

Impact case study (REF3)

Institution: King's College London		
Unit of Assessment: 3		
Title of case study: Enabling a paradigm shift in the prevention and treatment of tooth decay worldwide: the Global Collaboratory for Caries Management.		
Period when the underpinning research was undertaken: 2000-2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Nigel Pitts	Professor	2013 – Present
Edwina Kidd	Professor	1982 – 2004
Avijit Banerjee	Professor	1995 – Present
Raman Bedi	Professor	2001 – 2018
Christopher Longbottom	Senior Lecturer	2013 – 2018
Stefania Martignon	Senior Lecturer	2014 – 2019
Period when the claimed impact occurred: 1 August 2013 - 31 December 2020		
Is this case study continued from a case study submitted in 2014? N		

1. Summary of the impact

Dental caries (tooth decay), the most prevalent disease globally, constitutes a major challenge across the life-course. Building on a portfolio of King's College London research, the King's-led Global Collaboratory for Caries Management has, since REF2014, evolved into an international umbrella group leading the paradigm shift towards comprehensive Preventive Dental Medicine. For REF2021, impact is evidenced across: 1. Operationalisation of international guidance - ICCMS™ (for Dentists delivering clinical caries care), 2. Integrating clinical (ICCMS™) and public health strategies for caries control (for Dentists and Professional Organisations), 3. Facilitating shifts in policy and payment systems (for a range of stakeholders) and 4. Shaping and delivering Corporate Social Responsibility activity (with a global company).

2. Underpinning research

Background: Dental caries (tooth decay) presents a major global challenge across the life-course. Although perceived by many as a disease of childhood, the risk of caries continues into adulthood. Tooth decay is now an increasing problem for the elderly and vulnerable. Untreated tooth decay in permanent teeth was ranked number 1 across all diseases by the Global Burden of Diseases Study while untreated tooth decay in primary teeth in children was number 6. Caries was estimated to affect 2.8 billion people worldwide. Tooth decay affects people in a variety of profound ways. It can cause recurring pain (both acute and chronic), lead to infection and the need for complex, on-going and expensive rehabilitation. For an individual, suffering from tooth decay can severely compromise the ability to speak, smile, smell, taste, eat and convey emotions through facial expressions, with confidence and without pain.

King's College London researchers recognised deficiencies in the traditional ways that caries has been diagnosed and managed (treating the symptoms rather than the cause, serially removing excessive tooth structure, with repeated fillings often leading to sub-optimal long-term health outcomes). The change needed has been from the traditional surgical care model – with a focus only on the drilling and filling of cavities (late-stage disease) in clinical settings divorced from either clinical or public health attempts at decay prevention; to comprehensive 'preventive dental medicine' (B,C) – aiming to integrate our research findings (detailed below) to control early- to late-stage caries in both individuals and populations, over the life-course.

King's researchers showed combining assessment of caries severity and activity supports improved diagnosis and clinical decision making. This research devised a novel, rational clinical framework for integrating the available knowledge on judging both caries *severity* (extent) and current lesion *activity* assessment, in order to provide a coherent clinical strategy for dentists deciding when to provide prevention and when to fill a tooth with a minimally invasive approach

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(1). Key recommendations were for: careful assessment of *both* enamel *and* dentine decay as well as current lesion activity with surgical intervention as a last resort. This built on:

King's developed novel methods to clinically “stage” the severity of caries. Researchers developed and validated visual and radiographic scoring systems for dentists (which had not been previously available) to use for “staging” caries severity in practice. These systems were developed by careful study of the correlations between clinical and histological assessments of a series of lesions in extracted human teeth. They provided a simple numerical score (0-4 with increasing lesion severity) which allowed dentists to differentiate early, mid- and late-stage disease for each tooth surface (2). Further research then also compared the derived severity scores with in vivo microbiological assessments to determine the level of infection of the dentine inside decayed teeth (3). The recommended scoring systems were subsequently incorporated as key features into the International Caries Detection and Assessment System, “ICDAS”.

King's refined the understanding of the dental caries “process” and developed a new approach to disease control. This research integrated evidence from the histological and microbiological research with studies of mineralisation dynamics to produce a new concept of caries control across the continuum of lesion severity stages. The clinical strategy so developed advocated regular biofilm disturbance and fluoride interventions to prevent both the initiation of new lesions and progression of existing ones (4).

A newly formed, King's-led, Global Collaboratory used implementation science approaches to understand how these research findings (1-4) could be assembled coherently for clinicians in a format which could be implemented effectively. King's researchers, working with King's *Implementation Science* and international dental colleagues, developed the “ICCMS™ (International Caries Classification and Management System)” Guide for clinicians using robust methodology adapted from the Scottish Intercollegiate Guideline Network (5). The initial King's research has been (and continues to be) validated by the International research community using both the ICDAS and ICCMS™ Systems (5). ICDAS/ICCMS™ has been cited in 423 research publications from 36 countries in this REF window [A]. The published ICCMS™ Guide (5) was designed from the outset to be an implementation tool for the underpinning research and has been developed further, in parallel with a range of impact activities (see section 4).

King's-led research and synthesis linked individual and population level caries prevention interventions to inform public health policy making. This research included a team from the Department of Health together with rigorous statistical modellers. It explored evidence to understand how combining interventions for caries prevention at both the individual level (e.g. fissure sealants and fluoride varnish) and the population level (e.g. water fluoridation and sugar restriction) could lead to more effective caries control across populations through integrated policy changes and multi-faceted implementation (6).

3. References to the research

1. Ekstrand KR, Ricketts DN, Kidd EA. (2001). *Occlusal caries: pathology, diagnosis and logical management*. Dent Update 28(8):380-7.
2. Ricketts DN, Ekstrand KR, Kidd EAM and Larsen T. (2002). *Relating Visual and Radiographic Scoring Systems for occlusal caries detection to histological and microbiological evidence*. Operative Dentistry 27:231-237.
3. Kidd EAM, Banerjee A, Ferrier S, Longbottom C, Nugent Z. (2003). *Relationships between a Clinical-Visual Scoring System and Two Histological Techniques: A Laboratory Study on Occlusal and Approximal Carious Lesions*. Caries Res; 37:125-129. 10.1159/000069018
4. Kidd EAM, Fejerskov O. (2004). *What Constitutes Dental Caries? Histopathology of Carious Enamel and Dentin Related to the Action of Cariogenic Biofilms*. J Dent Res 83 (Spec Iss C): C35-C38. 10.1177/154405910408301s07
5. Pitts NB, Ismail AI, Martignon S, Ekstrand K, Douglas GVA, Longbottom C. (2014). ICCMS™ Guide for Practitioners and Educators. Zenodo. <http://doi.org/10.5281/zenodo.853106>
6. Bedi R (Ed). *Reforming Dental Services in England: Policy Options*. (2005). Health Education Journal Vol 64 (4) (Supplement) ISSN 0017 8969

4. Details of the impact

Since the REF2014 impact case study King's, working with international partners, has: (i) further translated the best-practice international system for detecting caries (the ICDAS, built on 1-4), into an accessible tool for dentists (the ICCMS™ Guide, 5), to help detect, assess and manage caries and to act as an implementation vehicle; and (ii) has continued to improve understanding that joining up clinical and public health interventions optimises caries prevention and improves oral health (6). These research-led outputs formed the basis for wide-ranging impact by King's researchers and others to tackle different components of this complex problem, broadening the scope and scale of earlier work. This impact has been enabled by the evolution and re-structuring of the implementation vehicles led by King's and its partners.

The Global Collaboratory for Caries Management (GCCM) [A] has, since 2014, developed into an integrated umbrella group leading the international paradigm shift towards comprehensive preventive dental medicine [B,C], building on King's underpinning research, to control all stages of caries in individuals and populations across the life course. The GCCM facilitates impact by King's and its partners, collaborating synergistically with two King's-led implementation charities. The ICDAS Foundation works with dental professionals to implement the ICCMS™ worldwide and, specifically for general practice, through a more recent entity, CariesCare International. The Alliance for Cavity Free Future (ACFF) promotes dental public health initiatives that tackle tooth decay and engages a wide cross-section of dentists, health professionals and the public. King's brought together key aspects of ICDAS and ACFF through the Dental Policy Labs; and GCCM policy activities recently led to the creation of a global task force on 'Making cavities history'. Examples of impact over the REF2021 period are evidenced below across 4 areas.

1. Operationalisation of international guidance developed by King's and partners (for Dentists delivering clinical caries care)

ICCMS™ has changed international clinical guidance from the FDI World Dental Federation on caries management for dentists worldwide. The FDI is the international representative body for the more than 1 million dentists worldwide, setting policy and clinical guidelines for the profession and linking 200 National Dental Associations (NDAs). In 2015 the FDI-commissioned White Paper on caries management highlighted King's research, the subsequent ICDAS system and the ICCMS™ guidance for caries detection and management [B]. In 2016 they distributed this to all NDAs as best practice, followed in 2017 by a further Chairside Guide implementation tool, translated into 10 languages [B]. In 2019, they published a new Policy Statement on 'Cariou Lesions and First Restorative Intervention' that specifically advocates to all NDAs worldwide that the "FDI World Dental Federation supports a shift in caries management from restorative treatment to measures that arrest and prevent caries development including monitoring, following the concepts of International Caries Classification and Management System" [C].

Collaborative development of accessible guidelines for caries care in general dental practice, for use by dentists internationally. A King's-led team responded to feedback from general dentists that they needed a more "practice-friendly" format of ICCMS™, hosting two workshops reaching a broad group of 44 authors from 17 countries through 8 Co-chairs to produce a version more suitable for everyday practice. The result, 'CariesCare Practice Guide: consensus on evidence into practice', was published in the British Dental Journal (BDJ) [D] in September 2019 and was one of the journal's most downloaded papers for that entire year [D]. Two supportive BDJ Editorials have advocated collaborative adoption in the UK and worldwide [E]. The guide is now available without charge via a dedicated website [A], with a clinical case study, videos of International Symposia and e-Learnings [E]. In its first 8 months, the website attracted 5,400 users from 10 Countries (particularly Latin America, US, UK), undertaking 9,100 sessions [A].

2. Integrating clinical and public health strategies for caries control through the ACFF (for Dentists and their Professional Organisations).

The ACFF was set up by King's researchers and collaborators to "challenge global stakeholders including health and dental health professionals to learn the importance of caries as a continuum" and promote local and global action that delivers comprehensive caries prevention and management (using King's underpinning research 1-6). The charity is unique in scope, headquartered at King's and in 2018, was

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recognised as one of the 5 “Big Ideas for Service” at the launch of the King’s Service to Society Strategy. The Foundation supporter since inception has been Colgate.

The ACFF has forged unique collaborations between dentists, public health professionals and local governments to promote local public health projects in over 50 countries. The diverse ACFF network now includes 28 local “Chapters” (up from 6 in REF2014) operating in >50 Countries, bringing together clinical, dental public health, academic and Government representatives to advance evidence-based, locally appropriate initiatives to make progress towards a ‘cavity-free future’ [A]. Large numbers of International (15) and National Professional Organisations partner with ACFF to advocate for integrated dental public health and clinical control of caries [F]. This broad range of successful, enduring, partnerships built around the single-issue of moving towards a Cavity-Free Future is very unusual. A 2019 survey of Chapter activities showed that across dentists, other health professionals and the public, over 700,000 people were reached through an annual awareness day alone, with over 8.6 million people reached in 2019 overall [G].

The ACFF is co-producing public health strategies for caries control reaching 194 countries. The ACFF has achieved sufficient recognition that the charity now works with 194 Chief Dental Officers (CDOs) around the world to share materials to deliver integrated clinical and public health strategies for caries control. The ACFF has provided resources for the FDI “CDOs and Dental Public Health Section” web pages, reports annually on progress and participates in meetings and open sessions at annual FDI World Dental Federation Congresses [H].

Diversity and Inclusion. The wide range of impact based on King’s research results from open collaborations across national, racial, cultural and economic barriers. We are proud of the diverse teams that work together for the benefit of all and commissioned an external Diversity/ Inclusion audit on ACFF, which validated our success in this area and will help us improve [I].

3. The Global Collaboratory brings together ICCMS™ implementation and public health strategies to facilitate shifts in policy and payment systems (for a range of stakeholders in caries control). The Dental and Policy Institutes at King’s recognised that for the Global Collaboratory for Caries Management to make significant global changes to caries care, we would need to bring together the implementation of ICCMS™ and integrated public health strategies to facilitate a paradigm shift in models of care and payment. This also requires changes to policy and funding, as well as structured engagement between key stakeholders to drive the real change needed to more fully implement the findings of our underpinning research.

The Dental Policy Labs. To foster this process, in 2017-19 King’s and the ACFF hosted three ‘Dental Policy Labs’. These unique, King’s-developed events brought together crucial groups who do not usually meet in a safe space to co-create solutions to complex policy challenges. These focused on: (i) changing policy; (ii) payment models for dental care; (iii) accelerating change through engaging Industry [H]. All three were informed by and built on King’s underpinning research (1, 3, 4, 6) and informed further shifts in caries prevention and management using the ICCMS™ implementation vehicle (5). The Labs were welcomed by senior attendees, and in an British Dental Journal editorial [J]. Across each of the 3 “Labs”, European and Global CDOs Groups were actively represented, with enthusiastic participation from 8 CDOs. The Labs have already led to substantial impact, particularly in the economic arena – paying dentists for prevention as well as surgical care has long been a barrier to providing optimal caries care. The novel “hybrid” template for dental care payment developed at the second Lab is already influencing care in Belgium (using the model to pay hygienists and dentists from 2019), and France [J].

Influencing the French NHIS to trial a new payment model for dentistry nationally. There was French representation at the second Policy Lab and an existing link to “Les CDF” through King’s [J]. They are the largest dental trade union in France representing >10,000 members and were interested in potential innovations; a timely policy opportunity was provided by the economic reforms of President Macron. Intensive work in the 18 months following the lab resulted in a National Experiment being agreed between the French Government, the national health insurance system and all dental trade unions. This work has been agreed under Article 51 legislation (a national health innovation scheme), and will test use of the payment model for dental care developed by the 2nd Dental Policy Lab, in combination with the *CariesCare International* caries management model. This project has a budget of Euro 5.9 million for the first 3 years and will

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involve 15,000 patients with over 600 Dentists. The national agreement includes a review after 3 years, and for adaptation in order to attempt country-wide implementation [J].

ACFF Task Force to define and advocate for Global Policies to Make Cavities History. This recent initiative arose from the third Lab. It takes us into a new impact area with King's, ACFF, Colgate and an International Secretariat working in partnership to have a broadly-based Task Force of leading experts co-create global policies to accelerate *Making Cavities History* worldwide. In 2020 this work has been planned and funded, working with a Secretariat experienced in this space. We recruited a core group of 20 senior experts and a parallel review group of 15, from a total of 20 countries. New international consensus policy recommendations were co-created, setting out what is needed in a form which can be adapted locally and regionally for high, middle and low income countries and which is compatible with the developing WHO Oral Health Agenda [K].

Impact of Health Policy Changes. Taken across the range of activities in impact sections 2 and 3, it should be appreciated that coordinated health policy changes can have a systematic impact on health outcomes which will be more readily apparent as much needed international standardisation enables the acquisition of comparable data for disease surveillance.

4. Shaping and delivering Corporate Social Responsibility activity (with a global Company).

King's, ICDAS Foundation and ACFF have had long-term, mutually beneficial relationships over many years with Colgate, who initially supported e-learning and educational materials promoting ICDAS / ICCMS™ to dentists and then became the foundation supporter for ACFF. They have provided serial CSR contracts and support for ACFF from 2014 to the value of USD 2.1m over this REF period [K]. Colgate also, in October 2020, extended the partnership for a further 3 years with a commitment to a further core CSR contribution of USD 900,000 [K]. They supported the King's/ACFF Dental Policy Labs and, in 2020, also provided new funding for the ACFF Task Force project. Over the years of this relationship ACFF and King's has also shaped the Colgate company's strategic approach to CSR in the caries space by providing strategic advice and policy insights. Colgate's Global VP for Professional relations stated: *"Long term influence has been seen with the public, patients, dental professionals, government and NGO organizations and as well as policy makers – it takes years of consistent work to achieve significant impact in the dental arena – and this has been achieved by ACFF and King's working with Colgate."* [K].

5. Sources to corroborate the impact

[A]. Global Collaboratory for Caries Management Website(s) - King's FoDOCS website linking to the King's-led charities websites for ICCMS™, CariesCare International and ACFF; including details of the use of ICDAS/ICCMS™ in the literature over this period. (PDF)

[B]. FDI White Paper on caries prevention and management (Pitts NB & Zero, 2016); Caries Prevention and Management Chairside Guide (2017), FDI World Dental Federation. (PDF)

[C]. FDI Policy Statement on "Carious Lesions and First Restorative Intervention"; FDI World Dental Federation Guidance Document (2019). (PDF)

[D]. CariesCare Practice Guide: Consensus on Evidence into Practice - September 2019 publication in the British Dental Journal. (PDF)

[E]. CariesCare International - Related Evidence and Resources - including: *CariesCare International: Practice Guide*; two British Dental Journal Editorials; the "Caries OUT" project e-learning and translations all available on the dedicated CCI website. (PDF)

[F]. Professional Organisations partnering with GCCM – including those implementing ICCMS™ Guidance and Advocating integrated Dental Public Health and Clinical Caries Control.

[G]. ACFF impacts on dentists and patients across > 50 Countries, with key metrics. (PDF)

[H]. Reports from the 3 Policy Labs and meeting papers downloadable from FDI World Dental Federation's Chief Dental Officers/Dental Public Health Section's website. (PDF)

[I]. External Diversity and Inclusion Audit of ACFF activities (PDF)

[J]. Testimonials evidencing impact of the Dental Policy Labs in Belgium, France; from Vice-President, American Dental Association Health Policy Institute; BDJ Editorial "Paying for a Cavity Free Future", March 8th 2019. (PDF)

[K]. CSR testimonial from VP Professional Relations, Colgate New York; including ACFF Task Force on Making Cavities History policy recommendations. (PDF)