



# Caries Risk Management Protocols in Australia and New Zealand: a Scoping Review

## Background

The introduction of community water fluoridation programs, fluoridated dentifrices and other professional products alongside enhanced oral self-care practices have contributed to a general decline in dental caries experience globally. This is particularly noticeable over the past few decades amongst high-income countries.<sup>1,2</sup> The WHO Global Oral Health Data Bank<sup>1</sup> report showed that Australian and New Zealand children have experienced very low (mean DMFT <1.2) and low (mean DMFT between 1.2 and 2.6) levels of dental caries in children aged 12 years, respectively, whereas the adult cohorts of both these countries presented high caries levels (mean DMFT >13.9) at 35-44 years of age.

Moreover, certain groups within these countries are at a higher risk of developing dental caries than others. This may be attributed to differences in both the individual characteristics and the social context in which people live. Migrants, Indigenous populations, institutionalised older adults and those living in geographically remote areas have greater experience of dental caries than their counterparts who are socially and economically better-off<sup>3</sup>. For example, the prevalence of dental caries in 35-44 year old Indigenous Australian and New Zealand populations is 10% and 32%, respectively, higher than their non-Indigenous counterparts<sup>4,5</sup>. In this context, respectively, documentation and implementation of caries risk management is critical and particularly important in providing the best patient care.

## Management of Dental Caries

The conventional approach of operative management of dental caries has focused on identifying dental decay, removing diseased tissue and restoring the cavity<sup>6</sup>. With the recurrence of caries in already restored teeth and/or the failure of restorations, this approach has led to the vicious cycle of re-removal of carious tissue/failed restorations, progressive loss of sound tooth tissue, weakening of tooth structure and eventual loss of teeth<sup>6-8</sup>. Despite the introduction of new adhesive restorative materials and minimal intervention dentistry in the early 1990s intended to preserve sound tooth structure,<sup>6,7</sup> the focus of caries management in general dental practices has been largely operative<sup>9</sup>. Against this backdrop, the importance of using preventively-oriented evidence based caries risk management protocols in the overall prevention and control of dental caries cannot be understated.

While a range of caries risk assessment and management protocols has been reported in the literature, a majority of them have been confined to specific caries management protocols involving one

individual strategy rather than a combination of strategies. For example, the Cochrane Database of Systematic Reviews have reported more than 20 caries risk management protocols, which have discussed the effects of a single strategy on caries management such as water fluoridation<sup>10</sup>, pit and fissure sealants<sup>11</sup>, fluoride varnishes<sup>12</sup>, fluoride mouthrinses<sup>13</sup> and fluoride toothpastes<sup>14</sup>. However, a few protocols including Caries Risk Assessment Tool (CAT)<sup>15</sup>, Caries Management by Risk Assessment (CAMBRA)<sup>16</sup>, Cariogram<sup>17</sup>, Traffic Light Matrix (TLM)<sup>18</sup> and Caries Management System (CMS)<sup>9</sup> have incorporated a combination of strategies in assessing risk and managing caries.

By means of a scoping review with a systematic search, this information sheet identifies and maps the caries risk management protocols which have been used in Australia and New Zealand and reported in the existing literature.

### What is a scoping review?

A scoping review, also known as a mapping review, can be regarded as a method of mapping the fundamental notions underlining a research area including the type and magnitude of evidence available<sup>19,20</sup>. It can be used to:

- > explore the nature and extent of a research activity as a rapid review
- > detect the importance of conducting a full systematic review
- > recap and publicise research findings
- > recognise research gaps in the current literature

## Caries risk management protocols reported in Australia and New Zealand

> **Inclusion criteria:** Descriptive, cross-sectional, case-control, cohort and interventional studies including randomised-controlled trials which have been based on caries risk management protocols, written in English and limited to Australia and New Zealand were included in the review. There was no restriction on age, sex or publication time.

> **Exclusion criteria:** Articles written in languages other than English, studies not conducted in Australia and New Zealand, studies focusing on medically compromised individuals, case reports/case series, letters to editors, opinions, reviews, conference abstracts and dissertations were excluded from the review.

> **Search Strategy:** Five databases, namely, PubMed, Web of Science, Scopus, Embase and Dentistry and Oral Science were electronically searched. Subsequent to an initial search conducted in PubMed and Embase, text words in title as well as abstracts and index terms of articles were analysed. Then a search including all identified key words and index terms were conducted across the five databases. A research librarian was also consulted to develop the search strategy. Figure 1 shows the flow chart of the scoping review process including the study selection.

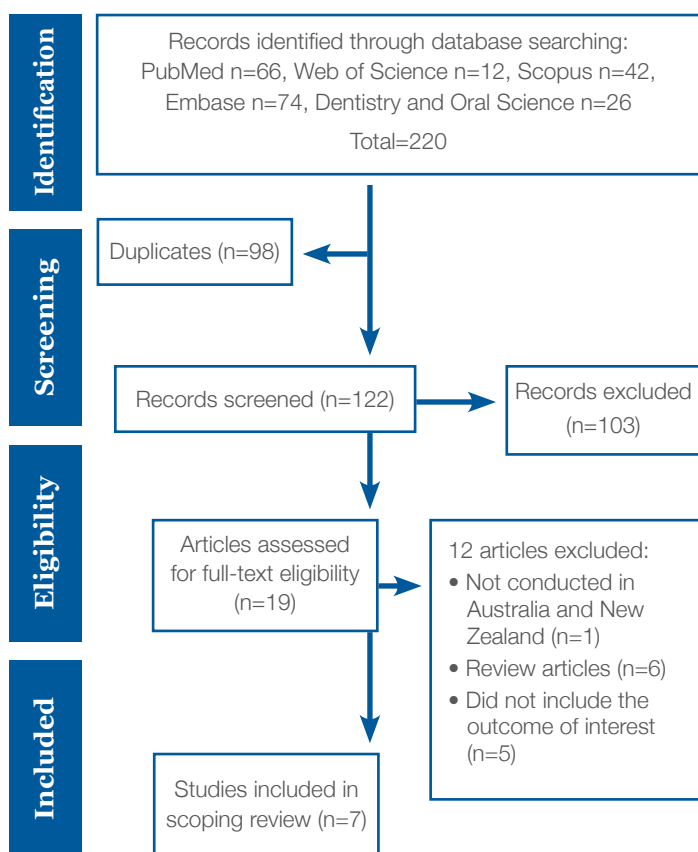


Figure 1. Preferred Reporting Items for Systematic reviews and Meta-analysis (PRISMA) <sup>21</sup> Flow Diagram for the scoping review process

## Protocols used in Australia and New Zealand

Tables 1 and 2 show the basic characteristics and main findings of seven articles included in the scoping review, which have been reported in Australia until 2016.

It was disclosed that apart from a pragmatic parallel group RCT, all other six studies have focused on the Caries Management System (CMS). The former study conducted by Arrow and Klobas<sup>22</sup> comparing the efficacy of Minimum Intervention Dentistry with Atraumatic Restorative Treatment (MID-ART) as opposed to the standard care in successfully managing Early Childhood Caries (ECC) have defined successful management of ECC as managing dental treatment needs of the child without referring to a specialist.

Author (year)	Age	Study design	Sample size
Arrow & Klobas (2015) <sup>22</sup>	<6 years	A pragmatic, parallel group, Randomized Clinical Trial (RCT)	254 (Test, 127: Control, 127)
Curtis et al. (2011) <sup>23</sup>	5-89 years	Three-year multicentre cluster RCT	902 patients (Test=452: Control=450) from 22 private dental practices.
Evans et al. (2008) <sup>9</sup>	-	Descriptive	No sample
Evans et al. (2009) <sup>24</sup>	-	Descriptive	No sample
Evans et al. (2016) <sup>25</sup>	45-89 years	Two and four-year follow-up of a 3-year RCT conducted by Curtis et al. (2016)	At 2 years 302 patients (Test=63 from 4 practices: Control=239 from 8 practices) and 4 years 214 patients (Test=52 from 4 practices: Control=162 from 7 practices)
Warren et al. (2010) <sup>26</sup>	5-89 years	Decision analytic model constructed on data from a 3-year RCT conducted by Curtis et al. (2016)	Hypothetical sample of 10,000, representative of the Australian population.
Warren et al. (2016) <sup>27</sup>	45-89 years	Decision analytic model constructed on the 4-year post-trial follow-up data from a study conducted by Evans et al. (2016)	10,000 hypothetical sample of patients, representative of the Australian population.

Table 1. Basic characteristics of the studies included in the scoping review

They found that providing MID-ART for children with ECC significantly reduced the likelihood of them being referred to a specialist. In addition, this increased the chance of them being provided with treatment while having the potential to decrease the cost of care. The authors were wary of a potential influence of the pragmatic nature of the trial, which compelled them to deliver the standard care to the control group through the public dental service.

## Caries Management System (CMS)

The CMS has been introduced as a structured evidence-based non-invasive strategy to manage caries risk by arresting and remineralising non-cavitated lesions<sup>9,24</sup>. The fundamental basis for caries management in the ten-step strategy of the CMS was consideration of the patient at risk, the status of each lesion, patient management, clinical management and monitoring. A detailed history is taken to review risk factors for caries including sugar consumption, fluoride use and evaluation of dental plaque control, which is followed by a thorough clinical examination to detect enamel cracks and incipient caries. If frank cavitation is not evident, bitewing radiography is used to record radiolucency of the lesions and diagnose dentine caries. Based on the clinical examination, bitewing radiography, clinical presentation at the first visit and the incidence of new lesions at follow-up, caries risk

status of the patient is assessed. Taking the status of the lesion into consideration, the lesions extending beyond the outer one third of dentine are restored, while those that are within the outer third of dentine are provided with 3-monthly professional fluoride varnish applications alongside home care of toothbrushing with a fluoride toothpaste, twice a day. According to the authors this approach ensures a decrease in caries risk status of such lesions, which is monitored at six monthly recall visits by clinical examination and bitewing radiography. Neither dealing directly with managing cavitated/symptomatic lesions nor focusing on managing patients with acute rampant caries associated with severe hyposalivation are the limitations of the CMS, as mentioned by the authors.

However, the authors were cautious about applying their findings to settings other than that in which they were originally tested and also about the effect of different values of input variables on the output of the statistical models that they used. This 3-year trial was followed up by a comparison of patient and practice-level DMFT increments between the test and control group, at 2-4 years post-trial<sup>25</sup>. This study showed that the test group provided with the CMS had a significantly smaller DMFT increments and lower odds of becoming high risk than the control though the authors had been cautious about the interpretation of the findings due to high attrition rate. The data from the 3-year trial were used to construct a patient level simulation decision analytic model,

Author (Year)	Protocol/Methods	Main findings	Limitations
Arrow & Klobas (2015) <sup>22</sup>	Minimum Intervention Dentistry with Atraumatic Restorative Treatment (MID – ART) was provided to the test group and standard care to the control group to treat early childhood caries (ECC).	Children provided with MID-ART were significantly less likely to be referred for special care and more likely to be provided with treatment.	Due to the pragmatic nature of the study, standard care was provided by both dentists and dental therapists working in public dental service while MID-ART was performed by school dental therapists who were additionally trained on the MID-ART.
Curtis et al. (2011) <sup>23</sup>	Monitor Practice Programme (MPP) based on the methodology of Caries Management System (CMS) was provided to the test group and the control with standard care. Both groups were followed-up for 3 years and the efficacy and cost-effectiveness of the MPP compared to standard care were reported.	Efficacy of MPP was high with lower caries increment both at 2 and 3-year follow-up in test group compared to control. Cost per DMFT avoided was A\$1287.07 at 2 years and A\$1148.91 at 3 years pointing to the cost-effectiveness of the MPP.	Study was confined to 22 volunteer private practices and hence, the generalisability of the findings was limited. No validated measure of compliance was used to adjust for compliance in the sensitivity analysis of the model.
Evans et al. (2008) <sup>9</sup>	Caries Management System (CMS) for adults	Descriptive study	Apart from identifying operative care needs of cavitated or symptomatic lesions, the CMS does not deal directly with managing such lesions. The CMS does not focus on managing patients with acute rampant caries caused by excessive lack of saliva.
Evans et al. (2009) <sup>24</sup>	Caries Management System (CMS) for children and adolescents	Descriptive study	
Evans et al. (2016) <sup>25</sup>	Caries Management System (CMS) was provided to the test group and standard care to the control. Patient-level and practice-level DMFT increments were estimated at 2 and 4 years post 3-year RCT.	The test group had a significantly smaller DMFT increment than the controls (28% difference). The test group had significantly lower odds of becoming high risk than controls (OR=0.23, 95% CI=0.66, 0.88).	High rate of attrition – nearly 600 patients and 8 practices were lost to follow-up over 4 years - had influenced the power of the study and hence, the findings need to be interpreted cautiously.
Warren et al. (2010) <sup>26</sup>	Long-term outcomes and costs between Caries Management System (CMS) and standard dental care were compared using a patient level simulation decision analytic model.	The incremental cost per DMFT avoided was projected to be A\$1287.07, A\$1148.91, and A\$1795.06, respectively, at 2 years, 3 years and lifetime. The CMS was more likely to be cost-effective in patients with a high caries risk.	Only specific transitions in health states were permitted in the model. Each individual event was given an equal weight. The generalisability of the findings could be affected due to higher reimbursements.
Warren et al. (2016) <sup>27</sup>	A patient level simulation decision analytic model was developed to re-evaluate the long- term cost-effectiveness of the CMS in a real life per-protocol setting.	In the CMS and the control groups A\$5,689 and A\$3,613, respectively, were discounted per patient over 7 years. The CMS was found to be more cost-effective if the CMS protocol was properly adhered to.	Since the D was not recorded the findings could not be compared with other studies where DMFT was used. The model assumptions on transition of future events would underestimate new restorative events over the life course.

**Table 2. Protocol, main findings and the limitations of the studies included in the scoping review**

The remaining four studies have focused on evaluating the long-term cost-effectiveness and outcomes of the CMS. A 3-year multicentre cluster trial among 902 patients from 22 private dental practices providing the CMS and standard care, respectively, to the test and control groups revealed that both the efficacy and cost-effectiveness of CMS were higher than the standard care at 2 and 3-year follow-up<sup>23</sup>.

which was based on eight Markov sub models with 11 health states to compare long-term outcomes and costs between the CMS and standard dental care<sup>26</sup>. While emphasising some limitations including the model permitting only specific transitions in health states, equal weight given by the DMFT for each individual event and the potential effect of higher reimbursements on the generalisability of the findings,

the authors concluded that the CMS would be more likely to be cost-effective in high caries risk patients. Based on the same model, the long-term cost-effectiveness of the CMS in a real life per-protocol setting was re-evaluated<sup>27</sup> by using the 4-year post-trial follow-up data from a previous study<sup>25</sup>. The efficacy was represented by the number of restorative events avoided due to the CMS while the additional cost per restorative event avoided represented the incremental cost-effectiveness ratio (ICER) in their analysis. Despite the limitations of not recording the D component of the DMFT and the potential underestimations made by the model of new restorative events over the life course, the authors disclosed that the CMS would be more cost-effective if the CMS protocol was properly adhered to.

In summary, this scoping review identified that:

- > Among the caries risk management protocols, which have been used in Australia and New Zealand, the CMS has been studied at length and exclusively reported in Australia.
- > The proponents of the CMS have made several attempts to evaluate the long-term cost-effectiveness and outcomes of the CMS in patients ranging from 5-89 years while highlighting its restrictions in managing cavitated or symptomatic lesions and patients with acute rampant caries.
- > Studies have been focused on the assessment of individual behavioural risk factors for dental caries when developing and implementing the caries management systems.

## Recommendation:

Consideration of both the individual characteristics and the social context of different population groups when developing caries management systems may assist in improving the effectiveness of clinical care provided by the dental practitioners.

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