THE UNIVERSITY OF MELBOURNE

Melbourne Dental School

Annual Research Report 2024

Advancing Research

Acknowledgment of Country

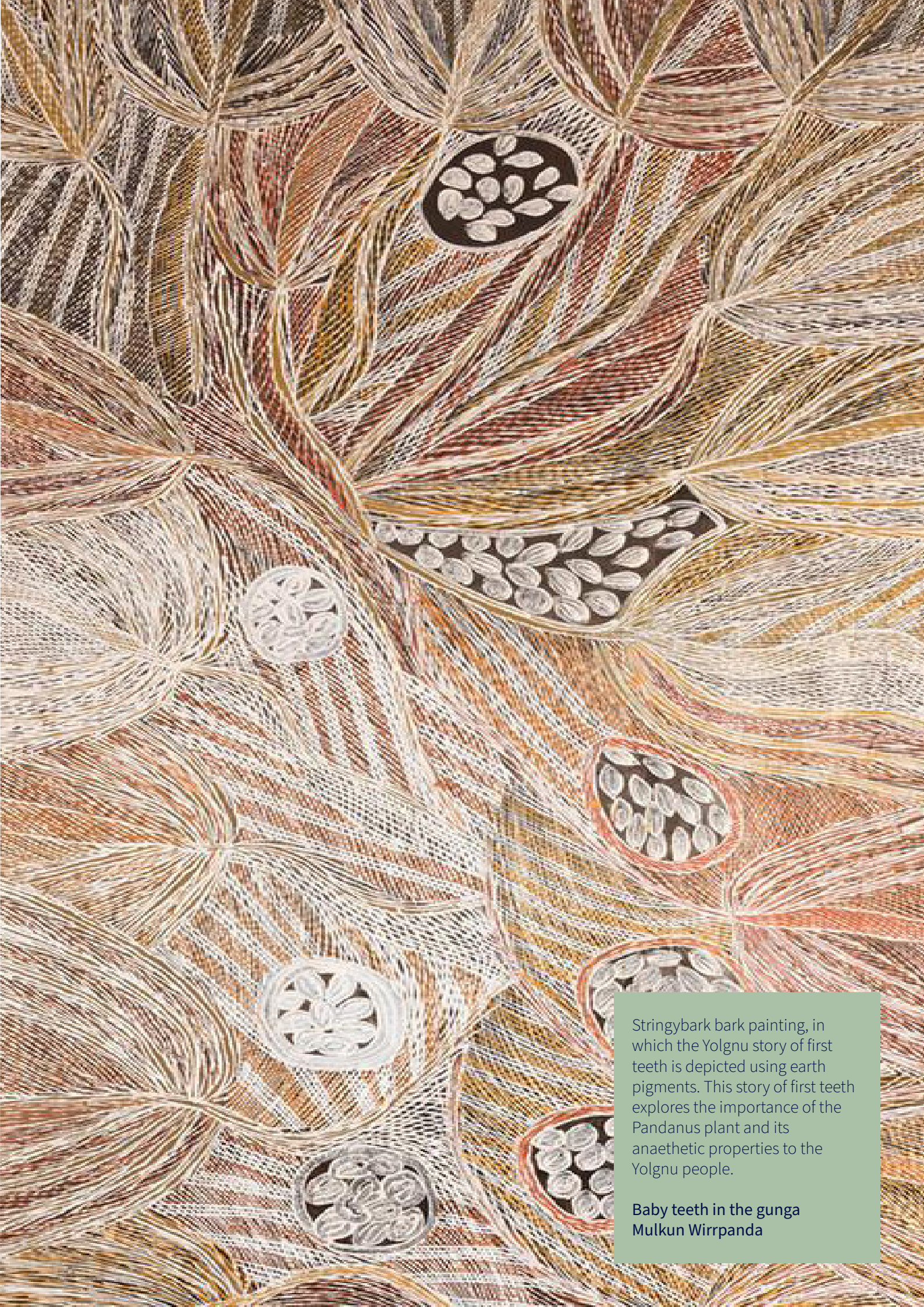
The University of Melbourne acknowledges the Traditional Owners of the unceded land on which we work, learn and live: the Wurundjeri Woi-wurrung and Bunurong peoples (Burnley, Fishermans Bend, Parkville, Southbank and Werribee campuses), the Yorta Yorta Nation (Dookie and Shepparton campuses), and the Dja Dja Wurrung people (Creswick campus).

The University also acknowledges and is grateful to the Traditional Owners, Elders and Knowledge Holders of all Indigenous nations and clans who have been instrumental in our reconciliation journey.

We recognise the unique place held by Aboriginal and Torres Strait Islander peoples as the original owners and custodians of the lands and waterways across the Australian continent, with histories of continuous connection dating back more than 60,000 years. We also acknowledge their enduring cultural practices of caring for Country.

We pay respect to Elders past, present and future, and acknowledge the importance of Indigenous knowledge in the Academy. As a community of researchers, teachers, professional staff and students we are privileged to work and learn every day with Indigenous colleagues and partners.

In making this Acknowledgment of Country, we commit to respectful and responsible conduct towards all others according to the Traditional lores of this land, particularly at times of formal ceremony.



Stringybark bark painting, in which the Yolgnu story of first teeth is depicted using earth pigments. This story of first teeth explores the importance of the Pandanus plant and its anaethetic properties to the Yolgnu people.

Baby teeth in the gunga
Mulkun Wirrpanda

Content

Introduction to the School and University

The University od Melbourne's enduring purpose is to benefit society through the transformative impact of education and research (Advancing Melbourne 2030).

1884

A group of dentists formed the Odontological Society of Victoria. Mr John Iliffe (1847-194), member and later President was the driving force in Victoria and the establishment of a hospital and college in Melbourne.

1890

The Melbourne Dental Hospital opened its doors.

1897

Followed by the opening of the Australian College of Dentistry devoted solely to the education of dentists.

1904

In 1904, a Faculty of Dental Science was established, and the College was affiliated with the University of Melbourne. In 1963 the Faculty and the hospital moved from 193 Spring Street to 711 Elizabeth Street, Melbourne.

1989

In 1989, the Faculty of Dentistry merged with the Faculty of Medicine (established 1876) to create a new Faculty of Medicine and Dentistry comprising a School of Medicine and a School of Dental Science respectively to reflect additional responsibilities.

1991

The Faculty expanded responsibilities to become the present Faculty of Medicine, Dentistry and Health Sciences.

2003

The growth and development of the Dental School led to the design and construction of a new school building and laboratories at 720 Swanston Street, co-located with the Royal Dental Hospital of Melbourne.

2004

Launch of the Oral Health Co-operative Research Centre

2011

The school changed its name from the School of Dental Science to the Melbourne Dental School with the implementation of the Melbourne Model of graduate entry for Doctor of Dental Science students.

2012

The Melbourne Oral Health and Training and Education Centre (MOHTEC) commenced operations. The Centre includes a Preclinical Simulation Laboratory, the Haptic Virtual Reality Simulation Laboratory, and the Melbourne Dental Clinic.

2020

DentAlliance is a global strategic partnership formed on 23 October 2020, between the Adams School of Dentistry at The University of North Carolina at Chapel Hill; the Faculty of Dentistry, Oral & Craniofacial Sciences at King's College London, the Melbourne Dental School at University of Melbourne, and the Faculty of Dentistry at the National University of Singapore.

Welcome from Interim Director of Research

"The Melbourne Dental School has an increasing number of strong and meaningful collaborations and partnerships at the local, national, regional and global levels."

I am delighted to present the 2024 Melbourne Dental School Annual Research Report, my first as Interim Director of Research. As you peruse through these pages, you will witness the remarkable achievements and stories of our researchers in 2024. Oral Health is essential to overall health and well-being but remains a major global public health problem. Research at the Melbourne Dental School is transforming the health and well-being of our community.

Our work is innovative: As a clinical school, we deliver research that changes the world. Ranging from unravelling the mysteries of biology, to clinical breakthroughs and public health strategy, our researchers are providing new solutions to the challenges, both new and old, that face our community. We encourage diversity, adventure and imagination, cutting across our divisions of basic and clinician sciences, population oral health and education research.

Our school proudly supports researchers at all career stages, nurturing academic careers and tomorrow's leaders. Never before has the need for academic leadership been greater. As outlined in this report, the Melbourne Dental School's commitment to our researchers is fundamental to our identity and our success. We are nimble and proactive as we continue to navigate the evolving external research environment.

We thrive in collaboration, and boldly seek to engage with others in the pursuit of excellence and impact. With a clear vision, we reach out beyond our teams and our fields, leveraging the unique ecosystem that is the world leading Parkville Biomedical Precinct. We partner with our community, our region and the world to take our research further.

Research is central to the vision and mission of the Melbourne Dental School. I hope you enjoy this snapshot of our achievements in 2024. Whether a student, researcher, collaborator or partner, I extend an invitation to you to join us as we continue our path to change the world.

Yours sincerely

Associate Professor Mihiri Silva
Interim Director of Research

Welcome from the Interim Head of School

"Our research has the ability to influence people's lives for the better through the development of novel therapies, better understanding of the basis of disease and changes to health policy and education."

I am thrilled to introduce the Annual Research Report for the Melbourne Dental School for 2024. The domain of research has been a longstanding integral part of the Dental School, and we are recognised for our research activities in discovery, impact and translation.

At the Melbourne Dental School, we are broadening our collaborative reach internationally, and also working with industry partners to achieve our research aims of positively impacting health in our communities and across the world.

The Melbourne Dental School is well placed physically to boost its research activity and impact, being located adjacent to Melbourne's biomedical precinct. This means we have world-class expertise and state-of-the-art scientific equipment at our fingertips.

Our research community is built on excellence and a dedication to improving the oral health of communities near and far. The School supports an active research ecosystem of collaborative researchers; from leaders in their fields to emerging researchers and clinician-scientists. In an uncertain research climate, we continue to push forward in our endeavours, and we welcome collaboration.

We proudly invite you to discover our latest work in the research themes of Infection, Inflammation and Immunity, Repair, Rehabilitation and Regeneration, and Population Health, Community and Education.

I believe you will find many items in the following pages that interest you, engage you and inspire you. This annual report is our opportunity to highlight the breadth and depth of our research, our talented and hardworking researchers and their recent successes and activities. I encourage you to make contact with our researchers to engage and perhaps collaborate.

Yours sincerely

Associate Professor Rita Hardiman
Interim Head of School

About Us

Established in 1904 the Melbourne Dental School is one of Australia's leading oral health research centres. With over 60 researchers and research higher degree students, The Melbourne Dental School aims to be world leaders in the discovery and development of the next generation of preventives, therapeutics, vaccines, and diagnostics for oral diseases.

The School boasts state-of-the-art facilities in our three clinical and research laboratory buildings. Our research primarily targets prevention and cures for infectious, inflammatory, and immune diseases, with a focus on translational research that has a positive impact on global human health.

The Melbourne Dental School is situated in the University of Melbourne's Parkville Campus in the Melbourne Biomedical Research Precinct, Australia's, and one of the world's, leading biomedical precincts. Comprising over 40 hospitals, research, teaching and biotechnology institutes and organisations co-located just to the north of Melbourne's CBD, the Melbourne Biomedical Research Precinct provides the Melbourne Dental School with unprecedented access to the very latest research technologies and some of the best biomedical researchers in the world.

We engage and collaborate with other research institutes, industry, and governments from across the globe, giving us significant research capacity to address significant health issues and research questions. The School's vibrant research environment and extensive collaborations provide exceptional postgraduate research higher degree opportunities. We have an exceptional track record of translating research to the clinic and to policy.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Biomedical District

Melbourne Dental School
Research at a glance

Staff and students

750+

3 Major Research themes

- Infection, Inflammation & Immunity
- Repair, Rehabilitation and Regeneration
- Population Health, Community & Education

Publications

- 130+ journal articles published in 2024 with >53% international collaboration
- 37% of publications in top 10% journals
- 24,000+ citations (over ten years)
- Field-weighted citation impact of 1.46 (over five years)

Research Income for 2024

- Australian competitive grants $700K+
- Industry & other funding $1.6 million+

Partnering

Engagement with industry partners for basic research, translation and commercialisation

Collaborations in 2024

17+	20+	120+
Victoria	Australia	Global

Structures and Impact

Research at the Melbourne Dental School fits into three broad themes, with each theme supporting interrelated and interconnected research groups.

Infection, Inflammation and Immunity	Repair, Rehabilitation and Regeneration	Population Health, Community and Education
Periodontal Disease Therapeutics and Vaccines Research Group	Materials, Mineralisation and Wound Healing	Dental Public Health Research
Antimicrobials, Cancer, Therapeutics and Vaccine Research Group	Cariology	Dental Education Research
Dental Therapeutics	Orthodontics and Craniofacial Research Group	Rural, Remote and Indigenous Oral Health Equity
Oral Bacteria and Alzheimer's Disease	Prosthodontics	Paediatric Oral Health Research
Periodontics		
Oral Medicine and Oral Cancer Group		
Special Care Dentistry		
Type IX Secretion System Group		

Periodontal Disease Therapeutics and Vaccines Research Group

Project 1: Investigation of the Structure of *Porphyromonas gingivalis* Virulence Factors

Porphyromonas gingivalis is a key pathogen in periodontitis (severe gum disease) and is also indicated to be involved in the development of other diseases such as rheumatoid arthritis and Alzheimer's disease. *P. gingivalis* produces a range of proteins associated with this virulence but how these interact with the host is still being deciphered. Important virulence factors include HagA adhesin and the RgpA and Kgp gingipains which are protease-adhesin molecules anchored to the cell surface by covalent linkage to anionic lipopolysaccharide. HagA, RgpA and Kgp are large proteins that the bacteria cleave into smaller domains that remain co-associated but how this co-association occurs is unknown. Motifs in the adhesins called ABM1 and ABM2 are suggested to have a function in the co-association of fragmented adhesin domains.

In this study we used structural predictions of Kgp ABM1 and ABM2 and combined this with biochemical analysis of targeted gene and protein mutants to validate structure predictions. The data indicate that ABM1 and ABM2 bind in a unique manner to produce a hybrid molecule folded like a fibronectin III module, the binding being robust and holding the fragmented Kgp together. Similarly, ABM1 and ABM2 would combine RgpA and HagA fragments. This is illustrated in **Figure 1.**

This unique arrangement of tethering the adhesin modules would give them flexibility for orientation to bind to host tissues and increase virulence potential. Understanding this ABM1, ABM2 function points us in new strategic directions for intervention to reduce *P. gingivalis* virulence.

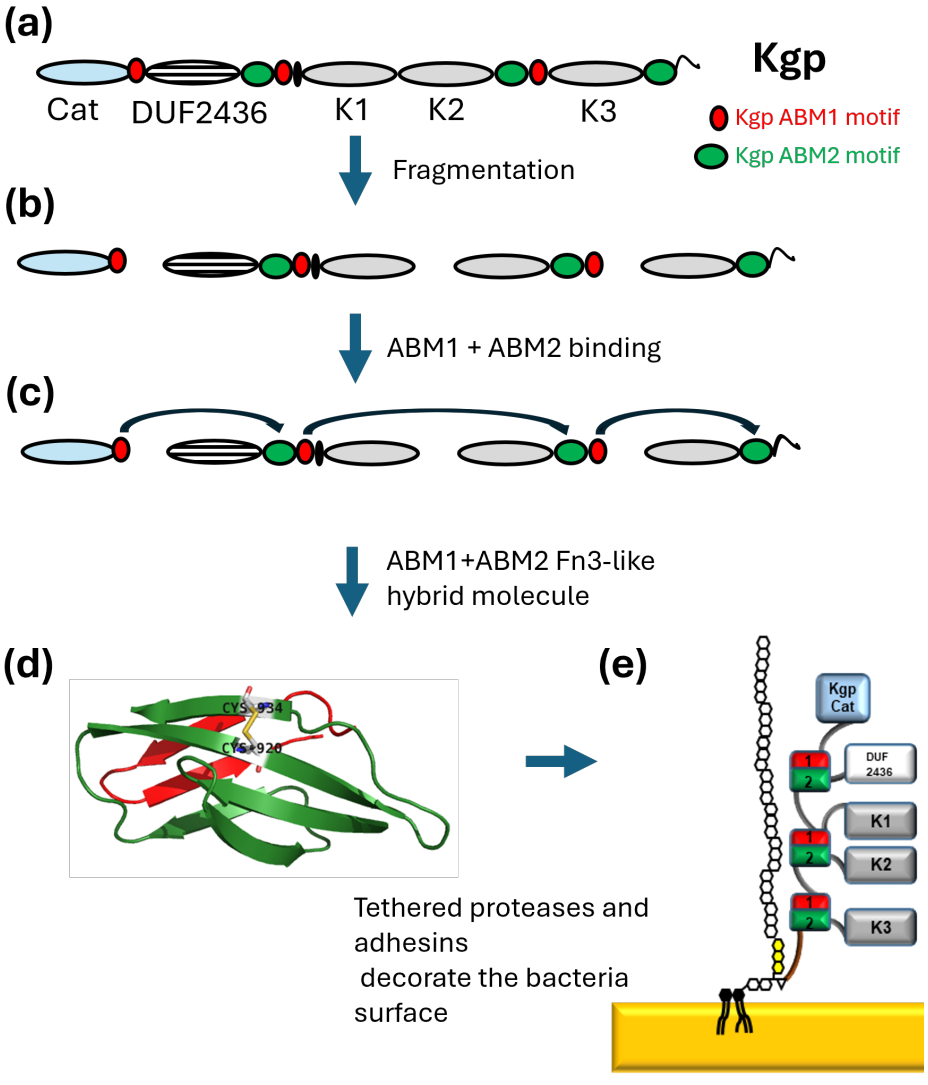


Figure 1 Kgp is produced as a large molecule (a) that is cleaved during maturation (b). Motifs ABM1 and ABM2 combine in trans (c) to produce a unique new molecule that has the structural shape of fibronectin 3 (Fn3) (d). The ABM pair module would allow other structured domains of Kgp (Cat, DUF2436, K1, K2, K3) and similarly for RgpA and HagA domains, to be anchored to the cell yet mobile, which would increase potential to interact with periodontal tissues.

Infection, Inflammation, and Immunity

Project 2: Brain pathology following *Porphyromonas gingivalis* oral infection in mice

Periodontal (gum) disease is a chronic condition that becomes more prevalent with age. Periodontal disease is hallmarked by the development of a gap (pocket) between the gum tissue and the tooth root, loss of the bone that holds the tooth in place and bleeding of the gums. The disease-causing bacteria that are found in the periodontal pocket can potentially penetrate the bloodstream during gum bleeding events. Attention is being paid to the potential for chronic bacterial infections to reveal as pathology at distant sites in the body, including changes in brain tissue resembling the pathology of Alzheimer's disease. This study examined the effect of infection with the bacterium recognised as a significant pathogen involved in periodontal disease, *Porphyromonas gingivalis (P. gingivalis)* on the brain. Using mouse models of infection, we have shown that dosing *P. gingivalis* into the mouths of mice not only results in periodontal disease in the mice but also correlates with changes in the brain consistent with those observed in people with Alzheimer's disease.

Figure 2 shows the slices of brains from mice infected with *P. gingivalis* three time a week for either 3 weeks or six weeks or sham-infected control mice. Immunohistochemistry showed that *P. gingivalis* infected mouse brains had RgpA, a molecule produced by *P. gingivalis* present and also amyloid beta (Aβ) protein deposits, a key characteristic of Alzheimer's disease. Importantly, the amount of RgpA and Aβ deposits increased with increased *P. gingivalis* oral dosing. Together the data show that *P. gingivalis* molecules can reach the brain from an oral site and that *P. gingivalis* infection correlates with brain pathology consistent with Alzheimer's disease.

This work provides an imperative to develop an intervention to eliminate or suppress *P. gingivalis* oral infection to help lower the risk of developing *P. gingivalis*-associated brain pathology.

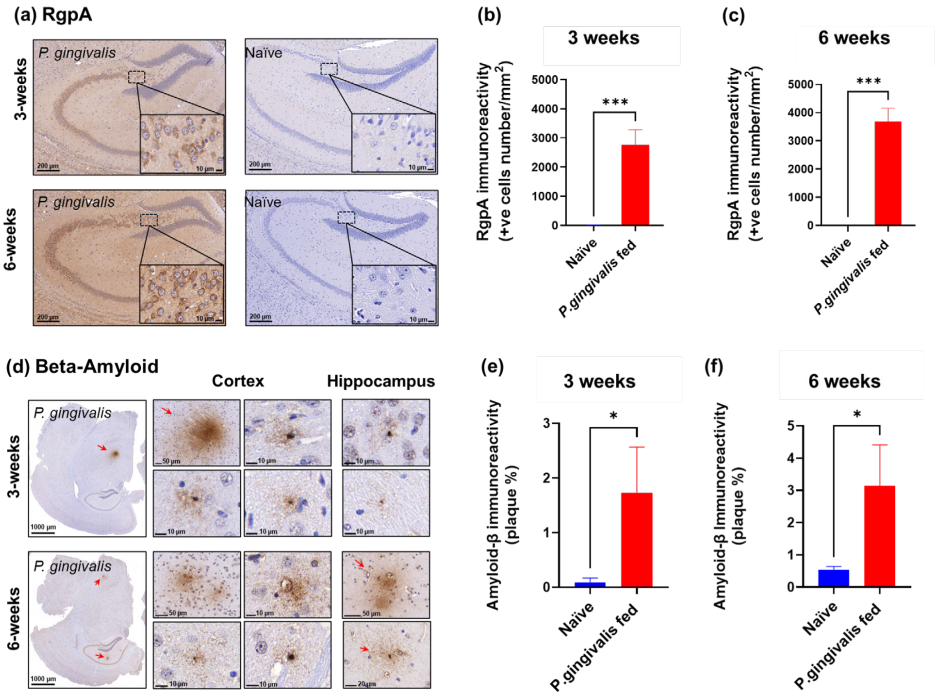


Figure 2 Immunohistochemistry reveals *P. gingivalis* molecule RgpA enters the mouse brain after oral inoculation with *P. gingivalis* 3 times per week for 3 weeks or 6 weeks (panels (a, b and c) which correlates with the development of beta amyloid protein deposits in the brain (panels d, e and f).

Dr
Christine Seers

Dr
Ali Mohammed

Associate Professor
Geoff Adams

Dr
Nada Slakeski

Dr
Lianyi Zhang

Laureate Professor AO
Eric Reynolds

Dr
James Holden

Mr
William Singleton

Ms
Yan Tan

Infection, Inflammation, and Immunity

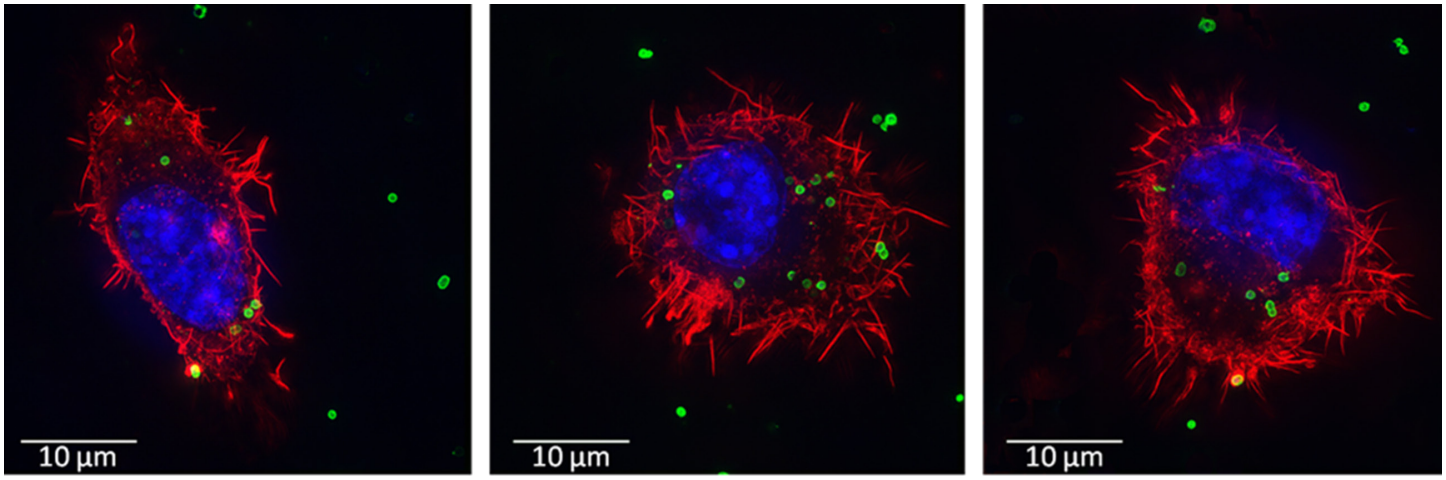
Antimicrobials, Cancer Therapeutics and Vaccine (ACTV) Research

The ACTV research group is focused on designing and synthesising peptide-based nanomaterials that have anti-bacterial or anti-cancer properties or can be used in the fabrication of vaccines or therapeutics targeting bacteria or cancer cells. The ACTV research group applies a multi-disciplined and inclusive approach to research focusing on applying an evidence-based iterative approach to understanding how the materials we make interact with the bacteria and cells they come into contact with. From this, we are able to design and redesign materials to produce peptides and nanomaterials that can be translated to clinical use. Our strategy is a chemical biology approach, and we employ a range of organic/peptide synthetic, immunological, and microbial approaches to achieve the goals of the team to produce antimicrobials. Antimicrobial Materials in Combatting Multidrug Resistant Bacteria 'Superbugs'.

ACTV Research Group Team in Focus

1. Professor Neil O'Brien-Simpson is the team's mentor and has a keen interest in peptide materials and nanomaterials in preventing bacterial infection. His work investigates outer membrane vesicles produced by bacteria and how they interact with other microbes and host immune cells to advance disease. His long time research into vaccines has resulted in a peptide/protein-based vaccine for periodontitis that is now in clinical trial and he is investigating peptide nanomaterials as cancer-based vaccines.
2. Dr Sara Hadjigol is a research fellow and is conducting research on antimicrobial materials and their efficacy against multi-drug-resistant bacteria and oral bacteria. She is heavily involved in the development of SNAPP-stars. She is also conducting a number of immunology-based industry projects.
3. Ms Bansari Shah is pursuing a PhD investigating the potential of peptide-based cancer vaccines. She has focused on developing a high throughput cancer vaccine screening assay and how nanomaterials can aid in the development of a cell-based immune response.
4. Dr Negar Yazdani is a general dentist and PhD student in the ACTV research group. Her research focuses on using antimicrobial peptides and SNAPP-stars, to prevent and treat dental implant infections (peri-implantitis) and gum disease (periodontitis). She aims to develop targeted, antimicrobial therapies to improve implant outcomes and reduce chronic oral infections.
5. Ms Krijma D'Costa is a PhD student in collaboration between the Faculty of Engineering and Information Technology (FEIT) and the Faculty of Medicine, Dentistry and Health Science (MDHS). She is currently investigating the ability of nanomaterials such as nanoparticles and peptides to aid implant tissue integration and prevent bacterial colonisation.
6. Graduated this year, Dr Connagh Redmond's PhD is based on improving the activity of antimicrobial peptides from Australian frogs. She also developed a novel media to test antimicrobial peptides to aid in the translation of materials from the lab to the clinic.
7. Ms Saharnaz Rafiee completed her PhD on identifying and the development of Caspase 9 peptide inhibitors. Her work identified materials that could specifically inhibit Caspase 9 rather than other caspases involved in the cell death pathways. Her work has major implications for cancer and neurodegenerative disease treatment.

Figure 3 Image of macrophages (red) phagocytosing (eating) the periopathogenbacteria *Porphyromonas gingivalis* (green) showing the importance of antibodies in coating (opsonising) the bacteria to help macrophages kill the bacteria. Cell nucleus is in blue.

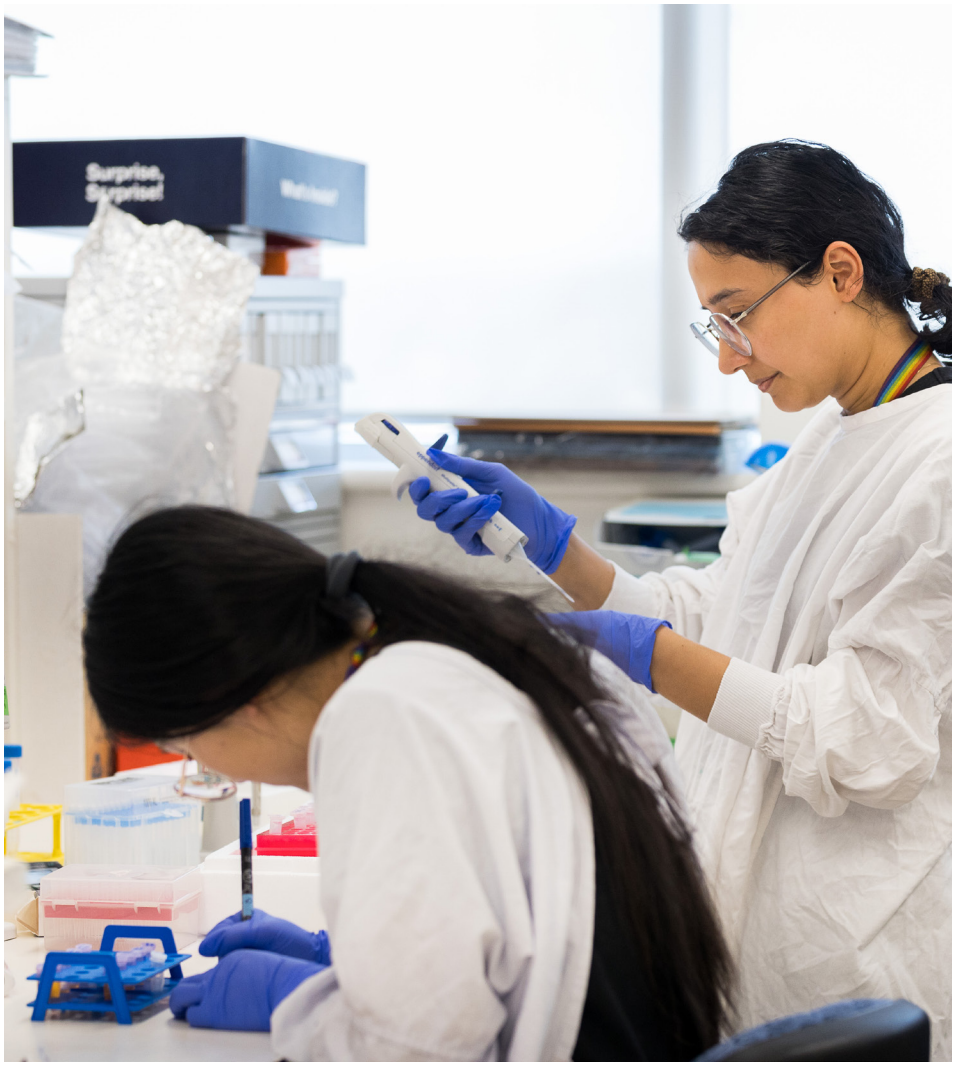


Unopsonised | Complement Opsonised | Antibody Opsonised

Infection, Inflammation, and Immunity

Research Highlights

1. Invitation to write a review on the SNAPP-stars for Nature Reviews Biotechnology, https://doi.org/10.1038/s44222-023-00143-4
2. Discovered how lipidation enhances antimicrobial activity of peptide materials. We found that lipidation allows the peptide material to bind to a common bacterial membrane component. This means the peptide is able to attach quicker and easier to the bacteria and so act faster and at lower doses. https://doi.org/10.1021/acsami.5c03839
3. Graduation of Dr Connagh Redmond, who during their PhD found that antimicrobial peptides from an Australian frog act synergistically to kill multi-drug-resistant bacteria.
4. Ms Saharnaz Rafiee completed and submitted her PhD on the development of peptide based inhibitors of Caspase 9.



Professor
Neil O'Brien-Simpson

Dr
Sara Hadjigol

Ms
Bansari Shah

Dr
Negar Yazdani

Ms
Krijma D'Costa

Dr
Connagh Redmond

Ms
Saharnaz Rafiee

Infection, Inflammation, and Immunity

Dental Therapeutics

The research conducted by the Therapeutics Group is devoted to the improvement of dental prescribing, with a focus on antibiotic prescribing. Our research projects in this field will collectively transform how drugs are used in dentistry, allowing for safer prescribing, improved patient management and enabling dentists to play their part in tackling the global public health problem of antibiotic resistance.

Antibiotic Resistance Is a Well-Established Global Public Health Problem

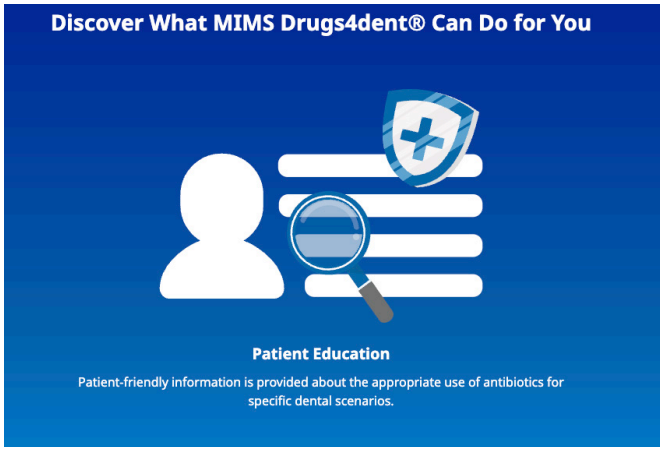
While dental antibiotic prescribing accounts for a significant 10% of all prescribed antibiotics globally, around 55% of dental antibiotics in Australia are prescribed inappropriately. Our group's work involves developing a digital medicines decision tool, titled Drugs4dent®, that provides dental-relevant drug information, dentist and patient education about appropriate use of antibiotics, as well as assists dentists with prescribing according to guidance. Our pilot study demonstrating the feasibility of our antibiotic stewardship intervention: Drugs4dent® and targeted education, produced a 45% reduction in the number of inappropriate indications for prescribing, and a decrease of 41% in the total number of antibiotics.

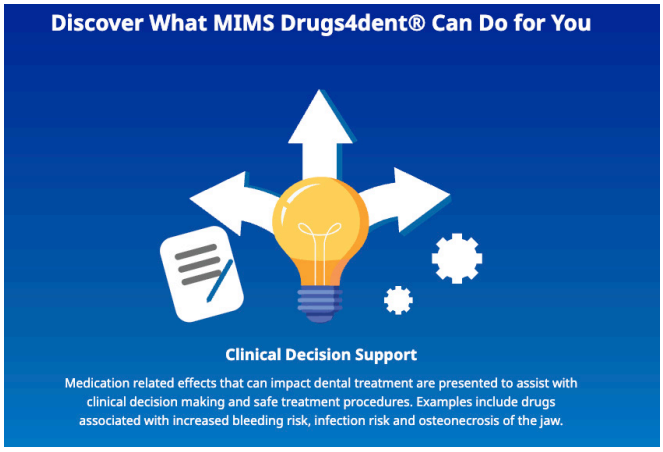
Commercialisation of MIMS Drugs4dent®, a Dental Medicines Decision Tool

In collaboration with the drug compendia company MIMS Australia, we have commercialised Drugs4dent® to produce the first Australian dental medicines decision tool, MIMS Drugs4dent®. MIMS Drugs4dent® has been available for Australian and New Zealand dental practitioners from 1 August 2024.

We are currently trialling MIMS Drugs4dent® in Southeast Asia (Indonesia, Malaysia, Singapore and Thailand), to explore the feasibility, usability and suitability of this product for dental practitioners in these countries.

Find out more about MIMS Drugs4dent® here!





Infection, Inflammation, and Immunity

Funding

This project was awarded funding by the National Health and Medical Research Council Investigator El1 grant (Leanne Teoh), and Associate Professor Leanne also received a Dame Kate Campbell Fellowship.

Awards

IADR ANZ Preventive and Community Dentistry Award - awarded to Associate Professor Leanne Teoh, Professor Michael McCullough and collaborators from the National Centre for Antimicrobial Stewardship in September 2024, for research in antimicrobial prescribing for oral and dental conditions in private and public Australian hospitals from 2013 to 2022 (Teoh L et al 2024. https://doi.org/10.1016/j.jdent.2024.105241).

Associate Professor Leanne Teoh

Professor Michael McCullough

Dr Nadia Kaunein

Dr Marietta Taylor

Figure 4 Published by Cambridge University Press, "Handbook of Dental Therapeutics" is aimed at dental practitioners and students in Australia and New Zealand. Our book is a practical and comprehensive guide to the use of drugs in dentistry and safer prescribing.

Infection, Inflammation, and Immunity

Oral Bacteria and Alzheimer's Disease

As part of a worldwide push to ascertain whether microbes play a role in the causation of Alzheimer's disease (AD), Associate Professor Catherine Butler and Professor Stuart Dashper, a molecular microbiologist and oral microbiologist respectively, applied their combined 50 years of experience in the growth and manipulation of oral pathobionts to the study of the role of oral bacteria in Alzheimer's disease. Using funding from the National Foundation for Medical Research and Innovation (Australia) and the Infectious Diseases Society of America Foundation (USA), the research team was grown to include experienced AD researcher Dr Joe Ciccotosto and research assistant Elly Bijlsma. Their resulting research using mouse models of infection with the oral pathobionts *Porphyromonas gingivalis* and *Treponema denticola* showed that although AD-like pathology was produced in the brains, there was no sign of active infection, leading them to hypothesise that membrane vesicles, subcellular nanoparticles secreted by these bacteria, caused the pathology. The natural progression of this research was to examine the roles of the membrane vesicles in disease causation.

Subsequently, the team showed that bacterial membrane vesicles can escape the oral cavity and enter the bloodstream. Once in the bloodstream they are carried towards the brain, where they are able to cross the blood brain barrier, and enter the brain. These bacterial membrane vesicles are decorated with a range of bacterial virulence factors that cause neuroinflammation and Alzheimer's disease-like pathology.

The discovery that this pathology occurs in the absence of whole bacterial cells and is the result of bacterial membrane vesicles produced in the oral cavity during periodontitis, has major ramifications for prevention, biomarker discovery and treatment of this debilitating disease.

Their paradigm shifting research has been recognised by the award of a National Health and Medical Research Council Ideas Grant of $1.73 million over the next 4 years. Titled "Defining how pathogenic bacterial membrane vesicles impact neurodegenerative processes in Alzheimer's disease", this prestigious grant will enable the team to expand their research in this vital area and further explore links between oral and systemic diseases.

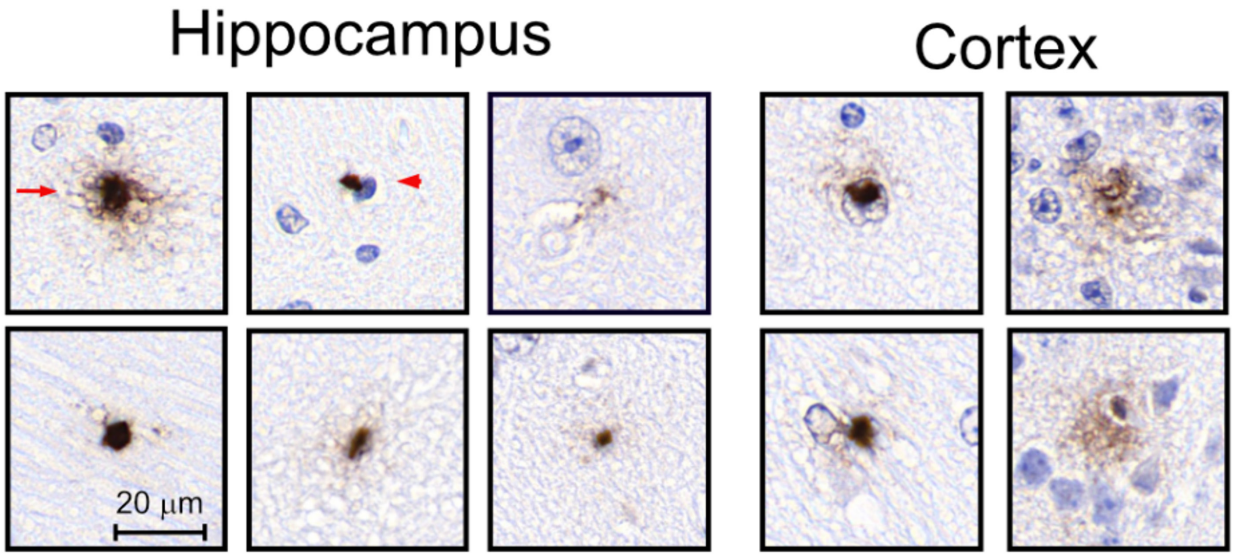


Figure 5 Examples of brain Aβ plaques, a pathological hallmark of Alzheimer's disease, induced in C57BL/6 mice chronically exposed to oral bacteria for 12 weeks.

Infection, Inflammation, and Immunity

Current Funding

CIA Butler, CIB Ciccotosto, CIC Dashper. 2024 NHMRC Ideas grant 2039279. “Defining how pathogenic bacterial membrane vesicles impact neurodegenerative processes in Alzheimer’s disease” $1.73 million for 2025-2028.

Research Highlights

1. GD. Ciccotosto[*], AI. Mohammed[*], R. Paolini, E. Bijlsma, S. Toulson, J. Holden, EC. Reynolds, SG. Dashper[+], and CA. Butler[+](2024). Chronic oral inoculation of *Porphyromonas gingivalis* and *Treponema denticola* induce different brain pathologies in a mouse model of Alzheimer disease. The Journal of Infectious Diseases, Volume 230, Issue Supplement_2, Pg S109–S116,[*]Co-first author,[+]Co-senior author, Invited manuscript.
2. CA. Butler, GD. Ciccotosto, N. Rygh, E. Bijlsma, SG. Dashper, and AC. Brown (2024). Bacterial membrane vesicles: The missing link between bacterial infection and Alzheimer’s disease. The Journal of Infectious Diseases, Volume 230, Issue Supplement 2, Pg S87–S94, Invited review.
3. S. Liu, C. Butler, S. Ayton, E. Reynolds, and S. Dashper (2024). *Porphyromonas gingivalis* and the pathogenesis of Alzheimer’s disease. Critical Reviews in Microbiology Volume 50, Pg 127-137.

Associate Professor
Catherine Butler

Dr
Joe Ciccotosto

Professor
Stuart Dashper

Ms
Elly Bijlsma

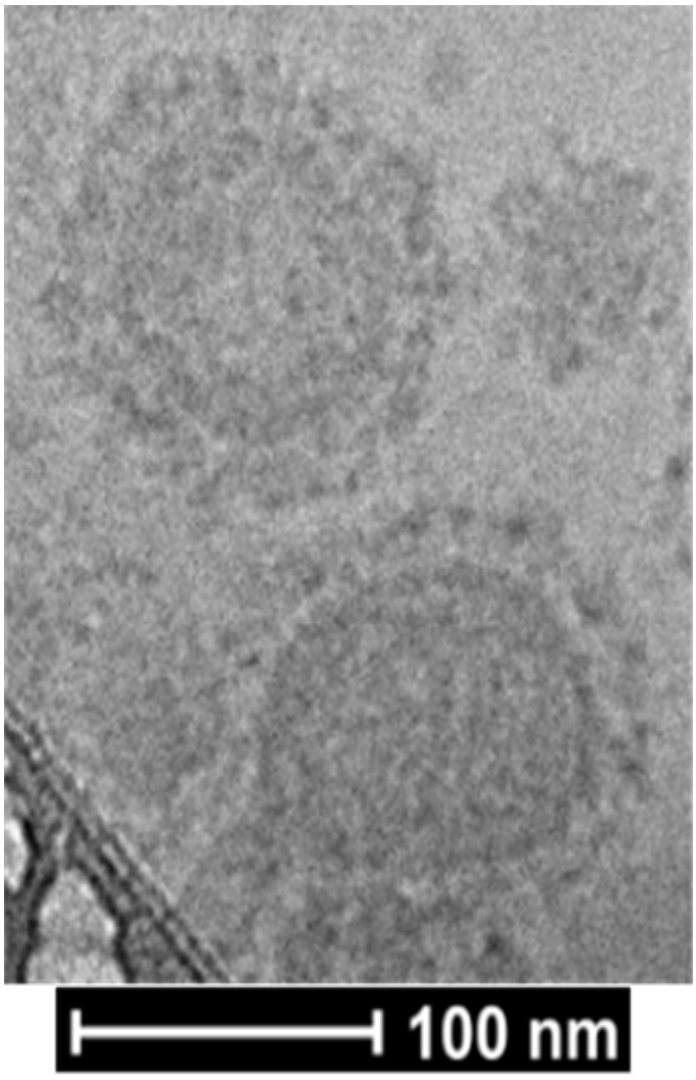


Figure 6 *P. gingivalis* membrane vesicles imaged using cryo-TEM.

Infection, Inflammation, and Immunity

Periodontics

The Periodontics research group investigates all aspects of periodontal disease and surgical implant dentistry with a particular focus on periodontal microbiology and immunology as well as implants in the aesthetic zone and bone regeneration.

Mental Health and Periodontal Diseases

Mental health disorders are clearly associated with periodontal diseases. The review by Ball & Darby in 2022 highlighted a number of mechanisms and risk factors.

Further research by us looked at the relationship in four groups: periodontally healthy with no MDH, periodontally healthy with MHD, periodontitis with no MHD and periodontitis and MHD. Surprisingly, apart from differences in the initial clinical presentation, there was no statistical significance between the groups. Whilst stress, anxiety and depression scores did not statistically differ between the healthy periodontium and periodontitis group, high stress, anxiety and/or depression affected the oral microbial communities.

Researchers: Dr Alex Khominksy, Associate Professor Catherine Butler, Professor Stuart Dashper, Professor Ivan Darby

Genetics and Periodontal Disease

There is a clear relationship between periodontitis and genetics. The disease can "run" in families and some reports suggest that up to 50% is heritable. That said due to the multi-factorial nature of periodontitis many of the pathways are yet to be elucidated. Recent research in our group has investigated the association between IL-10 gene haplotypes, DEFB1 gene haplotypes and stage III and IV periodontitis (moderate to severe generalised periodontal disease). IL-10 has an inhibitory effect on TH1 downregulating expression of IFN-y, along with inhibitory effects on TH2 cells downregulating IL-4 and IL-5 There was evidence for a non-protective association of individual SNPs of the IL-10/19 gene. Also, we found no association between DEFB1 SNPs or haplotypes and Periodontitis

Researchers: Dr Clarence Da Cruz, Dr Amhed El-Haddidi, Dr Luan Ngo, Professor Ivan Darby, Associate Professor Neil McGregor

Socket Grafting in the Posterior Mandible and Maxilla

Upon removal of a tooth the socket undergoes remodelling during the healing process with loss of bone volume. This may affect the ability to place an implant and/or in the correct restorative position. Socket grafting or alveolar ridge preservation has been shown to maintain bone volume. Although the buccal plate still resorbs, the graft material minimises loss of ridge volume. This has been in the upper maxilla quite clearly where aesthetics is important. However, there is little information about the effect of socket grafting at posterior sites.

We have just shown that socket grafting is an effective therapy to attenuate dimensional reduction of the alveolar ridge that normally takes place after extraction of a posterior tooth. The influence of grafting in the reduction in hard tissue bone crest position, ridge width and cross-sectional area was most beneficial in the DB plane, particularly in the marginal portion of the ridge

Researchers: Dr Alana Smith, Dr Luan Ngo, Associate Professor Stephen Chen, Professor Ivan Darby

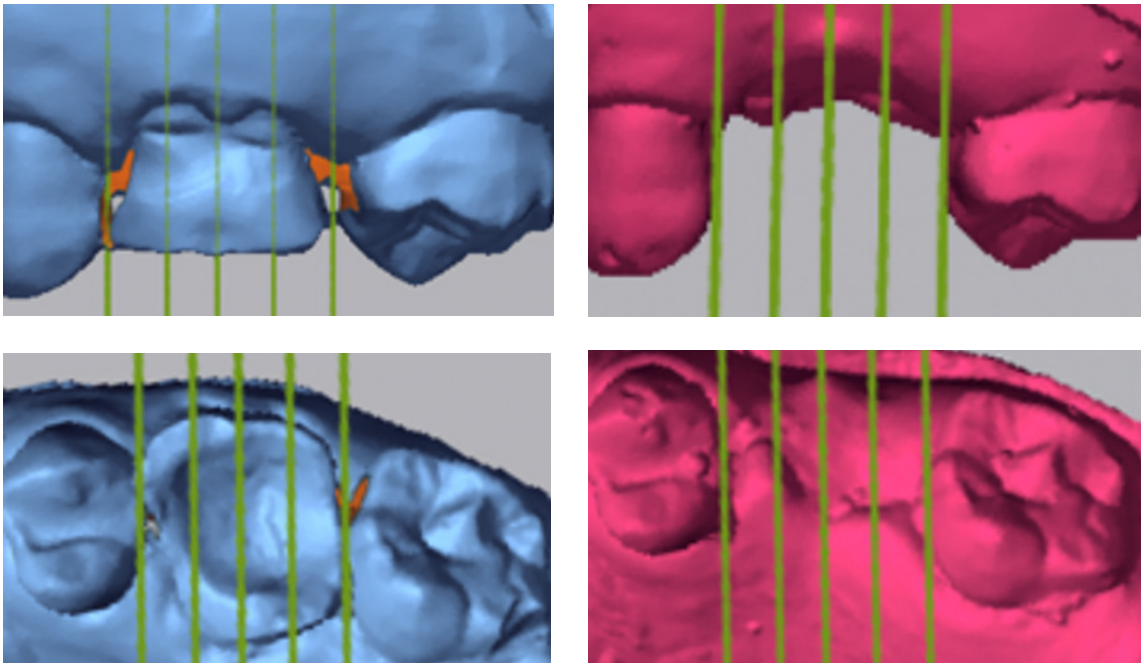


Figure 7 Pre- and 3 month post-extraction STL files superimposed demonstrating vertical lines for assessment of mesial, mesio-buccal, mid-buccal, disto-buccal and distal sagittal planes.

Infection, Inflammation, and Immunity

Sequential Intraoral Scanning and Soft Tissue Analysis of Periodontitis Patients: From Pre-treatment to Supportive Therapy

Periodontitis is an inflammatory disease that affects the gum and bone holding the teeth in place. The severity is measured by probing the pockets (pocket depth), measuring how much bleeding there is (bleeding on probing), and how much soft tissue and bone has been lost. Dental cleaning or non-surgical periodontal treatment (NSPT) is the first line of treatment for managing periodontitis for all patients. Periodontal parameters such as Probing Depth (PPD), Clinical Attachment Level (CAL), and Bleeding on Probing (BOP) improve significantly after NSPT. However, less is known about how soft tissue volume changes correlate with these clinical parameters. Traditional measurements are 2D in nature and do not provide an overall view of how much gum tissue there is and its position in 3D. Recent advancements in technology, such as intraoral 3D scanning, allow for precise measurement of soft tissue changes post-treatment, providing new insights into the healing process. This study aims to measure soft tissue volumetric changes following NSPT and exploring the relationship between these changes and clinical periodontal improvements by using 3D scanning technology.

Researchers: Dr Jordan Sparkes, Associate Professor Khaled Ahmed, Professor Ivan Darby

Oral Healthcare Professionals' Adherence to Diabetes Screening Guidelines, and Referral Compliance in Patients with Suspected Type 2 Diabetes Detected in a Dental Setting

The project's objectives include raising awareness of the bidirectional relationship between oral health and diabetes amongst patients and oral healthcare professionals (OHPs), advocating for early identification of type 2 diabetes (T2D) and prediabetes in the dental setting, and promoting interprofessional collaboration between OHPs and the medical professionals that manage people with T2D.

Our team, led by Professor Ivan Darby, Associate Professor Phyllis Lau, Associate Professor Rodrigo Mariño and Dr Andre Priede have suggested several key initiatives to improve diabetes prevention, diagnosis, and management in Australia:

1. Early Identification of At-Risk Individuals - We recommended the early identification of at-risk individuals through administering the Australian Type 2 Diabetes Risk Assessment (AUSDRISK) tool in dental settings. Additionally, we proposed a new item code to compensate OHPs for this screening service.
2. Awareness and Education - We emphasised the need to raise awareness about the bi-directional relationship between oral health and diabetes among patients through national health promotion campaigns and healthcare professionals through education and training.

In the future, we plan to develop interventions to maximise the effectiveness of diabetes screening in the private dental setting. Our team also proposes creating resources to support OHPs in activities to prevent or delay the development of diabetes and manage those patients with known T2D.

Researchers: Dr Andre Piedre, Professor Ivan Darby, Associate Professor Phyllis Lau, Professor Rodrigo Marino

Professor Ivan Darby

Dr Andre Piedre

Associate Professor Khaled Ahmed

Infection, Inflammation, and Immunity

Oral Medicine and Oral Cancer (OMOC) Research Group

The Oral Medicine and Oral Cancer Research Group at the Melbourne Dental School continues to advance innovation in oral health, focusing on the early diagnosis, prevention, and treatment of oral mucosal diseases. With expertise spanning in silico, in vitro, in vivo, and clinical research, the group tackles major challenges in oral potentially malignant disorders (OPMDs) and oral squamous cell carcinoma (OSCC) through a comprehensive bench-to-chairside approach.

PhD Students Involved
Dr Elham Moslemi
Dr Suhaib Alqudah
Dr Nadia Kaunein
Dr Syed Ameer Hamza
Dr Huda Asmael Al-Azzawi
Dr Rishi Ramani
Dr Zilefac Brian Ngokwe
Dr Satutya Wicaksono
Dr Yidan He

Current Research Projects

1. Development of AI-driven diagnostic tools using deep learning and in vivo confocal microscopy to detect dysplasia and oral cancer.
2. Investigation of the effects of oral anticoagulants on the risk and progression of oral cancer.
3. Targeting CASP8 signaling pathways using organoid models for novel oral cancer therapies.
4. Creation of patient-derived organoid models to study oral dysplasia and test therapeutic responses.
5. Exploration of Candida albicans diversity and virulence in the context of oral cancer progression.
6. Development of oral gonorrhoea models to study its interaction with mucosal health and cancer risk.
7. Application of machine learning to microRNA signatures for non-invasive early cancer diagnosis.
8. Anti-inflammatory potential of bioactive phytochemicals and their influence on canine Intestinal Health
9. Research on microRNA dysregulation in oral carcinogenesis and its link to oral cancer epidemiology.

Research Proceedings

1. Paolini R, Moore C, Hamza SA, McCullough M, Unemo M, Hocking JS, Celentano A, Kong FYS. Development of a novel in-vitro co-culture model to study Neisseria gonorrhoeae dynamics and antimicrobial resistance in human oral cells. ANZ IADR 63rd Scientific Meeting, Cairns, Queensland, Australia. Date: 25-27/09/2024.
2. Hamza SA, Paolini R, O'Brien-Simpson NM, Singleton W, Moore C, McCullough M, Celentano A. Non-anticoagulant heparin exerts selective anticancer effects in oral squamous cell carcinoma cells in vitro. ANZ IADR 63rd Scientific Meeting, Cairns, Queensland, Australia. Date: 25-27/09/2024.
3. O'Reilly L, Celentano A, Sakthianandeswaren A, Low J, Silke N, Yap T, Sieber O, Silke J. The Role of Inflammation and Regulated Cell Death in HNSCC Development and in Therapeutic Approaches for late Stage Disease. EMBO Workshop. Sant Feliu de Guíxols, Spain. DATE 11-15/10/2024.
4. Celentano A, Paolini R, O'Brien-Simpson NM, Singleton W, McCullough M, Hamza SA. Non-anticoagulant heparin exerts selective anticancer effects in oral squamous cell carcinoma cells in vitro. The 22nd International Congress of Oral Pathology and Medicine - 2024 - Cancún, México, 18-22/06/2024
5. Ramani RS, O'Reilly LA, Whitehead L, Bussau L, Silke J, Celentano A, McCullough M, Yap T. High resolution confocal microscopy with deep learning for accurate real-time detection of graded oral epithelial dysplasia in a murine model of oral carcinogenesis. Global Oral Cancer Forum (GOCF), Kuala Lumpur, Malaysia. Date: 25-26/05/2024.
6. A 2D in-vitro cell-based model for antimicrobial susceptibility testing against oral gonorrhoea". 25th IUSTI World Congress incorporating the Australasian Sexual and Reproductive Health Conference. ICC Sydney, Australia. 17-20/09/2024.
7. "High Molecular Weight Hyaluronic Acid Mitigates Chemotherapy-Induced Oral Mucositis". ANZ IADR 63rd Scientific Meeting, Cairns, Queensland, Australia. Date: 25-27/09/2024.
8. "Development of an in-vitro 2D human oral cell model to explore antimicrobial resistance in Neisseria gonorrhoeae". BacPath 2024, Pokolbin, New South Wales, Australia. Date: 11-14/11/2024.
9. Celentano A, Hamza SA, Paolini R, O'Brien-Simpson NM, Singleton W, Moore C, McCullough M. Non-anticoagulant heparin exerts selective anticancer effects in oral squamous cell carcinoma cells in vitro Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology, Volume 139, Issue 1, e32 - e33.

Figure 8 Dr Nadia Kaunein, winner of the 2024 No-Bell Prize People's Choice Award, Faculty of Medicine, Dentistry and Health Sciences.

Infection, Inflammation, and Immunity

Showcase Project 1: AI-Powered Digital Biopsies

A major highlight of the past year was the OMOC Group's breakthrough in AI-driven diagnostics, published in Scientific Reports. The study introduces a deep learning approach for detecting early oral cancer and pre-cancerous lesions using in vivo confocal laser endomicroscopy. By training convolutional neural networks (CNNs) on high-resolution "digital biopsies," the team achieved rapid, non-invasive classification of oral mucosa into diagnostic categories - ranging from no dysplasia to oral squamous cell carcinoma.

Showcase Project 2: Developing Novel Treatments for Oral Gonorrhoea

Our lab has pioneered the world's first in-vitro model of Neisseria gonorrhoeae (NG) infection in the human oropharynx - addressing a critical gap in the fight against antimicrobial-resistant oral gonorrhoea. Oral NG infections contribute significantly to disease transmission and antibiotic resistance, with current treatments falling short of efficacy benchmarks. This innovative model allows for the screening of novel therapeutic candidates, with the long term goal of developing an effective oral topical product (e.g. medicated gum) to prevent and treat these infections. This impactful project is a collaboration with the World Health Organisation and the University of Melbourne's Dental School and School of Population and Global Health.

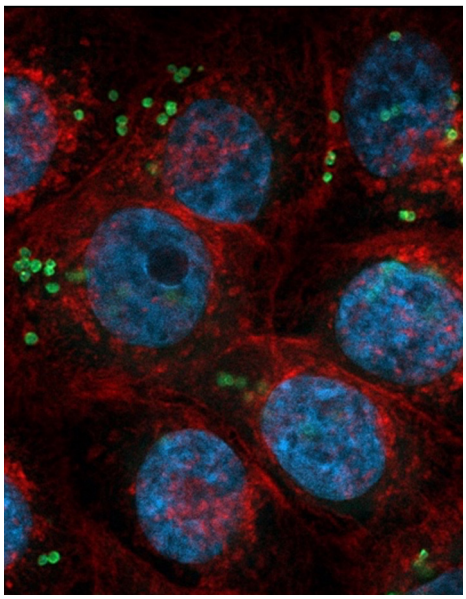


Figure 9 Floor of the mouth cells infected with FA1090 (Zeiss LSM800; 63 x oil objective; 1.3 x zoom. Membrane, WGA Alexa 594; Nucleus, DAPI; Gonococci, NGab-FITC).

Grants and Research Support

1. Dr Elham Moslemi: 2024 - MDS collaborative grants, University of Melbourne: Organoids, Caspase-8 mutation and targeted therapy challenge in oral squamous cell carcinoma.
2. Associate Professor Antonio Celentano: ARC Industrial Transformation Research Hub to combat Antimicrobial Resistance (AMR Hub) (Project ID IH190100021; 2022-2206)
3. Associate Professor Antonio Celentano: NHMRC Investigator Grant (APP2033078; 2025-2029)
4. Dr Syed Ameer Hamza: 2024 Rowden White Scholarship
5. Dr Satutya Wicaksono: 2024 Rowden White Scholarship
6. Dr Zilefac Brian Ngokwe: 2024 Rowden White Scholarship
7. Dr Tami Yap: MDHS Innovation Seed Grant. Project title: "Integrated AI Assistance in Community Oral Cancer Screening."
8. Professor Nicola Cirillo: King Hussein Medical Centre, Assessment of potential salivary biomarkers for Medication Related Osteonecrosis of the Jaw (MRONJ) in patients using Bone Modifying Agents (BMAs)

Awards

1. Professor Michael McCullough: Alan Docking IADR Science Award, recognising distinguished research in dentistry.
2. Dr Brian Ngokwe: The Melbourne Dental School Innovation Booster Award
3. Dr Satutya Wicaksono: MDHS Health Innovation & Enterprise Bootcamp Pitch Event -First prize.
4. Dr Rishi Ramani and Dr Nadia Kaunein: First and second prize in the Poster Presentation Competition, Global Oral Cancer Forum.
5. Dr Tami Yap, Professor Michael McCullough, and Dr Rishi Ramani: Graeme Clark Institute for Biomedical Engineering Proof-of-Concept Award: ThermOralCam Project: $50K Proof-of-Concept Award.

Dr
Tami Yap

Associate Professor
Antonio Celentano

Professor
Michael McCullough

Professor
Nicola Cirillo

Dr
Nik Saha

Mrs
Caroline Moore

Ms
Rita Paolini

Infection, Inflammation, and Immunity

Special Care Dentistry

The Special Care Dentistry Group conducts extensive research in the field of Special Needs, spanning from in silico research to clinical studies. Special Needs patients have a higher prevalence of oral diseases and unmet dental needs compared to the general population, but grossly inadequate training and experience in managing patients with special needs has been highlighted as a significant barrier to accessing care. Our research aims to highlight opportunities for future development in this critical area of dentistry to improve access to care for society's most vulnerable.

Oral Presentations

1. Title: "Development of an in-vitro 2D human oral cell model to explore antimicrobial resistance in Neisseria gonorrhoeae". BacPath 2024, Pokolbin, New South Wales, Australia.
2. Title: "High Molecular Weight Hyaluronic Acid Mitigates Chemotherapy-Induced Oral Mucositis". ANZ IADR 63rd Scientific Meeting, Cairns, Queensland, Australia.
3. Title: "A 2D in-vitro cell-based model for antimicrobial susceptibility testing against oral gonorrhoea". 25th IUSTI World Congress incorporating the Australasian Sexual and Reproductive Health Conference. ICC Sydney, Australia.
4. Title: "Capacity, suppression, and people with cognitive disability. Understanding critical systemic levers through the lens of oral health". Inclusion Melbourne Working Smarter for Inclusion Masterclass.
5. Title: "Barriers and challenges in dental care and maintenance in the long term: What is the landscape like in Australia, and how can we do better?" Australian and New Zealand Head and Neck Cancer Society Annual Scientific Meeting 2024 (Melbourne, Australia).
6. Title: "Does providing education to healthcare workers improve the oral care of hospital inpatients with brain injuries?" International Association of Disability and Oral Health Seoul 2024 (iADH Research Oral Presentation Competition (Finalist/ Winner).

Research Proceedings

1. Paolini R, Moore C, Hamza SA, McCullough M, Unemo M, Hocking JS, Celentano A, Kong FYS. Development of a novel in-vitro co-culture model to study Neisseria gonorrhoeae dynamics and antimicrobial resistance in human oral cells. ANZ IADR 63rd Scientific Meeting, Cairns, Queensland, Australia.
2. Hamza SA, Paolini R, O'Brien-Simpson NM, Singleton W, Moore C, McCullough M, Celentano A. Non-anticoagulant heparin exerts selective anticancer effects in oral squamous cell carcinoma cells in vitro. ANZ IADR 63rd Scientific Meeting, Cairns, Queensland, Australia.
3. O'Reilly L, Celentano A, Sakthianandeswaren A, Low J, Silke N, Yap T, Sieber O, Silke J. The Role of Inflammation and Regulated Cell Death in HNSCC Development and in Therapeutic Approaches for late Stage Disease. EMBO Workshop. Sant Feliu de Guíxols, Spain.
4. Celentano A, Paolini R, O'Brien-Simpson NM, Singleton W, McCullough M, Hamza SA. Non-anticoagulant heparin exerts selective anticancer effects in oral squamous cell carcinoma cells in vitro. The 22nd International Congress of Oral Pathology and Medicine - 2024 - Cancún, México.
5. Ramani RS, O'Reilly LA, Whitehead L, Bussau L, Silke J, Celentano A, McCullough M, Yap T. High resolution confocal microscopy with deep learning for accurate real-time detection of graded oral epithelial dysplasia in a murine model of oral carcinogenesis. Global Oral Cancer Forum (GOCF).

Published Abstracts of Scientific Meetings

1. Celentano A, Hamza SA, Paolini R, O'Brien-Simpson NM, Singleton W, Moore C, McCullough M. Non-anticoagulant heparin exerts selective anticancer effects in oral squamous cell carcinoma cells in vitro Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology, Volume 139, Issue 1, e32 - e33.

Figure 10 Dr Mathew Lim presenting his collaborative work with the Acquired Brain Injury team at Caulfield Hospital at iADH 2024 in Seoul, South Korea.

Infection, Inflammation, and Immunity

Current Research Projects:

1. Evaluating global research trends in special needs dentistry: A systematic bibliometrix analysis
2. The global distribution of special needs dentistry across dental school curricula.
3. Investigation of the effects of oral anticoagulants on the risk and progression of oral cancer.
4. Post-extraction bleeding for heparinised patients.
5. Management of bleeding related to dental treatment for individuals with haemophilia.
6. Oral hygiene interventions for patients with acquired brain injuries in acute rehabilitation facilities.
7. What do Australians with intellectual disability want from their oral health and dental care?
8. Views of Victorian public sector oral health professionals towards treating patients with disabilities and complex health needs.
9. Complexity of referrals received by specialist dental services for people with special needs.
10. The role of oral health educators in working with Victorians with disabilities.

Showcase Project 1: Evaluating global research trends in special needs dentistry: A systematic bibliometrix analysis

A major highlight of 2024 for the group was the project "Global Trends in Special Needs Dentistry: A 35-Year Bibliometric Analysis", published in Clinical and Experimental Dental Research (Senthilvadevel et al., 2024). The study introduces the first comprehensive bibliometric analysis of Special Needs Dentistry (SND), mapping global research productivity, key contributors, and evolving trends from 1985 to 2021. It highlights significant gaps in institutional collaboration and underscores the need for broader interdisciplinary engagement and focus on underrepresented populations.

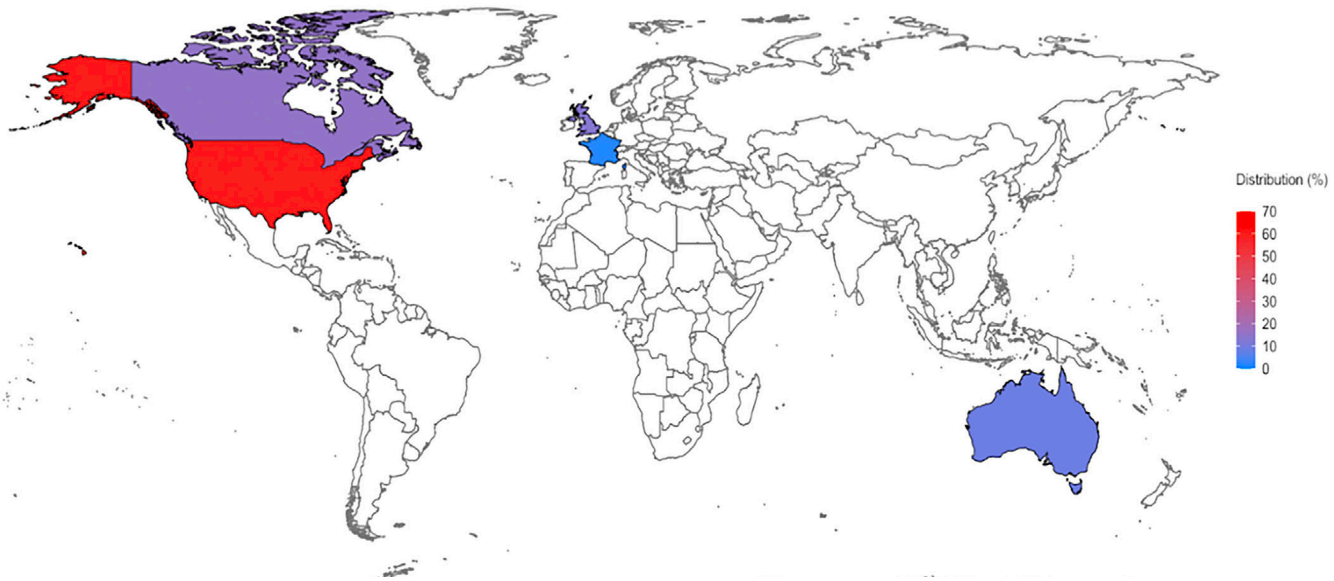
Showcase Project 2: The global distribution of special needs dentistry across dental school curricula

Another highlight of 2024 was the project "Global Mapping of Special Needs Dentistry Education", published in Special Care in Dentistry (Scepanovic et al., 2024). The study introduces the first worldwide analysis of SND curricula across 180 countries and 1265 dental schools, revealing striking disparities in education provision. It demonstrates a strong correlation between national socioeconomic status and the inclusion of SND in training programs, emphasising the urgent need to expand education to better prepare the global dental workforce for managing individuals with special needs.

Dr Mathew Lim

Associate Professor Antonio Celentano

Figure 11 The global distribution of dental schools offering non-specialised degrees.



Infection, Inflammation, and Immunity

Type IX Secretion System (T9SS) Group

Near-atomic structure of the PorKN rings, disulfide bonded to PorG and bound to Attachment Complexes, provides mechanistic insights into the type IX secretion system.

Porphyromonas gingivalis, an obligate anaerobe, is strongly associated with severe periodontitis at sites refractory to treatment and is now recognised as a keystone pathobiont of periodontal disease. *P. gingivalis* uses the Type IX Secretion System (T9SS) to translocate at least 35 cargo proteins to the cell surface, including hallmark virulence factors such as the gingipain proteases RgpA, RgpB, and Kgp. The T9SS secreted cargo proteins play an important role in virulence of the bacterium, including biofilm formation, nutrition acquisition, antibiotic resistance, adhesion and degradation of host proteins.

The T9SS is composed of at least 18 proteins in *P. gingivalis*, namely: PorK, PorL, PorM, PorN, Sov, PorT, PorU, PorW, PorP, PorV, PorQ, PorZ, PorE, PorF, PorG, Plug, PorD, PorA. PorK and PorN form large ring-shaped structures in the periplasm that are tethered to the OM by the lipidation of the PorK N-terminus and by association with an 8-stranded OM β-barrel protein, PorG. Evidence from cross-linking studies indicated that a periplasmic loop of PorG is in close proximity to both PorK and PorN.

Although, the PorKN ring and its association with PorG was identified nearly a decade ago, their precise role remains unclear. Here, we present a high-resolution structure of the PorKN ring (**Figure 12**), offering new insights into their function. We also demonstrate that PorG is associated with PorK through a disulfide bond (**Figure 13**), which is crucial for the function of the T9SS and show that the Attachment Complexes are associated with, and co-localised in-vivo above the PorKN rings providing insight into the co-ordinated mechanism of T9SS secretion and attachment in *P. gingivalis*.

Dr
Dhana Gorasia

Dr
Christine Seers

Laureate Professor AO
Eric Reynolds

Mr
Tanmay Devgan

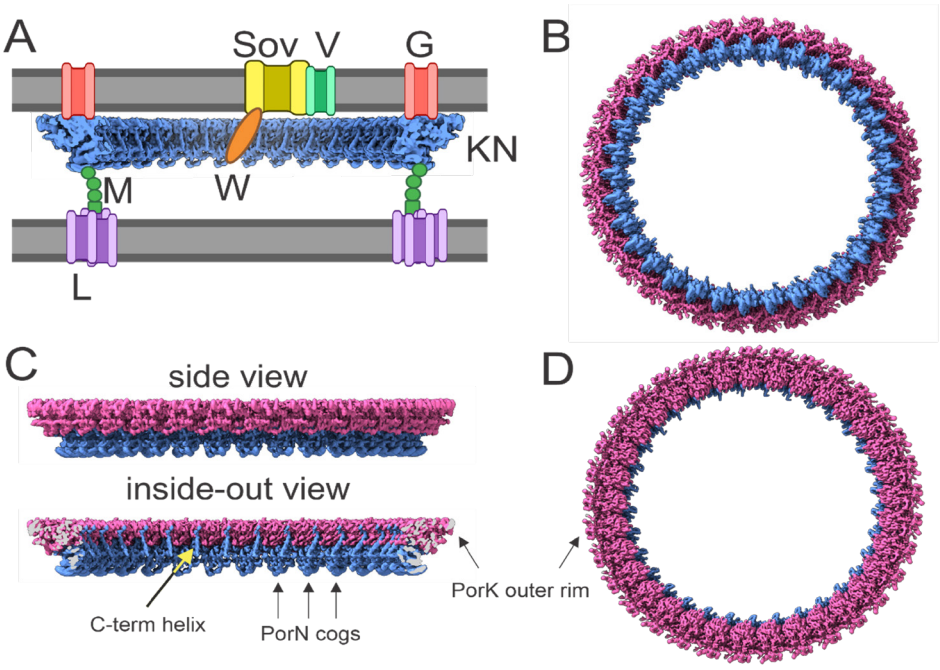


Figure 12 Structure of the PorKN ring

(A) Cartoon representation of the T9SS architecture showing the location of PorKN rings and PorG, PorLM motor, and the Sov translocon bound to PorV and PorW.

(B) A bottom view of 33-fold symmetry cryo-EM volume of the PorKN ring (Pink: PorK, Blue: PorN).

(C) Side views of the PorKN ring showing the flat upper surface and an outer rim formed by PorK with cog-like projections formed by PorN.

(D) Top-view of the PorKN ring.

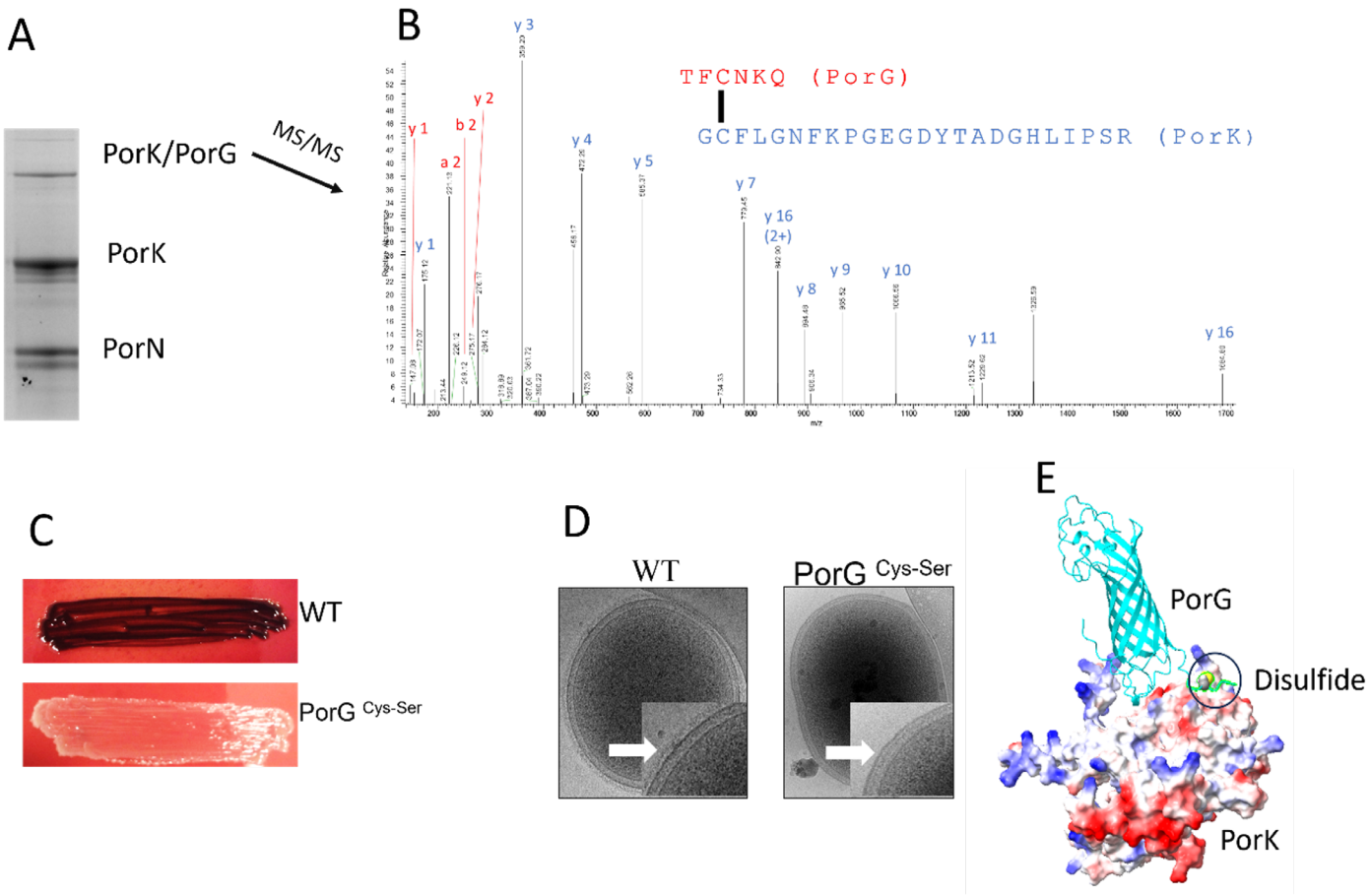


Figure 13 PorG is disulfide linked to PorK

(A) SDS-PAGE of purified PorKNG complex electrophoresed under non-reducing (DTT -) conditions.
(B) MS/MS spectra consistent with a disulfide bond peptide between PorG (230TFCNKQ235) and PorK (355GCFLGNFKPGEGDYTADGHLIPSR378).
(C) *P. gingivalis* WT and PorGCys232-Ser pigmentation on blood agar plates after 7 days of incubation.
(D) Cryo-electron micrographs showing the absence of an EDSL (white arrow) on the PorGCys-Ser mutant cells.
(E) AlphaFold3 model of PorG (green)-PorK(pink) interaction showing the close proximity of the PorG Cys232 and PorK Cys356 (circled).

Repair, Rehabilitation, and Regeneration

Materials, Mineralisation and Wound Healing

The Mineralised Tissue Research Group investigates a range of aspects of mineralised tissues: from fundamental human bone biology to dental tissue regeneration and associated soft tissue wound healing.

These include the effects of life events and population ancestry on teeth and the craniofacial skeleton. In addition, we investigate the functional roles of stem cells in mineralised tissue regeneration and the development of 3D organotypic/ synthetic biological model systems to understand tissue injury and repair. Research is conducted by an interdisciplinary group of anatomists, dental and biological anthropologists, bioengineers, clinical dentists and specialists and earth scientists.

Tracking Development of Age-related Cortical Porosity

The collaborative project with St Vincent's Research Institute aims to understand how human bone responds in ageing.

High-resolution micro-CT imaging and infrared light imaging will be combined with histomorphometry to analyse the mineralised phase of human cortical bone. This research is being carried out using samples from the Melbourne Femur Research Collection: a unique, well-provenanced collection of contemporary human bone samples. This project has the potential to help answer questions about cortical bone remodelling, which applies to many aspects of dental treatment and research.

This new project will bring new understanding to the bone remodelling process, adding important information to the current body of knowledge.

Restorative Dental Materials

New direct restorative dental materials are coming onto the market regularly, and bespoke materials are being developed for patients' requirements. Glass-ionomer (GI) and resin-based ion-leaching restorative materials (RB-ILMs) are being developed as so-called "smart materials". These restorative materials can release ions as a function of the ions present within the restorative dental material, and also recharge ions from other dental products (e.g., varnishes and toothpastes, etc.) in response to their chemical surroundings. These stored ions help augment the concentration of ions present in the saliva and the oral environment to prevent tooth demineralisation and encourage remineralisation.

Recently (2021), PhD student (Chirayu Ruengrungsom) investigated contemporary ILMs materials to evaluate their mechanical properties in addition to their ion release, and rechargeability to provided evidence for improved material selection for each clinical scenario.

AI-assisted Multiscale Simulation Framework for Intentional Design of Dental Restorative Materials

Research in collaboration with Dr Ellie Hajizadeh in the Department of Mechanical Engineering at the University of Melbourne and our industry partner SDI Ltd is focused on developing a chemistry-informed computational framework for the design and development of new restorative dental products based on glass-reinforced resin composites (GR-DRCs) alongside elevating a proof-of-concept (TRL3) AI-enabled software tool, which achieves automated & intentional design of polymeric materials to TRL5. Supported by external research fundings (three Australian Government Industry PhD Scholarships and an Australian Economic Accelerator Ignite grant), this multidisciplinary project will serve to improve the flexibility and robustness of the software whilst also designing improved formulations for globally competitive new dental restorative products, as well as insight about the most cost-effective design variables.

Researchers: Professor Alastair J Sloan, Associate Professor Rita Hardiman, Associate Professor Khaled Ahmed, and Associate Professor Jaafar Abduo

Figure 14 Professor Alastair J Sloan presenting Ms Sze Wei Liu's work at ASBTE (Australian Society of Biomaterials and Tissue Engineering scientific meeting in Brisbane, April 2025).

Repair, Rehabilitation, and Regeneration

Genomic and Proteomic Analyses of Human Dental Pulp Stem Cells Secretomes

Dental pulp stem cells (DPSCs) are increasingly recognised for their potential in regenerative medicine, particularly in oral and maxillofacial surgeries. However, the unique microbial environment of the oral cavity necessitates a better understanding of how bacterial challenges may affect DPSC function to optimise their reparative capabilities and potential clinical/therapeutic use. This project is focused on identifying and understanding differentially expressed proteins in response to bacterial challenge and utilises comparative proteomic methodology of the secretome and whole cell lysates with deeper analysis of differentially expressed proteins using STRINGDB and REACTOME databases to elucidate key proteins and networks, highlighting their involvement in DPSC's role on cell survival, immune response, wound healing, and cellular protein-protein interactions.

Researchers: Professor Alastair J Sloan, Dr Rachael Moses, Ms Sze Wei Liu, and Ms Rita Paolini

3D Chronic Wound Healing Model Using Animal-Origin-Free Components

Chronic wounds represent scenarios where the acute wound healing response is impaired, burdening both patients and healthcare systems. Rodent models are often used to replicate the human wound repair process, providing information on *in vivo* wounds and assessing the potential of novel wound healing therapeutics. However, these rodent models have limitations in their translation to human wound healing situations due to vital differences in skin architecture and wound healing cascade. This project is developing a novel 3D organotypic model using animal-free components to reduce variability associated with animal-derived products. This novel 3D chronic wound model will more accurately represent the human wound healing scenario, is more cost-effective and without the ethical considerations associated with rodent models and animal-product use.

Researchers: Dr Rachael Moses, Professor Alastair J Sloan, Mr Alex Logothetis (current PhD project)

Engineering Extracellular Vesicles for Therapeutic Development Using 3D Models of Skin and Bone Regeneration

Stem cells offer tremendous potential for the field of regenerative medicine, but recent studies have shown that their secreted extracellular vesicles, particularly small extracellular vesicles (sEVs), can replicate their beneficial effects. *In vitro* and *ex vivo* experiments have demonstrated that stem cell sEVs can promote skin and bone repair in 2D models. As researchers have gained a deeper understanding of how these sEVs work, it has become clear that the miRNA contained within them plays a major role in their function. By increasing the abundance of specific target miRNA in the parental cells, the abundance of functional miRNA within their secreted sEVs can also be increased. This project evaluates the efficacy of stem cell sEVs in various 2D and 3D models and then will enhance their function using genetic engineering techniques. This project is part of an ongoing collaboration between the University of Melbourne, Australia, Monash University, Australia and Cellese, Inc., Irvine, California, USA.

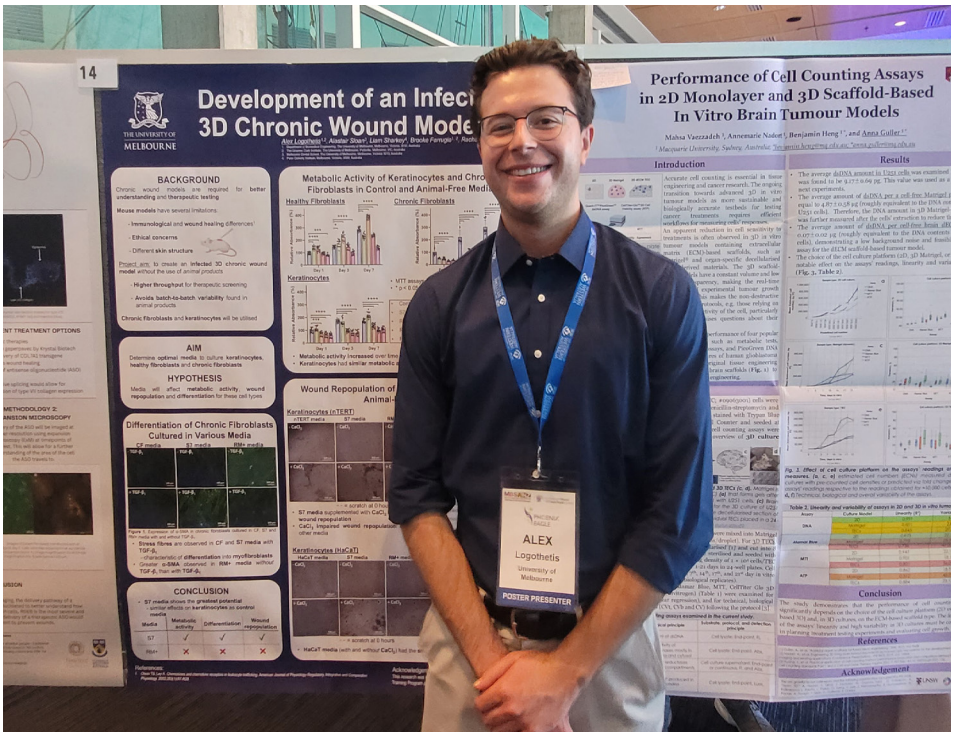
Researchers: Dr Rachael Moses, Professor Alastair J Sloan

Does NLRP3 Inflammasome Play a Role in Host Defence (Innate Immunity) and Regenerative Capacity in Dental Pulp Stem Cells (DPSC)?

Dental pulp stem cells (DPSCs) are a quiescent population of stem cells present in stem cell niches within the dental pulp, which become activated following stimulation/trauma. To understand inflammation in the dental pulp, the role of the NLRP3 signalling pathway is being investigated in this project. This signalling pathway is stimulated by a two-step signal that triggers a complex cellular cascade causing the assembly of the NLRP3 inflammasome to produce pro-inflammatory cytokines, IL-1β and IL-18. This project is focused on investigating the role of the NLRP3 inflammasome in host defence (innate immunity) and regenerative capacity in DPSCs.

Researchers: Dr Rachael Moses, Professor Alastair J Sloan

Figure 15 Mr Alex Logothetis, a 2nd year PhD student presenting his poster at AWTRS (Australasian Wound and Tissue Repair Society scientific meeting in Fremantle, October 2024).



Repair, Rehabilitation, and Regeneration

Assessment of Dentine Matrix Proteins on Dental-Pulp-Stem-Cell Migration and Mineralisation

Root canal treatment aims to alleviate clinical signs and symptoms of apical periodontitis through instrumentation and antimicrobial irrigation. Adjunct therapies to conventional root canal treatment are of growing interest. Dentine matrix proteins (DMPs) present in the dentine extracellular matrix have been suggested to regulate the formation of regenerative dentine in response to trauma or infection and have therapeutic potential to regenerate dentine, pulp, and periradicular tissues. Dental pulp stem cells (DPSCs) are crucial to this process. When exposed to growth factors, DPSCs can differentiate into odontoblast-like cells responsible for synthesising mineralised or pulp-like tissue in empty root canals. This project focuses on the differentiation and mineralisation capability of DPSCs following exposure to DMPs, and the resultant therapeutic potential of DMPs in dental tissue regeneration.

Researchers: Dr Rachael Moses, Associate Professor Mark Evans, Associate Professor Satish Alapati, and Professor Alastair J Sloan

Parathyroid Hormone-Conditioned Dental Pulp Stem Cells and Growth Factor Release: An *in vitro* Study

Dental pulp stem cells (DPSCs) provide increasing recognition in contributing to regenerative medicine-based therapies. Their neural crest origin provides multipotent capacity to differentiate into a large array of tissues, which affords applications far beyond that of the oral cavity. The use of parathyroid hormone (PTH) has been demonstrated to stimulate the expression of matrix metalloproteinase-13 (MMP-13), which has a crucial role in bone formation and remodelling. Recent research has found a critical role between MMP-13 and the regulation of tooth development through the Wnt signalling pathway and increased expression of Runx2 and miR-873-3p. Combining these concepts together with DPSCs may shed light on a novel pathway where the responses in DPSCs can be potentially stimulated into differentiation by means of PTH.

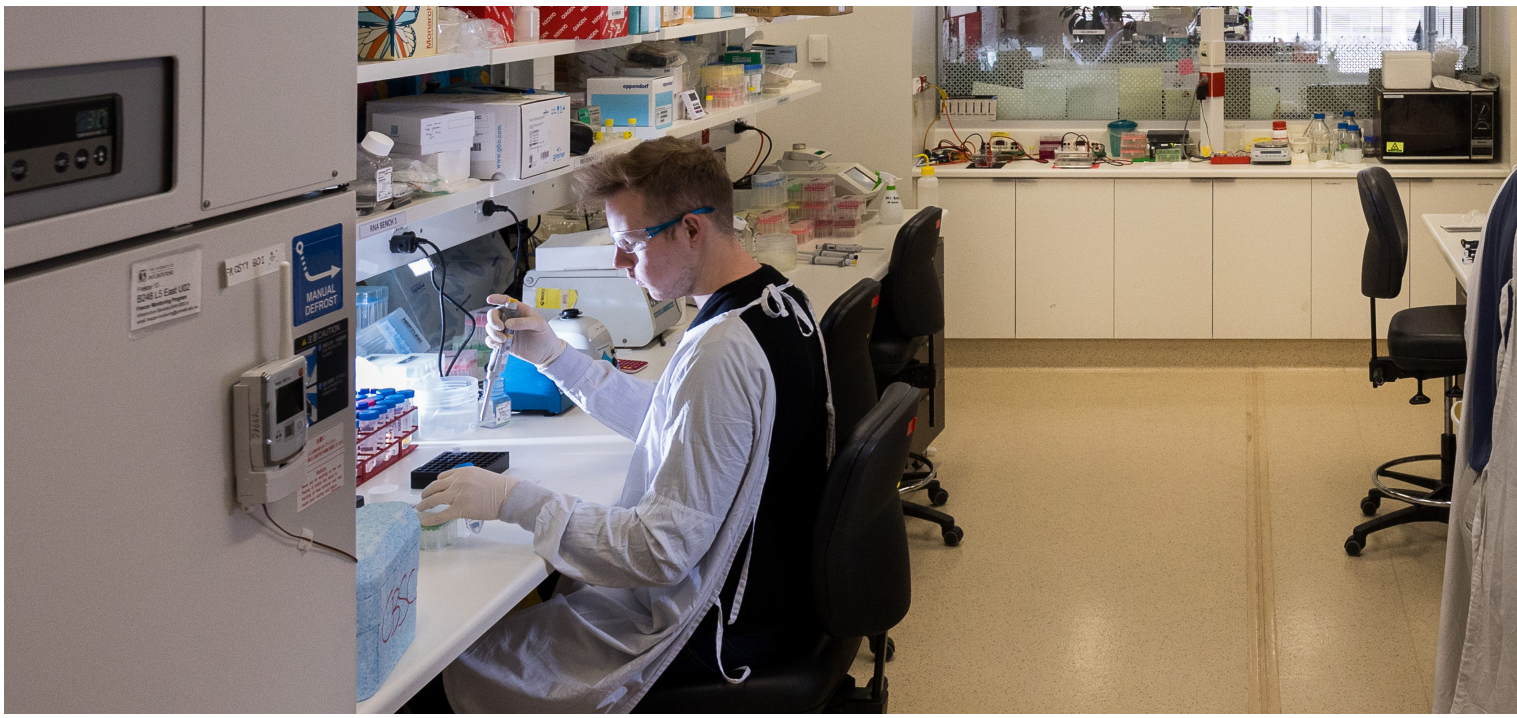
Researchers: Dr Rachael Moses, Associate Professor Mark Evans, Associate Professor Satish Alapati, and Professor Alastair J Sloan

Migration of *Streptococcus anginosus* and Enterococcus faecalis through Dentine: An *Ex-Vivo* Study

Bacterial infections within the mouth can spread to other regions; this study will determine the mechanism of action for this through culturing *S. anginosus* on tooth slices and performing TEM imaging to determine how the bacteria interact with the teeth and how they line up with the blood vessels; proteomics will provide information on the proteins involved in this process.

Infected dental pulp occurs when bacteria invade the pulp tissue and form biofilms, triggering inflammation in the surrounding periapical tissue. This process can ultimately lead to apical periodontitis. Polymicrobial infections, particularly those involving *Streptococcus anginosus (S. anginosus)* and *Enterococcus faecalis (E. faecalis)*, significantly reduce the viability of dental pulp stem cells. Therefore, this project focuses on understanding bacterial penetration mechanisms, which is crucial for elucidating how bacteria invade tooth structures and contribute to apical pathosis.

Researchers: Dr Rachael Moses, Associate Professor Mark Evans, Associate Professor Leanne Teoh, Associate Professor Satish Alapati, Professor Alastair J Sloan, and Mr Yoshikatsu Shibata (current DCD/PhD project)



Repair, Rehabilitation, and Regeneration

Advancing Dental Safety: Evaluating Heat-Induced Pulpal Responses from Light-Curing Units Using a Novel 3D Tooth Model

This project aims to tackles the critical concern of heat damage caused by light-curing units (LCUs) during dental restorative procedures. This research will investigate the thermal effects of LCUs and resin-based composites (RBCs) on dental pulp stem cells (DPSCs) viability, and the design of a novel 3D human tooth model.

Researchers: Dr Cristiane Maucoski, Dr Mohammed Al-baadani, Dr Rachael Moses, Dr Leon Prentice, Dr Richard Price, and Professor Alastair J Sloan.

Dr
Rachael Moses

Associate Professor
Mark Evans

Professor
Alastair J Sloan

Associate Professor
Satish Alapati

Associate Professor
Rita Hardiman

Associate Professor
Jaafar Abduo

Associate Professor
Khaled Ahmed

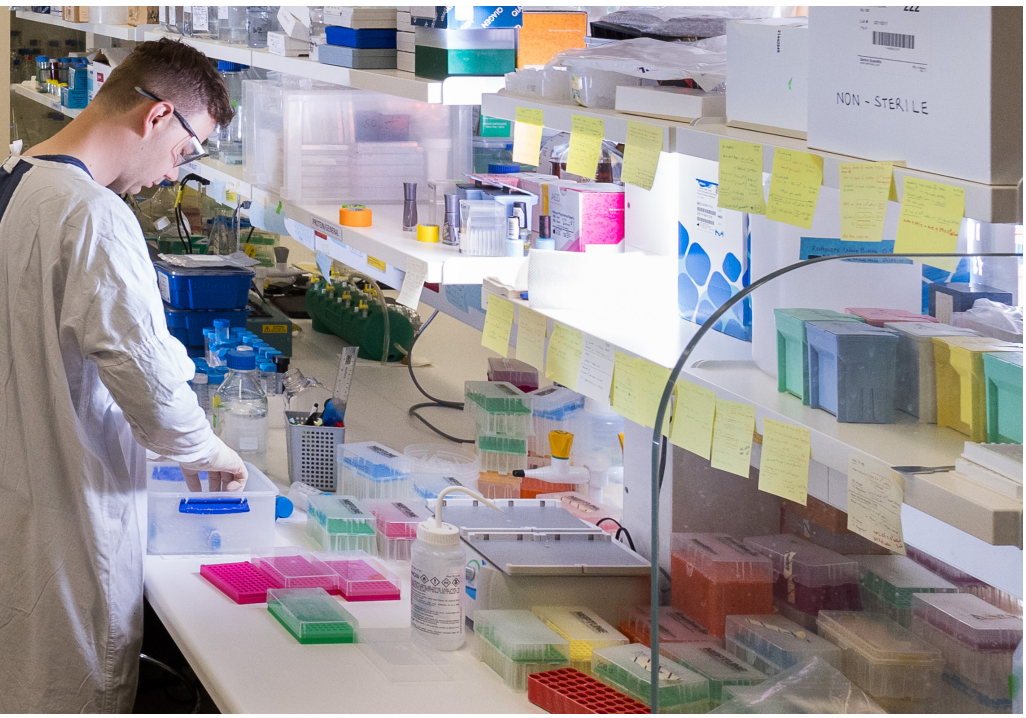
Dr
Mohammed Al-baadani

Associate Professor
Leanne Teoh

Ms
Rita Paolini

Ms
Sze Wei Liu

Dr
Cristiane Maucoski



Repair, Rehabilitation, and Regeneration

Cariology Research

Project 1: Concealment of White Spot Lesions with 60% CPP-ACP/SnF2 (1100ppmF) After Bleach with GC TiON0 *In Vitro*

Orthodontic treatment with fixed appliances often results in white spot lesions (WSLs) on teeth, primarily on the labial surfaces of maxillary incisors, causing aesthetic concerns post-treatment. Up to 96% of patients may develop these lesions, with 72.9% showing new WSLs during treatment. Most WSLs do not regress and can worsen over time. Non-invasive treatments like high-concentration fluoride can remineralise the lesions but do not fully mask them. Micro-invasive methods, such as resin infiltration, are costly and may cause long-term aesthetic issues. CPP-ACP dental creams can slowly reverse WSLs, but results are variable and take time. Combining CPP-ACP with fluoride ions may speed up remineralisation but still requires months.

Previous studies have shown that a combination of 60% CPP-ACP with fluoride is more effective in mineral deposition. Additionally, pre-bleaching with carbamide peroxide enhances remineralisation and esthetic outcomes. The goal of this in vitro study is to develop a rapid, non-invasive treatment using 60% CPP-ACP/SnF2 and the TiON bleach whitening system for masking WSLs.

In the study, six enamel slabs with lesions were treated with the TiON whitening system, followed by application of a 60% CPP-ACP/0.454% SnF2 gel. The slabs were immersed in artificial saliva at 37°C, with the treatment repeated three times daily for three 10 days (Monday to Friday). Photographs were taken before and after each treatment.

The study demonstrated that treatment with GC TiON bleach followed by CPP-ACP/SnF2 gel produced a significant white spot masking effect. Representative images of white spot lesions before and after 10-day treatment are presented in **Figure 16**. As seen in Figure 16, treatment with GC TiON bleach followed by CPP-ACP/SnF2 gel almost completely concealed white spot lesions on the tested half-slab surface.

Project 2: *Porphyromonas gingivalis* inhibition by CPP-ACP /SnF2

SnF_2 possesses strong antimicrobial effects, particularly against cariogenic bacteria like *Streptococcus mutans*, which are responsible for dental caries. It reduces plaque formation and gingival inflammation by inhibiting bacterial growth and biofilm formation.

Clinical studies have shown that SnF_2 exposure leads to a decrease in harmful bacteria like *S. mutans* and an increase in beneficial bacteria like *S. sanguis*. This shift contributes to a healthier oral microbiota, preventing plaque buildup and decay.

SnF_2 provides both enamel remineralisation via fluoride ions and antibacterial action via stannous ions, helping to inhibit demineralisation and promote enamel repair while reducing bacterial activity.

SnF_2 possesses strong antimicrobial effects, particularly against cariogenic bacteria like *Streptococcus mutans*, which are responsible for dental caries. It reduces plaque formation and gingival inflammation by inhibiting bacterial growth and biofilm formation.

Before treatment: Test half-slab (Left) and Control half-slab (Right)

After treatment: Test half-slab (Left) and Control half-slab (Right)

Figure 16 Representative images of white spot lesions before and after 10-day treatment (n=6). Upper pair: before treatment with the test half slab on the left and control half slab on the right; Lower pair: after 10-day treatment with the test half-slab on the left and control half-slab on the right.

These findings have profound implications for clinical practice, particularly in the non-invasive management of white spot lesions in patients after orthodontic therapy.

Repair, Rehabilitation, and Regeneration

Clinical studies have shown that SnF_2 exposure leads to a decrease in harmful bacteria like *S. mutans* and an increase in beneficial bacteria like *S. sanguis*. This shift contributes to a healthier oral microbiota, preventing plaque buildup and decay.

SnF_2 provides both enamel remineralisation via fluoride ions and antibacterial action via stannous ions, helping to inhibit demineralisation and promote enamel repair while reducing bacterial activity.

However, despite its widespread use in commercial dentifrices, the efficacy of SnF_2 can be compromised by oxidative decomposition, which diminishes its effectiveness over time. The inherent instability of SnF2 poses significant challenges, as it can undergo complexation and oxidation if not properly stabilized in toothpaste formulations, leading to reduced bioavailability, efficacy and a shorter shelf life. SnF2 also is not stable in saliva at pH 7 where it can form insoluble hydroxide and phosphate salts making the stannous ions unavailable to interact with plaque pathogenic bacteria. Hence toothpaste formulations need to not only stabilise the SnF2 in the formulation but also in the oral environment to increase bioavailability and efficacy.

CPP-ACP (Casein Phosphopeptide-Amorphous Calcium Phosphate) promotes remineralisation with CPP stabilising calcium and phosphate ions, enhancing enamel remineralisation and reducing the risk of caries. It is especially effective when combined with fluoride, amplifying its anticariogenic potential. CPP-ACP has shown to help in the prevention of caries in laboratory, animal, and human studies, offering a protective role for enamel and dentine. When combined, SnF_2 and CPP-ACP provide a synergistic effect, promoting remineralisation and antibacterial benefits beyond what fluoride alone can achieve, thereby improving oral health and preventing tooth decay.

To compare antimicrobial bioactivities of SnF2 with and without 10% CPP-ACP, the antimicrobial activity of 29 mM SnF2 (1100 ppm F) with and without 10% CPP-ACP was determined using Porphyromonas gingivalis (Pg) as a model oral pathogen and a blood agar diffusion assay.

The results in Figure 17 for this study demonstrated that CPP-ACP/SnF2 was far superior in inhibiting growth of Pg at pH 7.0 which correlated with the CPP's ability to solubilise and stabilise Sn ions at pH 7.0. Significance: The saliva biomimetic CPP-ACP promotes stability and bioactivity of SnF2 with enhanced remineralisation and antimicrobial efficacy.

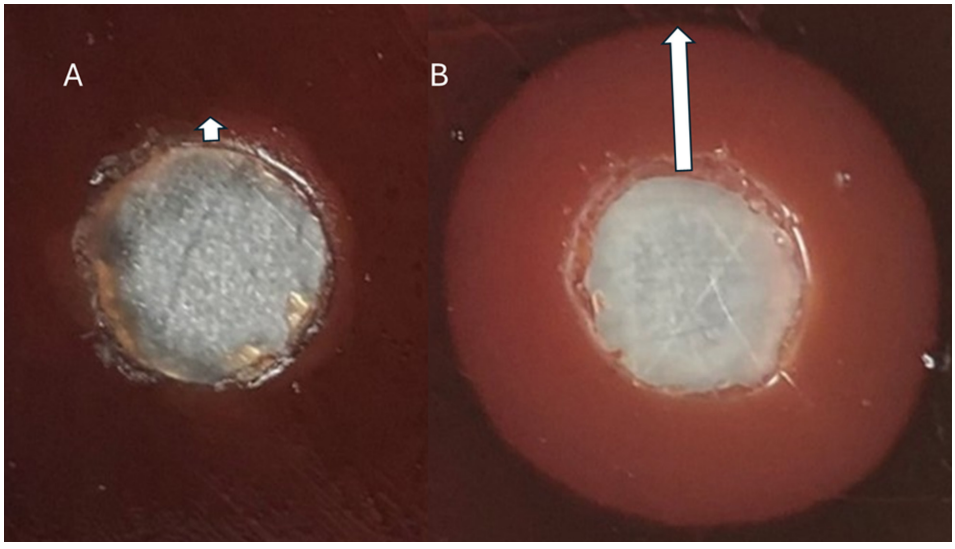
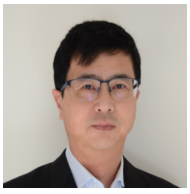


Figure 17 Inhibition of *Porphyromonas gingivalis* growth on blood agar at pH 7.0 by 29 mM SnF2 (well A) and 10% CPP-ACP/SnF2 29 mM (well B). The presence of 10% CPP-ACP increased the solubility of Sn ions at pH 7.0 from 0.1 ± 0.1 mM Sn (0.1% soluble Sn/total) to 26.3 ± 1.5 mM Sn (91% soluble Sn/total) and produced a defined clear zone of growth inhibition on the blood agar plate (shown with white arrow).

Associate Professor Peiyan Shen

Dr Lianyi Zhang

Dr James Fernando



Dr Yi Yuan

Associate Professor Geoff Adams

Laureate Professor AO Eric Reynolds

Ms Coralie Reynolds

Repair, Rehabilitation, and Regeneration

Orthodontics and Craniofacial Research Group

Solid clinical research is the future in Orthodontics since the specialty is still lacking consensus on many important clinical issues. More specifically, the Orthodontics and Craniofacial research group mostly focuses on 3D outcomes of orthodontic treatments, stability after orthodontic treatment, digital workflows, and aesthetic appliances. The projects include randomised controlled clinical trials as well as large retrospective studies, aiming to foster strong research outcomes towards better clinical guidelines in orthodontics. The group is in close contact with the Australian Association of Orthodontists and wishes to set up joint projects within the eviDent Dental Practice Based Research Network.

Furthermore, the group has an ongoing international collaboration with Aarhus University (Denmark) and the University of Oslo (Norway), collecting 5-year data for a large randomised controlled clinical trial about orthodontic retention. The group also has ongoing collaborations with Sapienza University (Rome, Italy) and Boston University (USA).

PhD Students Involved
Dr Tassneem Elagib
Dr Amin Mohamed

Key Achievements

1. Doctor of Clinical Dentistry (DCD) student Sophie Roberts winner of the 2024 Athanasios E Athanasiou Best Master's Thesis Award of the World Federation of Orthodontists.
2. DCD student Denice Loo selected to participate for the William R. Proffit Resident Scholar Award at Annual Session Annual meeting of the American Association of Orthodontists in New Orleans in May 2024.

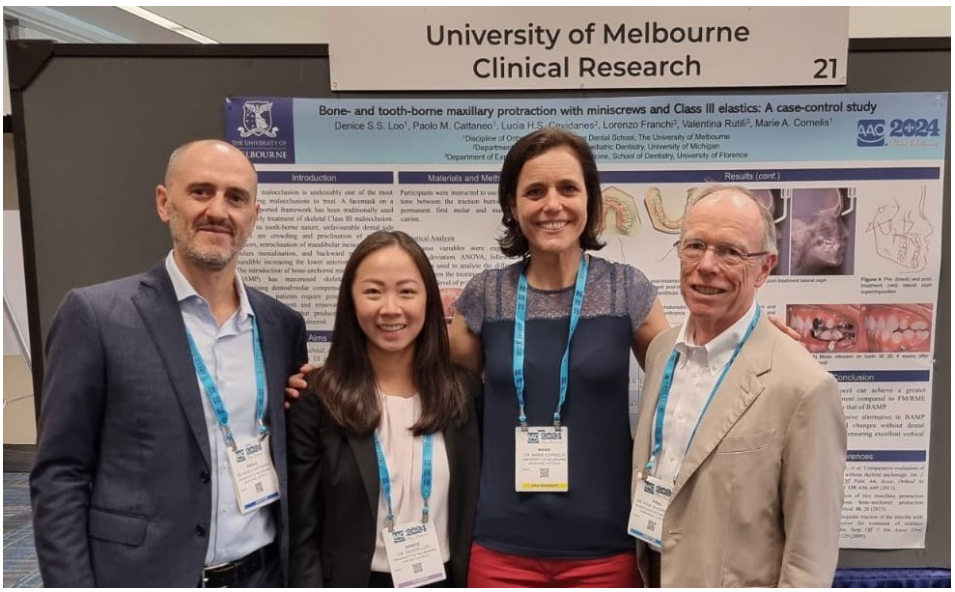
Grants and Funding

1. 2024 "Investigator-initiated Study" research grant from Straumann. "Influence of clear aligner trimline on tooth movement & patient satisfaction during orthodontic treatment". Paolo Cattaneo, Keishi Barnes, Marie Cornelis, Amin Mohamed (~$34,000)
2. 2024 Kwok Paul Lee Bequest Foundation. "Effectiveness of clear plastic retainers in maintaining post-orthodontic treatment stability". Maurice Meade, Paolo Cattaneo, Marie Cornelis ($29,239)
3. 2024 International Orthodontics Foundation. "Mixed reality navigation for orthodontic mini-screw implantation". Yi Fan, Paolo Cattaneo, Marie Cornelis
4. 2024 Australian Society of Orthodontists Foundation for Research and Education. Student Research Donation granted to Marie Cornelis, to be administered on behalf of the DCD Students. ($30,000)

Research Proceedings

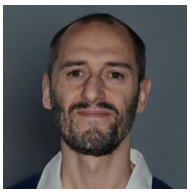
1. 11/2024 "Functional appliances". Online lecture - International Short term Course in Orthodontics. Aarhus University, Denmark
2. 11/2024 "Bone Anchored Maxillary Protraction". Invited lecture (ASOFRE Faculty rotations) – University of Otago. Dunedin, New Zealand
3. 09/2024 "Bone anchored maxillary protraction" – "Functional appliances" – "Retention" – "An evidence-based approach to digital orthodontics" (joint lecture with PM Cattaneo). Invited lectures - NZAO ERDG 2024 Symposium. Denarau, Fiji
4. 08/2024 Keynote Speaker: "An evidence-based approach to digital orthodontics" (joint lecture with PM Cattaneo) - Australasian Society of Lingual orthodontists 2024 (ASLO). Sydney, Australia
5. 05/2024 Keynote Speaker: "Orthodontic retention: an evidence-based update". – Annual Session American Association of Orthodontists. New Orleans, USA
6. 04/2024 "Bone Anchored Maxillary Protraction: where are we now?" Webinar- American Association of Orthodontists Online

Figure 18 Dr Denice Loo's (second from left) presentation at the American Association of Orthodontists Annual Session, 2024.



Repair, Rehabilitation, and Regeneration

7. 03/2024 Keynote Speaker: ”An evidence-based perspective on Retention protocols. 29th Australian Orthodontic Congress. Adelaide, Australia
8. 01/2024 “ How efficient is lingual orthodontics?” Invited lecture – 51st Annual Meeting Angle Society of Europe. Online
9. Invited Lecture: University of Otago. Dunedin, New Zealand. (ASOFRE Faculty rotations). “Finite Elements and Orthodontic Tooth Movement” & “CBCT and Upper Airways”. 23 August 2024.
10. Invited Lectures: NZAO ERDG 2024 Symposium. Denarau, Fiji. “Cone Beam Computed Tomography & Upper Airways”, “An evidence-based approach to digital orthodontics” (joint lecture with Marie Cornelis). 26-29 September 2024.
11. Keynote Speaker: Australasian Society of Lingual Orthodontics (ASLO) meeting. Sydney, NSW. “An evidence-based approach to digital orthodontics” (joint lecture with Marie Cornelis). 1-4 August 2024.
12. Invited Lecture: Annual Session American Association of Orthodontists. New Orleans, USA. “Pharyngeal Airway Changes Five Years After Bimaxillary Surgery – A Retrospective Study”. 4-6 May 2024.
13. Keynote Speaker: 29th Australian Orthodontic Congress. Adelaide, Australia. “Orthodontically Induced Root Resorption and Its Association with the Applied Force System”. 14-16 March 2024.



Professor
Paolo M Cattaneo

Professor
Marie Cornelis

Associate Professor
Paul Schneider

Dr
Yi Fan

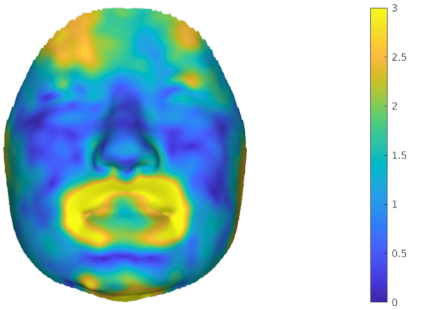


Figure 19 RMSE: Mapping differences from facial scans.

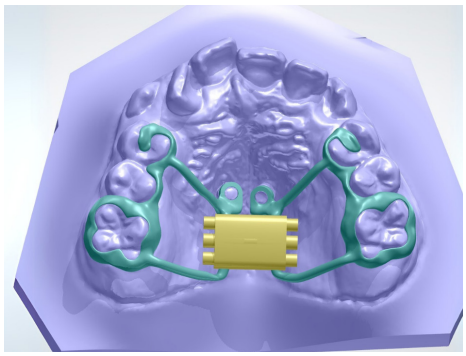


Figure 20 CAD/CAM class III correction appliance.

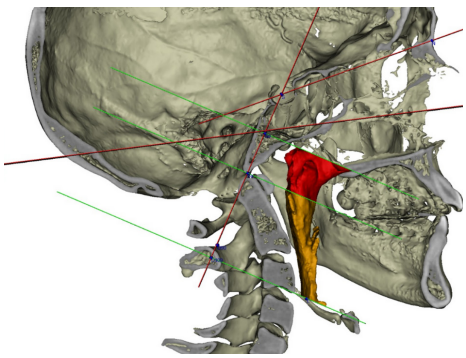


Figure 21 CBCT and Upper Airways.

Repair, Rehabilitation, and Regeneration

Prosthodontics

The prosthodontics research has a strong track record in the clinical and lab testing of dental materials. The key aim of this research group is to deliver outcomes directly applicable to current clinical practice. The clinicians and researchers in this team have established linkages with other university partners with exceptional industry relationship's providing significant scope for high level translational research. A key focus of this group is dental implants.

Making Dental Implants Available for More Patients: Rectangular Block Implant (RBI)

2024 has been a productive year for the Prosthodontic Group. The Rectangular Block Implant project was awarded prestigious grants via the Australian Education Accelerator Award in May 2024. This grant funds commercial-level production of the implant in conjunction with an Australian-based manufacturer (Signature Orthopaedics-Sydney). Subsequently, in October 2024, the project was awarded a Faculty Innovation Grant. This highly competitive award was open to research groups across the faculty, with four successful groups. The grant provides seed funding to design a multicentre trial of the RBI.

In December 2024, Associate Professor Roy Judge led a team (group leads Professor Alastair J Sloan, Professor Neil O'Brien-Simpson and Professor Elena Ivanova) which was awarded access to the new University Translational Research Platform, the Aikenhead Centre for Medical Discovery. The project title is "Enhancing Implant Care for Medically Compromised and Elderly Patients". This project will take a patient-centred approach to clinical research, education and translation to clinical practice. The ACMD platform is due to open in September 2025 with multiple University and industry stakeholders adopting an interdisciplinary approach to clinical research.

As part of our collaboration with original partners, the Prosthodontic Group was able to publish with academics at Universitas Airlangga in the prestigious journal Clinical Oral Implants Research:

Putra, R. H., Cooray, U., Nurrachman, A. S., Yoda, N., Judge, R., Putri, D. K., & Astuti, E. R. (2024). Radiographic alveolar bone assessment in correlation with primary implant stability: A systematic review and meta-analysis. Clinical Oral Implants Research, 35(1), 1-20.

Associate Professor Roy Judge

Associate Professor Jaafar Abduo

Associate Professor Joseph Palamara

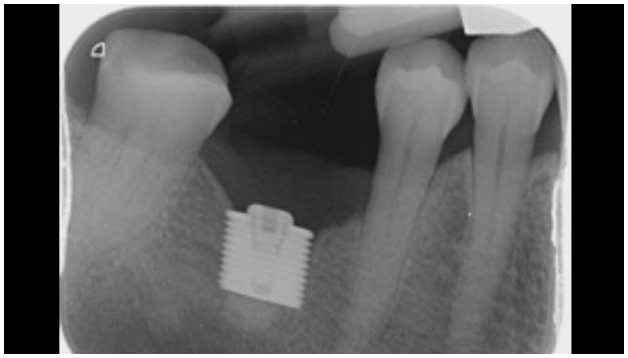


Figure 22 Radiograph showing osseointegration of the RBI

Figure 23 RBI components; the implant, healing cap and retaining screw.

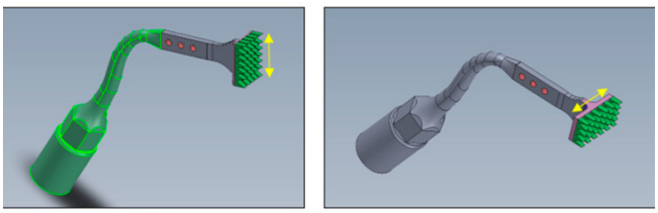


Figure 24 Two bespoke rectangular piezotome designs facilitate rectangular osteotomy for the Rectangular Block Implant project. Design (a) cuts in the buccolingual (Y-axis) direction, enabling osteotomy along the Y-axis dimension. Design (b) cuts in the mesiodistal (X-axis) direction, facilitating osteotomy along the X-axis. Yellow arrows represent 5 mm lengths for the required rectangular osteotomy dimensions. These specialised designs allow precise, flat-bottomed rectangular osteotomies for successful implant integration.

Close-up of Bespoke Rectangular Piezotomes - critical tools for successful rectangular block bone grafting and implant procedures.

Population Health, Community and Education

Dental Public Health Research

Research activity focused on issues of access to dental care in Australia, with a commentary on the Senate inquiry into dental services and an invited paper on primary care dentistry from an Australian perspective. Ongoing research activities focused on dental practitioner attitudes to expanding Medicare to include more dental services, exploring affordability of dental care and the geographic and socioeconomic distribution of dental practitioners in Australia.

Publications

1. Sloan AJ, Wise S, Hopcraft MS. Primary care dentistry: an Australian perspective. J Dent 2024;145:104996
2. Hopcraft MS. Commentary on the Senate Select Committee into the Provision of and Access to Dental Services in Australia: an opportunity for reform. Aust Dent J 2024;69(3):162-174

Associate Professor Matt Hopcraft

Population Health, Community and Education

Dental Education Research

The Dental Education and Scholarship of Teaching and Learning group aim to explore how the design and implementation of learning activities, and assessment and feedback practices influence student learning. The focus areas for research include Assessment for Learning, ePortfolio pedagogy and reflective practice, self-regulated learning in a blended learning environment, and technology enhanced learning including AI.

Motivations for Student Activity Choices in Dental Anatomy Workshops

The Doctor of Dental Surgery program encourages self-regulated, and self-directed learning. In a foundational anatomy subject, students complete a variety of workshop activities, and curate a selection of these activities for a portfolio assessment. This project explored the relationship between student motivation for the selection of assets to include in the portfolio assessment and workshop activity learning intention within a self-regulated learning framework. This research was presented at 2024 IADR General Session in New Orleans.

Researchers: Associate Professor Rita Hardiman, Dr Meena Iyer, and Associate Professor Samantha Byrne

Self-regulated Learning and Preparation for a Flipped Classroom

The aim of this project was to examine patterns of preparation in an online learning environment and compare these patterns for students with high and low levels of self-regulated learning (SRL). Self-reported SRL was able to distinguish between students who demonstrated these behaviours in an online environment when preparing for a flipped classroom. This indicates that identifying students with low SRL may enable targeted support to encourage preparation for class. This research was presented at 2024 IADR General Session in New Orleans.

Researchers: Associate Professor Samantha Byrne, Associate Professor Heather Verkade, Associate Professor Sean Kang, Associate Professor Kristine Elliott

Associate Professor Samantha Byrne

Associate Professor Rita Hardiman

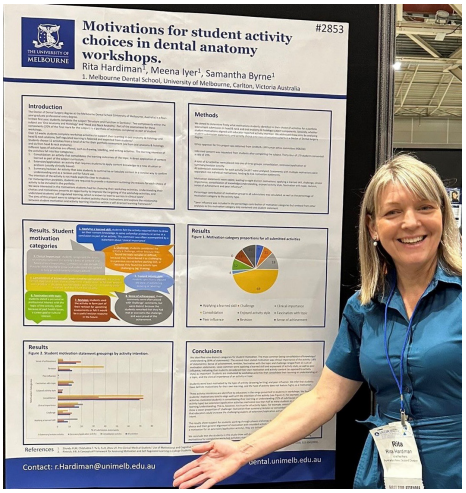


Figure 25 Associate Professor Samantha Byrne and Associate Professor Rita Hardiman with their posters at the IADR General Session in New Orleans 2024.

Population Health, Community and Education

Rural, Remote and Indigenous Oral Health Equity

NEAL Oral Health Plan

Developed in collaboration with the Northern Territory Government, Miwatj Health Aboriginal Corporation, Laynhapuy and Marthakal Homelands Corporations in North East Arnhem Land and with the support of AMSANT, the NEAL Oral Health Plan lays out the strategic partnership activity and research to improve oral health in the region. Chaired by Professor Julie Satur, the Advisory committee overseas the plan's activities and the integration of dental students from the Melbourne Dental School who contribute to clinical service delivery and oral health promotion for the Yolŋu people of NEAL. Ongoing work around oral health promotion evaluation, co-design of dental services and tele-dentistry are part of the plan.

Researchers: Professor Julie Satur, Ms Claire Phelan (NTG), Ms Andrea Whyte (Miwatj HAC)

Community Consultation on Oral Health for Aboriginal and Torres Strait Islander Peoples

Access to culturally safe dental services is a key challenge for Aboriginal communities. This research, developed out of need identified by two Indigenous communities, is designed to understand the needs of Aboriginal and Torres Strait islander peoples to inform the delivery of culturally safe oral health care. Co-designed and informed by Indigenous methodologies and community engagement, yarns were utilised to conduct community consultation with the Yolŋu and Yort Yorta communities to understand the barriers and enablers for culturally safe dental services. This research will help improve oral health promotion and service delivery and educational preparation of dental practitioners.

Researchers: Ms Eliza Collins, Professor Julie Satur, Professor Shawana Andrews

RACGP & NACCHO National Guide to Preventive Healthcare for Aboriginal and Torres Strait Islander People; Chapter 16 Oral Health

The National Guide is a practical resource intended for all health professionals delivering primary healthcare to Aboriginal and/or Torres Strait Islander people. Our team reviewed the current evidence to develop the chapter on Oral Health for this fourth edition published by the RACGP and NACCHO.

Researchers: Professor Julie Satur, Professor Stuart Dashper, Professor Michael McCullough

Find out more about the RACGP guidelines here!

Oral Health for Rural Populations

In partnership with the National Centre for Farmers Health at Deakin University and, our team has undertaken a scoping review of oral health for rural populations to identify the barriers and enablers, evidence for successful interventions and gaps in the evidence to inform our research. This work also informs advocacy around oral health in rural communities for the Victorian Oral Health Alliance and National Rural Health Alliance.

Researchers: Professor Julie Satur, Ms Caroline Koedyk, Dr Jackie Cotton (Deakin)

Figure 26 Ms Eliza Collins and Professor Julie Satur at the National Rural Health Alliance Conference, 2024.

Population Health, Community and Education

Rural Workforce Development

The oral health of rural residents is hampered by shortages of dental practitioners preventing access to dental care. Evaluation research to understand the effectiveness of dental student rural clinical placements on the development of rural dental workforces is demonstrating the value of positive social engagement in rural communities as an enabler for dental workforce recruitment. This research is undertaken to inform and improve the delivery of rural clinical placement programs in the Melbourne dental school and beyond.

Researchers: Ms Jing Wen Lee, Ms Caroline Koedyk, Professor Julie Satur

Rural Workforce Capacity Development

Access to dental services is a challenge in many public and rural dental services. Increasing restorative scope of practice for dental and oral health therapists helps extend the capacity of existing services. Research to evaluate the delivery of educational preparation in this scope is underway and demonstrating the ability of on-line learning supported by clinical residency to enable access to these services in rural and remote communities.

Researchers: Ms Brenda Ryan, Professor Julie Satur, Dr Jennifer Gray (Adelaide University)

Professor
Julie Satur

Professor
Stuart Dashper

Ms
Brenda Ryan

Ms
Caroline Koedyk

Professor
Michael McCullough

Ms
Eliza Collins

Population Health, Community and Education

Paediatric Oral Health Research

In partnership with the Murdoch Children's Research Institute, our multidisciplinary research team of clinicians and scientists strive to understand and improve oral health and disease across the life course. Our group works collaboratively across the Melbourne Dental School and the Melbourne Children's Campus, undertaking longitudinal and interventional research to improve the health and well-being of children and their families, including from priority populations. Our research is driven by our thriving relationships family partners and many collaborators.

4D Care: A Community Health Initiative to Improve the Oral Health of Young Children with Developmental Concerns, Autism and/or Disability

Children with developmental concerns, delay and disability and their families experience unique barriers to accessing person-centred dental care. In collaboration with Access Community and Health, and funded by a Dental Health Services Victoria Innovations Grant, our team are developing resources and strategies to address this major health inequity. We conducted 27 outreach dental assessments for children accessing early childhood intervention services, interviewed 11 parents and met with 37 dental practitioners around Australia. This work was featured at the DHSV Public Health Conference in 2024, presented jointly with our family partners and collaborators.

Diagnostic Agreement Between Visual Examination and an Automated Scanner System with Fluorescence for Detecting and Classifying Occlusal Carious Lesions in Primary Teeth: Colgate Research in Prevention Travel Award at 2024 IADR General Session

New approaches to caries detection offer exciting potential to improve preventive approaches to managing oral disease. In partnership with our MCRI industry collaborators 3Shape/Trios A/C, we are investigating the diagnostic agreement between visual examination and an automated scanner system for detecting and classifying carious lesions in primary teeth. Initial research findings show that while the automated scoring system may be used to visualise caries to enhance communication, the presence of scoring artefacts could impact its clinical utility. We are now exploring if machine learning can be used to automate caries detection using intraoral scan data.

Figure 27 Panellists at the DHSV Public Health Conference, sharing the stage with our family and Community Health partners.

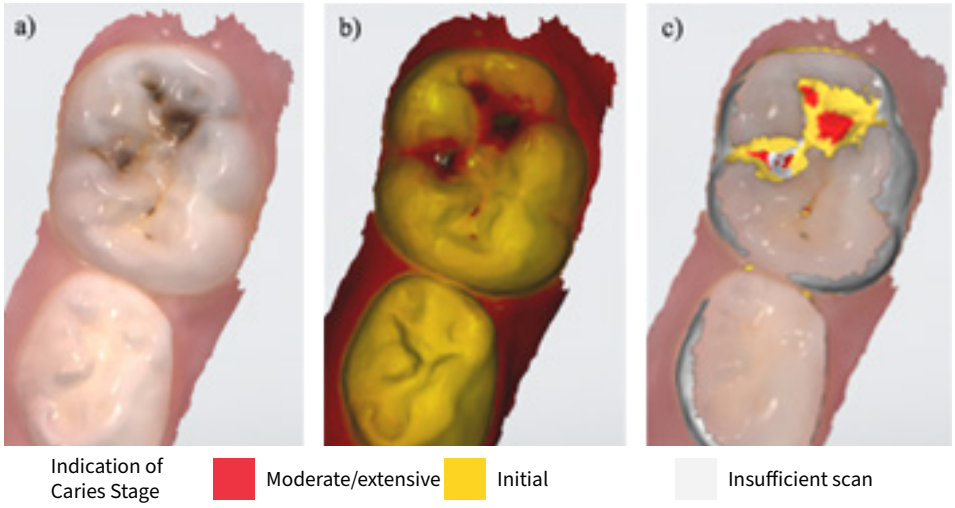


Figure 28 Examples of 3D models of the lower left first and second primary molars with approximate natural tooth colour (a), fluorescence texture (b), and automated caries score as an overlay (c) are presented. The images were obtained using TRIOS Patient Monitoring Software (Version 2.3, 3Shape TRIOS A/S Denmark).

Population Health, Community and Education

Barriers to Optimal Infant Oral Care: a Qualitative Study wins IADR Paediatric Oral Health Research Faculty Prize at 2024 General Session

Conducted as part of the MRFF-funded Infant2Child project, we found barriers and facilitators for toothbrushing and timely first dental check at individual, social and environmental levels. By understanding these behaviours, we can then identify the optimal means of addressing them. The implications from this research suggest the need for targeted early intervention programs in oral health. Our winning research suggests that interventions ought to focus on upstream factors, such as government dental schemes, and downstream factors, such as parental knowledge. These findings are being applied in INFANT, a statewide initiative to support early childhood nutrition and activity.

Associate Professor Mihiri Silva

Dr Rachelle Welti

Dr Bree Jones

Dr Tejashree Kangutkar

Ms Nileshni Fernando

Dr Dharini Ravindra

Dr Stephanie Shields

Ms Yeganeh Khazaei

Dr Felicity Crombie

Technical Officers

The Research Team is responsible for providing high level support to multiple research groups within the Melbourne Dental School. Expert technical support and maintenance of research infrastructure is provided. The team supports compliance of laboratories throughout the Melbourne Dental School as well as provides expert technical services which enable research priorities.

Responsibilities include assisting academic staff, post-graduate students (PhD, Honours and DCD) and student research groups (DDS) on a variety of experimental designs and technical skills to enable their research within Melbourne Dental School to run efficiently and effectively.

The Team provides research support over a variety of technical skills including:

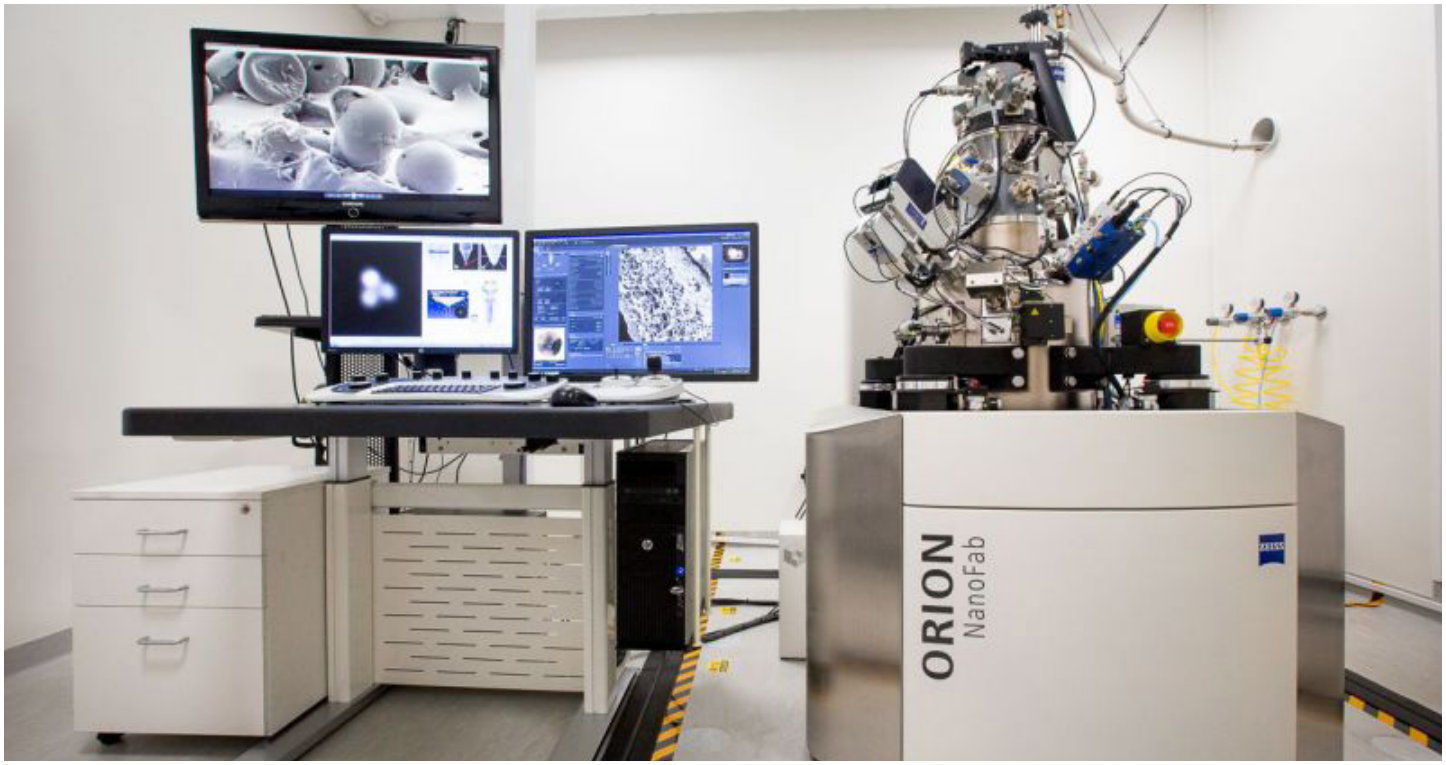
- Cell Biology
- Molecular Biology
- Microbiology
- Live cell Imaging and Confocal Microscopy
- Proteomics
- Murine Models of Disease
- Histopathology/ Immunochemistry
- Flow Cytometry
- Mycology
- Dental Biomaterials

Ms
Rita Paolini

Ms
Sze Wei Liu

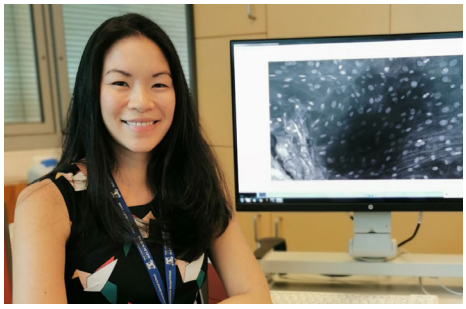
Ms
Caroline Moore

Ms
Su Toulson



Researchers in Focus

Early Career Researchers



Dr Tami Yap

MouthMap: AI-Enabled Oral Cancer Screening
MouthMap is a bespoke software with AI-enabled, integrated reporting capability to allow oral medicine expertise to be applied remotely. MouthMap's utility supports capacity building of existing health provision and promotion services, creating near-home access to expertise and reducing the number of oral cancers diagnosed late. In 2024 collaboration with Ludwig Maximillian University, MouthMap has been used as an interface to apply their centre's developed AI for oral cancer screening in a community level study of residential care service in Germany.

Dr Mohammed Al-baadani

Brian and Ann Dooley Early Career Research Fellow, Melbourne Dental School
Dental implantology has revolutionised oral rehabilitation, offering effective solutions for missing teeth and restoring functionality and aesthetics. While dental implants offer effective rehabilitation, many fail due to insufficient primary stability and bacterial infection during surgery, particularly in patients with poor bone quality.

Dr Mohammed Al-Baadani, a clinician and biomaterials researcher at the Melbourne Dental School, is developing a bioactive insert system that addresses both issues. Using electrospinning technology, the insert provides mechanical support at placement while delivering targeted antibacterial and bone-regenerating agents to enhance early healing. Dr Al-Baadani also leads research into thermal risks in restorative dentistry, creating a 3D tooth model to assess pulp tissue response to heat from curing lights.

In collaboration with leading Australian industry partners, his work is advancing cost-effective, clinically relevant solutions to improve patient outcomes and safety, offering significant potential across dentistry and broader biomedical applications.

Dr Mathew Lim

The Melbourne Disability Institute Seed Funding
The Seed Funding allowed the development of new collaborations with several disability organizations in Tasmania, including the Association of Children with Disability, Speak Out Advocacy, Disability Voices Tasmania, and Possability, as well as new health sector partners, including Oral Health Services Tasmania and Primary Health Tasmania. Dr Lim and his group are in the process of designing a project to evaluate current health resources with people with disabilities and their families, with the aim of establishing foundational data to support more significant health interventions to break down oral health care barriers for this population.

Research Collaborative Grant
The Research Collaborative Grant enabled Dr Lim to support a project exploring the views of Australians with disabilities towards their oral health and dental care. The project aimed to involve people with disabilities directly, rather than just their carers and families, and fostered a research collaboration between the Melbourne Dental School, the University of Queensland, and the University of Newcastle.

International Association for Disability and Oral Health, Seoul
Research Presentation Competition in Education Category - First Place

In addition, Dr Lim received the First Place award at the International Association for Disability and Oral Health meeting in Seoul for his presentation "Does Providing Education to Healthcare Workers Improve the Oral Care of Hospital Inpatients with Brain Injuries?" The project measured oral hygiene of brain injury patients at Caulfield Hospital before and after a 15-minute education session with rehabilitation ward staff. The results showed that a simple education session on the importance of oral care can improve patients' oral hygiene.

Research Higher Degree Students

The Melbourne Dental School Innovation Booster Award Recipients

The Melbourne Dental School Innovation Booster Award aims to support activities of research students that foster and advance innovation in selected research projects within the dental school. This scheme complements other School and Faculty-led initiatives by supporting research students in undertaking activities that assist innovative projects in developing novel intellectual property.

Mr Scotia Mullin
The Innovation Booster award will allow Scotia to collaborate with leading forensic experts on developing queer-inclusive protocols for identifying Intimate Partner Violence and strangulation in living populations. This project will create queer-inclusive frameworks for forensic medicine and dentistry in the context of same-sex intimate partner violence and strangulation. It involves collaboration between the University of Melbourne, Johns Hopkins University, and Arizona State University.

Mr Brian Ngokwe
Early diagnosis of oral precancerous lesions can prevent the development of oral cancers, which have a high mortality rate. Brian intends to use organoids - three-dimensional in vitro models that closely resemble the genomic constitution of oral cancers - to study and understand these oral precancers better. However, these models are costly. The award will assist him in developing the first oral precancerous organoid model, serving as a stepping stone to investigate the molecular changes implicated in carcinogenesis. If successful, this research aims to identify biomarkers for the early diagnosis of oral precancers.

Scotia Mullin and Brian Ngokwe (photos from top to bottom)

Global Oral Cancer Forum Poster, Kuala Lumpur Prize Winners

Dr Rishi Ramani
GOCF 2024 Poster Prize - First Place

Dr Ramani was awarded first place in the poster competition at the Global Oral Cancer Forum held in Kuala Lumpur. His research focused on the creation of a deep learning model for accurately detecting graded oral dysplasia and oral cancer in a carcinogenic murine model, highlighting a novel pipeline to develop and challenge pharmacological oral cancer prevention.

Dr Nadia Kaunein
GOCF 2024 Poster Prize - Runner Up

Runner up in the poster competition was Dr Kaunein. Her research explored on a minimally invasive molecular test that accurately matched findings from standard-care biopsy.

Dr Rishi Ramani and Dr Nadia Kaunein (photos from top to bottom)

Dr Bree Jones

International Association for Dental, Oral, and Craniofacial Research, New Orleans
2024 IADR Colgate Research in Prevention Travel Award

Bree was named one of the recipients of the 2024 IADR Colgate Research in Prevention Travel Award, which recognises young investigators undertaking research in the prevention of oral diseases and provides an opportunity to present their work to the international dental and oral health research community.

IADR Australian/New Zealand Division, Cairns
2024 IADR Colgate Competition, Senior Division - First Place

In addition, at the IADR Australian/New Zealand Division, held in Cairns, 25-27 September, Bree won first place in the Senior Division of the Colgate competition, and she will now go on to represent Australia in the Hatton Competition at the General Session at IADR in Barcelona in 2025.

Research Higher Degree Students

2024 Rowden White Scholarship Recipients

This scholarship was established with a donation from Sir Alfred Edward Rowden White and is offered to students undertaking research studies with the Melbourne Dental School, Melbourne Medical School, Faculty of Engineering and Information Technology, or Faculty of Science.

Dr Dharini Ravindra
The oral microbiome is a dynamic community of microorganisms residing in the oral cavity which plays a crucial role in oral health. Understanding how environmental factors impact this community could lead to avenues for caries prevention. Dr Ravindra's study aims to unpack this by considering plaque as an oral biomarker and measurable temporal outcome in a multi-cohort analysis of Australian children.

Dr Amin Mohamed
Understanding how moisture impacts orthodontic aligner materials is essential to advancing patient care. Amin's research focuses on evaluating the mechanical properties of both traditional and novel 3D-Printed Aligner materials (TA-28). By linking laboratory data with clinical outcomes, he aims to enhance aligner performance and patient care. This scholarship will empower Amin to contribute meaningful, science-driven advancements to the future of orthodontic treatment.

Dr Syed Ameer Hamza
Dr Hamza specialises in cell culture and microbiology. With a background in dentistry and seven years of research experience, his current focus is on oral gonorrhoea infection, which presents significant challenges in the oral and pharyngeal regions due to increased resistance. Dr Hamza aims to develop 2D and 3D in vitro models to explore infection dynamics and screen targeted treatments for oral gonorrhoea.

Dr Brian Ngokwe
Brian's research is based on the early diagnosis of oral precancerous lesions, which will prevent the appearance of oral cancers that have very high mortality rates, with 1 out of every 2 patients with oral cancer likely to die within the next 5 years. To better study and understand these oral precancers, he intends to use organoids, which are in-vitro, three-dimensional models. They are faithful models with a genomic constitution closely resembling that of oral cancers.

Dr Stephanie Shields
Molar incisor hypomineralisation (MIH) is a common developmental enamel condition and its aetiology is currently unknown. Inflammation or exposure to phthalates in early childhood may contribute to MIH pathophysiology. Children affected by MIH experience aesthetic and functional sequelae. Dr Stephanie will harness modern causal inference methods in her thesis to contribute to the understanding of the aetiology and impact of MIH.

Dr Satutya Wicaksono
The Rowden White Scholarship supports Dr Wicaksono's integrated research into the role of *Candida albicans* in oral cancer, focusing on its genetic diversity and interaction with alcohol metabolism. He will also work with electrical engineers to develop a sensor-based device that measures oral alcohol metabolism rates, facilitating personalised risk assessments for prevention of oral cancer.

Dr Dharini Ravindra, Mr Amin Mohamed, Dr Syed Ameer Hamza, Mr Brian Ngokwe, Dr Stephanie Shields, and Dr Satutya Wicaksono (photos from top to bottom)

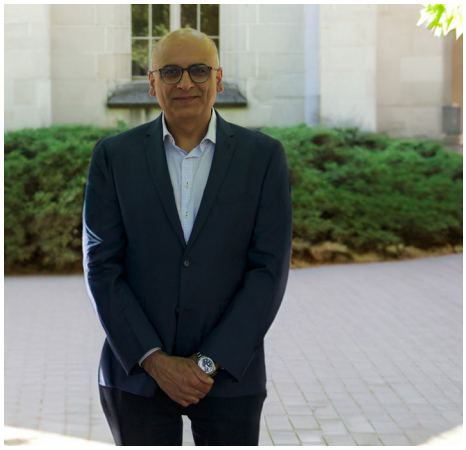
Awards and Honours

Laureate Professor Eric Reynolds AO

IADR Distinguished William H. Bowen Research in Dental Caries Award

Laureate Professor Eric Reynolds has been awarded the International Association for Dental, Oral, and Craniofacial Research Distinguished (IADR) Scientist William H. Bowen Research in Dental Caries Award. The award acknowledges the outstanding contributions made by his research group at the dental school to the field of dental caries research over many years. Their work, supported by the National Health and Medical Research Council and industry partnerships, has led to research translation with tangible impact - resulting in dental products now available in more than 50 countries worldwide.

The recognition by the peak international association for dental research is a significant honour, particularly as the award bears the name of William H. Bowen, a renowned researcher and mentor who inspired many in the field, including Laureate Professor Reynolds.



Associate Professor Roy Judge

Faculty of Medicine, Dentistry and Health Sciences (MDHS) Innovator Award

Associate Professor Roy Judge, alongside other cross-disciplinary projects across the Faculty, has been awarded a combined total of $1 million over two years through the Faculty of Medicine, Dentistry and Health Sciences' inaugural Innovator Award. This award aims to drive innovative research to develop and refine potential treatments and support clinical evaluation activities. Associate Professor Judge and his research team will continue to develop the Rectangular Block Implant (RBI) through an independent Multicentre Clinical Trial. This implant is designed to replace missing teeth in individuals who are unable to receive conventional dental implants, with a particular focus on older patients.

Associate Professor Leanne Teoh

IADR ANZ Division Investigator Award in Preventative and Community Dentistry

Associate Professor Leanne Teoh, Professor Michael McCullough, and their collaborators from the National Centre for Antimicrobial Stewardship were awarded the IADR Australian and New Zealand Division Investigator Award in Preventative and Community Dentistry in September 2024. This recognition celebrated their research on antimicrobial prescribing practices for oral and dental conditions in both private and public Australian hospitals from 2013 to 2022, demonstrating for the first time, the appropriateness and guideline concordance of antimicrobials prescribed in these settings.

Scan to stay updated on our news & events!

Professor Michael McCullough

Alan Docking IADR Science Award

Professor Michael McCullough received the highest accolade, the Alan Docking Award from the IADR Australian and New Zealand Division, recognising distinguished dental research based on outstanding scientific achievement. At the time of receiving the award in 2024, he had published 218 articles, five book chapters, two books, supervised 23 research higher degree students to completion, and was supervising 9 PhD students. Professor Michael was one of the first to use molecular tools for epidemiologically assessing relationships between strains and species of fungi; recognised a new emerging species of yeast, *C. dubliniensis* preferentially infecting HIV patients oral cavity; demonstrate genotypically defined fungi across diverse patients global populations; the role of the oral microbiome in mucosal disease; assess the association between the microbiome and mucosal disease; assess tools for the early recognition of mucosal changes associated with oral cancer; show the critical relationship between the local immune dysfunction in chronic oral inflammatory conditions; and recently demonstrated the diagnostic potential of microRNA in oral disease. Further, Professor Michael contribution to enhancing Dentists correct use of medications extends over the past two decades with involvement on the first two editions of Therapeutic Guidelines, Oral and Dental and most recently research on Australian dental prescribing practices using education and a dental prescribing clinical decision support tool.

Professor Alastair J Sloan

Edward Leo Sheridan Medal

Professor Alastair J Sloan was honoured with the Edward Leo Sheridan Medal and invited to deliver the prestigious Edward Leo Sheridan Memorial Lecture at the Royal College of Surgeons in Ireland (RCSI) Faculty's Annual Scientific Meeting on 25 October 2024. The medal, awarded biannually, recognises significant contributions to the medical and dental communities, and is named in honour of Edward Leo Sheridan, MD, DDS, former RCSI President.

Professor Sloan, the only Australian recipient of this distinguished medal, presented his lecture on "3D Tissue Models and Novel Approaches for Dental Tissue Infection Management and Repair".

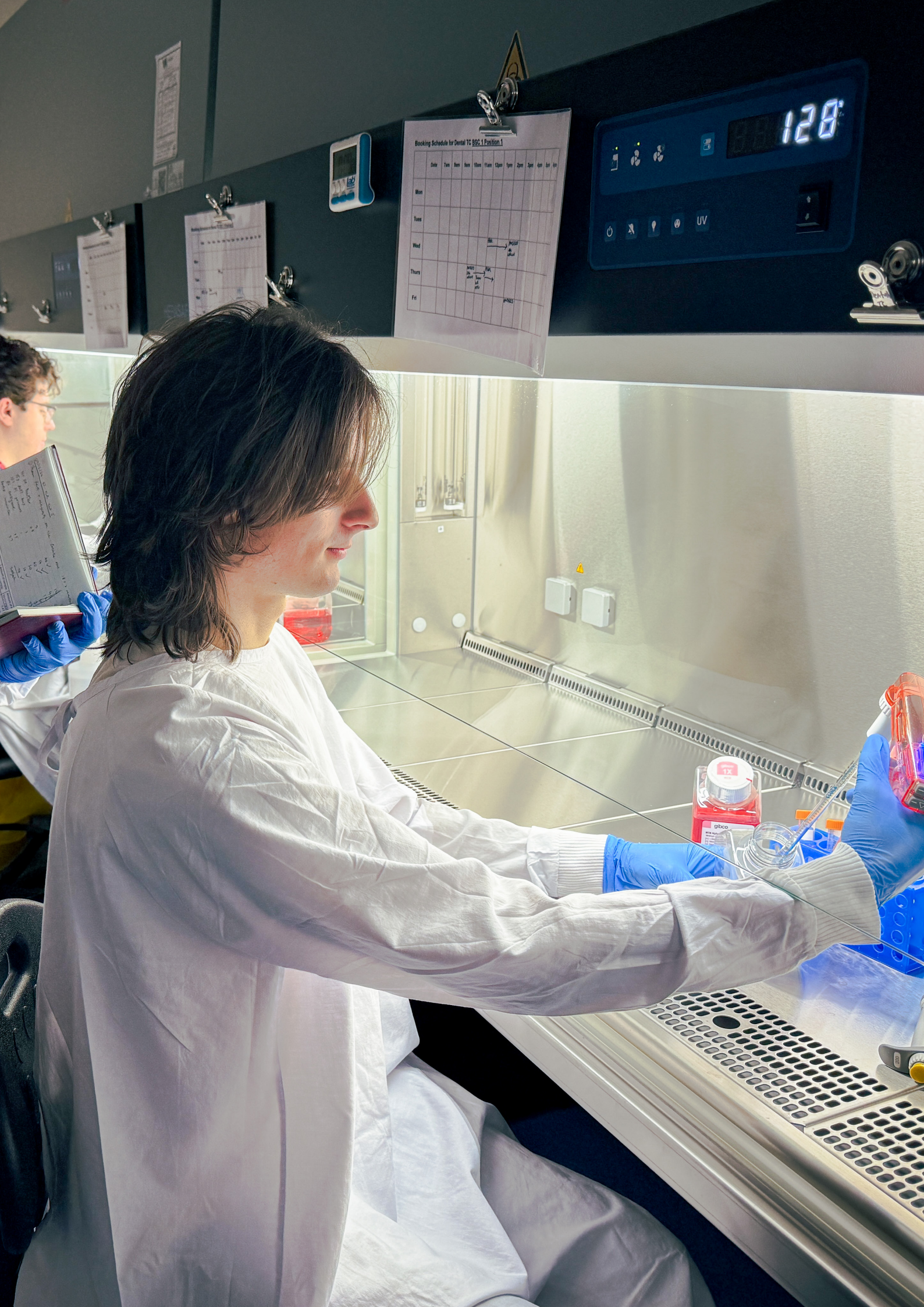
Pictured (left) with RCSI President Professor Deborah McNamara and Dean of the Faculty of Dentistry Professor Chris Lynch.

Honours and Masters Programs

The Melbourne Dental School offers undergraduate students the opportunity to undertake a research-based Honours degree within the Bachelor of Biomedicine, Bachelor of Science, or Bachelor of Oral Health programmes. Postgraduate options include the Master of Biomedical Science, Master of Philosophy, and PhD.

The scope of study spans a broad range of disciplines, including microbiology, immunology, cancer biology, biochemistry, molecular biology, chemistry, anatomy, cell biology, dental therapy, public health, and materials engineering. Our research extends beyond oral health to encompass wound healing, drug delivery, bone health, and microbiomics. Students conduct their research in our state-of-the-art laboratories at Melbourne Dental School and the Bio21 Institute, both equipped with the latest technology.

Find out more about our Honours and Masters Programs here!


Booking Schedule for Dental TC BSC 1 Position 1
Mon
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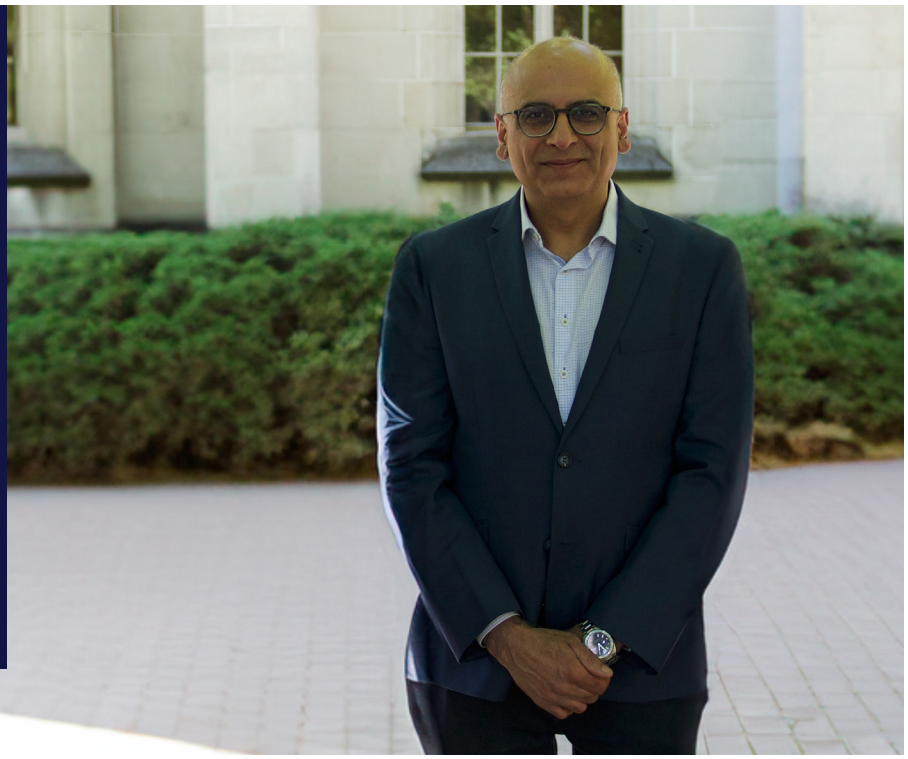
Director of International

"The Melbourne Dental School is a highly collaborative and outward looking Dental School with established global, regional, and national networks with both academic and industry partners. We are undertaking several new international initiatives with a view to increasing our engagement and research collaborations across the Asia Pacific region. Our aim is to work with our partners to support the communities that we serve by providing evidence based focused on improved oral and patient centred outcomes. We are supporting and engaging with the current and future leaders across Indonesia, India, Malaysia, Japan, South Korea, China, Jordan, and New Zealand."

Associate Professor Roy Judge
Director of International



DentAlliance Workshops

DentAlliance continues to play a pivotal role in advancing collaborative research and supporting the development of early career researchers across its four partner institutions: the Melbourne Dental School, King's College London, the National University of Singapore, and the University of North Carolina at Chapel Hill. Among its key initiatives, the DentAlliance Research Workgroup hosts regular online workshops designed to build capacity and foster high-impact research across these institutions.

In March 2024, during the IADR conference in New Orleans, the DentAlliance Board convened for an in-person meeting. This rare opportunity for face-to-face engagement enabled the Heads of School from each partner university to reflect on shared achievements and strategise the future direction of the Alliance. A follow-up meeting is scheduled for the IADR conference in Barcelona in June 2025, reaffirming the Alliance's commitment to sustained, strategic collaboration.

The New Orleans conference also provided a platform for networking and celebration at the DentAlliance Reception, co-hosted by all four partner institutions. The event underscored the importance of global collaboration and offered researchers a valuable opportunity to connect across disciplines and institutions.

Further expanding its global presence, DentAlliance participated in the annual CAPP conference in Dubai. The conference brought together clinicians, researchers, and industry leaders to explore the latest innovations in digital and aesthetic dentistry. DentAlliance hosted an exhibition booth that attracted significant interest, and also delivered a series of well-received lectures and livestream sessions, engaging more than 2,700 participants worldwide.

Find out more about DentAlliance here!

Director of International

Melbourne Dental School welcomed several senior international visitors throughout 2024, including colleagues from Tufts University (July), Shanghai Jiao Tong University (September), the University of the Western Cape (November), and Universitas Airlangga (December). These visits offered valuable opportunities for our guests to meet a diverse range of staff and students, tour the school's extensive facilities, and explore potential avenues for international collaboration.

Inaugural Pan Pacific Group Meeting

In May 2024, Seoul National University hosted the inaugural meeting of the Pan Pacific Group, comprising the University of Melbourne, Peking University, Tokyo Medical and Dental University, and the University of Otago. This auspicious two-day event marked the beginning of a significant collaborative effort across the Pan Pacific region, focusing on research partnerships and staff and student exchanges. Notably, the meeting provided a valuable platform for early career researchers and academics to network and present their work. The second annual meeting is scheduled to take place in Dunedin in October 2025.

Study Visits to Melbourne Dental School

The Melbourne Dental School has been collaborating with key partners to host dental students through a newly structured and integrated approach to inbound student visits. Central to this new design is ensuring that students can engage with and gain a deeper understanding of the University across the campus, participate in workshops with postgraduate students, and directly interact with like-minded cohorts. The first of these inbound visits is scheduled for 2025, welcoming groups from King's College London and the Tokyo Institute of Science.

Strengthening Research and Educational Links

In June 2024, the Melbourne Dental School hosted an online research symposium between eight research groups with multiple collaborators from the Christian Medical College Vellore and the Melbourne Dental School. In attendance were Professor Solomon, Principal at CMC, Professor Nathan Grills (International Lead for India/FMHDS), with Professor Sarath Ranganathan kindly providing the opening remarks. This online symposium reflects the strong and ongoing research faculty-level relationship with CMC and the opportunities afforded to the Melbourne Dental School and the dental department at CMC. At the CAPP conference in Dubai, DentAlliance (MDS, KCL, NUS, UNC) was again able to provide speakers for the highly successful workshops at this international meeting.

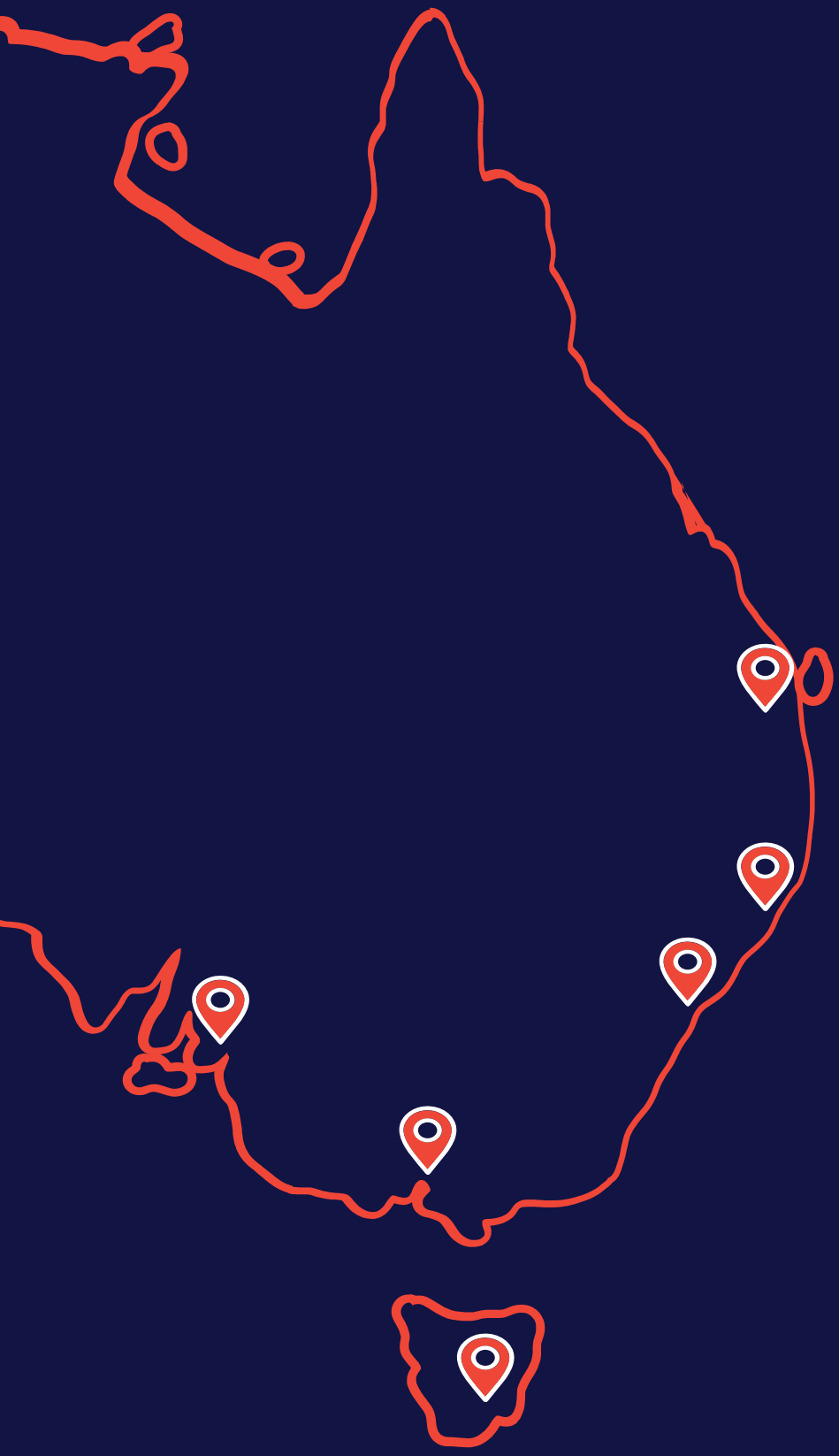
In November 2024, Dr Roy Judge was asked to be the external examiner at Fiji National University, examining final year students over a one-week examination period. The students and staff at Fiji National University are to be commended for their approach to learning and congratulated on the quality of this graduating class.

Collaborations Victoria

Melbourne

1. Bio21 Molecular Science and Biotechnology Institute
2. Melbourne School of Psychological Sciences
3. Melbourne School of Population and Global Health
4. Melbourne School of Health Sciences
5. Melbourne Medical School
6. School of Culture and Communication
7. School of Computing and Information Systems
8. Alfred Health
9. Austin Health
10. Cancer Council Victoria
11. Deakin University
12. Dental Health Services Victoria
13. Federation University Australia
14. Florey Institute of Neuroscience and Mental Health
15. La Trobe University
16. Monash University
17. Murdoch Children's Research Institute
18. Peter Maccallum Cancer Centre
19. Royal Children's Hospital
20. Royal Melbourne Hospital
21. Royal Melbourne Institute of Technology University
22. St. Vincent's Hospital Melbourne
23. The Peter Doherty Institute for Infection and Immunity
24. Walter and Eliza Hall Institute of Medical Research

Collaborations Australia



Australia

25. Black Dog Institute
26. Charles Sturt University
27. Cooperative Research Centres Australia
28. CSIRO
29. Curtin University
30. Fiona Stanley Hospital
31. Griffith University Queensland
32. Nepean Hospital
33. New South Wales Ministry of Health
34. Princess Alexandra Hospital Brisbane
35. Queensland Health
36. Queensland Institute of Medical Research
37. Queensland University of Technology
38. Sir Charles Gairdner Hospital
39. University of Adelaide
40. University of Queensland
41. University of Sydney
42. University of Tasmania
43. University of Western Australia
44. University of Wollongong
45. Western Sydney University

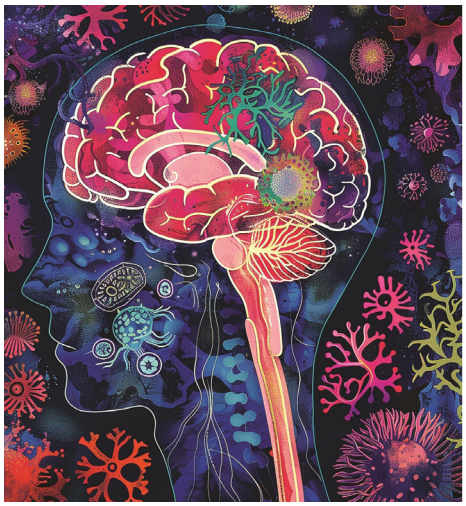
Collaborations Global

46. Aarhus University, Denmark
47. Aix-Marseille Université, France
48. Ajman University, United Arab Emirates
49. Al Jouf University, Saudi Arabia
50. Alexandria University, Egypt
51. All India Institute of Medical Sciences, New Delhi, India
52. American Dental Education Association, United States
53. Amsterdam UMC, Netherlands
54. Auckland University of Technology, New Zealand
55. Bangor University, United Kingdom
56. Cardiff University, United Kingdom
57. Catholic University of the Sacred Heart, Italy
58. China Pharmaceutical University, China
59. CHU de Bordeaux, France
60. CHU de Nancy, France
61. CHU de Toulouse, France
62. CNRS, France
63. Duke University, United States
64. East Carolina University, United States
65. Erasmus University Rotterdam, Netherlands
66. Etablissement français du sang, France
67. European Commission, Belgium
68. European Commission Joint Research Centre Institute, Belgium
69. European University Cyprus, Cyprus
70. Fondazione Policlinico Universitario Agostino Gemelli IRCCS, Italy
71. Guy's and St Thomas' NHS Foundation Trust, United Kingdom
72. Harbin Institute of Technology, China
73. Heidelberg University , Germany
74. High Point University, United States
75. InHolland University of Applied Sciences, Netherlands
76. Jagiellonian University in Kraków, Poland
77. Johns Hopkins University, United States
78. Jordan University of Science and Technology, Jordan
79. King George's Medical University, India
80. King Khalid University, Saudi Arabia
81. King's College London, United Kingdom
82. Lehigh University, United States
83. Ludwig Maximilian University of Munich, Germany
84. Malmö University, Sweden
85. Marche Polytechnic University, Italy
86. Marquette University, United States
87. Memorial University of Newfoundland, Canada
88. Ministry of Health, Saudi Arabia, Saudi Arabia
89. Nanjing University, China
90. National Institute of Public Health and the Environment, Netherlands
91. National University of Singapore, Singapore
92. New York University, United States
93. Newcastle University, United Kingdom
94. Newcastle upon Tyne Hospitals NHS Foundation Trust, United Kingdom

95. Niigata University, Japan
96. Obafemi Awolowo University, Nigeria
97. Oregon Health and Science University, United States
98. Padjadjaran University, Indonesia
99. Parnassia Bavo Groep, Netherlands
100. Queen Mary University of London, United Kingdom
101. Riga Stradins University, Latvia
102. Riga Technical University, Latvia
103. RIKEN, Japan
104. Roseman University of Health Sciences, United States
105. Scripps Mercy Hospital, United States
106. Shahrekord University of Medical Sciences, Iran
107. Shandong First Medical University & Shandong Academy of Medical Sciences, China
108. Shenzhen University, China
109. Shiraz University of Medical Sciences, Iran
110. Soka University, Japan
111. Sri Ramachandra Institute of Higher Education and Research, India
112. Swansea University, United Kingdom
113. Tohoku University, Japan
114. Ulster University, United Kingdom
115. Umm Al-Qura University, Saudi Arabia
116. United States Department of Defense, United States
117. Universidad Autónoma de Campeche, Mexico
118. Universidad Autónoma de Chile, Chile
119. Universidad Autonoma del Estado de Hidalgo, Mexico
120. Universidad Autonoma del Estado de Mexico, Mexico
121. Universidad de la Frontera, Chile
122. Universidad de los Andes Chile, Chile
123. Universidad de Valparaíso, Chile
124. Universidad Diego Portales, Chile
125. Universidad Europea, Spain
126. Universidade de São Paulo, Brazil
127. Universitas Airlangga, Indonesia
128. Universitas Syiah Kuala, Indonesia
129. Université de Bordeaux, France
130. Université de Lorraine, France
131. Université de Montpellier, France
132. Université de Yaoundé I, Cameroon
133. Université Fédérale Toulouse Midi-Pyrénées, France
134. Université Laval, Canada
135. Université Paul Sabatier Toulouse III, France
136. University of Alberta, Canada
137. University of Amsterdam, Netherlands
138. University of Antwerp, Belgium
139. University of Cambridge, United Kingdom
140. University of Colorado Anschutz Medical Campus, United States
141. University of Copenhagen, Denmark
142. University of East Anglia, United Kingdom
143. University of Eastern Finland, Finland
144. University of Edinburgh, United Kingdom
145. University of Foggia, Italy
146. University of Glasgow, United Kingdom
147. University of Groningen, Netherlands
148. University of Ibadan, Nigeria
149. University of Jordan, Jordan
150. University of Liverpool, United Kingdom
151. University of Manchester, United Kingdom
152. University of Michigan, Ann Arbor, United States
153. University of Mosul, Iraq
154. University of Naples Federico II, Italy
155. University of Oslo, Norway
156. University of Otago, New Zealand
157. University of Pennsylvania, United States
158. University of Puthisastra, Cambodia
159. University of Rochester, United States
160. University of Santiago de Compostela, Spain
161. University of Sharjah, United Arab Emirates
162. University of Southern Denmark, Denmark
163. University of the Balearic Islands, Spain
164. University of the Western Cape, South Africa
165. University of Tikrit, Iraq
166. University of Toronto, Canada
167. University of Turin, Italy
168. University of Utah, United States
169. University of Waterloo, Canada
170. Vrije Universiteit Amsterdam, Netherlands
171. Waikato Hospital, New Zealand
172. World Health Organization, Switzerland
173. Zhejiang University of Technology, China

Focus On Publications

The Melbourne Dental School publishes a great breadth and depth of research every year in some of the finest academic journals in the world. Here are five examples from the 2024 that give an insight into the quality and variety of our research.



Chronic oral inoculation of *Porphyromonas gingivalis* and Treponema denticola induce different brain pathologies in a mouse model of Alzheimer disease

Poor oral health, particularly periodontitis, is a modifiable risk factor for Alzheimer's disease (AD) pathogenesis, with components of oral pathobionts *Porphyromonas gingivalis* and *Treponema denticola* identified in postmortem brains of persons with AD. The aim of the current study was to determine the ability of *P. gingivalis* and *T. denticola* to induce AD-like pathology following chronic oral inoculation of female mice over 12 weeks. *P. gingivalis* significantly increased all 7 brain pathologies examined: neuronal damage, activation of astrocytes and microglia, expression of inflammatory cytokines interleukin 1β (IL-1β) and interleukin 6 and production of amyloid-β plaques and hyperphosphorylated tau. *T. denticola* significantly increased 4 brain pathologies: neuronal damage, activation of astrocytes and microglia, and expression of IL-1β. The host brain response elicited by oral coinoculation of *P. gingivalis* with *T. denticola* was less than that elicited by each bacterium, suggesting coinoculation was less pathogenic.

GD. Ciccotosto[*], AI. Mohammed[*], R. Paolini, E. Bijlsma, S. Toulson, J. Holden, EC. Reynolds, SG. Dashper[+], and CA. Butler[+](2024). Chronic oral inoculation of *Porphyromonas gingivalis* and *Treponema denticola* induce different brain pathologies in a mouse model of Alzheimer disease. The Journal of Infectious Diseases, Volume 230, Issue Supplement_2, Pg S109–S116,[*]Co-first author,[+]Co-senior author, DOI: 10.1093/infdis/jiae286

A retrospective review of the circumstances and characteristics of 72 adult autoerotic neck compression deaths in Australia, between 2000 and 2022

Autoerotic neck compression is a form of asphyxial death that occurs due to compression of the neck during sexual activity such as masturbation. While this phenomenon is rare both in Australia and globally it is a recurring forensic medical issue. Similar to international findings caucasian men under the age of fifty represent the bulk of fatalities. The study highlights common contextual features such as isolation during the activity, sexual paraphernalia, and genital stimulation. While injuries included oro-facial, and facio-cervical injuries including skeletal fracture such injuries were rare. Superficial injuries such as abrasions and petechial hemorrhaging were more common amongst the sample. The study emphasises the need for clear categorization of such deaths and a need to differentiate them from suicide and homicide. The authors propose new investigative variables that may be beneficial in the future.

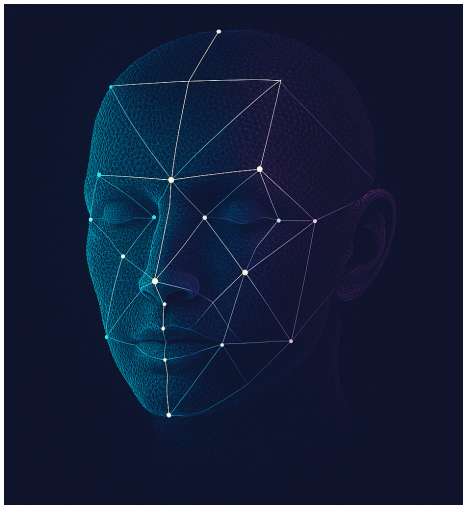
SP Mullin, AJ Sloan and R Hardiman. A retrospective review of the circumstances and characteristics of 72 adult autoerotic neck compression deaths in Australia, between 2000 and 2022. Forensic Science International, Volume 36, DOI: 10.1016/j.forsciint.2024.112342

Focus On Publications

The global distribution of special needs dentistry across dental school curricula

Special Needs Dentistry (SND) is a growing specialty, yet access to care remains limited due to gaps in professional training. Our study is the first to map SND education across 180 countries and 1,265 dental schools, revealing stark inequalities. While most dental schools are in developing economies, SND teaching is concentrated in developed countries, with the USA, Canada, UK, and Australia leading advanced programs. Alarmingly, only 112 SND specialists enter the global workforce annually. These findings underscore the urgent need to expand SND education worldwide, ensuring equitable care for individuals with special needs.

Scepanovic T, Mati S, Ming ALC, Yeo PYS, Nguyen D, Aria M, D'Aniello L, Fung D, Muriithi E, Mamgain A, Zihao W, Zeng JH, Nichols A, McCullough M, Lim MAW, Wylie M, Yap T, Paolini R, Celentano A. The global distribution of special needs dentistry across dental school curricula. Spec Care Dentist. 2024 Jul-Aug;44(4):1191–1210. doi: 10.1111/scd.12973. Epub 2024 Feb 22. PMID: 38385902.



Validity and Reliability of New Three-Dimensional Reference Systems for Soft Tissue Analysis Using Non-Ionizing Three-Dimensional Imaging

Evaluating facial soft tissue changes proves crucial for assessing orthodontic and orthognathic surgery outcomes. This work evaluated two new reference systems for analysing 3D facial scans from stereophotogrammetry, a radiation-free imaging technique. Across 60 growing and non-growing participants, the systems demonstrated good reliability, repeatability, and small differences from cone-beam CT references for midline positioning. The findings validate their potential as standardised, radiation-free methods for precise facial soft tissue analysis related to treatment or growth, enhancing outcome assessments focused on optimal facial aesthetics.

Rongo R, D'Antò V, Michelotti A, Cornelis MA, Cattaneo PM. Validity and Reliability of New Three-Dimensional Reference Systems for Soft Tissue Analysis Using Non-Ionizing Three-Dimensional Imaging. Appl Sci. 2023 Jun 14;13(12):5307. doi: 10.3390/app13125307. PMID: 37292849.

Diagnostic Agreement Between Visual Examination and an Automated Scanner System With Fluorescence for Detecting and Classifying Occlusal Carious Lesions in Primary Teeth

This study compared visual caries examination using ICDAS criteria to an automated scanner system in 213 five-year-olds' primary teeth. The automated system was 46% less likely to detect initial caries and 70% less likely to identify moderate-extensive caries than visual inspection. It also underestimated lesion severity. Solely relying on the automated tool risks missing early carious lesions treatable through timely intervention or misclassifying advanced lesions, delaying necessary treatment in children's primary dentition.

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Translation and Commercialisation

Over the course of 2024, the School has seen commercialisation success, and growth in engagements with industry partners.

Commercialisation Successes and Milestones

Rectangular Block Implant

Associate Professor Roy Judge was successful in securing funding from the Australian Department of Education through the inaugural, pilot Australian Economic Accelerator Seed Round grant, to advance the transition of a novel, low bone volume dental plant (Rectangular Block Implant - RBI) through to scalable manufacture in accordance with Good Manufacturing Practices (ISO13485 - Quality Systems for Medical Devices). In 2023, the first RBI was implanted by Associate Professor Judge and the team. In collaboration with Signature Orthopaedics Pty Ltd, the Sydney-based company will transfer the RBI design into its certified manufacturing facility and processes to enable scalable production and manufacture of the RBI to further enable clinical studies. Associate Professor Judge was also successful in securing a Faculty Innovator Award to advance the project towards commercialisation.

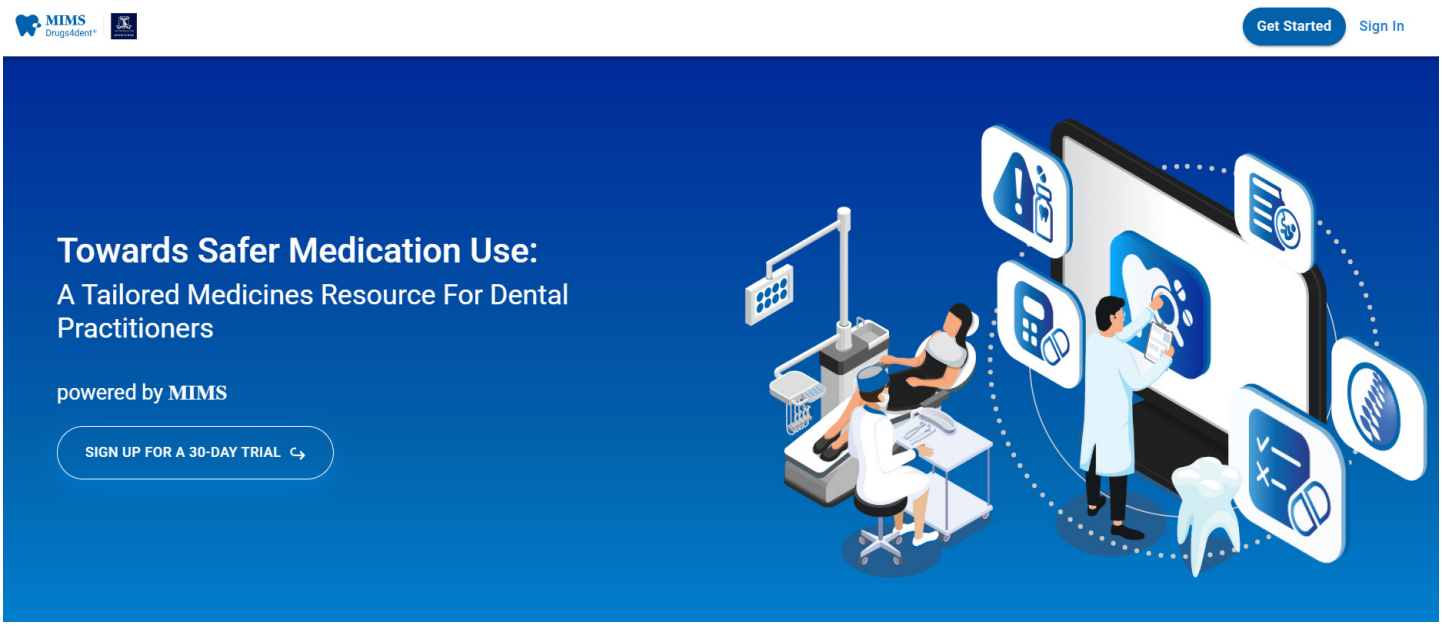
MIMS Drugs4dent®

Drugs4dent®, a digital resource to support safe medicine management and prescribing by dental practitioners developed by Associate Professor Leanne Teoh and Professor Michael McCullough, has been successfully outlicensed by the University of Melbourne for digital distribution across Australia and New Zealand. Developed by Associate Professor Teoh during her PhD with Professor McCullough as her supervisor, the drug compendium and prescribing tool is now available through MIMS, the leading supplier of medicines information to Australian healthcare professionals. The arrangement with MIMS also sees a formal co-branding arrangement with the University of Melbourne to publicly illustrate the evidence-base of the tool.

MIMS Drugs4dent® provides information about the impact of drugs on dental procedures, oral adverse effects of drugs, safety checks such as drug and allergy interactions to reduce prescribing errors, helps dentists prescribe according to guidance and assists with calculating pediatric doses.

Denteric

Denteric, a spin-out of the Dental School based on the work led by Laureate Professor Eric Reynolds, Professor Neil O'Brien-Simpson and Dr Nada Slakeski, celebrated a signficant clinical milestones in 2024 with the initiation and close-out of its first human patient study for the clinical evaluation of a vaccine for *P. Gingivalis.* Supported through investment by Brandon Biocatalyst, an early-stage life sciences investor, Denteric continues to progress its lead candidate, GPV381, towards commercialisation.



Translation and Commercialisation

Email for industry enquiries

industry-enquiries@unimelb.edu.au

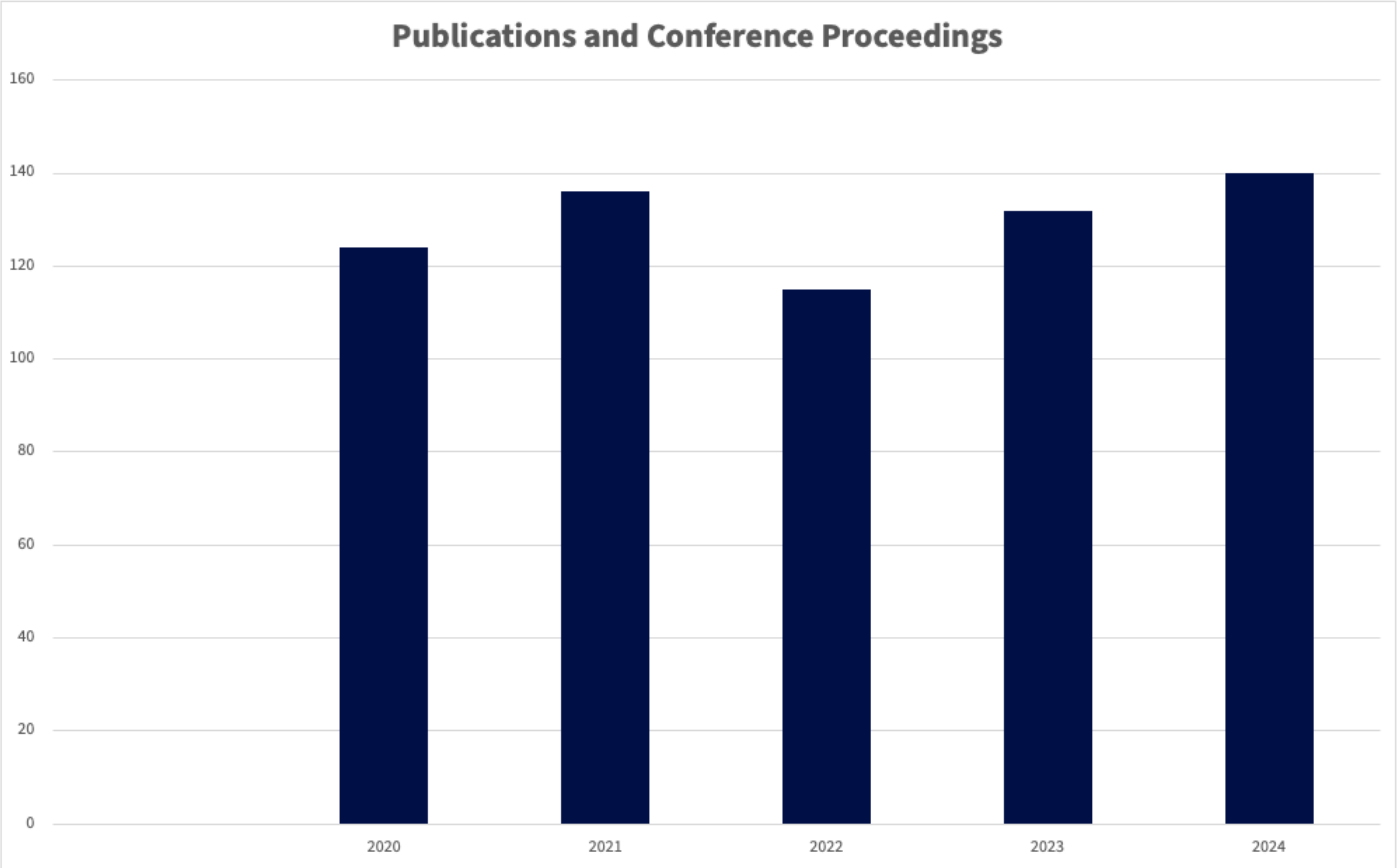
Industry Engagement

Over the course of 2024, the School has rekindled efforts to engage with industry organisations. Multiple workshops have been conducted with SDI Ltd, and Incisive Technologies (a spin-out of the University) and Signature Orthopaedics (including collaborators from RMIT) to explore opportunities for industry-oriented projects across the development and evaluation of novel dental products. In tight collaboration with key collaborators in the Faculty of Engineering and IT (Dr Ellie Hajizadeh and Prof David Ackland), an inagural cohort of 3 PhD students have been supported by the Department of Education's National Industry PhD Program to undertake projects examining the use of AI and machine-learning -based technologies for the development of novel dental materials. The establishment of this cohort is a significant milestone, as it is the first of its type for The University.

Overall, the School has had a very productive year across research translation activities, and has established a strong foundation for further success in years to come.

Dr
Andre Tan

Publications



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