ANNUAL RESEARCH REPORT for 2021
I am delighted to be able to present to you, our Annual Research Report for 2021.

The researchers in our School have been negatively impacted by the COVID-19 challenges we have all faced due to COVID that have obstructed and slowed down the pathway to carrying out research. These include housing work, limitations on access to environments and research participants; less face-to-face contact with immediate and distant colleagues and networks; and the diversion of attention to important dependent care that continues to be unpredictable and demanding. There have also been the indirect challenges that have meant financial difficulties with increasing costs of materials and delays in the fulfilment of orders and their delivery.

Despite these significant barriers, we have not only continued to progress ongoing work but have also forged ahead with grand applications, innovative research and making impacts.

For such a small School we punched well above our weight with the number of impact case studies we were able to put forward to the University for the Research Excellence Framework (REF) 2021, assessment exercise and, ultimately, had accepted to be submitted as examples of the work our University does. WE await the outcome of that process and expect to hear in May this year.

Professor Daniel Aeschlimann was generous enough to step down from his role as Director of Research to ensure our REF submission was optimal and see us through the challenges we have faced. He did this as well as heading the Environmental Microbial Diseases group, the School, and I, are very grateful for his motivation, leadership and support over the years. I am delighted to welcome our new Director of Research, Dr Elaine Ferguson, who has taken on the reins of some of the ongoing projects that Professor Aeschlimann was leading, including scrutinising our research portfolio. There have been several retirements and changes in staff that make it timely to consider outcomes of activity. As part of this, we have removed the separation of research groups under themes and are working to increase collaboration across the School. Another change that, for the first time, we have included our research related to Education and Scholarship within the brochure and we expect to also see activity in this area grow over the next few years.

So, all in all, this has been a very active year for the School. We remain responsive to the environment and the society, that we serve with our alumni-based activity and look forward to sharing further impactful research as we continue to seek out and address, important questions to improve the world we live in.

The past year has continued to see our researchers rising to the challenges brought about by COVID-19 as they applied their expertise in clinical practice, immunology and medical statistics to tackling the pandemic. Examples of some of our COVID-19-related research are given on pages 5 and 6. Additionally, the Violence Research Group has studied the effect of COVID-19 lockdowns on assault-related attendance to the emergency unit in Cardiff, the Clinical Dentistry group has contributed to increasing our understanding of the risk of contamination in relation to periodontal care procedures relevant to COVID-19 and the Microbial Diseases group has investigated the clinical and microbiological profiles of patients co-infected with COVID-19.

This year also saw the successful submission to the REF 2021. As part of Unit of Assessment 3 (Allied Health Professions, Dentistry, Nursing and Pharmacy), we submitted 100% of T&F staff with at least 1 output each to the REF 2021. In total, we submitted 55 research outputs and 3 impact case studies, whose effects were felt around the world. We are now actively pursuing the plans outlined in the Unit’s environment statement as we eagerly await the results in May 2022. I would like to thank all our dedicated academic staff for their world-class contributions to the submission, as well as our professional and technical services staff for their valued insights and support.

In 2021, we bade farewell to two longstanding colleagues: Mrs Maria Morgan and Professor Mike Lewis. Maria retired from her position as a senior lecturer in dental public health in July. During her 23 years in the School, Maria led the Welsh Oral Health Information Unit to plan and deliver the NHS Dental Survey Programme for Wales, who was Head of School between 2010 and 2017, retired in August. His clinical- and laboratory-based research in oral medicine focused on the effects of bacterial, viral and candidial infections on the oral mucosal tissues. Leadership roles in the School have also changed in 2021. Professor Daniel Aeschlimann’s term as Director of Research came to an end and I was appointed to the role in September 2021. I would like to close by thanking everyone who has supported my transition to this role, especially Daniel, who shared his wisdom, insight and vast experience with me and my colleagues in the Senior Leadership Team, who have encouraged me and shared my vision for the future of research in the School.
Case Study 1:  
**The Graduating European Dentist and Hygienist**  
- Dr James Field

Over the past 5 years, staff at Cardiff have been instrumental in leading pan-European taskforces for writing modern curricula for both the graduating European Dentist (GED) and Hygienist. The last time that the European curriculum for dentistry was updated was in 2010, and this is the first time that a European curriculum for hygiene has ever existed.

The new curricula provide clear guidance and support for dental education and training on a European scale, and the new frameworks will:

- Further refine and harmonise oral health professional undergraduate curricula across Europe, whilst respecting regional, socio-economic and cultural variation.
- Reinforce the importance of an outcome-based curriculum, which is informed by a robust and effective system of student and staff feedback.
- Facilitate the transition from a student to a practitioner who is considered, as a minimum, “a safe beginner,” and able to build confidence and further competence as part of a workplace-based training programme.
- Provide guidance and support for educators who are developing curricula for undergraduate dental education and training.

The curricula were developed through widespread consultation, and consensus, with educators and their respective institutions, regulators, professional societies, trade unions, students, and industrial partners. Since their open access publication in 2017 (Dental) and 2020 (Hygiene) the curriculum documents have been cited over 200 times and now form the basis for various regulatory curricula across Europe.

The GED documentation has been digitised and now has a home online (https://adee.org/projects/graduating-european-dentist/graduating-european-dentist-resource-pages) where you can search and comment on the curriculum.

Case Study 2:  
**Providing evidence for the role of mouthwash as a SARS-CoV-2 risk mitigation strategy in dentistry**  
- Professor David Thomas

Since the outset of the pandemic, we have been working with colleagues in the Immunity, Evolutionary Medicine and Public Health Institutes (Prof Valerie O’Donnell and Dr Richard Stanton). Our initial interests were in the potential for reduction of SARS-CoV-2 in saliva using mouthwashes to disrupt the viral lipid envelope. We participated in an international review of the evidence in Function (https://doi.org/10.1093/function/zqaa002). Following this, we demonstrated rapid, virucidal (>104-fold reduction) effects of selected mouthwashes against SARS-CoV-2 in vitro (https://doi.org/10.1101/2020.11.13.381079).

We next sought to study the impact of mouthwash, including duration of effect, on virus infectivity in patients, in a randomised controlled trial in hospitalised COVID patients across Wales (MOMA; ISRCTN25647404). This was conducted at University Hospital Wales, with Ceri-Ann Lynch (Cwm Taf Morgannwg University Hospital Board), Arvind Arya (Betsi Cadwaladr University Health Board) and their teams. The manuscript is currently under revision. In parallel with this work, the O’Donnell and Stanton groups, undertook the first detailed characterisation of the viral lipid envelope to better understand the unique features of the disease process. This work led to a £600k research grant from BBSRC (BB/W003376/1; O’DONNELL PI); mapping the lipid envelope composition of SARS-CoV-2 and studying how this modifies inflammation, thrombosis and infection. As part of this grant, working with Public Health Wales, we established a community-based (Cwm Taf Morgannwg UHB) and hospital-based study in COVID patients in Cardiff and Vale, Aneurin Bevan- and Betsi Cadwaladr University Health Boards (AVECO; ISRCTN 54053617).

Clinically, at the height of the pandemic in June 2020, we worked with the Chief Dental Officer; employing mouthwash as part of risk mitigation in a “Protocol of return to practice of routine dental care”. A pilot scheme introduced a reduced fomite time from 60 to 20 minutes; incorporating mouthwash alongside routine Infection Prevention Control policy in 5 dental practices across South-East Wales. Patient outcomes were monitored at 14 days post treatment. Between June and August 2020 >6400 patients were treated with this protocol.

This data reinforced our confidence in the safety of the cross-infection measures adopted in dental practice in the pandemic. The laboratory and clinical evidence on the mouthwash we generated led to oral-rinsing being adopted into routine patient care in the Salisbury NHS Trust (https://www.salisbury.nhs.uk/coronavirus/covid-19-mouth-care/).

In moving forward, a generous award from the Garner Roberts Charitable Trust Fund is supporting Prof Thomas and Dr Nick Claydon’s ongoing collaboration with colleagues in the Schools of Biosciences (Berube/Jones), Architecture (Lannon), Medicine (Roberts, McLeod) and Engineering (Giles) to better understand the relationship between aerosol decay and the built environment, to inform safe practice. Alongside this, with industrial partners, Professor Thomas, Dr Katja Hill and Dr Richard Stanton are also working in the laboratory to understand the potential of over the counter anti-viral and anti-microbial therapies.
Case Study 3: COVID Bereavement Study
Dr Damian JF Farnell, Dr Renata Medeiros Mirra
(Study statisticians for the COVID bereavement study)

282 million confirmed COVID-19 cases and 5.4 million deaths from COVID-19 have occurred globally as of the start of the New Year in 2022. Each death is associated with approximately nine close bereavements. The UK COVID bereavement study investigates the impact of the COVID-19 pandemic on the experiences of the bereaved and on bereavement support provision. The main investigators for this study are Dr Emily Harrop at University of Cardiff and Dr Lucy Selman at the University of Bristol.

People who were bereaved during the first wave of the pandemic completed an online questionnaire detailing their experiences, where 44% of the deceased died to (known or suspected) COVID-19 and the rest died of other causes. 51.6% of 711 bereaved people demonstrated high or severe levels of grief. They also experienced very high levels of pandemic-related challenges (see table) and they needed high levels of support (see figure).

Qualitative analysis of free-text survey data from bereaved participants identified the main themes that related to challenges of bereavement. A quote from this work encapsulates the experiences of many of the bereaved:

“It was brutal. It still is, as I feel the grieving process is so much worse now due to isolation and lack of contact and the trauma of (Name)’s sudden death and not having any time with him. I feel people that unless you have lost someone you love so much suddenly, during this pandemic, you can never understand the feelings of hopelessness, despair, sadness, so much was ripped away from me and my children.” (Bereaved wife)

Findings from the study were presented at the launch of the UK Commission on Bereavement in June 2021 with a public statement by the Minister for Mental Health to address the gaps and challenges identified by the study. For more information, please see recent TV news coverage with Dr Lucy Selman [https://youtu.be/7sBDrnExVMk] and [https://youtu.be/0ZMWLvu3PMM] and a statement by the medical schools council into UK universities’ research into COVID-19.

The COVID bereavement study will now focus on the long-term effects of bereavement and on the impact of COVID-19 on services, including key adaptations, challenges and approaches to delivering accessible bereavement care during pandemic.

Table: Frequency of pandemic-related challenges experienced by the bereaved before or after the death during the first wave of the COVID-19 pandemic.

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Percentage</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unable to visit them prior to their death</td>
<td>54.30%</td>
<td>50.5% to 58.0%</td>
</tr>
<tr>
<td>Limited contact with them in last days of their life</td>
<td>57.80%</td>
<td>54.1% to 61.5%</td>
</tr>
<tr>
<td>Unable to say goodbye as I would have liked</td>
<td>63.90%</td>
<td>60.2% to 67.4%</td>
</tr>
<tr>
<td>Restricted funeral arrangements</td>
<td>93.40%</td>
<td>91.3% to 95.1%</td>
</tr>
<tr>
<td>Social isolation and loneliness</td>
<td>66.70%</td>
<td>63.1% to 70.1%</td>
</tr>
<tr>
<td>Restricted contact with other close relatives or friends</td>
<td>80.70%</td>
<td>77.6% to 83.6%</td>
</tr>
</tbody>
</table>

Support needed:
- Feelings and tasks such as managing the funeral, registering the death, other personal tasks, e.g., writing to family, e.g., getting food, medication, childcare

Matrix Biology and Tissue Repair

We are a multidisciplinary team of scientists with expertise in cell and molecular biology, structural biology, and immunology. Our research aims to understand and manipulate the interface between extracellular matrix (ECM) and the diversity of cells in the craniofacial complex.

www.cardiff.ac.uk/research/explore/research-units/matrix-biology-and-tissue-repair-research-group

Our goals are:
- To elucidate and counteract pathological processes leading to tissue destruction in inflammation, cancer and ageing.
- To create functional tissue through application of life science principles.

The ECM and its interaction with various cells are critically important to regulate inflammation, repair/regenerative processes and invasive cancers. Connective tissue cells control migration, survival and proliferation of endothelial and epithelial cells as well as recruitment and activation of antigen presenting cells that orchestrate the inflammatory response. Altered connective tissue cell responses are associated with many diseases, because of either direct involvement in the aetiology or because of fibrosis, which accompanies the tissue damage. Experimental models have been established within the group to decipher cellular interactions regulating distinct aspects of the repair and disease process. These relate to inflammation, angiogenesis, re-epithelialisation, cancer stromal cell interactions and ECM changes occurring with ageing. The emphasis is to gain a molecular understanding of the role of post-translational modifications of proteins in organ system function, and how aberrant protein modifications or proteolysis contributes to pathogenesis.

Our plans for 2022:
- A novel collaboration with industry will explore gut-microbiome interactions.
- We will apply our expertise in cartilage engineering to develop models mimicking the multi-scale hierarchical changes in matrix organization that reflect joint specificity and genetics.
- We will develop a microfluidic tissue platform for modelling complex vascular and immune functions in the context of recently established cross-HET collaboration (Organ-on-a-Chip Technologies Network).
- Regulation of c-MET signalling in oral cancer by small bioactive molecules and metalloproteinases will be further explored as new therapeutic approaches.
- Based on analysing the structure and site-directed mutagenesis of major human cancer cell M3 protein we will further our understanding of its influence on inflammatory diseases and cancers arising from dysregulation of the host chemokine network.
**Key project summary:**

**Cell surface topography controls phagocytosis and cell spreading:**

The membrane reservoir in neutrophils

*Al-Jumaa M et al, 2020 Biochimica et Biophysica Acta (BBA) - Molecular Cell Research 12: 118832*

**Background:**

Neutrophils are the main innate immune cell recruited to the oral cavity. They provide the first line of defence against invading pathogens, ensuring a healthy periodontal tissue. In chronic inflammatory diseases such as periodontitis however, excessive neutrophil accumulation leads to periodontal tissue damage, and in severe cases, bone loss. Understanding the mechanism of action of these powerful cells, is therefore key to promoting and controlling a healthy oral environment.

Neutrophils exhibit dramatic and rapid cell shape changes as they spread onto surfaces (e.g. when they transit through blood vessels to tissue sites) or undergo phagocytosis of pathogenic material. These shape changes require a large apparent increase in the cell surface area (about 200–300% of the initial cell surface area), however the total amount of plasma membrane remains stable. We therefore hypothesised that the ‘wrinkled’ cell surface topography of neutrophils could be important in providing the membrane reservoir for required cell spreading and phagocytosis.

**Discovery:**

Advances in monitoring cell surface topography in living cells enabled us to test this hypothesis. We manipulated the cell surface topography and cell behaviour, while using a technique named subdomain fluorescence recovery after photobleaching (sdFRAP). This measures the kinetics of fluorescence recovery at a locus remote from the bleach front. By comparing with the kinetics expected from a flat surface, the wrinkledness of the diffusion path can be established (Al-Jumaa, 2017).

Osmotic shrinking of neutrophils produced hyperwrinkled cells, which were unable to spread normally or undertake phagocytosis. Triggering a Ca²⁺ signal in osmotically shrunk cells (by IP3 uncaging) evoked tubular blebs instead of full cell spreading. During phagocytosis, inducing osmotic shrinking after the phagocytic Ca²⁺ signal had initiated, halted the event at the phagocytic cup stage. Restoration of iso-tonicity was able to restore complete phagocytosis.

**Importance:**

These data provide new evidence that the wrinkled surface topography of neutrophils provides the membrane reservoir for the large apparent increase in cell surface area. From this we can conclude that neutrophils use this approach over the slower and more energy expensive exocytosis and endocytosis mechanism which other cell types may use, enabling their rapid spreading and high phagocytic capacity.

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MSc (Biochemistry, Biophysical Cell Biology and Molecular Genetics), 1990, Biocenter, University of Basel, Basel, Switzerland. PhD (Biochemistry), 1993, University of Basel, Basel, Switzerland. Fellowships from EMBO and Swiss National Science Foundation. Various academic positions in Switzerland, USA and UK. Since 2001, Professor of Biomedical Sciences, Cardiff University, UK. Head of Matrix Biology & Tissue Repair Research Unit and until September 2021, Director of Research for School of Dentistry. Full list at: www.cardiff.ac.uk/people/view/39472-aeschlimann-daniel

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Diploma in Physics, 1981. IGG University Frankfurt a. M., Germany. Ph.D. in Biology, 1984. MPI Biophysics, Frankfurt M., Germany. Habilitation (Docent) in Biophysics, 1995. University Linz, Austria; various academic positions and fellowships in Basel, Switzerland; Linz, Austria; Portland OR, USA; Piacenza, Italy; USA; Nagoya, Japan; Lyon, France; since 2004 Lecturer in Protein Biophysics, Cardiff University, U.K. Full list at: www.cardiff.ac.uk/people/view/39488-beck-konrad

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Diploma in Chemistry (equivalent BSc, University of Bielefeld, Germany), Dr rer. nat. equivalent PhD in Biochemistry, University of Bielefeld, Germany, 1993-1995 Welcome Trust Travelling fellow (Strangeways Research, Cambridge), 1995-2000 Post-doctoral fellow (University of East Anglia, Norwich), 2001-2006 Lecturer (University of York, York), since 2006 Senior Lecturer (Cardiff University) Full list at: www.cardiff.ac.uk/people/view/39462-knauper-vera

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**Key Publication:**


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**Key Publication:**


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**Key Publication:**

Advanced Therapies Group

We are a multi-disciplinary team of clinicians, microbiologists, pharmacists, cell biologists and engineers whose research aims to apply our knowledge of the molecular and cellular control of human disease processes, to inform the design, development and testing of novel therapies. www.cardiff.ac.uk/research/explore/research-units/advanced-therapies-group

Working with our academic, industrial and clinical partners around the world, we are using our expertise in the design and delivery of novel therapeutic interventions to target a range of, often life-threatening, infective and chronic inflammatory conditions including multi-drug resistance, cystic fibrosis, chronic skin wounds and also peri-implantitis.

Our goals are:

- To translate our findings, from the laboratory to the clinic, to improve treatments for patients.
- To develop treatment strategies (both topical and advanced-therapies-group delivery of novel therapeutic interventions to target human disease processes, to inform the design, knowledge of the molecular and cellular control of engineers whose research aims to apply our microbiologists, pharmacists, cell biologists and technicians have developed, to analyse anti-biofilm intravenous) to improve current treatment efficacy/
clinic, to improve treatments for patients.

Highlights of 2021:

- BBBSRC UK award of £808,000 with the School of Medicine entitled ‘Mapping the lipid envelope composition of SARS-CoV-2 to modify inflammation, thrombosis and infection’.
- Completion of the MOMA interventional mouthwash study across Wales in patients with COVID-19.
- Commencement of the School’s first China Scholarship Council PhD studentship (to Jingiang Wu), in a project with Oxford University and QBiotics.
- Appointment of Dr Juliette Oakley (MD student) as Consultant in Respiratory Medicine at Bristol Children’s Hospital and Dr Catrin Williams (RA) as Lecturer in Microbiology in BISIS, Cardiff University.
- Promotion of Dr Elaine Ferguson to Director of Research for the School of Dentistry.

Our plans for 2022:

- Continuing the epoxy-tigliane work in relation to: colistin resistance, biofilm modelling and biofilm EPS
colloidal particles (d) 500 nm FluoSphere® particles, in response to polymyxin B treatment. (b) Diffusion coefficient <Deff>


(Key project summary:

Quantifying the effects of antibiotic treatment on the extracellular polymer network of antimicrobial resistant and sensitive biofilms using multiple particle tracking

Background: Novel therapeutics designed to target the polyanionic matrix of biofilms, require innovative techniques to accurately assess their efficacy. Here, we used multiple particle tracking (MPT) microscopy to characterise the physical and mechanical properties of antimicrobial resistant (AMR) bacterial biofilms and for the first time, to quantify the effects of antibiotic treatment.

Discovery: Studies employed nanoparticles (NPs) of varying charge and size (40–500 nm) in Pseudomonas aeruginosa PA01 and methicillin-resistant Staphylococcus aureus (MRSA) biofilms and also in polymyxin B (PMB) treated Escherichia coli biofilms of PMB-sensitive (PMBsens) IRS7 and PMB-resistant (PMBr) PN47 strains. NP size-dependent and strain-related differences in the diffusion coefficient values of biofilms were evident between PA01 and MRSA (Table 3). Bisection-dependent treatment effects induced by PMB in PMBres E. coli biofilms included increases in diffusion (Fig. 1) and creep compliance (Fig. 2; P < 0.05), not evident in PMB treatment of PMBres E. coli biofilms (Fig. 3).

Importance: The ability of MPT to quantify the diffusion and mechanical effects of antibiotic treatments within the biofilm matrix of antibiotic-resistant and -sensitive bacteria, highlights its potential usefulness for pre-clinical screening of anti-biofilm therapies.

![Fig 1](image1.png)
![Fig 2](image2.png)
![Fig 3](image3.png)
Dr Elaine L Ferguson
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With a background in Pharmacy, my translational research in polymer therapeutics focuses on optimising drug release by attachment of biodegradable polymers to target proteins, peptides and drugs to sites of inflammation, thereby minimising toxicity, overcoming resistance and increasing bioavailability. Ongoing research, in collaboration with pharmaceutical and nutraceutical companies, is investigating novel combinations of polymers and biomolecules/drugs, and investigating novel temporal triggers for drug release from polymer therapeutics. I was appointed as Director of Research for the School of Dentistry in September 2021.

Dr Katja E Hill
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With a background in microbial ecology and molecular biology, I am interested in the mechanisms of gene regulation and control in bacterial biofilms. My current research involves translation to clinical practice through the testing of novel compounds (from e.g. seaweed and the Australian rainforest) for the management of human chronic diseases such as cystic fibrosis and wound healing of ‘difficult to treat’ wounds, to characterise their mechanisms of gene regulation and control in bacterial biofilms. My current research with pharmaceutical and nutraceutical companies, is investigating novel combinations of delivery strategies to improve their management and diagnosis, I lead the Advanced Therapies Group.

Dr Manon F Pritchard
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Following completion of my dental degree, clinical foundation years and PhD in microbiology, I have successfully published a series of papers and been awarded several prizes in recognition of my work. I am currently developing therapeutic nanomedicines for the treatment of multi-drug resistant bacterial biofilm infections. My research is consolidated by my successfully obtaining a Precision Medicine Fellowship from the Welsh European Funding Office (WEFO).

Professor David W Thomas
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A clinician with a background in studying the role of microbial biofilms in human disease states to improve their management and diagnosis, I lead the Advanced Therapies Group. I am a previous Welcome Trust Clinical Fellow (Bristol University) and currently Professor Hon. Consultant in Oral and Maxillofacial Surgery at the University Hospital of Wales.

Highlights of 2021:

• Mrs Rania Nassr received the 2021 IADR Colgate Research in Prevention Travel Award in recognition of her research entitled: “Antimicrobrial Activity of Phylic Acid: A Potential Endodontic Irritant.”
• Dr Katrina Duggan was successful in passing her PhD viva with her thesis entitled: “Biomaterial modulation for diagnostic and therapeutic benefit in catheter-associated urinary tract infection.”
• Mr Abdullah Albarrak joined the group on a studentship to explore “Strategies to analyse and control the extracellular polymeric substances of biofilm.”
• Ms Megan Williams was a recipient of a UK-Canada Global link award to undertake research with Dr Laurent Bozec at the University of Toronto. Her project will investigate nanoscale interactions of Candida species with oral bacteria and surfaces.
• Completion of second cycle of National Audit of Antimicrobial Prescribing in UK and Ireland Dental Hospitals.

Microbial Diseases

The interests of the Microbial Diseases Research Group encompass a breadth of oral and non-oral human infections. An important research focus is investigating the involvement of microbial biofilms in human infection, the way the host responds to biofilms and the development of novel approaches to manage these recalcitrant microbial growth forms. We are a multidisciplinary research group and work closely with clinicians, chemists, pharmacists and engineers. Our research is supported through our dedicated facilities and equipment for biofilm study. As we are based in a clinical school and operate in close alignment with the oral and medical microbiology laboratories, we benefit not only from access to clinical specimens but also in rapidly identifying research areas where there is clinical concern.

www.cardiff.ac.uk/research/explore/research-units/microbial-diseases-research-group

Our research aims are:

• To develop novel approaches in the management of biofilm-mediated human infections
• To characterise biofilm communities, the relationships between associated microorganisms and the way the local environment influences biofilm behaviour
• To explore how the host responds to infection, with the aim of developing diagnostics and immunotherapies

Previously, the study of microorganisms in human infection primarily focused on monotypic species grown in broth culture. Furthermore, the assessment of antimicrobial susceptibility is also predominantly based on testing microorganisms in liquid culture. What is now increasingly evident is that infections most frequently involve microorganisms attached to a surface and encased within protective extracellular matrices. These growth forms are referred to as biofilms and are responsible for an estimated 65% of human infections. Dental plaque is the most widely studied biofilm and is the cause of both caries and periodontal disease which are amongst the most prevalent of human infections. Biofilms are highly resilient and can exhibit a 1000-fold greater tolerance to administered antimicrobials compared to the same microorganisms grown in broth culture. Exploring strategies to eradicate biofilms where they are causing infection therefore represents an extremely challenging and important area of study.

Our plans for 2022

• The microbial diseases research group will continue to investigate clinically relevant biofilms with a focus into the characterisation of the composition of in vitro and in vivo characterisation of the microbiome and the quantity and type of extracellular matrix components in biofilms.
• Using nanoscale surface imaging interrogation of substrate and microbial surfaces we will expand our knowledge of the interactions of biofilm cells with their environment and how this influences biofilm pathogenicity.
• To promote these activities the group will further develop its collaborative links both nationally and internationally with research partners in the area of ‘biofilmology’.
Antimicrobial efficacy of the potential endodontic irrigant, Phytic acid.

Background: Bacteria and their associated biofilms are significant causes of failure of root canal treated teeth. Consequently, the elimination of contaminating bacteria is a key objective during root canal treatment. Treatment of root canal infections involves physical debridement coupled with use of irrigation solutions treated with antimicrobial activity to remove biofilms. The synthetic chelant ethylenediaminetetraacetic acid (EDTA), is one of the most frequently used agents for smear layer removal during root canal treatment. However, EDTA has several disadvantages including host cell toxicity against periapical tissue and an inability to effectively eradicating biofilms. As a result, there is need to identify alternative agents.

Recently, a naturally occurring compound called phytic acid (IPA) has been reported to effectively remove the smear layer, without associated host cell toxicity. Importantly, preliminary studies have indicated antimicrobial activity of IPA against planktonic cultures of the endodontic pathogen Enterococcus faecalis. However, the spectrum of this activity and effectiveness against biofilms has yet to be determined. The aim of this research was to further evaluate IPA against a range of microbial species and associated biofilms and compare the findings with those of EDTA.

Discovery: Antibacterial and antibiofilm activity of IPA against 12 microbial strains was assessed by determining the minimum inhibitory concentration (MIC), minimum bactericidal activity (MBC) and minimum biofilm eradication concentration (MBEC). Comparative tests were also undertaken using EDTA and sodium hypochlorite (NaOCl). IPA had antimicrobial activity against all planktonic test cultures at 0.156% (w/w). In vitro biofilms in microtiter wells were also found to be eradicated by IPA and at a greater extent than those treated using either NaOCl or EDTA. Progression of this research to biofilms generated on hydroxyapatite coupons in a bioreactor confirmed the effective antibiofilm properties of IPA. In these studies, 5 min exposure of 72-h old biofilms revealed a substantial kill of Enterococcus faecalis compared with untreated biofilms (Figure 1).

Importance: The significance of this work lies in the identification of the antibiofilm activity of IPA which is a potentially safer endodontic agent than NaOCl. Clinical application of IPA could in the future help both in reducing occurrence of root canal treatment complications and negative effects on healthy vital tissue.

Acknowledgements: This research is a collaborative study involving the School of Dentistry, Cardiff University and researchers at Mohammed Bin Rashid University of Medicine and Health Sciences, Dubai. The work forms part of a PhD scholarship being conducted by Mrs Rania Nassar under the supervision of Professor David Williams, Dr Melanie Wilson and Prof Abiola Seniak.

Figure 1. Enterococcus faecalis biofilms (72 h) on hydroxyapatite coupons stained with a live/dead stain and imaged by confocal laser scanning microscopy. Green cells are viable and red cells are dead. A) untreated biofilm, B) Biofilm treated with 5% (w/w) phytic acid for 5 min.
Regenerative Biology Group

Our research aims to enhance understanding of the cellular and molecular mechanisms regulating the repair and regeneration of oral, dental, dermal and neural tissues, during health and disease. With research interests across cell, biology, matrix biology, drug delivery, biomaterial sciences and clinical dentistry, our goal is to develop stem cell, pharmaceutical, biomaterial, bioelectrical and other therapeutic strategies to promote repair in these and other tissues throughout the body.

www.cardiff.ac.uk/research/explore/research-units/regenerative-biology-group

Our goals

- To understand the mechanisms underlying the repair and regeneration of oral, dental and neural tissues, during health and disease.
- To develop novel targeted technologies to promote tissue repair and regeneration in oral and non-oral tissues.

Despite significant medical advances in recent years, clinical conditions associated with impaired or dysfunctional healing remain a major healthcare challenge; especially with the rising incidence of these conditions due to ageing populations, diabetes, antimicrobial resistance and the acknowledged inadequacies in current treatment options.

Research within the Regenerative Biology Group is particularly focussed on the role of tissue-intrinsic mesenchymal stromal cells (isolated from dental pulp, bone marrow, oral mucosa) in driving tissue repair processes.

We aim to have a positive impact on patient health and well-being, by continuing our research advances in developing “stem” cell technologies with pharmaceutical, biomaterial, bioelectrical and other therapeutic approaches for the treatment of diseases and conditions affecting dental, maxillofacial and orthopaedic functioning; impaired dermal wound healing and organ fibrosis; and spinal cord repair. A further focus of our research is the development of novel antimicrobial delivery and release technology for oral progenitor cells as stimulators of soft tissue repair.

Dr Ryan Moseley was awarded a 3-year Dunhill Medical Trust Research Project grant (£298,338) to develop small molecule therapeutics for the treatment of non-healing, chronic skin wounds and a 2-year QBiotics Group Funded grant (£272,205), to elucidate how small molecule therapeutics modulate wound healing responses in dermal fibroblasts.

Dr Ryan Moseley was appointed as Chair of the Regenerative Dentistry Research group, and the British Society British Society for Oral and Dental Research (BSODR) and elected as a Board Member of the European Tissue Repair Society (ETRS).

Prof Rachel Waddington was elected President of the BSODR, the first female president in the Society’s 53-year history.

Our plans for 2022

The Regenerative Biology Group (RBG) will focus on three key research areas in 2022: namely the utilisation of (i) extracellular vesicles, (ii) small molecules and (iii) cell-based therapies for tissue repair and regenerative approaches.

We will continue to characterise and investigate the therapeutic potential of extracellular vesicles as anti-scarring and antimicrobial agents for soft tissue wound repair and as pro-osteogenic mediators for accelerating mineralised tissue repair.

Our group will build on our track record of small molecule development and light-based therapies in the repair of dermal and gingival soft tissues respectively.

We will apply our expertise in tissue engineering and translational medicine to progress cell-based approaches to regenerate nerve tissues.

Highlights of 2021

- Dr Wayne Nishio Ayre, in collaboration with Prof Phil Davies (Chemistry), Dr Bo Hou (Physics), Dr Kelly Berulè (Biosciences) and Dr Tim Jones (Earth and Environmental Sciences), was awarded a £1M EPSRC Strategic Equipment grant to commission the UK’s first photo-induced force microscopy (PiFM) system at Cardiff University.

- Prof Phil Stephens received funding to commission an external Regulatory Strategy & Gap Analysis as part of the group’s on-going translational development of oral progenitor cells as stimulators of soft tissue repair.

- Dr Ryan Moseley was awarded a 3-year Dunhill Medical Trust Research Project grant (£298,338) to develop small molecule therapeutics for the treatment of non-healing, chronic skin wounds and a 2-year QBiotics Group Funded grant (£272,205), to elucidate how small molecule therapeutics modulate wound healing responses in dermal fibroblasts.

- Dr Ryan Moseley was appointed as Chair of the Regenerative Dentistry Research group, and the British Society British Society for Oral and Dental Research (BSODR) and elected as a Board Member of the European Tissue Repair Society (ETRS).

- Prof Rachel Waddington was elected President of the BSODR, the first female president in the Society’s 53-year history.

Key project summary:

Silane-treated anatase titanium dioxide, a promising radiopacifier for preventing bone cement failure.


Background: Total joint replacements are one of the most successful surgeries of the 20th Century, reducing pain and restoring function to diseased hips and knees. According to the National Joint Registry, approximately 200,000 hip and knee replacements were performed in the UK in 2019 with 14,498 revisions performed due to implant failure, predominantly caused by aseptic loosening (33-40% of all revisions). A material widely employed in these procedures is polymethyl methacrylate bone cement, which acts as a grouting material, securing the metal implant to bone (Fig 1). Cracking of bone cement can lead to loosening of the implant and early failure and is associated with stress concentrations, which arise from defects, such as voids and radiopacifier agglomerates. This research investigated whether alternative radiopacifiers could be used to prevent crack formation in bone cement and whether chemical functionalisation of the radiopacifier could further enhance the biological and fatigue performance of orthopaedic bone cement.

Discovery: The use of anatase titanium dioxide or yttria-stabilised zirconium dioxide as alternative radiopacifiers over conventional barium sulphate did not enhance the compressive and bending strength of bone cement (Fig 2). The addition of anatase titanium dioxide at high concentrations significantly reduced the bending strength and fracture toughness of the cement whilst increasing the overall stiffness of the material. Similarly, crack resistance was reduced due to the formation of voids around agglomerates of these alternative radiopacifiers (Fig 3). By functionalising the surface of these radiopacifiers with a silane coupling agent (methacryloxypropyltrimethoxysilane) however, better adherence to the cement matrix was achieved, resulting in significant enhancements in mechanical and fatigue properties. Interestingly, the addition of anatase titanium dioxide to bone cement also encouraged hydroxyapatite nucleation in simulated body fluid and significantly increased the attachment of MC3T3-E1 preosteoblast cells.

Importance: These findings offer a potential solution to improve the mechanical and crack resistant properties of orthopaedic bone cement, whilst simultaneously encouraging more rapid hydroxyapatite formation and cell attachment. This technology has the potential to ultimately reduce cracking, aseptic loosening and failures rates in cement joint replacements.

Fig 1: Cemented hip replacement.

Fig 2: (a) Compressive and (b) bending strength of bone cements containing alternative radiopacifiers. Scanning electron microscopy images of radiopacifier agglomerates on the fracture surface of (c) BaSO4, (d) TiO2, (e) ZrO2, (f) silane treated TiO2 and (g) silane treated ZrO2 cement samples.

Fig 3: MC3T3-E1 (a) cell attachment and (b) viability on cement samples containing different radiopacifiers.
Dr Ryan Moseley

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Blc (Hons) Biochemistry, Swansea University, 1991; PhD Oral Biochemistry, University of Wales College of Medicine, 1996. Since 2017, Reader in Tissue Repair, Cardiff University.

Research interests: Mechanisms underlying preferential (e.g. oral mucosa), normal (e.g. skin, bone) and impaired/abnormal tissue repair (e.g. chronic wound, diabetic/osteoporotic wounds) and normal vs. impaired regeneration. Current projects explore the interactions of tissue repair with the extracellular environment, matrix components and extracellular vesicles to enhance tissue repair and regeneration.

Key Publication:

Dr Petros Mylonas

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BSc, University of Birmingham (2012); MRes, Warwick University (2013); PhD in Prosthodontics and Biomaterials, King’s College London (2015). Member of the Joint Dental Faculties of the Royal College of Surgeons of England (MDF RCS, 2013); member of the Faculty of Dental Surgery of the Royal College of Physicians and Surgeons of Glasgow (FMDS RCS, 2016), Fellow of the Higher Education Authority (FHEA, 2016). Surface Topography: Metrology and Properties Emerging Leaders award for research excellence in Surface Metrology (2021); BES Fast-track Inspirational Lecturer award for teaching excellence (2021). Currently Clinical Lecturer and Specialty Training Registrar in Restorative Dentistry.

Research interests: understanding the role of the extracellular environment, matrix components and extracellular vesicles, in the regulation the biology and differentiation of mesenchymal stem cells during bone, dentine and periodontal tissue repair. Projects include examining the interactions between tissue repair and the extracellular matrix, both in vitro and in vivo, in an in vitro platform. The aim is to discover and translate insights into improved clinical outcomes.

Key Publication:

Dr Wayne Nishio Ayre

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BSc, Mechanical Engineering, Cardiff University Biomechanics and Bioengineering Centre Versus Arthritis (2013); BEng Medical Engineering, Cardiff University (2009). Welsh Crucible Future Research Leaders of Wales Programme (2017); British Orthopaedic Research Society – International Traveling Fellowship (2018); Cardiff (Institute of Tissue Engineering and Repair Young Investigator Award (2015); MDrFEN GSH-Mineralised tissue group prize (2014); The Worshipful Company of Engineers Mercia Award in Medical Engineering (2014). Currently Lecturer in Biomaterials, School of Dentistry.

Research interests: mechanisms underlying preferential (e.g. oral mucosa), normal (e.g. skin, bone) and impaired/abnormal tissue repair (e.g. chronic wound, diabetic/osteoporotic wounds) and normal vs. impaired regeneration. Current projects explore the interactions of tissue repair with the extracellular environment, matrix components and extracellular vesicles to enhance tissue repair and regeneration.

Key Publication:

Professor Bing Song

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MD, China Medical University, China (1995); PhD, School of Medical Sciences, University of Aberdeen, UK (2004); University Research Fellow, the Royal Society, UK (2005). Since 2006, Professor of Regenerative Medicine, Cardiff University. British Council Global Innovation Initiative award (2014). Since 2017, Director of International, School of Dentistry, Cardiff University.

Research interests: Electric signal regulated stem cell biology; electric signal promoted neuronal regeneration and repair; reprogramming of regenerative neuron with oligodendrocyte progenitor cells; dental pulp stem cells based bioengineered nanoscaffold assisted tissue engineering; stem cell enucleoplasm; coma and retina regeneration; electric signal regulated immunosurveillance and wound repair.

Key Publication:

Professor Phil Stephens

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BSc (Hons) Biochemistry and Cell Biology, University of Leeds; PhD Biochemistry and Cell Biology, University of Leeds. Since 2009, Professor of Cell Biology, Cardiff University. Since 2013, Designated Individual HRA Research Licence, Cardiff University. Since 2015, Academic Lead for Cardiff University Biobank. Since 2016, Dean of International Engagement, College of Biomedical and Life Sciences, Cardiff University. From 2017 to 2019, President of the European Tissue Repair Society (ETRS).

Research interests: Oral progenitor cell biology (lineage development/control; immunosuppression; bacterial suppression; tissue healing; dysfunctional (chronic skin wound) biology; development of in vitro systems to replace animals in experimentation; live cell imaging (in vitro and in vivo).

Key Publication:

Professor Rachel Waddington

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PhD, Faculty of Medicine, University of Liverpool (1988); BSc (Hons), Biochemistry, University of Birmingham (1984). Winner of Senior Colgate prize (1990) and the MNTR Mineralised tissue research travel prize (1996), awarded by the British Society for Dental and Oral Research. Currently professor in oral biochemistry and Associate Director for Engagement, Enterprise and Innovation, co-lead of the mineralised tissue research group.

Research interests: understanding the role of the extracellular environment, matrix components and extracellular vesicles, in the regulation the biology and differentiation of mesenchymal stem cells during bone, dentine and periodontal tissue repair. Projects include examining the interactions between tissue repair and the extracellular matrix, both in vitro and in vivo, in an in vitro platform. The aim is to discover and translate insights into improved clinical outcomes.

Key Publication:
Waddington R et al. (2021). Exploring a chemotactic role for EVs from progenitor cell populations of human extracted tooth tissues for promoting migration of naive BMSCs in bone repair process. Stem Cells International 2021: 6681771. Full list at: www.cardiff.ac.uk/people/view/39510-waddington-rachel
Dental Public Health

Our research focuses on oral health improvement. Our portfolio of research ranges from clinical trials of preventive dental technologies to studies designed to further understand, and address, oral health inequalities and projects to improve the delivery of dental care.

www.cardiff.ac.uk/research/explore/research-units/dental-public-health-unit

Our goals are:
To undertake research from a population perspective which will:

- Inform dental health and care need in Wales and beyond
- Contribute to the evidence base for effective preventive dental care
- Change how dental care is delivered to maximise benefit for patients and public.

Whilst oral health has improved dramatically over the decades, dental caries (tooth decay) remains a significant public health problem. In common with most chronic health conditions, oral disease correlates closely with social and economic circumstances and the differences that exist between the most and least deprived in our society result in inequalities in oral health.

We are involved in a range of research projects which aim to enhance the evidence base for improving oral health and delivering dental care. While our work is based in Wales and we have a particular interest in oral health in the Principality, our collaborations and the outcome of our work is of relevance, locally, nationally and internationally.

We work closely with colleagues in Cardiff and Vale Local Health Board, Public Health Wales and the office of the Chief Dental Officer of Welsh Government. We contribute to the Oral Health Workpackage of the Health Care Research Wales-funded Primary and Emergency Care Research (PRIME) Centre Wales (http://www.primecentre.wales/).

Our plans for 2022
We will continue to build on strong foundations of oral health improvement and health service research to pursue new research into urgent dental care, paediatric oral health and the provision of dental services. We have well established research collaborations with other dental schools, the NHS and wider academic primary care networks. Over the next 12 months we will grow these links and establish new national and international collaborations.

Highlights of 2021:

- The PRIDA study led by Dr Arwen Cope, reached its conclusion. The aim of this study was to understand the role of shared decision making in decisions about dental recall intervals in primary care. One of the outputs of this study was a ‘decision support aid’ which will facilitate discussions between patients and dentists about what is the best length of time between dental check-ups for each individual patient. This study was funded by Health and Care Research Wales.
- The OPTIMIZE study, led by Professor Ivar Chestnutt, has been working to develop a model of skill mix use in NHS General Dental Services to optimise the delivery of value-based, preventive-led care. The resulting product is a demand and skill mix optimisation model with a web-based user interface that can be used by service and workforce planners to explore different models of preventive care delivery. The study is nearing completion and will report in mid-2022. This study is funded by Health and Care Research Wales.
- The BRIGHT trial, a large randomised controlled trial, funded by the NIHR (£1.9M) and being conducted in collaboration with colleagues in the Universities of Dundee, Leeds, Sheffield and York continues, following the completion of a successful pilot stage. The study is looking at a school lesson followed by reminder text (SMS) messaging to improve toothbrushing behaviours in young people.

Key project summary:

A qualitative exploration of decisions about dental recall intervals. The attitudes of NHS general dental practitioners to NICE Guideline (CG19) on the interval between oral health reviews and perspectives of dentists and patients on the role of shared decision making in dental recall decisions


Background: NICE Guideline CG19 recommends that the intervals between oral health reviews should be tailored to patients’ disease risk. However, evidence suggests that most patients still attend at six-monthly intervals. Patients are sensitive to both the frequency and costs of dental recall visits. Shared decision making (SDM) is a principle of patient-centred care advocated by NICE and policymakers, whereby joint decisions are made between clinicians and patients.

Aims: (1) To explore facilitators and barriers to the implementation of CG19 in general dental practice. (2) To explore NHS dentists’ and patients’ attitudes towards SDM in decisions about recall interval.

Discovery: Semi-structured telephone interviews were conducted with 25 NHS general dental practitioners (GDP) in Wales, UK. Transcripts were thematically analysed. Dentists described integrating information on clinical risk, patients’ social and dental history and professional judgement when making decisions about recall interval. Although most GDPs reported routinely using risk-based recall intervals, a number of barriers exist to recall intervals at the extremes of the NICE recommendations. Many practitioners were unwilling to extend recall intervals to 24 months, even for the lowest-risk patients. Conversely dentists described how it could be challenging to secure the agreement of high-risk patients to 3-month recalls. In addition, time and workload pressures, the need to meet contractual obligations, pressure from contracting organisations, and the fear of litigation also influenced the implementation of risk-based recalls. Whilst many patients would be happy to accept changes to their recall interval, most wanted to be seen at least annually. Most patients were willing to be guided by their dental in decisions about recall interval, as long as consideration was given to issues such as time, travel and cost. This contrasted with the desire to actively participate in decisions about operative treatment. Although dentists’ understanding of SDM varied, practitioners considered it important to involve patients in decisions about their care. However, dentists perceived that time, patient anxiety and concerns about potential adverse outcomes were barriers to the use of SDM.

Importance: Although awareness of NICE Guideline CG19 was high, there is a need to explore how risk-based recalls may be best supported through contractual mechanisms. Since there is uncertainty about the most clinically and cost-effective dental recall strategy, patient preference may play a role in these decisions.
Professor Ivor G Chestnutt

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Ivor Chestnutt is Professor in Dental Public Health at School of Dentistry, Honorary Consultant to Cardiff and Vale University Health Board and is registered as a Specialist in Dental Public Health. He is a graduate of the University of Edinburgh (BDS 1986) and received both his MPhil (1995) and PhD (1997) degrees from the University of Glasgow. He holds Fellowships in dental surgery and dental public health from the Royal College of Surgeons of Edinburgh (1990 and 1996), the Royal College of Physicians and Surgeons of Glasgow (2003) and the Royal College of Surgeons, England(2002), nor is a Fellow of the Faculty of Public Health (2003) and a Fellow of the Higher Education Academy (2006). He is also the Clinical Director of the University Dental Hospital in Cardiff and is Director of Postgraduate studies in the School of Dentistry.

Key Publication:

Dr Anwen Cope

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Anwen Cope is a Senior Clinical Lecturer in Dental Public Health at the School of Dentistry and an Honorary Consultant to Cardiff and Vale University Health Board. She is a graduate of Cardiff University (BDS 2009; PhD 2015; MPH 2018) and a Member of the Royal College of Physicians and Surgeons of Glasgow.

Key Publication:

Maria Morgan

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Prior to retiring in May 2021, Maria Morgan was a public health professional with academic and health service experience. She led the work of the Welsh Oral Health Information Unit funded by Welsh Government, which involved evaluating Designed to Smile, the national child oral health promotion programme. She also contributed to public health research and education and worked part-time as public health specialist for Public Health Wales.

Key Publication:

Orthodontics and 3D Imaging Research Group

We are a small group of multidisciplinary researchers addressing important issues in Orthodontic provision and Craniofacial development, facial shape and form with wide reaching and sustained impact.

www.cardiff.ac.uk/research/explore/research-units/orthodontics-and-three-dimensional-imaging-group

Our Goals:
We wish to improve patient outcomes and experiences in Orthodontics. To achieve these aims, we will carry out fundamental basic research via 3D surface imaging techniques with associated mathematical and computational approaches, and we will translate this research into clinical practice. We will guide our work by promoting fairness, openness, honesty, and equality, whilst ensuring quality and excellence in our research.

Research Group Website: www.cardiff.ac.uk/research/explore/research-units/orthodontics-and-three-dimensional-imaging-group

Our plans for 2022:
Future research will focus on improving patient care in orthodontics (and beyond) by applying dental imaging modalities, especially 3D surface imaging. Including:

3D surface scanning:
- The consequences of dental treatment on the dental arches, facial shape and facial dynamics.
- Understanding facial aging.
- Determinants of facial and cranial shape.
- Face mask design (both reusable and disposable).

Forensics:
- Imaging of accidental and abusive bruises.

Eye-Tracking:
- Capturing a “patient’s eye view” of the orthodontic environment in the COVID era.
- What do clinicians look at when they carry out orthodontic interventions?
- Facial Aesthetics: A mixed-methods study, including eye-tracking.

Optimising patient pathways:
- Investigating and improving patient pathways using machine learning.
Establishing the evidence base for risk communication in orthodontics


Background: For valid consent, the potential risks of orthodontic treatment must be explained to patients. However, prior to this body of work, the content of discussions about risks with patients was not informed by agreed standards. This project aimed to establish an evidence base for risk communication in orthodontics.

Discovery: This project used sequential mixed methods. In phase one, the opinions of professionals were gathered using a two-round e-Delphi survey. This methodology aims to gain consensus amongst a group of individuals by engaging with information on risks when making decisions; (b) oral health to prevent and manage treatment risks; (c) the daily risks of brace treatment; and (d) important information about the risks of braces.

Importance: When triangulating the information gathered from phase one and two, there was some agreement between professionals and adolescents. However, the significance attached to some risks differed between the groups. Professionals agreed the following risks should be discussed: demineralisation (marks and holes developing on teeth), relapse, resorption (root shortening), pain, gingivitis, ulceration, appliance breakages, failed tooth movements, treatment duration and consequences of no treatment. Adolescents were most concerned with the “here and now” risks, whereas the professional body were more uncertain about the significance that should be attached to these risks.

Overall, this project has established a list of risks that should be discussed with patients. It is recommended that these risks are communicated during the consent process.

Key project summary:

Establishing the evidence base for risk communication in orthodontics

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Research interests: Medical imaging and image processing; Medical and dental research: epidemiology & statistical analysis of laboratory and clinical studies data; Mathematical Biology; Quantum magnetism, especially “frustrated” magnetic systems.

Dr Jennifer Galloway
GallowayJ@cardiff.ac.uk
+44 (0)29 2074 2447


Research interests: Previous experience in cleft palate development, modelling of 3D facial shape and dental health economics. Current research interest in optimising orthodontic patient care pathways.

Professor Stephen Richmond
Richmonds@cardiff.ac.uk
+44 (0)29 2074 2451


Research interests: Wide variety of research involving orthodontic practice, orthodontic treatment need and outcomes as well as the interface with many disciplines using 3D facial imaging.

Dr Alexei Zhurov
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+44 (0)29 2251 0619


Research interests: Three dimensional analysis of the human face, contact biomechanics, biomechanics of soft tissues and FEM simulation, Theory of heat and mass transfer and chemical hydromodynamics. Nonlinear differential equations and exact solutions, Dynamic systems and computer algebra.

Key project summary:

Research interests: Medical imaging and image processing; Medical and dental research: epidemiology & statistical analysis of laboratory and clinical studies data; Mathematical Biology; Quantum magnetism, especially “frustrated” magnetic systems.

Dr Jennifer Galloway
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Research interests: Previous experience in cleft palate development, modelling of 3D facial shape and dental health economics. Current research interest in optimising orthodontic patient care pathways.

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Dr Alexei Zhurov
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Research interests: Three dimensional analysis of the human face, contact biomechanics, biomechanics of soft tissues and FEM simulation, Theory of heat and mass transfer and chemical hydromodynamics. Nonlinear differential equations and exact solutions, Dynamic systems and computer algebra.
Alcohol and Violence

Our goals:
• Carry out a study to determine whether bespoke alcohol treatment services are an effective way to treat acutely intoxicated people and reduce the burden on overstretched emergency services.
• Research the pathways into alcohol use and misuse, including their life-course effects on health and well-being.
• Report annually from the National Violence Surveillance Network
• Roll out the Cardiff Model in other countries
• Assess the Causes of Alcohol-fuelled Violence

The Violence Research Group draws on expertise from across Cardiff University. The strength and reputation of the group comes from its interdisciplinary research across the fields of psychiatry, public health, dentistry, criminal justice, police, psychology, materials science, computer science, social science and economics; and its extensive record of innovation and contributions to policy and alcohol-related harms and violence prevention.

www.cardiff.ac.uk/violence-research-group

Highlights of 2021:
• The VRG are working closely with the NHS, Violence Prevention Units and Public Health Wales to better understand how Emergency Care pathways can better identify and support those exposed to violence.
• Modelling alcohol consumption data in middle-aged drinkers, suggests that a £0.50 minimum unit price for alcohol, which has been implemented in Wales and Scotland, may not provide the reduction in alcohol-related health harms initially envisaged.
• Analysis of assault-related injury data from Emergency Departments suggests that licensed premises lockdowns, mitigations in response to the SARS-CoV-2 pandemic, resulted in fewer assaults outside of the home, but violence in the home remained stable.
• Work in collaboration with the Welsh Government found alcohol-related brain damage is likely under diagnosed, and there are needs to better improve services in this area.

Our plans for 2022:
• We will continue to engage broadly across local, national, and international partners who have the shared interests of tackling the causes of violence and helping those most affected by violence. Over the next 12 months, we will launch several newly funded projects and continue to work towards a measurable difference to levels of violence.
• We will publish our analysis of assault-related injury attendances presenting to A&E, one of the most reliable measures of serious violence.
• We will launch a new project aiming to understand how Emergency Care pathways can react to patients exposed to violence and address any underlying causes.
• We aim to develop insights into how social media can influence rates of violence and if there are opportunities to use these platforms to intervene and reduce violence.

Key project summary:
Association Between COVID-19 Lockdown Measures and Emergency Department Visits for Violence-Related Injuries in Cardiff, Wales


Background: Government policy responses to coronavirus disease 2019 (COVID-19), especially social distancing measures, have generated speculation on behavioural health effects, including interpersonal violence, domestic violence, and child abuse.

1. We investigated the association between COVID-19 lockdown and emergency department (ED) visits for violence-related injuries in Cardiff, Wales, using detailed violence screening for all ED patients.
2. We hypothesised that lockdown measures would decrease violence outside the home but would increase violence at home.

Discovery: A significant decrease in ED visits in Cardiff by people injured by violence followed the UK lockdown, driven by a large reduction in ED visits due to violence outside the home. No significant increase in ED visits resulting from violence at home was noted.

Importance: Many organisations expressed concern that one potentially deleterious effect of COVID-19 mitigations would be an increase in domestic violence, due to significant restrictions to activities and spending an increased proportion of time at home. Our analyses suggest this concern did not materialise and should not be used in determining the net effect of lockdown.
Full list at: www.cardiff.ac.uk/people/view/39454-sivarajasingam

Improving Dentistry

Our research focuses on improving the delivery, experience and effectiveness of clinical dentistry through systematic review and data syntheses to understand the evidence, followed by applying primary research (clinical trials, observational studies, qualitative research) to fill the gaps in knowledge and then translating the evidence to practice, policy and education.

Dental caries is almost completely preventable yet has a significant health and economic global burden. It is the commonest childhood disease affecting around 50% of children in low- and middle-income, and 30-50% in high-income, countries.

The establishment of the dental profession as a surgical specialty in the late 19th century laid the pathway for dental disease to be managed using mainly operative techniques. This surgically focussed approach has continued with little change despite its failure to yield significant individual or public health benefits, as evidenced by widespread high levels of dental disease and treatment costs. Similarly, the education of dental professionals has largely followed a model with biological science paving the way for clinical skills and social sciences supplementing this to support professionalism, care of patients and behaviour management and more recently modification.

The understanding of dental caries as a biofilm-based disease meditated by behaviour has been harnessed to realise gains in prevention and management of disease. Our clinical trials and work with patients have shown the Hall Technique, Atraumatic Restorative Treatment and application of silver diamine fluoride can manipulate the carious biofilm, reduce its cariogenicity and therefore the intensity of its destruction, and reduce treatment costs. Similarly, this surgically focussed approach has continued with little change despite its failure to yield significant individual or public health benefits, as evidenced by widespread high levels of dental disease and treatment costs. Similarly, the education of dental professionals has largely followed a model with biological science paving the way for clinical skills and social sciences supplementing this to support professionalism, care of patients and behaviour management and more recently modification.

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Our plans for 2022:
• We will build on our initial success with continuing to bring together a network across Wales to identify and focus on problems in clinical dentistry that research might help to answer.
• We will set up and start the NIHR funded CALM Trial.
• We will complete the BRIGHT Trial, submit the report to the NIHR and start to publish the final results.
• We are investigating the possibility of setting up primary care practice “upskilled” Child Focused practices and will evaluate their success.

Highlights of 2021
• The BRIGHT Trial (£1.9M NIHR HTA funded UK wide randomised control trial) investigating the clinical and cost-effectiveness of a school-based lesson and SMS text messaging to encourage toothbrushing in children over traditional surgical treatments. These dental procedures are less invasive and do not generate aerosol, bringing additional advantages where aerosol and droplet production should be avoided. Reducing the invasiveness of treatment brings a quaternary prevention approach to the management of toothbrush is on the final stage of data collection in secondary schools, despite being compromised by the pandemic.

• NIHR HTA award of £1.7M funding of the CALM Trial to investigate the “clinical and cost-effectiveness of a guided self-help cognitive behavioural therapy intervention to reduce dental anxiety in children”. Co-applicant (Sheffield University lead institution/ PI Zoe Marshman, Kings College London, Newcastle Business School, University, and York Trials Unit, University of York https://fundingawards.nihr.ac.uk/award/NHRI131805
• Initiation of a primary care dental research network across Wales.

Our goals are to use clinical trials, observational studies, qualitative research and evidence syntheses to:
• gain the greatest research impact for patients, oral healthcare professionals and other stakeholders, by working with them to identify needs
• improve the management of dental caries for our patients, especially those with a high disease burden, limited access to dental care and who are marginalised
• understand the carious biofilm and how to manipulate it to manage the disease dental caries
• improve the evidence base informing policy and teaching around cariology, paediatric and restorative care
• understand and address barriers to implementation of evidence-based dentistry

Professor Jonathan Shepherd
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Professor Emeritus of Oral and Maxillofacial Surgery, Professor at Cardiff University’s Crime and Security Research Institute. Professor, Violence Prevention Unit for Wales. Honorary Professor at Deakin University, Australia. Fellow of the Academy of Medical Sciences. Fellow, Learned Society of Wales. NHS representative on the Welsh Government’s ministerial Violence against Women and Domestic Abuse Advisory Board. One of two academics on the UK’s £2 million Youth Endowment Fund grants and evaluation committee. Commissioner, UK Commission on Alcohol Harm. Founder trustee of the Cardiff College of Teaching and inaugural chair of the Cardiff’s journal and research committee which oversaw the development and launch of the new journals, Impact and The Profession. Member, Campbell Collaboration Crime and Justice Group. Member, Welsh Government Advisory Committee on Clinical Excellence for Wales. Commissioned to the UK Government in the form of the What Works Centres and the Cabinet Office What Works Council. Prompted by my discoveries I initiated and developed the Cardiff Model for Violence Prevention which has been widely implemented across the UK and internationally. My research on clinical decisions, violence, and the evidence ecosystem has made many contributions to clinical and public policy and to legislation.

The aim of my research is to translate basic-level, fundamental science and apply it to the real world in order to improve community safety and the health of individuals. My work is multi-disciplinary, crossing preventing interpersonal violence, economics, medicine, public health and other disciplines and typically involves practitioners and policy makers. My projects have a clear impact pathway, whether that is to inform policy and practice directly or to seed further work such as an implementation trial. Methods include “big data” data linkage projects, randomised controlled trials, computer modelling and simulation and various other approaches.

Professor Vaseekaran Sivarajasingam
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As Director, I continue to develop the National Violence Surveillance Network (NVSN) of Emergency Departments in England and Wales and am retained by the Office for National Statistics on Violence for advice. The NVSN interest led to co-production of a joint compendium on child abuse (2020), utilising NVSN data on injuries sustained in violence for those aged 0-18 years. Research on violence surveillance, alcohol intoxication management Services & evaluation (UK) & research to inform minimum unit pricing policy are drivers for Cardiff University RPF REF 2021 impact case, in these projects (which sit at the interface between clinical and academic research), I was clinical lead (idea generation, NHS ethics, patient recruitment and data quality) and maximised opportunity for outputs to align with clinical practice.
Key project summary:

Investigating droplet and aerosol generation, spread and settle by dental procedures to inform practice and policy across the UK.


Background: The global delivery of dental care and dental training was reduced and, in some cases, halted as a result of the COVID-19 pandemic. It has led to re-evaluation of infection control standards in dentistry. However, there has been a lack of clarity around what is known about droplets and aerosols generated during dental procedures and their potential to transmit disease. Areas most affected included dental and oral surgery procedures which involved procedures commonly using instruments that generate aerosols, notably rotary handpieces and ultrasonic scalers. Policy to re-open practices could not be confidently formulated based on evidence as there was such a lack of understanding of the potential for aerosol and splatter to spread through dental procedures. A UK-wide group of experts came together to address this uncertainty around aerosol generating procedures (AGPs) in dentistry by looking at what was already known.

Objectives: The reviews aimed to identify which dental procedures generate droplets and aerosols with subsequent contamination, and for these, characterise their pattern, spread and settle.

Discovery: We searched six databases and used high quality systematic review methodology to identify papers, extract data, assess studies’ quality/risk of bias and synthesis findings. We found 83 studies that fitted our criteria. There were 44 studies looking at ultrasonic scaling, 31 that investigated high speed air-rotors, 11 involving oral surgery procedures, four with slow-speed handpieces, four with air-water (triple) syringes, four with air-polishing, two with hygiene prophylaxis and two with hand-scaling procedures. They used widely varying methodologies. We did not find any studies directly investigating spread and settle of respiratory viruses. Some studies used bacteria to investigate contamination as an indirect measure of aerosol and droplet spread and settle. They did this, for example, by placing petri dishes around the dental surgery to collect and cultivate them following dental procedures. Other studies used similar methods but used blood or fluorescein placed in water supplies used during the dental procedures and detection methods for them.

Powered devices generated the highest levels of contamination and all dental activities investigated showed droplet and/or aerosol detectable at all distances studied across the surgery space. The operator’s torso, arm and the patient’s body seemed to be most affected.

The varied methodologies meant we could not directly combine different studies. However, some studies compared procedures and instruments within them and, using a network approach, a “hierarchy” of risk of contamination for different procedures was created.

This body of research is ongoing as new studies have been undertaken to fill some of the gaps we have identified and the research group are working on updating the work and including more detailed work on different types of rotary instruments.

Importance: This was a large and challenging dataset to work with. The significant gaps in evidence we found, the low sensitivity of the measures used, their indirect nature and variable quality, all limited the ability to draw conclusions around contamination for procedures. However, we were able to draw some conclusions around a continuum of instrument-related aerosol generation. Previously a binary AGP or non-AGP perspective had been taken. The findings informed discussion around AGPs, policy making in national and UK level groups and also directed future research to support knowledge and decision making around COVID-19 and dental procedures.
Dental Education, Scholarship and innovation

Our work focuses on developing excellence in dental education, innovating for new educational approaches and supporting scholarship activities, networks and collaborations.

Our Ambitions:
To improve the educational experience of dental and oral health professional students internationally

Our Strategic areas for development:
• To encourage staff involvement with wider educator networks and learned societies, the development of educational resources, and the dissemination of information and knowledge to the wider international educational community;
• To champion research-led teaching and innovative and inspirational approaches to learning, including local, national and international policy change;

We work in close partnership with local, national and international organisations and stakeholders to improve the ways in which we educate our students and trainees. We are involved in a wide range of education research and development projects, curriculum reviews and policy consultations.

Highlights of 2021:
• Dr James Field launched the online DigEdDent platform, which aims to create an online platform to support educators in the delivery of digital dental education. This project was supported by ADEE - https://adee.org/digeddent-digital-education-dentistry
• As a project partner in the K2 Erasmus+ funded “O-Health-Edu” project (https://o-health-edu.org/), we have worked to harmonise the understanding and delivery of dental education across Europe, by:
  • Publishing a scoping review on the reporting of oral health professional (OHP) education across Europe (10.1111/eje.12577)
  • Developing a live, online glossary of educational terms for use in OHP education to facilitate a common understanding throughout Europe (https://o-health-edu.org/articulate)
  • Creating a live, online data hub of dental schools across Europe, including details of the programmes that they offer, and important metrics. Cardiff was the first to submit its data, but the list is growing! (https://o-health-edu.org/ohe-datahub-directory)

Our plans for 2022
We aim to grow our influence as a community of dental educators, both locally, nationally and internationally. We will support our academic staff to engage with wider professional networks, develop and disseminate innovations, and drive for policy change. Our focus in the coming year will be on Sustainability, and the development of robust approaches to the use of digital workflows in dental education.

BARDES coming of Age?

Nearly 100 academics attended the 4th meeting of the British Alliance for Researchers in Dental Education and Scholarship (BARDES) in October of 2021: the meeting being hosted by the University of Glasgow Dental School.

A highly informative day delivered 2 excellent keynote lectures; one from Grant Creaney entitled “Sustainability: what should we be teaching the students?” and the other from AI Ross on “Incorporating Human Factors and Non-Technical Skills into the Undergraduate Dental Curriculum”.

Additionally, 3 PhD presentations were warmly received from Dr Jamie Dickie - ‘Building validity evidence for longitudinal assessment of dental students’, Dr Claudia Cunningham – ‘Selection to Undergraduate Dental Education’ and Mr Rayan Sharka – ‘Perceived Risk Factors of Using Digital and Social Media in the General and Dental Professional Contexts’. Further short research presentations were delivered by Ms Faith Campbell on “Co-creation of a Comprehensive Intervention to Facilitate Deep Reflection for Undergraduate dental students”, and a joint presentation was delivered by Professor Albert Leung and Dr Peter Fine, outlining the findings of an ADEE backed survey on the influence of Covid 19 on Feedback.

Attendee interaction and participation was key to the whole day with attendees exploring the topic “Working collaboratively with other Dental Schools” in workshops hosted by representative’s from BARDES. The workshops proved particularly useful and provided much discussion.

The group continues to go from strength to strength with an overriding wave of support to formalise the group’s existence. A small working party has been organised under the guidance of Professor Janice Ellis to explore the establishing of a bone fide “Society” and work has already begun with the establishment of the mission statement “To connect and support dental education researchers and scholars to deliver an evidence base that informs the future delivery of exceptional dental education.” and efforts to establish a web presence etc.

The Alliance will promote research into Dental Education and Scholarship through its articles and its commitment to:
• Facilitate connectivity of providers of undergraduate and postgraduate dental education programmes to enable and enhance delivery of educational research
• Develop communities of practice with similar areas of interest and expertise
• Provide opportunity for networking through similar activities, conferences, and web presence
• Provide support for members of the Alliance in the form of access to expertise, mentorship, and academic resources

The next conference of BARDES will be held at the University of Liverpool, School of Dentistry in the Autumn of 2022. Cardiff dental school through its commitment to grow and establish research into Dental Education remains a key stakeholder and protagonist in the formalisation of this important research group.

Dr R McAndrew (Cardiff) on behalf of the BARDES Working Party: Professor Janice Ellis (Newcastle), Professor Barry Quinn (Liverpool), Dr Vivian Binnie (Glasgow), Dr Alison Cairns (Glasgow) Dr Claudia Cunningham (Aberdeen), Dr Zoe Freeman (Newcastle) Dr Melanie Nasseripour (Kings College London), Dr Kim Piper (Kings College London).
Dr James Field
Fieldj2@cardiff.ac.uk
Dr James Field is a Senior Lecturer in Restorative Dentistry, Honorary Consultant and Director of Learning and Teaching at Cardiff University’s School of Dentistry. He obtained a BSc (Hons) in Zoology (2000), BDS (distinction, 2005) and a PhD (erosive tooth wear, 2012) from Newcastle University. Whilst undertaking specialist training, he also obtained a Master of Arts degree in Education (Edge Hill) and various certificates of learning and teaching in higher education. Dr Field is recognised by Advance HE as a Senior and Principal fellow, and he also holds a National Teaching Fellowship. He is a Fellow of the Faculty of Dental Trainers, and a Fellow of the Academy of Medical Educators.

Dr Robert McAndrew
mcandrew@cardiff.ac.uk
Dr Robert McAndrew is a Clinical Senior Lecturer in Restorative Dentistry, Honorary Consultant, Director of Undergraduate Studies and Theme lead for Dental Education, Scholarship and Innovation at Cardiff University’s School of Dentistry. He obtained a BDS (1986) from Dundee and an MSc (Dental Science, 1999), and a PhD (plastic restoration replacement, 2009) from Cardiff University. In 2006, Dr McAndrew is one of only two dentists in the UK to have completed a PGCE in Higher Education Leadership with Distinction and is a Fellow of Advance HE.

Key Publication:
Full list at: www.cardiff.ac.uk/people/view/50447-mcandrew-robert

Summary: Urinary catheters are functional medical devices, designed to assist bladder emptying in incontinent or neurologically impaired patients, but their surfaces are susceptible to contamination by bacteria in situ, particularly in patients with long-term, indwelling devices. Microorganisms that colonise the skin, digestive tract and found in the environment can contribute to CAUTI incidence, with uropathogenic species causing formation of crystalline biofilms, leading to catheter blockages. The overarching aim of my research was to evaluate a selection of biocidal agents against a panel of uropathogens, and to incorporate the leading candidates into silicone to prevent biofilm formation. Triclosan and triclosan acetate were among candidates in terms of minimum inhibitory concentrations (MICs) required to prevent bacterial growth (0.024 – 12.5 μg/ml) and also in the broad range of species they were active against in planktonic culture. Silicone bulk-loaded with 1%, w/w of triclosan and triclosan acetate demonstrated biocidal activity against Proteus mirabilis, Providencia stuartii, Klebsiella pneumoniae and Staphylococcus aureus, whilst the triclosan-loaded polymer was also biocidal against Escherichia coli and Candida albicans. Pseudomonas aeruginosa and Serratia marcescens were resistant to both silicone formulations. Importantly, HPLC analysis revealed that the silicones released triclosan over a 12 week period, with the triclosan acetate silicone demonstrating a slower, more sustained release. Whole urinary catheters dip-coated with silicone containing 0.2%, w/w triclosan and triclosan acetate prevented migration of P. mirabilis into the bladder chamber from the drainage bag when evaluated using an in-vitro bladder model, over a test period of 9 days. In contrast, bladders of models with uncoated catheters were infected after a mean of 6.7 days.

A novel 3D-printable formulation was also developed containing 1%, w/w triclosan that inhibited growth of P. mirabilis, E. coli and S. aureus and had superior mechanical properties to its compression moulded counterpart. A range of biosensors were developed to signal early CAUTI and thus, facilitate improved management. A previously developed bromothymol blue silicone sensor was structurally modified to allow earlier detection of Proteus mirabilis, and the commonly used cell viability dye, resazurin, was added to catheter drainage bags, signalling infection 40 h before catheter blockage occurred.

Dr Field’s research and scholarship is based around improving dental education and curriculum reform. His main activities include leading the biosciences of the Graduate European Dental curriculum and the Common Educational Framework for Dental Hygiene. He works with colleagues internationally to inform educational policy, drive curriculum innovation, and build educator networks to support innovation and improve the sharing of good practice.

Key Publication:
Full list at: www.cardiff.ac.uk/people/view/2398618-fieldjames

Jennifer Galloway
Gallowayjennifer@cardiff.ac.uk
Jennifer Galloway has been awarded a PhD in Information Science at Cardiff University. Her research interests include exploring the influence of population, biological sex, BMI, age, pubertal stage, metabolic factors, breathing disorders, maternal smoking and alcohol consumption during pregnancy on adolescent face shape. Multiple alternative analyses were used to confirm the results of the mPCA models. In the respective mPCA models, population, biological sex, BMI, height and fasting insulin explained more than 5% of the total variation in facial shape. Differences due to population, biological sex, BMI and height made biological sense. Fasting insulin appeared to influence the prominence of the browridge and chin differences in the findings between males and females. However, significance levels did not hold up to multiple testing for fasting insulin when analysed using Partial Least Squares Regression (PLSR).

Ultimately, this work shows that fasting insulin could be explored further to help improve understanding of facial shape development. Investigating whether fasting insulin influences the effectiveness of orthodontic treatments, particularly those that have historically aimed to adapt facial shape, would be useful. More far reaching, exploring whether controlling levels of fasting insulin could remove the need for some orthodontic treatment completely, would be interesting further work.

Publications
**Awards & Prizes**

**MSCD student Camilla Miles-Hobbs** won “Best Scientific Poster” prize at the European Orthodontic Society Congress 2021 for her research with colleagues in University of Bristol on “Exploring the impact of maternal exposures during pregnancy on hypodontia risk: a negative control experiment”.


**Microbial Diseases PhD student, Rania Nassar** received the 2021 IADR Colgate Research in Prevention Travel Award in recognition of her research entitled: Antimicrobial Activity of Phytic Acid: A Potential Endodontic Irrigant.

**Ms Megan Williams** was a recipient of a UK-Canada Global link award to undertake research with Dr Laurent Bozec at the University of Toronto. Her project will investigate nanoscale interactions of Candida species with oral bacteria and surfaces.

**Prof Rachel Waddington** has taken up her position as President of the BSODR, the first female president in the Society’s 53-year history.

**Prof Nicola Innes'** publication, “Caries management options for primary molars: 2-year outcomes of a randomised clinical trial” published in Deutsche Zahnärztliche Zeitschrift was awarded best publication of 2021 by The German Society for Dental, Oral and Maxillofacial Surgery.

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**Research Funding**

**Overview of active grants**

Our research groups were part of collaborative research awards with other institutions totalling £2.892K (A) for the financial year 2020-21, with £1.442K (B) being allocated to the School of Dentistry. Research funding for the financial year broken down per sector is given below.
Cardiff University School of Dentistry Annual Research Report for 2021

AMERICAS

Canada
University of Ottawa, Ottawa
University of Toronto, Toronto
University of British Columbia, Vancouver

USA
Emory University, Atlanta, GA
University of Alabama at Birmingham, Birmingham
Washington University School of Medicine, St. Louis
University of California, Los Angeles, CA
Stanford University, Stanford, CA
University of California, San Francisco, CA
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patients with developmental co-ordination disorder in dentistry: Developing an online self-assessment source for dental professionals by a review of the literature. Special Care in Dentistry (online ahead of print). 10.1111/sed12861


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