Australian Government
Australian Research Council

EI 2018 ENGAGEMENT AND IMPACT

Engagement and Impact 2018

The University of Melbourne

MEL11-BCS (HLS) - Impact

Overview

Title

(Title of the impact study)

Improving the dental health of the community: Innovations in oral health

Unit of Assessment

11 - Medical and Health Sciences

Additional FoR codes

(Identify up to two additional two-digit FoRs that relate to the overall content of the impact study.)

03 - Chemical Sciences

Socio-Economic Objective (SEO) Codes

(Choose from the list of two-digit SEO codes that are relevant to the impact study.)

92 - Health

Australian and New Zealand Standard Industrial Classification (ANZSIC) Codes

(Choose from the list of two-digit ANZSIC codes that are relevant to the impact study.)

85 - Medical and Other Health Care Services

Keywords

(List up to 10 keywords related to the impact described in Part A.)

Tooth decay

Oral health

Remineralization

Dental therapy

Oral Biology

Oral Microbiology

Sensitivities

Commercially sensitive

No

Culturally sensitive

No

Sensitivities description

(Please describe any sensitivities in relation to the impact study that need to be considered, including any particular instructions for ARC staff or assessors, or for the impact study to be made publicly available after EI 2018.)

Aboriginal and Torres Strait Islander research flag

(Is this impact study associated with Aboriginal and Torres Strait Islander content?
NOTE - institutions may identify impact studies where the impact, associated research and/or approach to impact relates to Aboriginal and Torres Strait Islander peoples, nations, communities, language, place, culture and knowledges and/or is undertaken with Aboriginal and Torres Strait Islander peoples, nations, and/or communities.)

No

Science and Research Priorities

(Does this impact study fall within one or more of the Science and Research Priorities?)

Yes

Science and Research Priority	**Practical Research Challenge**
Health	Better models of health care and services that improve outcomes, reduce disparities for disadvantaged and vulnerable groups, increase efficiency and provide greater value for a given expenditure.

Impact

Summary of the impact

(Briefly describe the specific impact in simple, clear English. This will enable the general community to understand the impact of the research.)

Oral diseases have been a major economic burden in Australia and since the mid-1990s the prevalence of oral disease has increased globally. University of Melbourne researchers have developed methods to repair tooth enamel using calcium and phosphate extracted from dairy milk. Today, that protein, sold commercially as Recaldent™, is used by millions of people every day. Products using Recaldent™, such as chewing gum or those administered during a routine dentist visit, have generated sales of over $2 billion to date, and it has been estimated they have saved over $12 billion in dental treatment costs worldwide. This research has had significant impact in lowering the economic burden of oral diseases but has also improved the quality of life of people around the world.

Beneficiaries

(List up to 10 beneficiaries related to the impact study)

The general public: Improved oral health outcomes through the use of products resulting from the research

The Australian economy: Estimated that products have generated more than $2 billion in sales and saved over $12bn in dental treatment costs worldwide

The Australian economy: Job creation from product manufacturing and taxes on those employees as well as company tax

Dental Health Professionals: Through the availability of new non-invasive treatments and professional development opportunities

Industry: Benefits from licensing agreements regarding technologies and enhancement of current oral care products

Industry: Local factories that manufacture Recaldent™

Countries in which the impact occurred

(Search the list of countries and add as many as relate to the location of the impact)

Australia
Japan
United States of America

Details of the impact

(Provide a narrative that clearly outlines the research impact. The narrative should explain the relationship between the associated research and the impact. It should also identify the contribution the research has made beyond academia, including:
- who or what has benefitted from the results of the research (this should identify relevant research end-users, or beneficiaries from industry, the community, government, wider public etc.)
- the nature or type of impact and how the research made a social, economic, cultural, and/or environmental impact
- the extent of the impact (with specific references to appropriate evidence, such as cost-benefit-analysis, quantity of those affected, reported benefits etc.)
- the dates and time period in which the impact occurred.

NOTE - the narrative must describe only impact that has occurred within the reference period, and must not make aspirational claims.)

Oral diseases are among the most prevalent diseases in the Australian community with more than 60,000 Australians a year hospitalised due to preventable oral health conditions. This pioneering project, led by Professor Eric Reynolds has seen ground-breaking scientific discoveries in vaccines, antibiotics and dental hygiene evolving out of the lab and into globally successful products that prevent and treat oral disease.

Dental practice has significantly changed due to Reynolds' research on casein phosphopeptide amorphous calcium phosphate (CPP-ACP; trademarked as Recaldent™). This peptide complex derived from dairy milk has been shown to replace minerals lost in the tooth decay process. Recaldent™ chemically adheres to teeth re-mineralising and desensitising to provide comfort while rebuilding enamel, which is integral to preventing damage and decay. A range of professional and consumer oral health products using this remineralising technology has been developed by Reynolds, his research team and industry partners and these products have changed the focus of modern-day dental practices from traditional drilling and filling to prevention and minimal intervention using remineralisation.

Recaldent™ has been successfully commercialised in various products by leading oral care, food and beverage companies worldwide. Some of the products available for sale commercially throughout the world include: Recaldent™ chewing gum, Tooth Mousse/MI Paste, Tooth Mousse Plus/MI Paste Plus, Fuji VII-EP glass ionomer cement, MI Varnish and MI One toothpaste. Ongoing research into the performance of these products has contributed to an increased market share in recent years. For example, chewing gum with Recaldent™ is sold around the world and in Japan it is the largest selling sugar-free gum. The entire range of Recaldent™ containing products are now sold in over 50 countries worldwide.

ECONOMIC BENEFITS
Economic impacts of this research and the resulting products have been substantial. Oral care and dental professional products using Recaldent™ developed by Reynolds and team have generated sales of over $2 billion to date and it has been estimated based on clinical trial data that this represents a saving of over $12 billion in dental treatment costs worldwide. Public dental services and governments who support these services have benefited from this research by reduced demand on their services and improved community oral health. These benefits are significant given more than 60,000 Australians are hospitalised each year for preventable oral health conditions. The cost to the Australian economy of oral diseases has been estimated at $8.4 billion a year. Job creation from product manufacturing is also a key economic impact of this research. Today all Recaldent™ used around the world is made using Australian dairy and processed at factory on the outskirts of Melbourne.

The commercial success of this research can be further demonstrated by the number of patents relating to this research. Between 2011-2016, Reynolds and his team filed more than 29 Patents and have been cited in 18 others. Seven patents have been licensed to Recaldent™ Pty Ltd and GC Corp (Japan) and another six have been licensed to CSL Ltd. Reynolds has been closely involved in technology transfer associated with all licence agreements.

SOCIAL/COMMUNITY BENEFITS
Oral health is integral to general health, with poor oral health likely to exist when general health is poor and vice versa. While oral diseases are common, they are largely preventable. The social impacts of this research are felt by consumers and patients across the world who have benefited by the reduced requirement for dental treatment through using these oral care products. Public attitudes have also changed: instead of relying on professional dental treatments to repair existing conditions, people can now focus on personal prevention regular use products like sugar-free chewing gum and toothpaste containing Recaldent™.

As demonstration of his world-leading expertise in this area, Reynolds is a Board member and Chief Executive Officer of the Oral Health Cooperative Research Centre (CRC), a large multidisciplinary group based at the University who seek to reduce the economic and social burden of oral diseases on Australians. The Oral Health

CRC works closely with the Australian dental industry and supports a Continuing Professional Development (CPD) program that is available to dental professionals around Australia. For example, every year the CPD offers over 30 courses to hundreds of oral health professionals. The courses are designed to translate the research to bring the latest clinical and scientific information to oral health providers.

Reynolds continues to seek out opportunities to make his research available to the public in accessible and useful ways. For example, evidence of the extent of the impact of his research is evidenced in the extensive mainstream media coverage of his work and its wide-ranging community reach. For example, popular fact sheets relating to oral health and hygiene are available for public download on the CRC website, with visits to the Oral Health CRC website increasing steadily from an average of 1,700 a month in 2014-15 to an average 2,500 in 2015-16. Furthermore, the multi-media content including video-casts and podcasts have proved popular among website visitors, in particular the videocast of the impacts of a possible periodontitis vaccine and the podcast featuring the findings of the clinical trial of Tooth Mousse in post-orthodontic patients.

The national and global impact of this project and the research of Reynolds was recognised when he was awarded the Prime Minister's Prize for Innovation in 2017. This honour, Australia's most prestigious and highly regarded award for outstanding achievements in research-based innovation, was awarded for the innovative translation of scientific knowledge into a commercially available product.

Associated research

(Briefly describe the research that led to the impact presented for the UoA. The research must meet the definition of research in Section 1.9 of the EI 2018 Submission Guidelines. The description should include details of:
- what was researched
- when the research occurred
- who conducted the research and what is the association with the institution)

Over the period 2002 to 2016, Professor Eric Reynolds led a program of research at the University of Melbourne on casein phosphopeptide amorphous calcium phosphate (CPP-ACP; trademarked as Recaldent™) and its interaction with fluoride (F) ion to form CPP-ACFP nanocomplexes and the clinical efficacy of CPP-ACFP in preventing oral diseases. Recaldent™ delivers calcium and phosphate to penetrate, strengthen and re-mineralise tooth enamel affected by plaque. The core product is a dental cream called Tooth Mousse, often used after dental work. It also strengthens 'chalky teeth' and reduces tooth sensitivity. It is sold in more than 50 countries.

The multi-disciplinary approach used by Professor Reynolds, bringing knowledge of molecular biology, biochemistry, immunology, microbiology, has had significant and demonstrated impact on the problems of periodontitis and tooth decay in the community.

Addressing oral health problems in this way has led to world-first discoveries and resulted in the application of the CPP-ACFP technology in oral care products available around the world.

FoR of associated research

(Up to three two-digit FoRs that best describe the associated research)

11 - Medical and Health Sciences
03 - Chemical Sciences

References (up to 10 references, 350 characters per reference)

(This section should include a list of up to 10 of the most relevant research outputs associated with the impact)

Alkhtib, A., Manton, D. J., Burrow, M., Saber-Samandari, S., Palamara, J., Gross, K., & Reynolds, E. C. (2013). Effects of bleaching agents and Tooth Mousse on human enamel hardness. Journal of Investigative and Clinical Dentistry, 4(2), 94-100. doi:10.1111/jicd.12001

Cai, F., Shen, P., Walker, G., Reynolds, C., Yuan, Y., & Reynolds, E. (2009). Remineralization of enamel subsurface lesions by chewing gum with added calcium. Journal of Dentistry, 37(10), 763-768. doi:10.1016/j.jdent.2009.06.003

Cochrane, N. J., Shen, P., Byrne, S. J., Walker, G. D., Adams, G. G., Yuan, Y., Reynolds, C., Hoffmann, B., Dashper, S. & Reynolds, E. C. (2012). Remineralisation by chewing sugar-free gums in a randomised, controlled in situ trial including dietary intake and gauze to promote plaque formation. Caries Research, 46(2), 147-155. doi:10.1159/000337240

Huq, N. L., Myroforidis, H., Cross, K. J., Stanton, D. P., Veith, P. D., Ward, B. R., & Reynolds, E. C. (2016). The Interactions of CPP-ACP with Saliva. International Journal of Molecular Sciences, 17(6), pii: E915. doi:10.3390/ijms17060915

Iijima, Y., Cai, F., Shen, P., Walker, G. D., Reynolds, C., & Reynolds, E. C. (2004). Acid resistance of enamel subsurface lesions remineralized by a sugar-free chewing gum containing casein phosphopeptide-amorphous calcium phosphate. Caries Research, 38(6), 551-556. doi:10.1159/000080585

Manton, D., Walker, G., Cai, F., Cochrane, N., Shen, P., & Reynolds, E. (2008). Remineralization of enamel subsurface lesions in situ by the use of three commercially available sugar-free gums. International Journal of Paediatric Dentistry, 18(4), 284-290. doi:10.1111/j.1365-263X.2008.00920.x

Morgan, M., Adams, G., Bailey, D., Tsao, C., Fischman, S & Reynolds, E. (2008). The Anticariogenic Effect of Sugar-Free Gum Containing CPP-ACP Nanocomplexes on Approximal Caries Determined Using Digital Bitewing Radiography. Caries Research, 42(3), 171–184. doi:10.1159/000128561

Reynolds, E. C., Cai, F., Shen, P., & Walker, G. D. (2003). Retention in plaque and remineralization of enamel lesions by various forms of calcium in a mouthrinse or sugar-free chewing gum. Journal of Dental Research, 82(3), 206-211. doi:10.1177/154405910308200311

Walker, G., Cai, F., Shen, P., Reynolds, C., Ward, B., Fone, C., Honda, S., Koganei, M., Oda, M., & Reynolds, E. (2006). Increased remineralization of tooth enamel by milk containing added casein phosphopeptide-amorphous calcium phosphate. Journal of Dairy Research, 73(1), 74-78. doi:10.1017/S0022029905001482

Wong, R. H. W., Palamara, J. P., Wilson, P., Reynolds, E. C. R., & Burrow, M. F. B. (2011). Effect of CPP-ACP addition on physical properties of zinc oxide non-eugenol temporary cements. Dental Materials, 27(4), 329-338. doi:10.1016/j.dental.2010.11.011

Additional impact indicator information

Additional impact indicator information

(Provide information about any indicators not captured above that are relevant to the impact study, for example return on investment, jobs created, improvements in quality of life years (QALYs). Additional indicators should be quantitative in nature and include:
- name of indicator (100 characters)
- data for indicator (200 characters)
- brief description of indicator and how it is calculated (300 characters).)