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Editorial

'No simple solutions, no single ingredient': Systems-orientated approaches for addressing *Wicked Problems* in population oral health

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A *Wicked Problem* is a problem that is impossible or difficult to solve partly because of its multi-component nature and its interconnection with other problems (Rittel & Webber, 1973). There are many *Wicked Problems* in the field of population oral health; tooth decay being one. Tooth decay is a function of biology (destruction of our tooth enamel); a function of our physical environment (availability, advertising and accessibility of sugar sweetened foods and drinks, availability of dental services); a function of our social environment (norms of oral hygiene and sugar consumption vary by socio-economic strata, country, and cultures); a function of us as individuals (dietary habits, visiting the dentist, oral health beliefs, toothbrushing, use of fluoride, dental anxiety, income); and a function of politics (our city, region and national policies on oral health education, tax on sugar sweetened drinks, water fluoridation, dental payment systems). The '*Wicked Problem* of tooth decay' therefore involves multiple factors, none of which occurs in a vacuum. There therefore seems little point then in studying them in a vacuum or intervening in a vacuum. Yet, we continue to do so. We have become adept at describing gradients in tooth decay according to income, education or occupation ('socio-economic inequalities') or documenting changes in tooth decay over time ('is caries prevalence better now than 10 years ago'?) or calculating odds associated with individual risk factors ('lower self-efficacy = worse caries experience'). These traditional 'factorial' approaches that study disease causation in chunks; wherein the individual and the environment are reduced to independent, quantifiable factors will not be sufficient for addressing complex problems (Baker & Gibson, 2014). Complex problems involve heterogeneous, interdependent influencers which interact with each other in complex and dynamic systems.

Systems science emphasises an understanding of the whole system rather than individual components (Luke & Stamatakis, 2012; Mabry & Kaplan, 2013). So, rather than focusing solely on the biological constituents of tooth enamel to predict the progression of tooth decay, a systems science approach would seek to model the biological, behavioural, attitudinal, demographic, social caries system to identify leverage points for intervention or health policy decision-making. Systems science approaches therefore complement existing approaches as they are better able to explore interactions between heterogeneous individuals and interactions between individuals and their environment within a connected whole – in this way they can explore dynamic non-linear processes including emergence, feedback and adaptation related to oral health. There have been calls for an increase in such complex systems approaches to public health problems in recent years and a resulting number of applications in a range of areas from cycling, to obesity, to the social determinants of health (Carey *et al*., 2015; Huang *et al*., 2009; Speybroeck *et al*., 2013). Why not oral health too?

Our paper in this issue *Systems science and oral health: Implications for dental public health* outlines how we might use approaches that address complexity in order to develop our thinking, understanding and skills in relation to the complex problems we face in oral health (Broomhead and Baker, 2019). The paper gives an overview of potential system sciences methods that could be utilised in dental public health research – system dynamics simulations, agent-based models, network analysis, Markov and discrete event modelling – and discusses some of the limited examples that can be found in the oral health literature. We discuss the implications of adopting such methods in dental public health research and policy with examples relating to caries; the inclusion of interactions and feedback mechanisms based on biological, behavioural, socio-economic and neighbourhood factors. These are all essential components of tooth decay that go way beyond what traditional statistical approaches can offer. Such methods can dynamically simulate real-world problems, with the potential for policy-related analysis. For example, policies (interventions) can be 'created' artificially and then tested before implementation or compared with other hypothetical policies to understand how they might function or whether they work synergistically. Such pre-testing is invaluable at a time of limited resources, allowing trials to be targeted where we expect the greatest benefit (Badham *et al*., 2018). Hirsch and colleagues (2012) did just this in the US to test which intervention(s) would lead to the greatest caries experience reduction in 0-5-year-old children. The systems dynamics model they developed enabled comparison of interventions, singly and in combination, to predict 10-year intervention costs and recommend policies to maximise public health and clinical care investment returns to reduce caries progression.

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Fluoride varnish, Xylitol and motivational interviewing were all effective and more so when combined. The benefits of the approach are easily apparent in terms of being able to explore multiple potential interventions in one study with minimal cost. Such methods really do fit the current economic effectiveness doctrine!

This is a really important pressing fiscal and ethical consideration in dental public health. We have seen, and are about to see, the publication of findings from £million (+) dental trials funded by the National Institute of Health Research (i.e. the taxpayer) many with null results. Is it that the wrong questions are being commissioned or does the quality of the trials, particularly the outcome measures, need attention? Or perhaps the methods need to be re-thought? Certainly, the current design of interventions and evaluation methods is engrained in a compartmentalised approach to thinking about problems (as is the way our funding bodies fund health research). This is because the methods developed to assess clinical effectiveness of interventions, so-called gold standard RCTs that factor out the context using control, are of limited use for complex public health problems. Or, at the very least, meaningful impacts for complex problems will require more than single interventions. As recent work suggests 'simple interventions for complex phenomena have led to ineffective or even harmful interventions' in the public health arena (Fink and Keyes, 2017, p. 2). Perhaps it is time to stop giving "the right answers to the wrong questions" and to consider an enlarged methodological and statistical toolkit to aid understanding of the complex problems we face in dental public health (Brocklehurst *et al*., 2018).

As the application of system science approaches continues to expand, associated methods are improving, as are the techniques and programs available. These developments are encouraging. Yet, it is important to remember that whilst there is a great deal of rhetoric around systems approaches at the moment, it is not a 'magic bullet' for answering *Wicked Problems* such as the rise in tooth decay in some children in deprived neighbourhoods or rising inequalities in oral health. It is but one approach in our analytic armamentarium. It does, however, give a clear imperative. We need to collaborate with diverse disciplines and conduct truly cross-disciplinary research, rather than a compartmentalised tick-box exercise ('a behavioural scientist', 'a cariologist', 'a qualitative researcher') nor hierarchical ('only dentally qualified applicants can apply'). This will not happen without the determination of those involved to form coalitions across sectors (public health, academia, policy, industry), without leadership and training for future dental researchers and public health policy makers, or without journal editors and reviewers with the relevant skills. Informed peer review is essential if we are to move forward in our methods and approaches. More training and transdisciplinary working with experienced systems modellers is required before systems science approaches are applied more regularly in dental public health research and practice. But it is not solely the methods of system science that could be useful, but also its methodological positioning. We need teaching in complexity theories and concepts, not just in the tools and skills to use such methods. Such training would fit well with the development of truly interdisciplinary researchers as outlined in recent key publications on strategies to optimise the research environment for population health (Academy of Medical Sciences, 2016).

As Stephen Hawking said in 2000, 'I think the next century will be the century of complexity'. We can carry on in our dental research careers churning out papers replacing one variable for another (self-efficacy instead of sense of coherence) or one population for another (older adults in Scotland instead of 65+ cohort in Taiwan) or one person-reported outcome measure for another (OHIP14 instead of GOHAI) or we can rise to the challenge of adopting new ways of thinking and doing. Moving beyond description to explaining and understanding: the *why?* and *how?* questions. Thinking how and in what way things happen rather than describing what happens. This will be difficult; complexity is conceptually and analytically complex! (Baker and Gibson, 2014). Yet, to debate and engage with the conceptual and methodological issues raised by systems science could potentially be one small step toward tackling the *Wicked Problems* we face in population oral health. 'The art of research is the sensitivity to decide when a useful and necessary simplification has become an obfuscating simplification' (Levins, 1996, p. 105).

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