Programme leader
Professor Warwick Duncan
Deputy Programme Leader: Dr Mo’men Atieh

Programme overview
Te Kaupeka Pūniho, New Zealand’s National Centre for Dentistry, is the centre of excellence in New Zealand for clinical and translational research in dentistry and oral health. The Research Programme groups together researchers and projects whose objective is to enhance care and achieve better outcomes for our patients. There is considerable overlap with other research programmes, particularly with respect to the translation from benchtop, in vitro and preclinical animal research into development of commercially-viable products or improvements in clinical practice.

Arch dental practice-based research network
Dr Lara Friedlander
Suzanne Hanlin

Postgraduate students
Yevgeny Sheftel
Frances Ruddiman
Tatiana Tkatchenko
Anumala Ram
Saeideh Nobakht
Siddharth Kothari
Rachel Farrar (Walters)
Christina Gee
Dina Abdelmoneim
Asrar Elahi

Clinical facilities within the new Faculty of Dentistry Clinical Services Building
Current projects range from clinical trials conducted within the school and out in the community, of new products or modified treatment protocols, to development of new therapeutic agents and devices from benchtop through initial in vitro and preclinical animal trials with the objective of phase 1 clinical trials, to surveys conducted within the school or in the community regarding the techniques employed in clinical dental practice and their outcomes. Funding for this work ranges across contestable research grants, commercial sponsorship and contract research, and includes both researcher-initiated investigations and research driven by manufacturers of dental products.

The major part of Clinical and Translational Research involves diverse projects undertaken by the staff, postgraduate and undergraduate students of the School. Additionally, work has continued on the development of our dental practice-based research network, Applied Research through Clinicians’ Hands (ARCH), with a view towards fostering research conducted outside the School by and for New Zealand dental practitioners, with the support of Dental faculty staff.

**Collaborations**

*Within the University of Otago*

- Department of Applied Sciences, Clothing & Textile Sciences
- Department of Geology
- Department of Preventive & Social Medicine, Dunedin School of Medicine
- Department of Physics
- Department of Chemistry
- School of Pharmacy

*Other Universities*

- Department of Mechanical Engineering, University of Auckland
- MedTech CoRE (Centre for Research Excellence), New Zealand
- University of Zürich, Switzerland

*Companies and other entities*

- Aroa Biosurgery Ltd
- Callaghan Innovation
- Geistlich Pharma (Switzerland)
- Ivoclar International (Liechtenstein)
- Molteno Ophthalmic Ltd
- Resorba Medical GmbH (Germany)
- Southern Implants Ltd (South Africa)
- Zimmer Biomet 3i (United States of America)

**Current research**

**Novel therapeutic agents**

- Silver nanoparticles (*Silverbone* project, more details on facing page) – *in vitro* and preclinical animal trial
- Optimisation of MoaBone® natural hydroxyapatite xenograft (with Molteno® Ophthalmic Ltd.) (*in vitro* and preclinical)
- Manuka honey as an antibacterial agent (*in vitro* and clinical trial)
- Manuka oil as an antibacterial agent (*in vitro*)
- Regenerative membrane for alveolar ridge preservation (with Aroa Biosurgery Ltd.) – preclinical trial
- Gel-loaded lactoferrin for oral bone grafting (with Auckland University and CReaTE Research Group) – *in vitro* and preclinical animal trial
- Novel grafting materials for sinus lift therapy (preclinical animal trial)
- Healing mechanisms in stem-cell driven regeneration of deer antler

**Novel therapeutic approaches**

- Hall technique for childhood caries – clinical trial
- Development of white crowns for Hall technique (over page) – *in vitro*
- Vital tooth bleaching - clinical trial
- Orthodontic tipping and bodily movement of premolars in a sheep model – preclinical trial

**Implant therapy**

- Titanium-zirconium narrow dental implants for replacing single posterior missing teeth - clinical trial
- Dental implant abutment-interface and marginal bone loss - preclinical animal trial

**Diagnostics**

- Ultrasonic devices for early diagnosis of periodontal diseases (*UltraD3* project, facing page) – benchtop, preclinical animal trial, clinical trial
Professor Warwick Duncan is working on two significant advances in dental technology that could cut the cost of treatments, improve general health and involve New Zealand’s agricultural sector with a new high-value product.

Aside from his University research, Professor Duncan runs a private practice where he experiences problems first hand.

“As a periodontist I treat gum disease, take teeth out and graft bone to be able to implant new teeth as necessary. But as mouths are relatively filthy places, infections can occur and if grafts don’t work you can actually lose bone. To a certain extent we can manage that with antibiotics, but we’re trying to reduce their use.”

The drive for improvement sees Duncan heading an international and interdisciplinary team including Chemistry’s Dr Carla Meledandri and Dr Nina Molteno from Molteno Ophthalmic Ltd, a Dunedin manufacturer specialising in bone graft materials.

“Molteno uses cow bone as the basis of a grafting material in eye sockets and we use it for dental applications. An existing product uses New Zealand beef bones, which are exported to a company in Switzerland where they turn them into grafting material and send that back to us at a high mark-up.

“This doesn’t make sense when beef bone is a by-product of our agricultural industry and just goes to make blood and bone instead of being turned into a high-value product. We need to improve upon that material, make it ourselves and get costs down.”

The cost of dental treatment is increasingly important since research revealed significant links between oral and general health.

One of the team’s main challenges is fighting infection, which is particularly prevalent in oral work where there is a higher likelihood of damage from bacteria than in ophthalmic and orthopaedic surgeries. There’s also increasing concern about rising bacterial resistance to antibiotics.

Working with manufacturer Molteno and nano-scientist Meledandri, Duncan’s team has come up with a new bone-based grafting material, Silverbone, that is robust enough for dental work and contains silver with antibacterial properties.

Cell culture work is now fine-tuning the new graft material to balance maximum protection from infection and maximum healthy bone growth.

“It would be nice not to have animal testing phases, but we have to show it is safe and promotes new, healthy bone growth. So now we are working in the laboratory to create something that will be superior and save money and be sold and used in dental procedures every day.”

Duncan is also working on developing UltraD3 – a miniaturised ultrasound device to help with dental diagnosis – with Callaghan Innovation engineer Paul Harris and a world-leading team with capabilities in dental research, ultrasonics, electronics and materials science.

“We’re trying to make a new tool to assist diagnosis of gum disease around teeth and dental implants. When Paul first asked how I diagnose gum disease I told him I probed it with a stick. It’s actually called a periodontal probe, but it’s much the same thing. We’re aiming to do better than that.”

The diagnostic technique hasn’t changed for a century, so it’s high time for an improvement, says Duncan.

Gum disease affects one in three adult New Zealanders and is the world's sixth most prevalent condition, with strong links to diseases with high morbidity and mortality. Early intervention should reduce both discomfort and late stage treatments, save money and improve health.

Ultrasound is used for many conditions, such as in breast cancer diagnostics, where it measures changes in tissue stiffness.

“The challenge is to make the device small enough to fit comfortably in the mouth and accurate enough dealing with very small amounts of tissue. We’re now on version three and we’re getting close. It should be a very useful diagnostic device and almost certainly will be able to be used in other ways in the future.

“Both SilverBone and UltraD3 are getting to very exciting stages, with likely results expected in the next couple of years. It’s really cool science and it’s really enjoyable.”

Silverbone and UltraD3 are supported by the NZ Ministry of Business, Innovation and Employment's Endeavour Fund.
Development of novel tooth-coloured shell crowns to treat dental caries in children

Dental decay is the most common chronic childhood disease in New Zealand. Treatment is often delayed, for many reasons – including fear and cost – which only serves to exacerbate the severity of the problem; consequently, increasing the cost and fear associated.

Decay also has a greater impact on certain subsets of society, such as a Maori and Pasifika, as well as children from lower socioeconomic environments. The impact is further compounded by the significant impact restorative dental care has on the public health system.

Dr Joanne Choi (right) and colleagues from the SJWRI’s Clinical and Translational Research programme are looking to improve upon a novel technique that could reduce some of the anxiety associated with going to the dentist. Known as the Hall Technique, this method allows for children to avoid the ‘drill and fill’ of conventional dental care.

Instead of the usual invasive measures, a stainless-steel cap is placed on the decaying tooth without any need for anaesthetic or drilling. The crown seals off the decaying tooth, preventing further tooth decay.

One downside to the Hall Technique is the crown’s aesthetically unpleasant look. The appearance of the crown represents a very real obstacle to its use. Dr Choi and her team are developing an alternative crown to stainless steel; one that is tooth coloured and hence less visible as different from the surrounding teeth.

This project is supported by Cure Kids, Hitem Co. Ltd. and the University of Otago Research Committee.

Funding highlights

$91,887; “Bovine-derived lactoferrin in a degradable PVA-tyramine hydrogel for oral bone regeneration in a tooth socket model”. Medical Technology Centre of Research Excellence Seed Fund; (W Duncan, D Musson, K Lim, J Cornish, T Woodfield) 2018.

$25,000; “EMG-Guard: a smart-phone assisted wireless EMG device for small superficial muscles”. Medical Technology Centre of Research Excellence Seed Fund; (M Farella, R Cannon, M-L Huckabee, M Paulin) 2017


$9,463; “Managing elderly patients requiring endodontic treatment - A New Zealand practice based research study”. New Zealand Dental Research Foundation (NZDRF) and Continuing Dental Education Trust (L Friedlander, N Chandler, B Daniel, P Hamadani) 2018

$15,000; “Development of an ovine model for investigating effects of orthodontic tooth movement”. NZDRF (Farrar R, Farella M, Duncan W, Antoun J, Melsen B) 2018

$49,458; “A novel approach for monitoring eating behaviour in children”. Cure Kids Innovation Seed Fund (M Farella, G Idris, B Galland, C Smith, R Taylor, C Robertson) 2018

$10,000; “Development of a simulant model for clinically relevant testing of implant-and natural tooth-supported all-ceramic restorations (Phase Two)” NZDRF (L Jansen van , J Broadbent, W Duncan, JN Waddell) 2018

$220,000 (AUD); “Titanium-zirconium narrow (3.3mm) versus standard (4.1mm) diameter dental implants for replacing single posterior missing teeth”. ITI Research Grant (M Atieh, W Duncan, A Tawse-Smith, S Ma). 2017

$210,254; “Evaluation of an Endoform membrane combined with Bio-Oss bone graft in a sheep tooth extraction model.” Aroa Biosurgery Ltd. (W Duncan ) 2017

$26,800; “Development of a novel tooth-coloured shell crowns to treat dental caries in children”. Cure Kids Innovation Seed Fund (J Choi, W Duncan, L Foster Page, JN Waddell) 2017

$150,000; “Healing mechanisms in stem-cell driven regeneration of deer antler”. Velvet Antler Research NZ (D Coates et al) 2017

$13,425; “Effect of different surfactant concentration on bacterial power and shelf life”. Dentalife Australia Pty Ltd (P Catro, D Gonzalez) 2017
Key publications


Patents

MELEDANDRI CJ, SCHWASS DR, COTTON GC, DUNCAN WJ. Antimicrobial gel containing silver nanoparticles. Google Patents; Publication number WO2017061878 A; Application number PCT/NZ2016/050162; Apr 13, 2017.