

Institution: King's College London (KCL)

Unit of Assessment: UoA3 Dentistry

a. Context: The Dental Institute's (DI) vision is to understand disease, enhance health, and restore function. By actively engaging with our partner NHS Trusts in King's Health Partners (KHP); patients, carers and the public; policy and commissioning organisations; and industry, **we improve patient care, inform health care policy, and create new products.**

Our NHS Partners: The major and first beneficiaries of our research are our partner NHS Foundation Trusts (Guy's and St Thomas' and King's College Hospital) and the patients they serve. The majority of the 300,000 patients our staff and students see each year come from areas among the most deprived in England with high incidence of caries, poor dental care of children and oral cancer along with co-factors of obesity, smoking, and drinking (<http://www.nwph.net/dentalhealth/caveat.htm>). The synergistic relationship between the DI and the Trusts creates an ideal test-bed for recognizing and studying the incidence and prevalence of conditions (case study A) and then implementing evidence-based innovation solutions in patient care. Other treatment innovations (e.g. impact cases B, D and F) have also established international reach and significance in patient treatment.

Patients, Carer and Public Involvement. Key beneficiaries of our research are the patients but we need to educate clinicians and the public as well. Resources we created for carers include an oral disease severity scoring system (impact case A) and guidelines for early detection of oral cancer distributed upon request to every UK NHS dentist (impact case C). As acknowledged experts, our staff influence the dental profession through elected leadership positions in an array of professional organisations as described in the environment template.

Public understanding and engagement are critically important, particularly in modifying patient behaviour that affects oral (and systemic) health. Our dental student-created Smile Society (<http://kclsmilesoc.wix.com/kcl-smile-society>) visits local schools, delivering staff-approved oral health messages to the local community. Web-based DI publications profile our impact in research, patient care, and education and innovations are routinely featured in the media raising the public's awareness of advances in dentistry (e.g. <http://www.bbc.co.uk/news/health-21718402>).

Influencing National and International Policy and Practice. We actively engage in influencing national policy, practices, and commissioning decisions by actively contributing through participation in committees of the NHS, Health Education England and Public Health England (and their predecessor organisations), the General Dental Council, the Deanery, and the Royal Colleges.

Internationally, we contribute to guidelines development and consensus panels in Europe and consult with public health officials in a host of developing countries seeking guidance in best practices and policies. The DI's Centre for International Child Oral Health, (<http://www.kcl.ac.uk/dentistry/about/centres/oralhealth/index.aspx>) in collaboration with Harvard School of Dental Medicine, and the Global Child Dental Fund, hosts a Senior Dental Leadership Programme, drawing senior global academic and policy leaders to address oral health challenges and opportunities. Each year delegates select a follow-on project which, since 2008, have delivered preventive treatment and educational packs to over 3 million children in Brazil and China and established dental and medical care centres for vulnerable and destitute children in Cambodia, Tasmania and Timor.

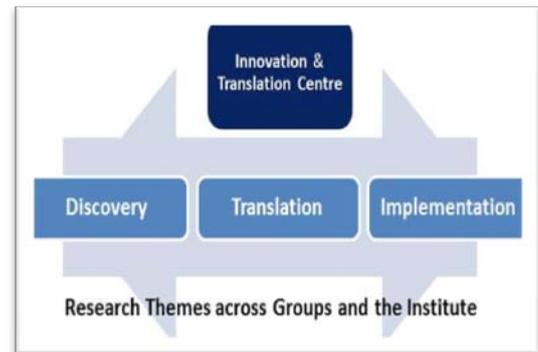
Industry partnership: By delivering high quality research, the DI has developed a robust partnership with nearly every major dental company to evaluate and test products. These industries also provide a route to translation of our innovations. The DI has one of the highest ratios of patents to staff of any KCL school. Developments of bioactive materials led to the creation of a spin-off company (impact case E) that has already delivered treatment for hypersensitive teeth to over 700,000 patients.

b. Approach to impact: Investigation, leading to new insights effectively shared, is the ethos of researchers, clinical academics, NHS dentists, health professionals and others engaged in the Dental Institute. We have established an organization and philosophy, complemented by a KCL- and KHP-based infrastructure that enables research and translation of research into practice, policy, and products. Working in partnerships and collaborations across fields, organisations,

Impact template (REF3a)

companies and countries, we have shared and implemented key research findings, bringing new diagnostic approaches, pioneering treatments and innovations to market.

Organization for impact: In 2009, the DI reviewed its research organisation. Recognizing the need to increase impact and improve interdisciplinary research, we defined crosscutting themes of **Discovery, Translation, and Implementation**. Theme leaders were named to serve as champions for these themes, cutting across research divisions and clinical disciplines, raising awareness of the research pipeline and its peculiarities of nonlinearity, bi-directionality, and unpredictability. To further emphasise impact, the **Dental Innovation and Translation Centre** was created in 2013 to enable translation of fundamental research into clinical practice, public health policy, and development of new technologies and products, often trialled in our Oral Clinical Research Unit.



The Clinical Academic Groups (CAGs) of King's Health Partners bridge any potential divide between the partner organizations. Through this arrangement, the Dental CAG (one of six) enjoys strong collaborations with both medical and psychiatry/psychology colleagues, broadening our impact to patients and influence on other health care providers. The Centre for International Child Oral Health and KHP-sponsored Centre for Global Health develops global health education, research and capacity building programmes.

KCL and KHP Supporting infrastructure: A KCL Intellectual Properties and Licensing Team, in conjunction with the KHP Commercialisation Institute, support the translation of research into product. King's Improvement Science (KIS), a KHP-wide initiative, integrates social science, social and organisational psychology and management, to discover reasons why health services are not as good as they could be and then work out changes needed and recommend best methods to implement them. Though both are relatively newly created, our Innovation and Translation Centre has already defined projects in collaboration with KIS.

Training Researchers in Innovation and Translation: KCL's year-long Innovation Fellows scheme actively engages researchers in dialogue with colleagues around opportunities for innovation and translation as well as working with King's business colleagues to exploit these opportunities to maximum benefit. During the assessment period, 4 DI staff (Festy, Moazzez, Liu, and Carpenter) participated and now act as DI innovation ambassadors.

Funding New Ideas: The DI enjoys an ethos of entrepreneurship but pump-priming funding is, and will always be, critical in exploring – and exploiting - new ideas. The DI, KCL, and KHP have an array of mechanisms for this purpose, ranging from a few thousand to a hundred thousand pounds of support. DI staff have been successful in obtaining these competitively awarded KHP funds.

Enabling learning and knowledge dissemination: Impact is best promoted when discoveries and innovations are made known and put into practice. We exploit these routes through continuing engagement with professional organizations, industry, public policy bodies, NHS, PHE, dental-related charities, funding agencies including venture capital and angel funders, the Royal Colleges, and colleagues. We encourage and financially support staff to present findings at professional meetings. We celebrate staff participation in professional organizations, review and consensus panels, editorial boards and collaborations with companies.

To accelerate the process, we recently created a series of workshops-conferences entitled 'Catalytic Conversations at King's' initiated last year to draw diverse stakeholders to address questions with international impact. The first, Innovations in Material Science for Direct Restorations, is summarised in the November 2013 issue of *Advances in Dental Research* and informed the UN Environmental Programme treaty recommendations for reducing the international burden of environmental mercury. The second drew 75 stakeholders from 11 countries to agree a framework for the international implementation of a caries management system (Impact Study F).

c. Strategy and plans: We realise that our collaborative advantage in translating our research into practice, policy, and products derives from the quality of our research inexorably linked with effective relationships with our NHS partners, patients, and relationships with industry, policy and funding agencies, and professional societies. In the next five years, we plan to continue the approaches described above and further enhance our strategic position by expanding patient

engagement in research with focused emphasis on translation of discoveries for maximum impact.

Expanding Patient Engagement in Research: The Dental Institute in partnership with its NHS partners sees over 300,000 patients each year, promising an exceptionally rich source of research information. But not all information regularly obtained about them is research accessible. We are working with our NHS partners to interest all patients in the possibility of their already-recorded information being available to researchers, subject to appropriate ethical approvals. In parallel, we want to have patients indicate a willingness to participate in prospective studies. The recent introduction of electronic records permits us to work with other institutions using the same electronic systems to better address oral disease prevention and management on a national / international scale. Taken together, this promises to improve the quality and timeliness of studies and provide insight into patient care and policy changes. Our Dental Innovation and Translation Centre, along with KHP Improvement Science and KHP Commercialisation Institute can translate these findings into patient care, policy and products to better serve both our patients and, with the global health initiatives described above, bring innovations to patients around the world.

Focused Emphasis on Translation of Discoveries for Maximum Impact: In the future, we will proactively review research activities and outcomes to identify discoveries and observations that have high potential impact. Then, working with the infrastructure in the DI, KCL, and KHP, we will define a specific strategy to optimise the impact and invest both human and financial resources in developing those areas. As an example, one emerging area identified as having high-impact is Cognitive Behavioural Therapy as an approach to the management of dental fear in a tertiary NHS setting. We have already demonstrated the efficacy of this approach, produced training materials and courses to assist with creating similar services across the country, defined a pathway of care for commissioning such services and received endorsement as a model approach by the Dept of Health (http://www.pccic.org.uk/sites/default/files/articles/attachments/salaried_dental_services.pdf). Now we are articulating a specific strategy to strengthen the widespread implementation of this approach.

d. Relationship to case studies: Our case studies reflect impact arising from scientific discoveries in our four research-oriented divisions with clinical investigations and observations all spear-headed by theme leaders. We summarise our significant cases below: showcasing their breadth spanning across improved patient outcomes (health and welfare), professional education and influencing policy worldwide (practitioners and services) to introducing new products (commerce).

Research Impact Activity	User Groups, Beneficiaries & Audiences with the <i>Impact Type(s)</i>	Impact approaches used [<i>and Research Group(s)/collaborators</i>]
Case Study A Oral Disease Severity Scoring Systems: a reliable objective assessment for monitoring and improving patient care	International healthcare teams dealing with oral mucosal conditions and dry mouth - and their patients <i>Impact Types:</i> - <u>Health and Welfare</u> Improved patient assessment - <u>Commerce</u> has adopted the dry mouth scoring system to rationalise care options -International clinical research delivery informed by measurement	Utilising our position as a major referral centre by developing and then implementing improvements using joint clinics with medical clinical academics (in this case dermatology, gastroenterology, rheumatology & ophthalmology) with strategic links to commercialisation [<i>Mucosal & Salivary Biology with Population & Patient Health and NHS partners</i>]
Case Study B Revolutionising treatment of salivary gland obstructive disease	International healthcare teams caring for those with obstructed salivary glands - and their patients <i>Impact Types:</i> - <u>Health and Welfare</u> New clinical techniques with improved user experience/outcomes for patients: e.g. reduced facial scarring. - Changes in care practices and referral patterns seen	Promoting and pump-priming interactions between selected basic scientists and clinical academics to innovate, develop and then help to implement minimally invasive disease management and demonstrate its benefits [<i>Mucosal & Salivary Biology with NHS partners</i>]

Impact template (REF3a)

Research Impact Activity	User Groups, Beneficiaries & Audiences with the <i>Impact Type(s)</i>	Impact approaches used [<i>and Research Group(s) collaborators</i>]
<p>Case Study C</p> <p>Early Detection of Oral Cancer and Potentially Malignant Disorders</p>	<p>Patients, primary care and oncology teams - including General Dental Practices</p> <p><i>Impact Types:</i></p> <ul style="list-style-type: none"> - <u>Health and Welfare</u> New diagnostic and prognostic technologies introduced - <u>Practitioners and Services</u> change in care and in continuing professional education materials for dentists and teams 	<p>The implementation of research findings in diseases with long-term outcomes into policy and practice can need extended timeframes. This key theme has been supported over the long term by our commercial NHS Oral Pathology service, clinical academics and basic scientists. [<i>Mucosal & Salivary Biology with NHS & Commercial partners</i>]</p>
<p>Case Study D</p> <p>Prevention and Management of Trigeminal Nerve injuries. Changing surgical practice for patient benefit</p>	<p>Patients and joint clinics comprising oral surgeons and dentists working with academics in neurology, psychiatry & psychology (local/national/international)</p> <p><i>Impact Types:</i></p> <ul style="list-style-type: none"> - <u>Health and Welfare</u> Safer approaches to wisdom tooth extraction developed, tested and introduced in a tertiary NHS service. - <u>Practitioners and Services</u> changes in pre-assessment of risk & surgical technique: guidelines, protocols & payment 	<p>Focus on high volume procedures with significant risk of morbidity. We seek to use multi-disciplinary teams to identify, develop and implement internationally, novel, minimally invasive interventions which redress the balance of benefit and harm. Patient engagement and involvement is invaluable (e.g. the patient-funded website). [<i>Biomaterials, Biomimetics & Biophotonics, with NHS partners</i>]</p>
<p>Case Study E</p> <p>Development of KCL spin out company OSspray Ltd to investigate treatment of dental hyper-sensitivity</p>	<p>Technology investors and grant funders.</p> <ul style="list-style-type: none"> - Dental Companies. - Dental Practitioners. <p><i>Impact Types:</i></p> <ul style="list-style-type: none"> - <u>Health and Welfare</u> Development and implementation of new technology adopted in practice - <u>Commerce</u> A spin-out company has been created with over £5m investment - products used in > 700,000 patient treatments so far. 	<p>The DI has developed a broad range of competencies, collaborators and funders in order to be able to take selected basic science innovations from invention to market-approved dental product being sold to dentists in many countries. It has helped pump prime and attract support for such activities. [<i>Biomaterials, Biomimetics & Biophotonics and NHS partners</i>]</p>
<p>Case Study F</p> <p>Towards World-wide Standardisation of Caries Detection, Assessment & Preventive Management</p>	<p>Dentists & health team members working in practice, public health, education & research settings globally, together with</p> <ul style="list-style-type: none"> - their patients - the public & governments - the oral health industry. <p><i>Impact Types:</i></p> <ul style="list-style-type: none"> - <u>Health & Welfare</u> Development of an internationally acknowledged method of staging and measuring caries - including early stage disease; incorporation into a preventive caries management system - <u>Practitioners and Services</u> Care and educational practices / training guidelines implemented across many countries - <u>Commerce</u> Establishing a Global Alliance for a Cavity Free Future [ACFF]: with Industry 	<p>Putting evidence into policy and practice by long-term international collaborations. Building on underpinning research from KCL and a number of other countries encompassing, practice, education and public health silos globally.</p> <ul style="list-style-type: none"> - Working with multiple stakeholders, including industry & governments to achieve common health / healthcare-related aims. - Building global collaborations to implement systems to promote preventive / minimally invasive caries care. <p>[<i>Biomaterials, Biomimetics & Biophotonics Dental Innovation and Translation Centre</i>]</p>