Zealand, for the Best Practice Advocacy Centre (BPAC), published in 2017[25].

CAPABILITY BUILDING

- Student supervision has been a key factor in achieving impact. Pauline supported a PhD student, Shirley Keown from Turanga Health, through an HRC grant. This paved the way for an enduring relationship with the Māori healthcare organisation since 2006. Now Shirley is a co-investigator on the latest HRC grant, and Pauline is working with her on another HRC application.
- Pauline has supervised many Pacific and Māori students through summer research studentships, enabling them to undertake projects that will benefit their own communities.
- Pauline has also supported practising pharmacists to complete Masters degrees, enabling promotion into more senior positions.

PATHWAY TO IMPACT

ANSWERING THE RIGHT QUESTIONS

- Impact has been achieved by identifying and answering the questions that will be of benefit to end users. This may be different from researching a topic that will get you a publication in a good journal or receive praise from colleagues.

> *"I think that it would be better if people were brave and tried to answer questions that the world needs an answer to."*
>
> Professor Pauline Norris CENTRE FOR PACIFIC HEALTH, FORMERLY SCHOOL OF PHARMACY

ENGAGEMENT AND COLLABORATION

- Face-to-face engagement has been a priority through all of Pauline's research. Making direct connections with people enables an understanding of who is committed to pushing projects forward, as well as an understanding of the local context. The annual visits by Pauline and Dr Simon Horsburgh, a co-researcher, to healthcare providers for The *Equity in Prescription Medicines Use* study is one example of Pauline's engagement. Visits were facilitated by Dr Jenny Harre-Hindmarsh, Research Officer at Ngāti Porou Hauora.
- Early engagement with key policy and implementation contacts in government is crucial. This can help test whether an idea will be able to achieve the desired impact. This was a key feature of the work with Ngāti Porou Hauora and Turanga Health, where a local advisory group was set up to ensure research was going to benefit the community.
- Collaboration and co-creation of projects has been essential for achieving impact. This involved harnessing the combined knowledge of researchers and stakeholders, as well as the existing connections between pharmaceutical scientists and social pharmacists in the School of Pharmacy.

> *"When you're sitting here in Dunedin, you don't really know the details of how things work on the ground, whereas you go up there and you spend a couple of hours chatting to people, and you realise why something has happened that way, or why something is not really accurate, because you're missing out a whole lot of something else that they do. You really need that local context."*
>
> Professor Pauline Norris CENTRE FOR PACIFIC HEALTH, FORMERLY SCHOOL OF PHARMACY

CASE STUDY FIVE

RESPONSIVENESS

- An awareness of, and a responsiveness to, emerging themes has been key to achieving impact. For example, findings of the *Prevalence and Extent of Antibiotic Use* study identified rheumatic fever as an important area for health policy and practice, and one that was also very relevant to the local community[4]. The findings were picked up by the media (for example,[26, 27]) and were widely publicised to illustrate inequities in antibiotic prescribing between Māori and non-Māori. These findings were used by politician Dame Tariana Turia in a speech to medical students, and in comment to the media saying that doctors are failing their patients[28, 29].

DISSEMINATION

- Pauline has actively disseminated her work beyond academic publications. This has included presenting at organisations such as PHARMAC/Te Pātaka Whaioranga, and writing press releases for a variety of media formats, for example in newspapers[29] and on the radio[30].
- Dissemination of research in multiple formats makes the key messages more accessible to the public as well as to government stakeholders and policy makers, encouraging them to take on board evidence-based messages.
- It is important that communication is directly targeted at government stakeholders as, unless research is published in a seminal journal, it is unlikely to be seen and implemented.
- Media exposure has increased interactions between the researchers and interested organisations.

WHAT NEXT?

- The ultimate aim of Pauline's research is to ensure people in New Zealand (and elsewhere) have access to medicines they need.
- Pauline is currently recruiting for a new study called *Free Meds* about prescription charges, aiming to ascertain the extent to which prescription charges are stopping patients from accessing medicines. This was featured on Radio New Zealand in January 2020[31].

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CASE STUDY SIX

UNIVERSITY OF OTAGO, CHRISTCHURCH

CHRISTCHURCH HEART INSTITUTE

CARDIAC BIOMARKERS USED IN HEART FAILURE DIAGNOSIS, PROGNOSIS AND TREATMENT

(L-R) Research Professor Chris Charles, Research Associate Professor Chris Pemberton, Professor Richard Troughton, Professor Vicky Cameron, Professor Mark Richards

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SUMMARY OF THE IMPACT

The world-leading research of the Christchurch Heart Institute (CHI), based at the University of Otago, Christchurch, has influenced international clinical practice in the area of heart failure (HF). The research team has undertaken pioneering work with B-type natriuretic peptide (BNP) and amino-terminal pro B-type natriuretic peptide (NT-proBNP), including the discovery of circulating NT-proBNP. Both biomarkers are now widely used and endorsed by all authoritative international guidelines for HF diagnosis, prognosis and management. NT-proBNP is the single most widely used blood test (measured hundreds of thousands of times per year) for HF diagnostics and prognostics globally, resulting in improved health outcomes for patients and wider economic benefit. The impact of the CHI is the result of 35 years of sustained high-quality research from the team of biomedical scientists and clinicians, through a desire to continuously improve patient outcomes and clinical practice.

" The BNP story has had a major impact – it's changed how people diagnose and treat heart failure, and to some extent heart attack, not only in New Zealand, but internationally. It has put New Zealand on the map, a contribution to the global effort."

Professor Vicky Cameron GROUP LEADER,
THE OMICS LABORATORY, CHRISTCHURCH HEART INSTITUTE

UNDERPINNING RESEARCH

The CHI was formerly named the Christchurch Cardioendocrine Research Group (CCERG) by Professor Richards when he recruited researchers from multiple disciplines to form a cohesive group in the 1990s. The CCERG represented a more formal alliance of previous looser collaborations between Christchurch academic cardiology and endocrinology investigators, which had its origins in the early 1980s. Over the past 35 years the CHI has played a leading role in characterising the biochemistry, bioactivity and biomarker value of a wide range of peptides, most notably the natriuretic peptides (NPs) - circulating hormones generated by the heart – and developing these as cardiac biomarkers (indicators of heart disease, such as HF). NPs participate in maintaining total body balance of fluid and electrolytes and are therefore essential to life.

HF occurs when the heart is unable to sustain an adequate circulation of blood to meet the body's needs[1]. It is a leading cause of death and disability worldwide, affecting 80 000 New Zealanders[2]. HF has a high mortality rate, with up to 40% of patients not surviving one-year post diagnosis[3] and 15-50% of patients readmitted to hospital within 6 months of discharge[4]. HF is the single most common cause of medical admissions to hospital in those aged over 60 years. Internationally HF is responsible for ~2% of total healthcare costs, with hospitalisation being a major cost to health care systems.[5, 6]

The work of the CHI team is comprehensive, with over 200 research papers produced on cardiac biomarkers in heart failure. Selected highlights are described in the following paragraphs.

Professor Mark Richards came to Christchurch in 1983. Just prior to this, in 1981, the first direct evidence of the first NP to be discovered was published from a Canadian centre[7]. ANP (atrial natriuretic peptide, a type of NP produced mainly by the atria[8]) was sequenced in 1984 by Japanese workers. Richards worked with pioneering colleagues Professor Gary Nicholls, Emeritus Professor Eric Espiner, Professor Hamid Ikram and Associate Professor Tim Yandle to provide the first data on the integrated cardiovascular, kidney and hormonal effects of ANP in humans, and showing it was produced by heart tissue[9].

BNP (another type of NP originating from the heart) was discovered in 1988 by Japanese scientists, and soon after this CHI researchers Professor Mark Richards, Emeritus Professor Eric Espiner and Associate Professor Tim Yandle developed an assay (a test to detect the protein). Associate Professor Tim Yandle and the cardiology team confirmed that BNP circulated in human plasma,

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and that there was a different predominant form of it in people with HF[10]. After studying different isoforms of NPs and developing measuring methods, the idea was born to measure NT-proBNP (the inert fragment of the pro-BNP hormone that is cleaved from the bioactive BNP peptide) levels as a biomarker of HF. The group first published evidence of circulating NT-proBNP in humans in 1995. Major commercial interest from Roche Pharmaceuticals in the CHI research sparked the creation of the NT-proBNP test.

CHI researchers began using measurement of BNP to test patients for acute heart failure in the Christchurch emergency department (ED) in 1993. Patients presenting with breathlessness were subjected to the test and Dr Mark Davis and the team showed that HF patients had high levels of BNP compared to those who did not have a cardiac problem. This was published in The Lancet in 1994[11], triggering many replication studies around the world confirming that BNP is diagnostic of acute HF in people with shortness of breath in the ED[eg 12,13,14].

The important results from the CHI research were later expanded in 2004, when Professor Mark Richards and Professor James Januzzi from the Harvard Medical School formed the *International Collaborative of NT-proBNP*, or *ICON* research study[15]. This multi-centre, international study confirmed that NT-proBNP testing had high diagnostic value for detection of acute heart failure and in predicting the prognosis of patients with shortness of breath who were suspected or confirmed to have acute HF. Furthermore, it provided important cut-off values of NT-proBNP, now enshrined in international clinical guidelines, to guide clinical decision making.

The CHI conducted the first ever trial of heart failure management guided by serial measurement of NT-proBNP[20]. This demonstrated benefit and triggered more than one dozen further trials by centres around the world. A meta-analysis of worldwide studies involving over 2000 patients undertaken in 2014[16], led by Professor Richard Troughton (Co-director Clinical Studies, CHI), provided compelling evidence that using BNP or NT-proBNP as a clinical guide (NP-guided patients) resulted in reduced all-cause mortality in those less than 75 years old. Additionally, hospitalisation due to heart failure or cardiovascular disease was significantly lower in NP-guided patients.

A recent clinical trial[17] has found that a new drug called Entresto, that acts in part by blocking the breakdown of BNP and ANP, resulted in a 20% risk reduction in mortality and new hospitalisation for HF compared with those receiving current ACE-inhibitor therapy. This is the biggest improvement in HF therapies for 20 years.

The randomized clinical trial *IMPERATIVE-HF*, comparing peri-discharge management (adjusting treatment if NP levels are raised) of Acute Decompensated Heart Failure with usual clinical care, finished data collection in 2020[18]. This trial will determine if NP-guided care, around the time of hospital admissions for episodes of worsening heart failure, has better outcomes compared to standard care.

KEY RESEARCH OF THE CHI GROUP INCLUDES:

- The first group to demonstrate the biological actions of ANP in humans.
- Showing BNP can be used in the diagnosis of HF (1994) and as an indicator of disease status[11].
- Discovery of NT-proBNP in 1995, which is part of the BNP precursor[19].
- Being the first group to show that treatment for HF can be altered using NT-proBNP levels as a guide. This RCT was published in The Lancet (2000)[20].
- Showing that NP levels increase after myocardial infarction (MI; heart attack), and can be used to predict outcomes in MI patients[21].
- Further refining the use of NPs in HF diagnosis, for example by studying NP levels in different age groups.
- Improving the diagnostic performance of NP tests. They have found that supplementing NT-proBNP testing with mid-region pro-ANP or micro-RNA tests[22] leads to improved diagnostic accuracy.
- Professor Richards has shown that BNP/NT-proBNP levels can identify patients who respond to heart failure treatments – in particular, he showed this for beta-blocker therapy in heart failure. It was shown that NT-proBNP and BNP above certain thresholds predict benefit from beta blocker therapy in coronary heart disease.

FUNDING

- Health Research Council (HRC) - continuous Programme Grant funding for the past 27 years, which has exceeded $20 million. Additionally, multiple HRC Project Grants have been funded, of which four are current, including the *IMPERATIVE-HF* study.
- NZ Heart Foundation - multiple fellowships and project grants are held by group members.
- Since 1997 the Heart Foundation has funded Professor Mark Richards in its Chair of Cardiovascular Studies, which provides resources including long-term salary support for key CHI clinical and laboratory staff members.
- Ministry of Business, Innovation and Employment
- Canterbury Medical Research Fellowship (project grants and fellowships)
- Lotteries Health
- Christchurch Heart Institute Trust

RESEARCH SNAPSHOT

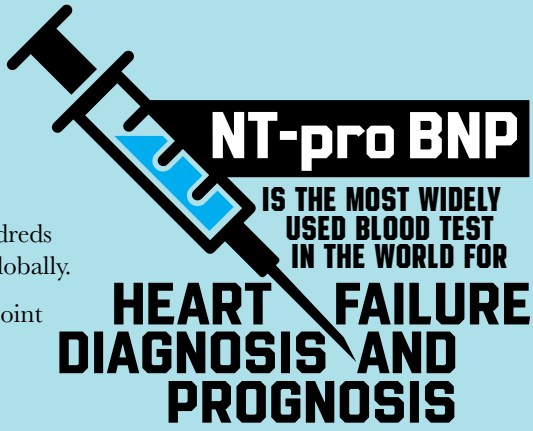
- The team has produced over 200 papers on cardiac biomarkers in heart failure.
- The article *Treatment of heart failure guided by plasma amino-terminal brain natriuretic peptide (N-BNP) concentrations* from 2000[17] has over 1200 citations[23].
- CHI research on NT-proBNP has been cited in 117 granted patents in the United States and Australia (PatCite).
- There has been extensive news coverage on the research within New Zealand (for example, the New Zealand Herald[24], the Otago Daily Times[25] and the Press[26], as well as overseas in Australia[27], China[28] and South Africa[29].

DETAILS OF THE IMPACT

HEART FAILURE TREATMENT GUIDELINES

Research from the CHI has appeared in multiple international guidelines, including:

- The American Heart Association (AHA) Guideline for the Management of Heart Failure[30] have made Class I (strong) recommendations for the use of biomarkers in diagnosis and prognosis. The AHA has also released a Scientific Statement on the Role of Biomarkers for the Prevention, Assessment, and Management of Heart Failure, citing CHI work[31].
- UK National Institute for Health and Care Excellence (NICE) Guidelines on Acute Heart Failure[32].
- The European Society of Cardiology Acute and Chronic Heart Failure Guidelines[33].
- The National Heart Foundation of Australia and Cardiac Society of Australia and New Zealand: Guidelines for the Prevention, Detection, and Management of Heart Failure in Australia[34].



CLINICAL APPLICATION

- NT-proBNP is the single most widely used blood test (measured hundreds of thousands of times per year) for HF diagnostics and prognostics globally.
- NT-proBNP is used as an inclusion criterion and as a surrogate endpoint for HF trials. It helps to select the right participants for trials and to indicate presence or lack of benefit from innovative therapies.

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ECONOMIC IMPACT

- Use of NT-proBNP has been shown to be cost effective in multiple international studies[3, 35-37]. One study showed the use of NT-proBNP decreases the lifetime cost of care per patient by $176 000 USD for men, and $101 000 USD for women[35]. Another showed NT-pro BNP use reduces the medical costs of ED visits, hospitalisations and outpatient services[37].

HEALTH OUTCOMES

- Patients are diagnosed with HF faster and more accurately, leading to shorter hospital stay[30, 33], reduced stay in ED[31], fewer readmissions to hospital[31] and reduction of the mortality rate [3, 32].
- Patients experience better quality of care, improved quality of life, and improved wellbeing [3, 35, 36].
- There is a reduction in hospitalisations and intensive care admissions[38].

COMMERCIALISATION

- Major commercial interest was received from Roche Diagnostics, who led the development of NT-proBNP as a test.
- Professor Mark Richards is a founder, and Associate Professor Chris Pemberton is a founder and Chief Scientific Officer of the spin-out company Upstream Medical Technologies. This company is developing tests to speed up the diagnosis of another heart condition, unstable angina[25].

FURTHER RESEARCH

- Thousands of papers have now been written on BNP and NT-proBNP from a worldwide network of people, which is incrementally adding to CHI research. The Medline database shows 13,799 articles have been written on BNP since 1990[39].

TEACHING

- The CHI team is engaged in postgraduate supervision and the teaching of advanced degrees across preclinical basic science and in clinical areas in order to develop the next generation of researchers, who will further improve clinical outcomes for patients.

PATHWAY TO IMPACT

COLLABORATION

- The research environment and infrastructure has been important to enhance the collaborative nature of CHI studies, in particular the recent NT-proBNP studies, which have been nested within clinical care and integrated with the Canterbury District Health Board and Christchurch Hospital.
- The CHI has a strong working relationship with Professor Rob Doughty's group at the University of Auckland (and prior to that Professor Norman Sharpe). For example, *IMPERATIVE-HF* is a two-centered study conducted in partnership with Auckland.
- There has been an excellent link between endocrine and cardiology researchers, basic scientists and clinicians within the CHI, resulting in ongoing fruitful cross-disciplinary conversation and mutual support.
- In 2016-7, the CHI launched a charity partnership with Ryman Healthcare and received $330,000 of funding to undertake a study about cardiovascular disease risk in New Zealand's retirement healthcare sector[40]. Residents take part in research trials and benefit from education and improved care through this process.
- Other researchers actively seek to collaborate with CHI. Currently, 29% of CHI research output on BNP has been done with collaborating authors (SciVal).

- The CHI has strong international collaborative links. Being located in New Zealand, away from large centers of cardiovascular research presents challenges. In recent years Professor Richards has spent a proportion of his time at the National University of Singapore, as founder of that University's Cardiovascular Research Institute (CVRI), enabling access to large cohorts of Asian patients and expanding collaboration for the CHI. The CHI is also been a part of major international research studies, for example the *ICON*, *GREAT*, *MAGGIC*, *GIANT* and *BIOS* biomarker and heart failure research consortia[15].

" What sets them apart from a lot of very successful research teams is their collaborative nature, which has increased the impact of the research that they've done."

Professor James Januzzi HARVARD MEDICAL SCHOOL & CARDIOLOGIST, MASSACHUSETTS GENERAL HOSPITAL, US.

COMMUNITY ENGAGEMENT

- Community engagement is a large part of the CHI ethos. The senior leaders of the group have given over 90 public lectures in the past five years, including to the University of the Third Age, Probus, Rotary, and talks in conjunction with the Heart Foundation and Ryman Healthcare.
- Hui are arranged with Māori participants, and studies are designed to oversample Māori and Pacific participants.

" We must give talks to the general public. Don't be shy about saying "'this is what I do, and this is how your money is being used."'

Research Associate Professor Chris Pemberton
DIRECTOR,TRANSLATIONAL BIODISCOVERY LABORATORY, CHRISTCHURCH HEART INSTITUTE

PLANNING FOR IMPACT

- Undertaking basic work on the biology of NPs and then in parallel subsequently developing their application as clinically useful biomarkers is an excellent example of translational (bench to bedside and back) research.

PUBLICITY

- CHI researchers actively take opportunities to publicise their work. For example, Professor Mark Richards has spoken to members of learned societies on over 280 occasions.
- By disseminating research results, traction is gained for further research and for application of the research. For example, with BNP, American and European interest was generated in the early 2000s, resulting in translation to treatment guidelines and the NT-proBNP test being created by Roche Diagnostics.
- The CHI uses the media team at the University of Otago to distribute press releases. This helps to inform the public and other scientists about the research they are doing[eg 41]. The CHI leadership also independently interacts with print and visual media and coordinates its own newsletter and Facebook account.

WHAT NEXT?

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- Research Associate Professor Chris Pemberton and Dr Andree Pearson are leading a study called *CHAMPIONZ* looking at cardiovascular risk in residents in the Ryman rest homes.
- The current HRC Programme Grant is wrapping up, so planning is underway for the area of focus for the next Programme Grant, which will be on acute coronary heart disease and its management. Coronary heart disease is the major precursor to heat failure. This work will take advantage of the improved integration of health data sets and information, including the *All New Zealand Acute Coronary Syndrome Quality Improvement (ANZACS-QI)* registry. The other theme of this work will be tailoring treatment to fit individual patients.

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CASE STUDY SIX

CASE STUDY SEVEN

FACULTY OF DENTISTRY

DR DON SCHWASS

CREATING TECHNOLOGY TO TREAT TOOTH DECAY

(L-R) Dr Don Schwass, Dr Gemma Cotton

PARTICIPANTS INTERVIEWED FOR THE CASE STUDY

PRINCIPAL INVESTIGATOR

Dr Don Schwass Senior Lecturer, Dean's Office (Dentistry), Faculty of Dentistry

RESEARCHER

Dr Gemma Cotton Postdoctoral Fellow, Sir John Walsh Research Institute, Faculty of Dentistry

STAKEHOLDERS

Dr Kevin Sheehy Commercialisation Manager, MacDiarmid Institute
Former Health Technology Commercialisation Consultant

Dr Alex Tickle Commercialisation Manager, Otago Innovation Limited, The University of Otago

Dr Gavin Clark Dean of Enterprise at Massey University
Former CEO of Silventum
Former Director of Research & Enterprise at the University of Otago

SUMMARY OF THE IMPACT

The research of Dr Don Schwass, a dentist, Senior Lecturer and researcher at the University of Otago, focusses on the incorporation of silver nanoparticles into dental materials to confer antimicrobial properties, and the development of novel dental materials for restorative dentistry. These products are to combat the bacterial dental infections of caries (tooth decay), periodontitis (gum disease) and peri-implantitis (infections around dental implants). In partnership with Dr Carla Meledandri from the Department of Chemistry and Dr Gemma Cotton from the Faculty of Dentistry, this research resulted in the filing of three patent families, one of which was licensed to a multinational dental manufacturing company. A spinout company (Silventum) has been formed in order to commercialise the research. Through the research process, Dr Gemma Cotton has gained her PhD and became an employee of Silventum, whilst continuing her research career. This has resulted in improved capability of the research team.

UNDERPINNING RESEARCH

Periodontitis is a bacterial infection of the bone and supporting tissues surrounding the teeth[1]. It is associated with an inflammatory response to dental plaque at the gum margin, and can ultimately cause a loss of teeth. Increasingly, tooth loss is treated using titanium dental implant screws to which crowns are attached. These implants are expensive and vulnerable to further gum disease such as peri-implant mucositis – an inflammatory reaction in the gum tissue around the implant, or peri-implantitis which affects the supporting bone, causing the loosening of the implant and its eventual failure[2]. Current treatment strategies for periodontitis and peri-implantitis involve mechanical debridement and antibiotics, which have limited success as they slow the progression of disease, but do not cure it[2]. Treatment with antibiotics also carries the risk of inducing bacterial antibiotic resistance, making it harder to treat the infection[2].

Don's research interest is in devising novel treatments for dental caries that are less invasive and less destructive of the tooth than traditional methods. Dental caries can occur when bacteria generating acid demineralises tooth enamel and causes cavities. Don's first interest was to develop a product that would disinfect dentine, the tooth layer beneath enamel, that had been infected by bacteria from caries. Current treatment of caries is to 'fill' the cavity with a restoration, but often the decay is not completely eliminated. If the seal around the restoration breaks down the remaining bacteria can cause further caries. Don's objective was to develop a substance that would completely inactivate any bacteria remaining in the dentine. Ideally, the substance would remain in the dentine and protect it from further bacterial invasion.

In 2010 Don went to a three-day induction course as a new academic staff member at the University of Otago. This course included a 'speed-collaborating' exercise, where staff members paired off and had to introduce themselves and discuss their research interests. In this exercise he met Dr Carla Meledandri, a chemist with expertise in nanoparticle research. They realised that Carla's expertise combined with Don's interest in solving clinical problems had significant collaboration potential. Don explained to Carla what he wanted from his novel material – an antimicrobial silver formulation that would not stain dental enamel. Carla saw how she could manipulate the silver nanoparticle size to prevent it from staining. They applied for an Otago Innovation Limited Proof-of-Concept grant, and won, which provided the initial funding for this research.

The first product patented was an antimicrobial solution of colloidal silver nanoparticles that look like water. The product did not discolour teeth, which was important for aesthetic reasons. Silver nanoparticles naturally aggregate, so ligands were used to create micellar structures that held the silver nanoparticles apart. There was a lot of in vitro testing and antimicrobial studies, with approximately 200 iterations before the first product was formulated. Don and Carla developed the product further so that it could be forced into tooth dentinal tubules by iontophoresis – by applying a charge to the tooth. A similar approach had been successfully used in the past when applying fluoride to teeth. Through this advance they produced an antimicrobial compound that binds to the tooth and could be forced deep into exposed dentine.

CASE STUDY SEVEN

Following the development of the colloidal product they collaborated with Professor Warwick Duncan (Head of the Discipline of Periodontology, at the University of Otago) to make an antimicrobial for use in periodontal treatments. They generated a gel that could be used in the mouth around teeth and gums that would degrade at a rate that is optimal for tissue repair following dental procedures or dental surgery. Professor Duncan used his established model of periodontitis in sheep, and developed a novel model for peri-implantitis in sheep to test the gel.

The third product made by the researchers was a silver nanoparticle-containing glass ionomer cement with antimicrobial properties for use as a dental filling restorative material.

FUNDING

- Proof of Concept grant, Otago Innovation Limited
- Partners for Innovation grant
- Otago Innovation research contracts and commercialisation resources (including patent filing, legal, regulatory consultants, and marketing)
- Otago Innovation Limited's devolved MBIE PreSeed Accelerator Fund
- Powerhouse investment leveraging matching Callaghan Innovation repayable loans (MBIE startup funding)
- University of Otago Research Grants
- MacDiarmid Institute

RESEARCH SNAPSHOT

- Dr Don Schwass and Dr Carla Meledandri have four publications from this work[3-6].
- Three patented technologies have patents filed[7-9], two have been filed nationally in multiple jurisdictions (including Europe, the US, Australia and New Zealand). There is one granted US patent for the first technology.
- The work has been featured in the media, including the Otago Daily Times[10], and in an interview with The Science Show on ABC Radio National (Australia)[11].

RECOGNITION

- Dr Carla Meledandri won the 2017 Prime Minister's MacDiarmid emerging scientist award, based partly on this work.
- Dr Gemma Cotton is a graduate of the Kiwinet Emerging Innovator Programme and a commercialisation consultant for Momentum (Return on Science).

DETAILS OF THE IMPACT

SPIN-OUT COMPANY

- In 2014, the spin-out company Silventum was formed, which will commercialise novel nano-chemistry technology developed from this research. It is currently owned by Otago Innovation (58.82% shares) and Powerhouse Ventures (41.18% shares).
- The creation of Silventum led to the exclusive licensing of the third (restorative material) technology, and a non-exclusive license for the second (gel) technology.
- Don, Carla and Gemma are founding staff members of Silventum. At its peak, it employed four people (2.0 FTE).

BUILDING CAPABILITY

- Dr Gemma Cotton conducted her PhD with the research team exploring the development of silver nanoparticle-based oral materials. Gemma continued working in the team for a year as a Research Fellow, and as Chief Technology Officer at Silventum. She is now a Research Fellow working with Professor Warwick Duncan and Associate Professor Dawn Coates.

POTENTIAL IMPACT

- The ultimate goal of this research was to take the patented restorative product to market. This has been pursued with great effort (see 'commericalisation' under 'pathway to impact'). It is hoped current research on a fourth product – looking at a new dental filling material that is closer to a tooth's composition – will support this goal.
- Silventum hopes to gain further investment via Powerhouse Ventures and additional external investors.
- One of the goals of Silventum is to manufacture their products in Dunedin, which will bring benefit to the local economy, resulting in job creation.
- There is potential to develop the products in the area of animal health.
- Whichever product(s) reach the market will change healthcare practice, resulting in greater prevention of bacterial dental infections. Health benefits include improved wellbeing for patients. There will also be economic impact in reducing the cost of treatment.

PATHWAY TO IMPACT

ADDRESSING REAL-WORLD PROBLEMS

- Dr Don Schwass, with 20 year's clinical experience, is a passionate believer in addressing real-world problems with research. By reverse engineering clinical problems, he has been able to keep a strong applied focus to his product development.
- Dr Gemma Cotton wanted to conduct research in this area due to her parents' dental issues; she was able to visualise the impact of the research might have on them.

"I really wanted to solve problems for society. The reason why I joined their team originally was that my parents had dental issues and so I took their problems and put it into what we were trying to address."

Dr Gemma Cotton POSTDOCTORAL FELLOW,
SIR JOHN WALSH RESEARCH INSTITUTE, FACULTY OF DENTISTRY

HIGH QUALITY RESEARCH

- Publishing high quality research papers has been a good marketing tool for the patented technology. Additionally, the University of Otago has a great reputation, so industry partners feel they can rely on the quality of the research.

COMMERCIALISATION

- The pathway to patenting, licensing and regulatory approval is complex, and Don and Carla have worked closely with Otago Innovation Limited through this process. Dr Alex Tickle (Commercialisation Manager at Otago Innovation Limited) became involved once the product was patentable and became project manager. They worked on the provisional patent, developing the business plan and finding industry partners and external investors. Don and Carla were involved in developing a regulatory approval pathway for the first product (the colloid) together with a contracted regulatory consultant and later with the licencee.

CASE STUDY SEVEN

- There is a balance between patenting and publication, as information about the technology cannot be in the public arena prior to patenting, and therefore publication plans are often delayed. This means that researchers may need alternative ways to maintain the publishing requirements for their academic job – for Don this meant participating in other research projects whilst the patenting process was taking place.
- Don's experience as a clinical dentist were crucial in the initial stages of scoping the products.
- Don's contacts as a clinical dentist supported the development of a network for market validation with dental companies.
- Carla and Don travelled to the United States, Germany and Liechtenstein to have meetings with major dental manufacturing companies interested in investing in their technology. Otago Innovation organised confidentiality agreements in advance. The fact that these companies were prepared to enter into these confidential discussions commends the relevance and novelty of this research and the existing relationships Don had with some of these companies.
- KiwiNet (an organisation supported by the Ministry of Business, Innovation and Employment, of which Otago Innovation Limited is a member) gave advice and support, and provided additional industry contacts.
- Dr Gavin Clark, former CEO of Silventum and former Director of Research & Enterprise at the University of Otago, recommends that researchers approach Otago Innovation Limited early in the research process if they believe that they have an invention that may have commercial value.

GAINING REGULATORY APPROVAL

- Gaining regulatory approval allowing the technology to be used in patients can be challenging. The original product (the colloid) was exclusively licensed to a dental material company, but as it was too novel compared to existing products and classified as a therapeutic product it had a complex regulatory route, which proved a challenge to navigate.
- The second product (the gel) was also classified as a therapeutic product and faced similar challenges to the first product.
- Following their experience with the two therapeutic products, Don and Carla realised there might be better opportunities in designing dental materials, which for regulatory purposes are classified as medical devices, and have a quicker and easier regulatory approvals route to market.
- Once the third product (the restorative material) was created, this led to the formation of the spin-out company Silventum. Silventum obtained the exclusive rights to the restorative material, as well as a non-exclusive license to the gel to avoid any freedom to operate. They worked through regulatory pathways to see if they could get a product including the restorative material technology onto the market, which has not yet been able to occur. Don and Carla were frequently consulted through this process to verify the technical information.

COLLABORATION

- The success of this research has been built on the cross-disciplinary collaboration between Don and Carla, and also by bringing in additional experts such as Professor Warwick Duncan.

> *" I guess I've just been a bit fortunate, because of the way I've thought about clinical problems and also landed on very good collaborations, that has just meant that all the stars have lined up nicely."*
>
> Dr Don Schwass SENIOR LECTURER, DEAN'S OFFICE (DENTISTRY), FACULTY OF DENTISTRY

DISSEMINATION

- Don presented research ideas at the European Organisation for Caries Research, where it was perceived as being highly novel and relevant.
- Otago Innovation Limited provided a demonstration video, patent information and the research team's publications to a wide range of dental companies. The University of Otago's press release about the exclusive licence of the colloid reached dental journals as far as the East Coast of the United States. This resulted in dentists approaching Otago Innovation to access Don's invention.

WHAT NEXT?

- Current research at Silventum is on a fourth product, aiming for a new dental filling material that is closer to a tooth's composition.

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CASE STUDY SEVEN

CASE STUDY EIGHT

SCHOOL OF PHYSIOTHERAPY

DR MEREDITH PERRY

IMPROVING ACCESS TO PARKS FOR PERSONS WITH A DISABILITY

(L-R): Child with mother, and Dr Meredith Perry

PARTICIPANTS INTERVIEWED FOR THE CASE STUDY

PRINCIPAL INVESTIGATOR

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RESEARCHER

Dr Pauline Boland Lecturer in Occupational Therapy, the University of Limerick, Ireland

STAKEHOLDERS

Olivia Dovey Parks Manager, Porirua City Council

Adrienne Murray Assistant Governor for District 9940 of Rotary
Member of Plimmerton Rotary Club and Plimmerton Inner Wheel

Christine Quested Health Promotion Advisor, Public Health South, Southern District Health Board

Mary O'Brien Moving Around Communities Co-ordinator, CCS Disability Action Southern Region

Janice Burton Professional Leader Health Promotion, Public Health South, Southern District Health Board

Raewyn Hailes Access and Community Development Manager, CCS Disability Action

SUMMARY OF THE IMPACT

Disability should not be a barrier for access to parks, which are important for physical health and social wellbeing. The *Parks for Activity and Recreation in the Community (PARCs)* study led by Dr Meredith Perry, a Senior Lecturer, researcher and physiotherapist in the School of Physiotherapy at the University of Otago Wellington, looks at access to parks for persons with a disability. Social ecological barriers can limit persons with disabilities' journey to, entry into, and full use of a park and its facilities. Through the *PARCs* research, Meredith created a tool which is used to evaluate park infrastructure against national and international minimum standards or legislative rights for disability access. Meredith's research aims to change policy around park design, in order to promote equity in access and usability of parks for persons with a disability. She has worked with multiple community organisations and city councils to achieve impact. The PARCs tool has been widely used to evaluate park access, and findings used in advocacy and lobbying to support council policy change.

UNDERPINNING RESEARCH

Parks, which are a component of greenspace, help to improve physical activity levels, and thus the health and wellbeing of the population[1]. Increasingly, parks are being recognised as supporting social cohesion and building community resilience[2, 3]. Dr Meredith Perry became interested in equity of access to parks for persons with a disability (including long-term health conditions) in 2016. In New Zealand, 25% of people self-report a disability, with this rising to over 64% in adults >65 years old[4]. Access to parks may be limited by the routes to and within the park, including parking and pathways, and also by the facilities and amenities, such as play areas, rest areas, toilets and drinking fountains. Equity in park access is important, particularly as community members with a long-term condition or disability are more at risk of developing health comorbidities related to physical inactivity[5]. A systematic review undertaken by Meredith and colleagues on park-based physical activity interventions for persons with disabilities identified health outcomes from health outcomes from park-based interventions [5p19] (Figure 1).

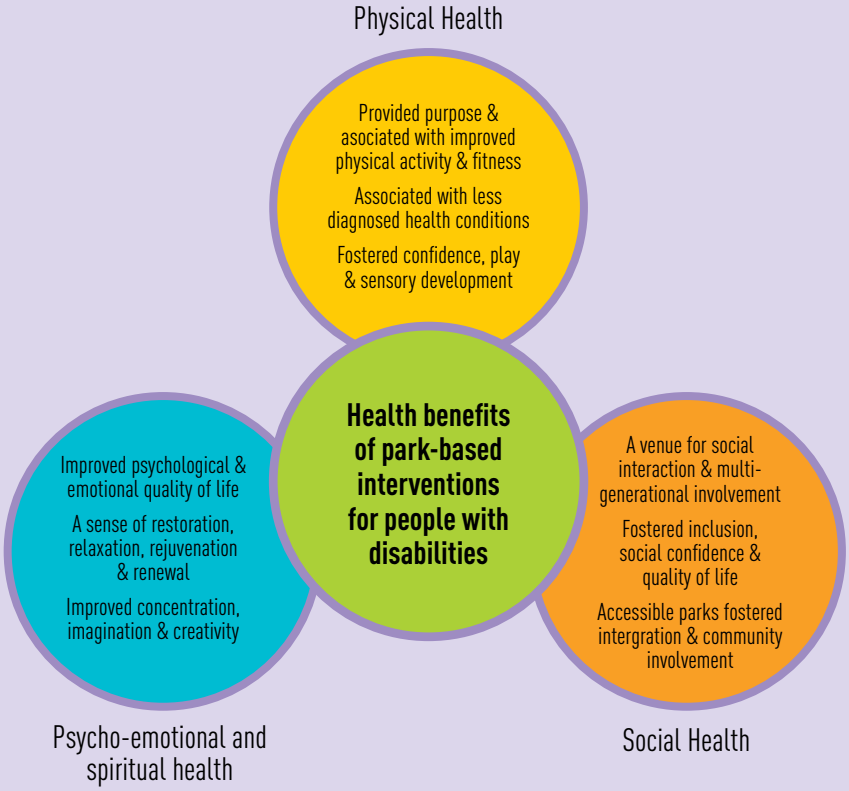

FIGURE 1: HEALTH OUTCOMES OF PARK-BASED INTERVENTIONS ACROSS THE LIFESPAN [5p19]

CASE STUDY EIGHT

Meredith developed an evaluation tool called the *PARCs tool* to determine whether a park meets disability access requirements. The 50-item tool comprises of questions divided into sections covering many aspects of accessibility[6 Appendix A: supplementary data]. This tool has been used in an evaluation of 21 parks in three metropolitan areas of New Zealand[6]. No parks met the national standards and/or international guidelines for park and playground design, and the study identified areas for improvement. Figure 2 outlines the results of the audit.

FIGURE 2 - RESULTS OF AUDIT OF 21 PARKS IN THE WELLINGTON AREA

This tool is now being used by multiple councils around New Zealand to evaluate their parks. Meredith has been working with organisations (such as Public Health South, Rotary and Inner Wheel, CCS Disability Action and the Blind Foundation), and councils across New Zealand to implement the use of the tool. City councils are able to use the PARCs tool to assess park access against international human rights laws and the United Nations Convention on the Rights of Persons with Disabilities (which New Zealand has signed).

In a further study (unpublished), Meredith conducted a survey of 1000 older adults and found private vehicle use to (OR 3.99 (1.48, 10.8)), and mobility within (OR 9.55 (1.95, 46.8)) the park significantly influenced park use in older adults with disability. Significantly more older adults with a disability had not visited an urban park in the last month than older adults without a disability. Older adults with disability enjoy visiting parks because this allows them to risk-take, feel socially connected, and it was perceived to improve health and wellbeing. However, qualitative interviews found the effort of negotiating inaccessible areas, the reliance on family members to support them moving freely through the park and no or limited accessible amenities (i.e. toilets) was off-putting.

Meredith has also interviewed 17 children and their whānau about their experiences of park use (unpublished). This research revealed only one child could visit their local neighbourhood park. The 16 others had to travel considerable distances to be able to participate in any park related activities. Whānau and the children appreciated going to the park as they challenged the children's capabilities and independence, offered a multi-sensory environment that benefited physical, psychological and social wellbeing and provided a place for the family to be together. The inaccessibility of their local parks made children with disability and their whānau feel excluded.

> *"This research is about creating the places and spaces that give the best benefit to the population that it serves."*
>
> Dr Meredith Perry SCHOOL OF PHYSIOTHERAPY, THE UNIVERSITY OF OTAGO, WELLINGTON

FUNDING

- University of Otago Research grant
- Porirua City Council
- Collaboration of Ageing Research Excellence Summer Student Grant

RESEARCH SNAPSHOT

- There are two research publications from this work[5, 6].
- Meredith's research is highlighted on the Activity & Nutrition Aotearoa[7], Office for Disability Issues[8], Plimmerton Rotary[9] and Porirua City[10] websites.

DETAILS OF THE IMPACT

PARCS TOOL USED IN EVALUATION

- Since Meredith's initial study, the PARCs tool has been used nationally and internationally to evaluate park access. The *Playable Porirua* audit was undertaken on all 41 parks in the Porirua Area, supported by Plimmerton Rotary and Porirua Rotary, and the Inner Wheel Club of Plimmerton, with the research team led by Meredith providing training and support[9]. The findings were used to make submissions to Porirua City Council regarding changes that could be made.

> *"Having that audit tool to be able to say 'this is the state of the playground that you're talking about', and 'this is what's required to bring it up to scratch', and 'these are the costs that are involved in doing that', is very, very valuable"*
>
> Adrienne Murray ASSISTANT GOVERNOR FOR DISTRICT 9940 OF ROTARY, MEMBER OF PLIMMERTON ROTARY CLUB AND PLIMMERTON INNER WHEEL

- Dr Pauline Boland, Lecturer at the University of Limerick (Ireland) teaches in a graduate entry programme for Occupational Therapy students. She uses part of the PARCs tool in her lecture on inclusive design. Students then use the tool to audit their campus to gain awareness of what may be challenging for those with a disability. She also illustrates how the PARCs tool can be used for lobbying authorities, and supporting clients to make statements about public spaces not accessible to them. Pauline had two Occupational Therapy Masters students in 2017 who, between them, audited about 50 parks in Limerick and Kerry. The findings of this study have been submitted to two county councils who gave consent for the audits to occur for their consideration in updating current parks and designing future ones.
- University of Otago Master of Dietetics students on placements with Public Health South (PHS; the public health unit at the Southern District Health Board) have developed a questionnaire focusing on the water fountain section of the PARCs tool. Drinking fountains were chosen to support PHS work in promoting water as the drink of choice. The students evaluated seven fountains in Dunedin and four in Invercargill and presented their results to PHS and CCS Disability Action staff. A report was also prepared which was subsequently used to advocate for improved drinking fountains with the Invercargill City Council's Parks and Reserves departments.

CASE STUDY EIGHT

- Community groups are able to use the PARCs tool to evaluate parks, and the results can then be used for advocacy purposes. Raewyn Hailes, Access and Community Development Manager at CCS Disability Action, has completed park audits for multiple councils in the Wellington area. The Rotary Club are trying to get training in the use of the PARCs tool so they can incorporate it into their District Plan in Plimmerton, and also into the national plan, led by Adrienne Murray (Assistant Governor District 9940 of Rotary).
- Waitaki District Council have been using the PARCs tool in an accessibility study in Oamaru. The West Coast Regional Council have begun an audit using the PARCs tool.
- Discussions are underway with the Dunedin City Council to evaluate their parks. Training on the PARCs tool for Dunedin Council Staff was completed in March 2019.

ENVIRONMENTAL CHANGE

- Submissions and discussions from the use of the PARCs tool by the Master of Dietetics students helped to inform the choice of a drinking fountain for the Bluff Community.
- Dunedin City Council have installed a wheelchair-accessible fountain in Caversham Reserve using the PARCs tool in August 2019. The council are now investigating putting similar fountains in the proposed George St upgrade.

POLICY CHANGE

- A draft policy change at Porirua City Council called Playable Porirua is a 10-year planning document informed by the Playable Porirua audit[8]. This provides guidance for playgrounds and will come up for review in 2022. The council will then go through the formal policy process, including community consultation, and they will take the document specific to playgrounds and integrate it into the Reserves Management Plan. At the moment Playable Porirua is classified as a 'working policy' – it is being implemented without yet being formalised.
- PHS staff have developed a guidelines document for choosing drinking fountains, and this is recommended by CCS Disability Action.

PATHWAY TO IMPACT

COLLABORATION

- A key feature of Meredith's research has been her close relationship with community organisations such as Rotary, Inner Wheel and CCS Disability Action, as well as local councils.
- Members of community organisations and councils value collaborating with Meredith and her colleagues at the University of Otago, saying their reputation meant the research was taken seriously. This is important in a challenging funding environment where councils operate on three-year cycles and have multiple potential projects to fund.

"Having the reputation of Otago University and the Physiotherapy School in behind what we're doing, having that name attached to the Playable Porirua work has just been valuable to getting councillors on board, getting the community on board and telling people that we are serious about accessible playgrounds and parks."

Olivia Dovey PARKS MANAGER, PORIRUA CITY COUNCIL

DISSEMINATION

CASE STUDY EIGHT

- Meredith spoke at multiple national and international conferences to disseminate this work, enhancing the uptake of the research by organisations and councils. She presented her research at:
  - The New Zealand Recreation Association conference in 2017 to parks and green space policy directors[11].
  - The International Society for Physical Activity and Health (ISPAH) in London in 2018, the biggest international physical activity conference in the world[12].
  - The Active Living and Environment International Symposium at the University of Otago in 2017[13].
  - The Physiotherapy New Zealand conference in 2018[14].
- Meredith, Olivia Dovey (Parks Manager, Porirua City Council), Christine Jacobson (Senior Policy Analyst Porirua City) and Adrienne Murray (Assistant Governor for District 9940 of Rotary) were invited to attend the IMPACT Conference hosted by the University of Otago in 2017[15] where they led a workshop about the project. Considerable interest was expressed by the audience comprising social research staff, health policy advisors and council members from around the country.

WHAT NEXT?

- Meredith would like to publish the PARCs tool in a free format that councils or other organisations can use.
- Meredith has two project ideas for the future; to formally evaluate a park before and after the PARCs tool intervention, and to create a park in conjunction with council from the bottom up – an inclusive park design. This would be best achieved via co-creation with the disability community.
- Meredith's ultimate goal is to make every park in New Zealand fully accessible.

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CASE STUDY EIGHT

RESEARCH IMPACT FOR RESEARCHERS

WHAT CAN WE LEARN FROM THESE CASE STUDIES?

Four key themes were identified in these case studies that guided the pathway to achieving research impact; meaningful engagement, broad dissemination, an inclusive culture, and high quality research. These themes have allowed us to identify some steps researchers can undertake to increase the impact of their work.

1. MEANINGFUL ENGAGEMENT

Study participants emphasised the need for meaningful engagement with a variety of groups, including the community to which the research is related, the media, policy makers, clinicians and next-users of the research. Researchers indicated the importance of identifying collaborators and end-users early, in order to shape the research question, get ongoing feedback, and open up further networking opportunities. Stakeholders spoke of feeling like true partners in the research process, and that research results could be easily translated into practice. Researchers actively planned engagement activities, as well as taking advantage of opportunities as they arose.

> *"A meaningful relationship is not just about completing a research study and that's the end. It can also involve a relationship outside of research in supporting your community partner to come and speak in their own rights about the research experiences that they've had, rather than maybe the university taking on that lead and going to all the conferences."*
>
> Cheryl Davies
> MANAGER OF TŪ KOTAHI MĀORI ASTHMA TRUST,
> REGARDING HE KAINGA ORANGA

2. BROAD DISSEMINATION

Means of communicating research results included public forums, panel discussions, blogs, press releases, parliamentary submissions, hui and providing comment to the media. Dissemination enabled engagement as it generated debate and discussion about the research. Dissemination was a key tool in advancing knowledge about the research topic to a wider audience, and allowed increased visibility of the research, therefore increasing the chance of impact.

> *"One of the things that I teach all my students and younger, emerging, staff is that I'm really big on communicating research to the lay community. They want to know the impact. They want to know what it's doing for them."*
>
> Professor Mark Richards DIRECTOR, CHRISTCHURCH HEART INSTITUTE

3. AN INCLUSIVE CULTURE

An inclusive culture supports impact. Impact is person-led, with principal investigators and research teams often being instrumental in creating cultures of collaboration and forward-thinking. It was identified that involving students in research led to a positive research environment as students are excited about research and learning, and researchers enjoyed teaching and up-skilling students. Teams that were inter-disciplinary were able to achieve impact in multiple areas, as research results were meaningful to a wider group of end-users. Finally, principal investigators were often described as exhibiting strong leadership skills by being able to bring together groups of people to work on a project, and being strongly focussed on achieving impactful results.

> *" Peter just for some reason plants a seed in these students, and it grows out that they are willing to work really hard on the project and get enthusiastic about it, and they do really well. That also sparks the interest in the students to progress into science."*
>
> Assistant Professor Raymond Staals
> THE UNIVERSITY OF WAGINENGEN, THE NETHERLANDS,
> REGARDING PETER FINERAN

4. HIGH QUALITY RESEARCH

Research impact is built on high-quality science and research. Participants acknowledged that publishing research in leading journals meant this could be used as a stepping stone or lever to achieve impact. Research targeted at addressing topics of need, or 'hot topics' was seen as important by stakeholders.

> *" Having published in the BMJ and The Lancet, the World Health Organisation came to me quite early on and said, 'We really like your work. Would you like to come, first of all, to look at housing and health?.' And then I was asked to chair this guidelines group."*
>
> Professor Philippa Howden-Chapman HE KAINGA ORANGA

UNDERTAKING IMPACTFUL RESEARCH

Research impact is an important concept to understand when planning and implementing research. Impact can be planned, but is inherently non-linear and unpredictable, so it is important to constantly assess the environment and respond accordingly.

1. MAKE A PLAN

Identify the types of impacts you are wanting to achieve. A framework such as that of Cruz Rivera et. al[1] can help to identify types of impacts to aim for. If applying for a grant, look at the guidelines to assess what types of impacts are important to the funder. Guidance on impact is available from the Health Research Council[2] and Ministry of Business, Innovation & Employment[3]. Logic models (for example, Figure 1) provide a helpful tool for planning impact – *inputs* include resources required for the research and who will be involved; *activities* occur during the research to support impact (see point 2); *outputs* are what is produced as a results of the research, for example publications and reports; *outcomes* are what occurs after research is taken up by stakeholders or end-users, for example changing the way people work or influencing decision-making; and *impacts* are the difference that research has made, and can include health, social, economic and environmental benefits, as well as benefits to equity.

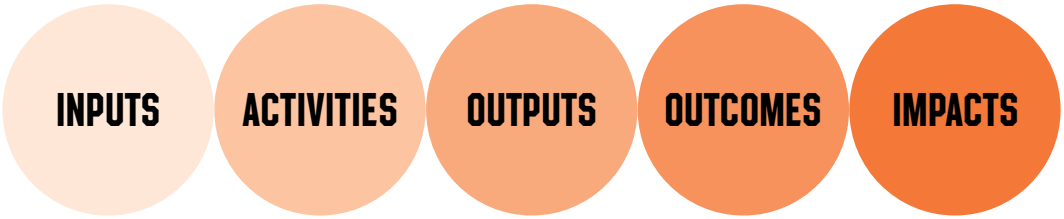

FIGURE 1: AN EXAMPLE OF A LOGIC MODEL

A tailored knowledge translation and/or dissemination plan can facilitate the transfer of research knowledge to the end-user(s).

2. ENGAGE IN ACTIVITIES TO SUPPORT IMPACT

Activities that may help to enhance the impact of research include identifying and collaborating with stakeholders, and co-producing or co-designing research. Relationships are the cornerstone to achieving impact. With Māori stakeholders or participants, it may be important to arrange specific engagement activities such as hui. Communication skills are key to relationship-building.

Understanding the wider environment in which you are working is crucial for impact. For example, you may need to time your research to fit in with local government funding cycles, or there may be policy windows during which you need to engage with policy makers.

Knowledge translation may involve arranging meetings to disseminate research. It may be necessary to disseminate research in different formats to different audiences, for example in press releases, lay summaries or clinical protocols.

1. Cruz Rivera S, Kyte DG, Aiyegbusi OL, Keeley TJ, Calvert MJ. Assessing the impact of healthcare research: A systematic review of methodological frameworks. PLoS Medicine. 2017;14(8):e1002370.
2. HRC NZ. 2020 Research Impact Assessment2020. Available from: https://www.hrc.govt.nz/sites/default/files/2019-09/2020%20Research%20Impact%20Slideshow%20with%20notes.pdf.
3. Ministry of Business Innovation & Employment. The Impact of Research. 2019.

3. MEASURE YOUR IMPACT

Measurement of impact is important when articulating the impact of research to research funders, and also establishing your impact track record when applying for further funding. Any evidence of impact – for example evidence of your research being incorporated into guidelines, research referenced in policy, engagement with communities or a commercial partner – should be recorded.

University of Otago library staff support the gathering of traditional and alternative impact metrics. With access to a number of key research analytics tools, and expert knowledge in bibliometrics and emerging trends in research impact, librarians can support both individual researchers and groups to identify top performing publications, demonstrate international reach and collaboration, and locate evidence of impact beyond academia. Examples include citations per publication, publications in top journal percentiles, references to publications in public policy, and news media mentions.

Subject Librarians are available to work with individual researchers to provide evidence of impact and develop strategies for increasing impact. Research Services Librarians are available to create metrics reports at research unit, departmental level, or above. Both subject and research services librarians collaborate to ensure the best outcome.

Consult the Library Liaison Service guide **https://otago.libguides.com/liaison** to contact your Subject Librarian.

Consult the Research Support Unit guide **https://otago.libguides.com/RSU** for more information on Research Services Librarians.

To learn more about measuring publication impact consult the Research Publishing & Impact guide: **https://otago.libguides.com/research_publishing_impact**

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