Severe early childhood caries: a modern (neglected) epidemic?

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ABSTRACT

AIMS: There is mounting concern that there is increasing severity in the oral health burden of children who have dental caries. This study aims to describe the current dentally examined rates of severe early childhood caries (S-ECC) among children aged five years within the Canterbury District Health Board (CDHB) region, overall and by major ethnic groups.

METHODS: A retrospective analysis of routine oral health data collected from all children aged five years attending the CDHB child oral health services for their routine oral health check between 1 January 2018 and 31 December 2019, inclusive.

RESULTS: The sample included 10,766 children, of whom 1,822 (16.9%) were Māori, 499 (4.6%) were Pacific and 8,445 (78.4%) were non-Māori/non-Pacific. Overall, 1,980 (18.4%) were classified as having S-ECC, and significant ethnic differences emerged between Māori, Pacific, non-Māori/non-Pacific children (26.2%, 40.1% and 15.4%, respectively; p<0.001).

CONCLUSIONS: Despite considerable public investment, Canterbury's children are carrying a heavy oral health burden, which is unequally shared. Risk factors for and the consequence of this burden have significant health and wellbeing implications, now and for the future. Systemic changes and interventions are necessary to redress this childhood oral health epidemic.

"Baby teeth do not matter as they fall out anyway" and "all children eventually get holes in their teeth" are but two common perceptions in New Zealand.[1] But baby teeth do matter; the evidence is unequivocal. Early childhood caries (ECC) has significant short- and long-term impacts—both for the affected individual and our society.[2] Children with ECC may experience pain, swelling, reduced quality of life, eating limitations, speech articulation/language development difficulties/delays which deleteriously affects learning and playing, increased absences from pre-school/school, reduced socialisation and self-esteem, and increased orthodontic need in their permanent dentition.[2–6] The costs to the country are substantial and growing. For the 2017/2018 financial year, district health board (DHB) funding for oral health totalled NZD$197.2 million, with child oral health services (COHS) accounting for NZD$98.42 million, adolescent dental services costing NZD$42.17 million, and hospital dental services spending NZD$49.68 million.[7] The cost of dental treatment under general anaesthesia (GA) was estimated at NZD$2,400 per case, but it can be considerably more.[8] Between 2004/2005 and 2014, the number of children receiving dental treatment under GA increased by 66.9%,[9] and hospital admissions rates for these treatments was greatest among children aged three to four years.[10] Dental caries does not occur when there is a normal commensal plaque; an ecological change is required to create a pathogenic plaque that leads to more enamel demineralisation than remineralisation.[11] Frequent intake of food and drink containing fermentable carbohydrate leads to a fall in the resting pH of dental plaque and a collapse in species diversity—the microbially diverse commensal plaque is replaced by a pathogenic plaque

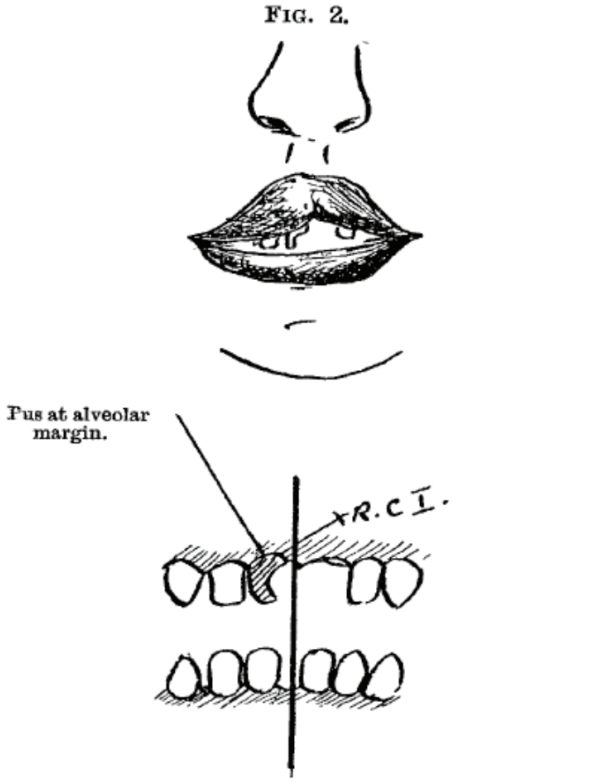
consisting mostly of acidogenic and acid-tolerant organisms.[12] The rate and degree of teeth destruction is modified by fluoride exposure.[13] Although largely preventable,[2,7] dental caries is the most common chronic disease of childhood and among the primary reasons for hospital admissions of children in New Zealand.[14]

Significant caries-free rate improvements have been made in recent years for New Zealand children aged five years,[7,15] although unacceptably wide inequalities among different ethnic and socioeconomically disadvantaged communities persist.[15–17] Pacific children carry the heaviest burden, followed by Māori, while non-Māori/non-Pacific children enjoy the lightest burden.[7,15] Nationally, in 2018, 64.3% of Pacific children aged five years had at least one tooth affected, compared to 59.2% of Māori children and 30.9% of non-Māori/non-Pacific children.[18] These ethnic disparities exist elsewhere;[2] with, for example, Pacific children aged five to nine years in the US having much poorer oral health than their national counterparts.[19] Although dental caries is one of the most common chronic diseases, and recognised that it disproportionately affects disadvantaged communities, children, and ethnic minority groups, oral health is often taken for granted.[20] This led a former US Surgeon General to describe it as a complex silent epidemic that demands attention.[20] More recently, a *Lancet* series focused on oral diseases and their marked inequities, characterised it as a neglected global public health challenge that requires radical action.[2,21] While the improvement in the caries-free rate of New Zealand's five-year-old children gives cause for celebration, the continued significant ethnic and social inequalities do not. Moreover, there is mounting concern that there is an increasing severity in the oral health burden carried among those children with caries.[2] So while fewer children may be experiencing caries, those who do have caries appear to be more severely afflicted.

The decayed-missing-filled teeth (dmft in deciduous and DMFT in permanent dentition) index is a measure of caries severity;[22] it has been used for 80 years and measures the number of decayed, missing (extracted due to caries) and filled teeth or alternatively, tooth surfaces. Most children have no decayed, missing or filled teeth (ie, dmft=0) and therefore the distribution is highly positively skewed and produces mean dmft scores that do not reflect the severity of the disease among those who have it. Alternatives have been suggested, including a category of severe early childhood caries (S-ECC), described by Drury and colleagues in 1999,[23] and adopted by the American Academy of Pediatric Dentistry.[24] S-ECC defines a long-recognised subtype of dental caries that is rapid in onset, involves multiple teeth and frequently affects the anterior teeth. Prior to the introduction of the term S-ECC, the condition had various other names, mostly associated with putative causes, such as 'nursing caries', 'baby bottle tooth decay', and 'comforter caries'. This last nomenclature was coined by Harries, in a 1911 *Lancet* article.[25] Harries documented several cases of children with extensive caries, including one of a three-year-old girl; his sketch is reproduced (with permission) in Figure 1. Incidentally, the young girl had been admitted with measles—another avoidable condition we are still grappling with over 100 years later.

Children with S-ECC carry an even greater physical and mental health burden than those with ECC,[26] and a greater risk of requiring dental treatment under GA.[27] However, despite its 20 years formal history and international use, the epidemiological evidence-base for S-ECC within New Zealand is modest. This study primarily aims to describe the dentally examined rates of S-ECC among children aged five years within the Canterbury DHB (CDHB) region, overall and by major ethnic groups, to highlight the large and disproportionate burden shared by our young tamariki. A secondary aim is to concurrently present data on the rate of missing (due to caries) deciduous teeth through extraction.

Figure 1: Dr Eric HR Harries' 1911 hand-sketch of a three-year-old girl's "Comforter caries" case study (reprinted from *The Lancet*, 178(4602), Harries E.H.R., "Comforter" caries, p. 1327-8, Copyright (1911), with permission from Elsevier).



CASE 2.—A female, aged three years, admitted for measles. Shows some hypertrophy of upper lip. Pus at root of carious right central incisor; left central incisor has disappeared. Breast-fed for 17 months. No evidence of rickets or syphilis. Other teeth sound. R.C.I., Right central incisor.

Methods

Design

A retrospective analysis of routine oral health data collected between 1 January 2018 and 31 December 2019, inclusive.

Target population

All children aged five years attending the CDHB COHS within the Canterbury region for their routine oral health check. Age five years is the first year of primary schooling for the majority of New Zealand children, and examinations are typically conducted at these schools.

Measures

For children aged five years, S-ECC is defined by having a ≥1 cavitated, missing (due to caries), or filled smooth surfaces in their primary maxillary anterior teeth or a decayed, missing or filled tooth surfaces score (dmfs) ≥6.[23] S-ECC indication was derived directly from the dental examination recordings. Missing teeth due to caries was also noted, and indicated if one or more teeth had been extracted. Demographic information was collected at enrolment with the COHS. Age was calculated from the difference between assessment date and date of birth. Ethnicity was determined by child's parent or caregiver. For children with multiple ethnic identifications, a single ethnicity was assigned using the hierarchy: (i) Māori; (ii) Pacific; (iii) Asian; (iv) Middle Eastern, Latin American, and African (MELAA); and, (v) European/other.[28] Here, categories (iii)-(v) were combined and relabelled as non-Māori/non-Pacific.

Procedure

Dental services are delivered by dental and oral health therapists at community dental clinics and in mobile dental units.

Routinely collected demographic and oral health information are entered into an electronic oral health record 'Titanium'.[29] The diagnosis of caries includes the use of radiography, where clinically appropriate, and extractions and fillings not due to caries and carious lesions not involving dentine are excluded. A research database was created, extracted from the Titanium database by ML, which only included the oral health and demographic variables outlined above, and no identifying information.

Statistical analysis

Reporting of analyses were informed by the REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) guidelines.[30] Data were imported into Stata SE version 16.0 (StataCorp, College Station, TX, US) for all statistical analyses. Descriptive statistics were calculated and reported for the demographic and oral health variables. Sample demographics were compared against StatsNZ 2018 Census figures for children aged 0–9 years within the CDHB region.[18] Fisher's exact test was employed for categorical comparisons, and with $\alpha=0.05$ was used to define statistical significance. Relative risk (RR) and associated 95% confidence intervals (CIs) were calculated using a binomial generalised linear model with a log-link function, and adjusted for age.

Ethical approval

Upon application to the New Zealand's Health and Disability Ethics Committee (HDEC), this study was deemed as a minimal risk observational research that did not met the requirement necessary for formal ethics committee review. All methods were performed in accordance with HDEC's relevant guidelines and regulations.[32] The research databases did not contain any personally identifying information, was only accessible via password protection, and was securely stored on the CDHB's and University of Canterbury's servers.

Results

Participants

Over the study period, dental examination data were available from 10,766 children, of whom 5,215 (48.4%) were girls and 5,551 (51.6%) were boys, and their mean age was 5.5 years (range: 5.0, 6.0 years). Using the prioritised ethnicity groupings, 1,822 (16.9%) were identified as being Māori, 499 (4.6%) were Pacific, and 8,445 (78.4%) were non-Māori/non-Pacific. This ethnic distribution is broadly similar to the StatsNZ 2018 Census prioritised ethnic figures for children aged 0–9 years within the CDHB region, estimated at 17.2% Māori, 4.7% Pacific and 78.0% non-Māori/non-Pacific.

Severe-ECC and missing teeth

Overall, 1,980 (18.4%) were classified as having S-ECC, and significant ethnic differences emerged between Māori, Pacific, non-Māori/non-Pacific children (26.2%, 40.1% and 15.4%, respectively; Fisher's exact test, $p<0.001$); see Table 1. For deciduous tooth extraction, overall 618 (5.7%) had at least one tooth extracted, and again significant ethnic differences emerged between Māori, Pacific, non-Māori/non-Pacific children (10.0%, 11.6% and 4.5%, respectively; Fisher's exact test, $p<0.001$); see Table 1. In each case, the prevalence of S-ECC and extracted deciduous teeth was highest for Pacific children, intermediary for Māori children, and lowest for non-Māori/non-Pacific. Compared to non-Māori/non-Pacific children, the RR of S-ECC was 2.6 (95% CI: 2.3, 2.9) for Pacific and 1.7 (95% CI: 1.5, 1.9) for Māori children, while the RR of at least one deciduous tooth extraction was 2.6 (95% CI: 2.0, 3.4) for Pacific children and 2.2 (95% CI: 1.9, 2.6) respectively for Māori children.

Discussion

Right now, almost one in every five children in Canterbury has S-ECC. This and other oral diseases are likely to have far-reaching sequelae into the affected children's and societies' foreseeable futures. Moreover, two in every five Pacific children and over one in every four Māori children aged five years have experienced S-ECC, reinforcing the gross inequity patterns previously observed both locally and globally.[2,31] Furthermore, compared to non-Māori/non-Pacific children, Pacific and Māori children were 2.6 and 2.2 times as likely to have had at least one tooth extracted, respectively, due to caries. In the New Zealand Oral Health Survey 2009, 1.4% of children aged 2–4 years and 4.9% of children aged 5–11 years had one or more primary teeth missing due to dental decay.[32] When combined, 3.9% of children aged

Table 1: The distribution of S-ECC and those with one or more deciduous tooth extraction, stratified by ethnic identification, and the estimated relative risk (RR) together with associated 95% CIs.

	Total	**Indications**			
	N	n	(%)	RR*	(95% CI)
S-ECC					
Māori	1,822	478	(26.2)	1.7	(1.5, 1.9)
Pacific	499	200	(40.1)	2.6	(2.3, 2.9)
Non-Māori/non-Pacific	8,445	1,302	(15.4)	1.0	(reference)
At least one deciduous tooth extraction					
Māori	1,822	182	(10.0)	2.2	(1.9, 2.6)
Pacific	499	58	(11.6)	2.6	(2.0, 3.4)
Non-Māori/non-Pacific	8,445	378	(4.5)	1.0	(reference)

Note: *adjusted for age.

2–11 years had one or more primary teeth missing, with higher rates in Pacific (6.1%) and Māori (5.7%) children.[32] While not directly comparable, due to the age differences and cumulative age effect associated with tooth loss, it is notable that 4.5% of Canterbury's five-year-old children (11.6% of Pacific and 10.0% of Māori children) had teeth missing in this study; rates, a decade on, that appear considerably higher than those observed within the national study. Perhaps, like that asserted within the Northland study results,[31] Canterbury's children high rates may be partly attributable to the lack of community water fluoridation within the region.[16]

Although unable to be reliably captured and investigated within these data, it must be strongly emphasised the oral health patterns observed here are likely predominantly, if not entirely, due to social determinants of health inequities between children rather than intrinsic cultural differences. While Māori and Pacific children are more likely to have early childhood dental decay, the issue, though seemingly straightforward, is not as simple as parents ensuring their children brush their teeth. Nor is it an issue of belonging to a Pacific or Māori family, except their families are more likely to experience conditions that make dental care a lower priority. These issues afflict many families who live with socioeconomic pressures, in regions with non-fluoridated water supplies, and for whom contact with dental or any health professionals are only made if absolutely necessary. Mixed health messages around the importance of baby teeth only exacerbate the ongoing dental care behaviours as children get older. The solutions are complex and their pathways require application to multiple levels, but require the engagement of many non-English first-language communities to be effective.

The statistics presented here suggest that we have an ongoing paediatric oral health crisis—a crisis that is not confined to New Zealand.[33] Situated within our current oral health delivery model, the logical response is a call for even greater funding and resourcing;[34] although it has been argued that the current downstream treatment-dominated, increasingly technology-focused system of oral health care is trapped in an interventionist cycle that does not tackle the underlying causes of disease nor address oral health inequalities.[21] And so, our current system is perhaps unintentionally designed for oral health services to perpetually "chase its tail".[21] The likelihood of children's annual visits to dental clinics ameliorating this crisis is remote, and has not succeeded to date. Instead, a radical rethinking and reframing of oral health care is needed. Watt and colleagues provide a road-map for such action, which emphasises upstream health promotion and disease prevention, and includes: improving epidemiology and oral health surveillance

systems; reform of oral health-care systems; integrated community-based models of workforce training; tackling oral heath inequalities; moving upstream to maximise oral health improvements; addressing commercial determinants of oral diseases; advancing and prioritising oral research agendas; and improving global advocacy.[21] Elements of this proposed reform have also been independently advocated within a local context.[7,35] However, operationalisation of these initiatives are non-trivial, and require forward looking co-designed strategies and partnerships. For instance, a major challenge for many health disciplines is how to effectively engage with multicultural communities, not just Māori and Pacific, deliver on the Crown's Treaty obligations, and deal with health inequalities. Understanding and working with communities is vital. It might be that messaging and social media platforms,[36] delivery at non-conventional venues such as churches or other community settings, and employing ethnic-specific oral health champions will be more effective in engaging the families of the most vulnerable children in those communities.[7]Common risk factors shared across a range of oral health and other non-communicable diseases, such as childhood obesity, would benefit from coherent and comprehensive regulation.[7,21] For instance, poor quality, low cost, convenience diets increase the likelihood of both childhood obesity and poor oral health outcomes. Both are common to more deprived communities where many Māori and Pacific people reside. Redressing and rebalancing the underlying commercial determinants of health, particularly sugar, through upstream polices, taxes, and more strongly regulated advertising and product placement is necessary. For Pacific communities, the associated reduction of refined sugar and a promotion of traditional daily diets (not the feast menus often associated with Pacific cuisine) is likely to improve oral health as well as reduce obesity.

The silos separating oral health and general healthcare need to be dissolved, thereby enabling both systems in their health promotion and service delivery.[35] To this end, the CDHB and Pegasus Health (the largest Primary Health Organisation within the region, catering for 445,000 enrolled patients) have entered into a data-sharing arrangement which will inform medical practices about the oral health of their enrolled children and ensure children are accessing oral health services. Recognising the relationship between oral health and health conditions and hospital admissions,[31] this shared formation will help inform and provide earlier detection for prevention measures aimed at reducing children's disease burdens. However, further integration of staff, services and resources is likely to yield even better population outcomes.

While no panacea, universal community water fluoridation appears one obvious upstream population-wide proven intervention. Nationally, approximately 52% of children reside in fluoridated regions.[16] Yet children and adolescents living in areas with fluoridated water have, on average, a 40% lower lifetime incidence of dental decay.[37] The only documented side effect of fluoridation at levels used in New Zealand is minimal fluorosis.[13] Currently, local authorities continue to have the legal authority to fluoridate water supplies; the bill to shift this decision to DHBs has been waiting (for over two years) for its second reading in Parliament. The challenge for the regions with little fluoridation, such as Canterbury and Northland, along with other local authorities who refuse community water fluoridation, is to recognise the significant preventable harm that this decision is causing their constituents. And that this burden of this harm falls heaviest on our most vulnerable. The anti-fluoridation lobby employ many arguments and tactics; most of which lack robust evidence or have credible backing.[38] Within New Zealand, the individual's right to refuse to undergo medical treatment in the form of community water fluoridation was employed as a legal challenge, although dismissed by the New Zealand Supreme Court ruled with its 27 June 2018 judgement.[39] Despite this, community water fluoridation continues to be a contentious issue in Canterbury and beyond; although not within the scientific community.

The Ministry of Health's 2006 strategic vision for oral health called for bold changes, including a much greater emphasis on prevention and early intervention;[40] however, there is scant evidence that this

has either happened or worked. While there have been small improvements in the proportion of children with no caries and overall caries severity, we believe this has obscured a polarisation of the burden of disease—we have not measured what matters but have made what we do measure matter. Despite the gallant and implacable efforts of oral health staff we will continue to witness appalling and inequitable child tooth decay rates.[34] On the grounds of preventable morbidity and the stark inequitably experienced by our most susceptible, we argue that good oral health is a basic human right for all children. Now is the time to act.

Competing interests:
Nil.

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REFERENCES:

1. Broughton JR, Person M, Maipi JT, et al. Ukaipō niho: the place of nurturing for oral health. N Z Dent J. 2014; 110:18–23.
2. Peres MA, Macpherson LMD, Weyant RJ, et al. Oral diseases: a global public health challenge. Lancet. 2019; 394:249–60.
3. Glick M, Williams DM, Kleinman DV, et al. A new definition for oral health developed by the FDI World Dental Federation opens the door to a universal definition of oral health. Int Dent J. 2016; 66:322–4.
4. Casamassimo PS, Thikkurissy S, Edelstein BL, Maiorini E. Beyond the dmft: the human and economic cost of early childhood caries. J Am Dent Assoc. 2009; 140:650–7.
5. Sheiham A. Dental caries affects body weight, growth and quality of life in pre-school children. Br Dent J. 2006; 201:625–6.
6. Bhujel N, Duggal MS, Saini P, Day PF. The effect of premature extraction of primary teeth on the subsequent need for orthodontic treatment. Eur Arch Paediatr Dent. 2016; 17:423–34.
7. Kanagaratnam S, Schluter PJ. A review of early childhood caries, risk factors and preventive strategies. N Z Dent J. 2019; 115:132–50.
8. Thomson WM. Public health aspects of paediatric dental treatment under general anaesthetic. Dent J (Basel). 2016; 4:E20.
9. Hunt GR, Foster Page LA, Thomson WM. Dental treatment of children under general anaesthesia in District Health Boards in New Zealand. N Z Dent J. 2018; 114:156–63.
10. Whyman RA, Mahoney EK, Morrison D, Stanley J. Potentially preventable admissions to New Zealand public hospitals for dental care: a 20-year review. Community Dent Oral Epidemiol. 2014; 42:234–44.
11. Marsh PD. Are dental diseases examples of

ecological catastrophes? Microbiology. 2003; 149:279–94.

12. Sissons CH, Wong L, Shu M. Factors affecting the resting pH of in vitro human microcosm dental plaque and Streptococcus mutans biofilms. Arch Oral Biol. 1998; 43:93–102.
13. Office of the Prime Minister's Chief Science Advisor and the Royal Society of New Zealand. Health Effects of Water Fluoridation: A Review of the Scientific Evidence. Wellington and Auckland: PMCSA and RSNZ, 2014.
14. Bach K, Manton DJ. Early childhood caries: a New Zealand perspective. J Prim Health Care. 2014; 6:169–74.
15. Ministry of Health. Oral Health Data and Stats. 2019. http://www.health.govt.nz/nz-health-statistics/health-statistics-and-data-sets/oral-health-data-and-stats (accessed 11 September 2019).
16. Schluter PJ, Lee M. Water fluoridation and ethnic inequities in dental caries profiles of New Zealand children aged 5 and 12-13 years: analysis of national cross-sectional registry databases for the decade 2004-2013. BMC Oral Health. 2016; 16:21.
17. Shackleton N, Broadbent JM, Thornley S, et al. Inequalities in dental caries experience among 4-year-old New Zealand children. Community Dent Oral Epidemiol. 2018; 46:288–96.
18. Statistics New Zealand. Ethnic group (detailed single and combination) by age and sex, for the census usually resident population count, 2013 and 2018 Censuses (RC, TA, SA2, DHB). 2019. http://nzdotstat.stats.govt.nz/wbos/Index.aspx (accessed 10 January 2020).
19. Greer MH, Tengan SL, Hu KI, Takata JT. Early childhood caries among Hawaii public school children, 1989 vs. 1999. Pac Health Dialog. 2003; 10:17–22.
20. Benjamin RM. Oral health: the silent epidemic. Public Health Rep. 2010; 125:158–9.
21. Watt RG, Daly B, Allison P, et al. Ending the neglect of global oral health: time for radical action. Lancet. 2018; 394:261–72.
22. Bödecker CF. The modified dental caries index. J Am Dent Assoc. 1939; 26:1453–60.
23. Drury TF, Horowitz AM, Ismail AI, et al. Diagnosing and reporting early childhood caries for research purposes. A report of a workshop sponsored by the National Institute of Dental and Craniofacial Research, the Health Resources and Services Administration, and the Health Care Financing Administration. J Public Health Dent. 1999; 59:192–7.
24. American Academy of Pediatric Dentistry and the American Academy of Pediatrics. Policy on early childhood caries (ECC): classifications, consequences, and preventive strategies. Pediatr Dent. 2016; 38:52–4.
25. Harries EHR. "Comforter" caries. Lancet. 1911; 178:1327–8.
26. Ayhan H, Suskan E, Yildirim S. The effect of nursing or rampant caries on height, body weight and head circumference. J Clin Pediatr Dent. 1996; 20:209–12.
27. Ladrillo TE, Hobdell MH, Caviness AC. Increasing prevalence of emergency department visits for pediatric dental care, 1997–2001. J Am Dent Assoc. 2006; 137:379–85.
28. Ministry of Health. Ethnicity Data Protocols for the Health and Disability Sector. Wellington: Ministry of Health, 2004.
29. Titanium Solutions. 2016. http://www.titanium.solutions/ (accessed 3 December 2019).
30. Benchimol EI, Smeeth L, Guttmann A, et al. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) statement. PLoS Med. 2015; 12:e1001885.
31. Aung YM, Tin Tin S, Jelleyman T, Ameratunga S. Dental caries and previous hospitalisations among preschool children: findings from a population-based study in New Zealand. N Z Med J. 2019; 132:44–53.
32. Ministry of Health. Our Oral Health – Key Findings of the 2009 New Zealand Oral Health Survey. Wellington: Ministry of Health, 2010.
33. Editorial. Oral health at a tipping point. Lancet. 2019; 394:188.
34. Martin H. 'Appalling' child tooth decay rates in Northland and Auckland. 2019. http://www.stuff.co.nz/national/health/111956057/appalling-child-tooth-decay-rates-in-northland-and-auckland (accessed 2 December 2019).
35. Jatrana S, Crampton P, Filoche S. The case for integrating oral health into primary health care. N Z Med J. 2009; 122:43–52.
36. Schluter P, Lee M, Hamilton G, et al. Keep on brushing: a longitudinal study of motivational text messaging in young adults aged 18-24 years receiving Work and Income Support. J Public Health Dent. 2015; 75:118–25.

37. Sapere Research Group. Review of the Benefits and Costs of Water Fluoridation in New Zealand. Wellington: Ministry of Health, 2015.

38. American Dental Association. Fluoridation Facts. Chicago, IL: American Dental Association, 2018.

39. Courts of New Zealand. New Health New Zealand Incorporated v South Taranaki District Council [2018] NZSC 60. 2018. http://www.courtsofnz.govt.nz/cases/new-health-new-zealand-incorporated-v-south-taranaki-district-council-2/?searchterm=fluoride (accessed 24 March 2020).

40. Ministry of Health. Good Oral Health for All, for Life: The Strategic Vision for Oral Health in New Zealand. Wellington: Ministry of Health, 2006.