A Systematic Review of Evidence on Caries Risk Assessment for Preschool Children and Recommendations for the Development of a Canadian Caries Risk Assessment Tool for Screening Purposes

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Background: Despite all the advancements in dental prevention over the past decades, the problem of early childhood caries (ECC) and severe ECC (S-ECC) persists in the twenty first century. Evidence from the United States would suggest that while the prevalence of caries among older children, youth and adults has declined, the prevalence of ECC in the preschool population has actually increased.[1] Indigenous children (including First Nations, Métis, Inuit, American Indian, and Alaska Natives), immigrants and refugees, children living in poverty, and those residing in isolated rural and remote communities are more likely to be affected by ECC than other children in North America.[2-7] However, while ECC may be concentrated in children from these groups, it does not discriminate and can also cross cultural and socioeconomic boundaries.

For many children with S-ECC, dental surgery under general anesthesia is the only treatment option.[8] In-hospital day surgery to treat S-ECC is the most common day surgical procedure in Canada.[9] The hospital costs to perform these dental surgeries exceeds $21 million each year.[9] Rates of dental surgery performed under general anesthesia are a useful indicator of the oral health status of young children when national clinical surveillance data is unavailable as it provides a snapshot of the most severe cases.[10] A recent report from the Canadian Institute of Health Information in 2013 revealed that the rate of dental surgery to treat S-ECC in Canada is 12.5/1000 children 1-5 years of age.[9] Children living in rural regions of Canada, from the least affluent households, and residing in neighbourhoods with a high percentage of Indigenous residents demonstrate higher rates of dental surgery.[9] The rates of dental surgery for S-ECC are even higher in northern portions of Canada (up to 227/1000 children), where many First Nations and Inuit communities are located.[9, 10] Unfortunately, this surgical approach

fails to address the underlying risk factors for S-ECC as many develop new or recurrent caries within months of surgery.[8] It is not uncommon for some children to undergo repeat visits to the operating room because of recurrent caries.[8] This highlights the importance of implementing an upstream effective prevention regimen to complement restorative care.

Like other chronic diseases, ECC is multifactorial in origin. While we are all familiar with the basic etiological triad, including teeth, bacteria, and sugars, there are other oral environmental, social, economic, personal factors and lifestyle behaviours at play.[11, 12] Childhood caries is shaped by a broad range of determinants of health. The Fisher-Owens conceptual model describes the various child (e.g. biological and genetic endowment, physical and demographic characteristics, use of dental care, etc.), family (e.g. socioeconomic status and family finances, health practices and behaviours, culture, family make-up, etc.), and community (e.g. health and dental care systems, physical and social environments, culture, etc.) level factors that shape a child's dental health. The multiple factors at play is what makes preventing caries so difficult in young children. The Canadian Dental Association (CDA) recognizes the role that these non-biomedical factors have in caries development and specifically mentioned that ECC is heavily influenced by the social determinants of health in their formal position statement on this disease process.[13]

The goal of caries-risk assessment is to help predict development or progression of caries lesions overtime, while at the same time aiding in providing patient-centered caries prevention and management strategies for patients. What makes caries risk-based care unique over traditional surgical/restorative approaches to dealing with caries lesions is that there is emphasis on intervening before there is irreversible damage to teeth, tailored on individual

needs.[14-16] It is vital that dentists and other members of the dental team familiarize themselves on how to undertake periodic caries-risk assessments of their patients. Caries-risk assessment tools can also be used by non-dental professionals to screen children, determine their caries-risk, and provide prevention services, including fluoride varnish and anticipatory guidance.

Several dental and pediatric organizations have developed tools that can be used to help guide practitioners in determining someone's likelihood of developing caries. These tools provide a means to allow practitioners to identify risk factors, disease causative behaviours that can promote caries, along with protective factors known to minimize the risk of onset.[13]

Timely risk assessment is an important first step in a combined approach to reduce the risk for ECC. [17] It can help identify whether a child is at low, moderate, or high likelihood of developing caries, and can serve as a guide to choosing appropriate preventive interventions and practices that can help minimize the risk for decay. These tools help guide the conversation between the dental provider and the parent or caregiver so that key information is obtained to assist in identifying many of the protective and caries-causing factors that are at play in a child's life.

Update to Systematic Review Since Initial Report was Submitted to the Public Health Agency of Canda (PHAC):

The Office of the Chief Dental Officer (OCDO) initiated this caries risk assessment project and commissioned a contract in 2017 to first explore the body of evidence as a means to develop and create a Canadian caries risk assessment tool that would allow non dental primary

healthcare providers and dental providers in non-dental clinical settings to assess the risk of tooth decay for kids under the age of six.

In March 2018, the OCDO at PHAC convened an important interprofessional stakeholder meeting of experts and potential users to discuss the findings from the initial report systematic review of the literature (November 2017), the review of existing tools, and the draft version of the caries risk assessment tool. Participants at this two-day meeting included staff of the OCDO, representatives of the Canadian Paediatric Society, Canadian Academy of Pediatric Dentistry, and the Canadian Association of Public Health Dentistry. Representatives from the Canadian Dental Association, Canadian Dental Hygienists Association, Canadian Dental Assistants Association, Saskatchewan Dental Therapists Association, and the College of Family Physicians of Canada, the Canadian Dental Regulatory Authorities Federation and the Association of Canadian Faculties of Dentistry attended as observers attended as observers.

Participants and observers at this meeting discussed the draft version of a tool that was developed following a systematic review of the literature and accompanying assessment of the level of evidence, a comprehensive review of existing caries risk assessment tools for children, and informed by Canadian evidence of risk factors for ECC, to debate questions that should be included in a proposed tool for preschool children. Following deliberations, a leaner seven-item draft caries risk assessment tool resulted comprising three domains: clinical factors, sociodemographic and biological factors, and protective factors. The working group also recommended that the initial systematic review report be amended to include an additional robust critical appraisal and to focus group test the drafted tool with non-dental primary care providers and other experts and to propose a refined tool for discussion at a follow-up meeting

with the stakeholder group in November 2018. This necessitated the OCDO at the PHAC to enter into a second contract with the project lead to undertake these additional activities. However, that project does not include pilot testing of this tool to determine its potential sensitivity and specificity.

Notable Reports and Systematic Reviews on Caries Risk Assessment (as reviewed by Fontana 2015):[18]

Over the years there have been several well conducted systematic reviews and commentaries on the topic of caries risk assessment.[19-26] The following are some highlights:

National Institutes of Health Consensus Development Conference Statement, March 26-28, 2001[26]

This NIH Conference discussed the question of "what are the best indicators for an increased risk of dental caries?". It concluded that although numerous risk indicators for caries exist, past caries experience is the most consistent predictor of caries risk in children. Other factors identified to increase risk included inadequate exposure to fluoride, inadequate oral hygiene and conditions that hinder regular long-term oral hygiene, fermentable carbohydrates consumption, medical conditions that impact salivary flow, the presence of mutans streptococci bacteria, and low socioeconomic status (SES).[27] However, much of the supportive evidence comes from cross-sectional correlations depicting accumulated caries experience, with few prospective predictive studies.[27]

Swedish Council on Technology Assessment in Health Care (2007)[28]

This 2007 report was a systematic review of caries diagnosis, risk assessment, and non-invasive treatment. This review revealed that past caries experience is the strongest single predictor of

future caries risk, and other factors have limited accuracy when assessed individually to determine caries risk.[18, 28] This systematic review supported use of multivariate models for caries prediction.[18, 28]

Tellez et al 2013[23]

A 2012 systematic review by Tellez et al concluded that there was limited and weak evidence on the validity of several caries risk assessment systems in use.[23] The authors concluded that most of the existing evidence was associated with use of the Cariogram, a computer-based risk-algorithm software, and yet that this tool has limited prediction accuracy, particularly in preschool children.[23] They concluded that there is a considerable need to establish valid and reliable means to assess caries risk based on evidence rather than the opinion of experts in the field.[23]

Scottish Intercollegiate Guidelines Network (SIGN)[29]

In 2014 the Scottish Intercollegiate Guidelines Network (SIGN) published a report "Dental interventions to prevent caries in children – A national guideline".[29] This document reviewed caries risk indicators, and caries risk assessment tools.[29] Considerable numbers of caries risk indicators have been identified, including: dietary factors, oral hygiene factors, microbiological factors, socio-demographics, and previous caries experience.[29] The SIGN report concluded that there was generally high quality evidence from systematic reviews (of case control and cohort studies) and high quality case control and cohort studies with a very low risk of confounding or bias. There is a high probability that the relationship is causal for caries, for the following factors: microbiological risk factors (e.g. levels of mutans streptococci), sociodemographic risk factors (e.g. low socioeconomic status, those living in areas of high deprivation, low

birthweight), previous caries experience, reduced salivary flow, and parental influences (e.g. presence of active decay in mothers, maternal levels of oral mutans streptococci, high maternal sucrose intake).[29] However, there is only evidence from non-analytic studies (e.g. case reports) relating to parental deprivation as a risk indicator for caries development in their children, and there is only expert opinion that salivary markers have proved helpful in determining caries risk.[29]

Overall, the SIGN document recommended that the following be considered when determining future caries risk for children[29]:

- Clinical evidence of previous disease (i.e. past caries experience)
- Dietary habits, especially frequency of sugary foods and drinks
- Social histories, particularly socioeconomic status
- Use of fluorides
- Oral hygiene and plaque control
- Saliva
- Medical history

Mejàre et al 2014[20]

This systematic review also identified that past caries experience is the best and most reliable predictor of future caries in preschool children, having moderate to good accuracy in this age group.[20] This review also indicated that the Cariogram has limited accuracy in predicting caries and supported the use of multivariate prediction models for preschool caries risk assessment.[20]

According to Twetman and Fontana, the following are some examples of factors routinely considered for a caries risk assessment[25]:

Table 1 – Factors routinely considered in caries risk assessment tools

Variable	Quantification	High-risk values
Sociodemographic		
Socioeconomic level	Education level	Low
Immigrant background	Parent generation	Mother 1st generation
Behavioural		
Mental or physical disabilities	Case history	Medication, impaired priority
Awareness and attitudes	Interview	Poor "health choices"
Diet and sweet intakes	Frequency	Cariogenic and several times daily
Juice and soft drinks	Habit and frequency	Sipping and several times daily
Nocturnal meals (toddlers)	Frequency	Regular habit
Toothbrushing	Frequency	Irregular, not supervised
Fluoride exposure	Frequency	Non-daily
Clinical and radiographic		
Caries prevalence	dmft/DMFT	Clearly higher than average for age
Proximal enamel lesions	bitewing radiographs	> 2 new lesions or progression
Oral hygiene level	visible plaque index	> 50% of inspected sites
Gingival condition	bleeding on probing	> 20% of measured sites
Supplementary tests		
Bacterial challenge	Cultivation	High mutans streptococcus counts
Salivary secretion rate	Sialometry	< 0.5 ml/min (stimulated)
Salivary buffer capacity	Titration	Low (pH ≤ 4.0)
The indicated values are suggestive of a high caries risk, but may vary by age and population and should be correspondingly adjusted.		

Sensitivity and Specificity of Caries Risk Assessment Tools:

One of the limitations of many caries risk assessment tools is that the majority have not been validated, and almost none has been validated across different population groups. The validity of a tool can be determined by assessing the sensitivity and specificity of the instrument.[21, 22, 26] .[21,] Sensitivity in the context of caries risk assessment refers to the capability

of the tool to predict future caries risk in someone who actually does develop caries lesions. Specificity refers to the likelihood that a tool will predict the absence of caries in those who actually do not go on to develop lesions. It has been suggested that for a caries risk assessment tool to be useful, it should have a combined sensitivity and specificity score of at least 160%, and should be relatively well-balanced between these two measures.[22]

Well-designed and contemporary caries risk assessment tools can facilitate clinical dental examinations as they help guide and prompt clinicians to review and query parents regarding a multitude of factors that are recognized to contribute to disease development and progression.[26] Unfortunately, many of these instruments are not validated. A study by Gao et al (2013) explored the validity of caries risk assessment programs and tools for use with preschool populations.[22] They explored the predictability, sensitivity and specificity of the American Academy of Pediatric Dentistry's (AAPD) Caries Risk Assessment Tool, the Caries Management by Risk Assessment (CAMBRA), the Cariogram, and the National University of Singapore caries risk assessment program (NUS- CRA).[22] They concluded that algorithm-based software programs like the NUS-CRA (which this group developed) and Cariogram had a better balance of sensitivity and specificity over the other checklist style caries risk assessment tools, with the NUS-CRA performing better than the Cariogram (Sensitivity/Specificity of its screening and comprehensive models were 82%/73% and 81%/85%).[22] However, these algorithm-based programs may not be always practical for use in screening situations.

Objective/Goal: Conduct critical appraisal of the most current evidence on caries risk assessment for children that will lead to a national assessment tool to be use by the body of

non-dental primary care providers working in medical homes and oral health professionals working in non-conventional clinical settings in order to assess the risk of tooth decay and thereby, leading to better determine their young patients' caries-risk level, and provide prevention services including fluoride varnish and anticipatory guidance.

Methods:

There were three main activities as part of this project. They were to:

1. Critically appraise the evidence on caries-risk assessment for children to inform the refinement of the caries risk assessment tool for use by non-dental primary healthcare providers in Canada.
2. Review of existing tools.
3. Build a form-based tool that can be easily administered and used by oral health and non-dental primary healthcare providers to assess caries susceptibility in Canadian children.

Search Strategy:

A formal search strategy was undertaken by Janet Rothney (JR), Dentistry Librarian at the University of Manitoba (Table 2). The search strategy was informed by previous search strategies used in other systematic reviews on caries risk assessment.[20-23, 30] Systematic searches were conducted in MEDLINE Ovid (1946 to 2017 Aug 09), Cochrane Library (searched 11 August 2017), Embase Ovid (1974 to 2017 Aug 09) and Scopus (searched 10 August 2017). No language and publication date limits were employed; letters and editorials were excluded where possible. Search strategies were modelled on the MEDLINE Ovid strategy (Table 2). 1921

results were gathered and duplicates were removed in EndNote by JR, with a final tally of 980 unique articles (Figure 1).

All abstracts were reviewed by the project lead (RJS – Team 1) and two additional teams (Team 2: CG, TK, RS and Team 3: CD, DD, DD). Inclusion criteria for selection of articles appear in Table 1. Articles were fully reviewed if an abstract was selected by a minimum of two review teams. For the purpose of this project, only those articles involving children < 72 months of age were selected (65 articles – see Figure 1). Those articles involving children six years of age and older will serve as a separate CRA project (69 articles – see Figure 1). Potential variables to include into the draft caries risk assessment tool for use were based on strength of associations (e.g., odd ratios, relative risk, hazard ratios, etc.), frequency of occurrence in the identified studies and existing caries risk assessment tools, as well as factors that were feasible to include. Quality of the evidence assessments performed by at least two review teams through consensus following GRADE.

Table 2 – Ovid MEDLINE(R) Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily and Ovid MEDLINE(R) 1946 to Present (Searched August 10, 2017)

1. exp dental caries/
2. risk assessment/
3. (risk* adj3 assess*).ti,ab.
4. dental caries.ti,ab.
5. 1 or 4
6. 2 or 3
7. infant/ or exp child/ or exp childhood/ or adolescent/ or adolescence/ or "minor (person)"/ or puberty/ or exp pediatrics/ or school/ or high school/ or kindergarten/ or middle school/ or nursery school/ or primary school/ or (infant* or infantcy or newborn* or baby* or babies or neonat* or preterm* or prematur* or postmatur* or child* or schoolchild* or school age* or preschool* or kid or kids or toddler* or adoles* or teen* or boy* or girl* or minors or pubert* or pubescen* or p?ediatric* or pe?diatric* or nursery school* or kindergar* or primary school* or secondary school* or elementary school* or middle school* or high school* or highschool*).ti,ab.
8. and/5-7
9. limit 8 to (editorial or letter)
10. 8 not 9

Table 3 – Inclusion Criteria for Reviewing Articles from Caries Risk Assessment Literature Search (modified from Mejàre et al[19] and Zero et al[30])

Study Design: ▪ Prospective/longitudinal cohort studies OR randomized controlled trial ▪ Studies using the same sample, but a different prediction model for caries risk are acceptable ▪ Studies using ≥ 1 risk factors/etiological factors/causative factors as a predictor of caries risk are acceptable (e.g. past caries experience; microbiological factors; host factors – enamel defects/hypoplasia, saliva flow rate; diet, socioeconomic; fluoride exposure; oral hygiene; etc.) ▪ Studies only looking at previous caries experience as a predictor of caries risk are acceptable.
Study Sample: ▪ Inclusion criteria for study defined, selection of study sample declared ▪ Population defined and representativeness of sample understandable (no appearance of selection bias) ▪ Demographic characteristics of participants described ▪ Clinical characteristics of participants described ▪ All participants initially involved should be included.
Methods: ▪ Caries diagnostic criteria described ▪ Predictor factors/variables are defined ▪ Validation variables are defined ▪ Studies involving only 1 dental examiner allowed if the same person completed both baseline and follow-up exams.
Follow-up Time: ▪ ≥ 1 year follow-up for primary teeth ▪ ≥ 2 year follow-up for permanent teeth.
Outcomes and Analysis: ▪ Caries incidence or caries increment (dentin and/or enamel) reported at the tooth and tooth surface level ▪ Predictive validity: sensitivity and specificity are reported, relative risk, odds ratio, hazard ratio, caries rate ratio (incidence density ratio) or area under ROC curve. For this systematic review we will only include articles that reported sensitivities and specificities derived from multivariate analysis, which allows us to compare predictors across included articles. ▪ Studies on post-eruptive age as a risk factor for caries will be included if caries rate (incidence density) or some other survival analysis is performed or possible to calculate from reported study data.

Results:

<u>Part A – Systematic Review of the Current Evidence on Caries-Risk Assessment in Children</u>

A total of 25 publications met the inclusion criteria for this systematic review (Figure 1).[17, 22, 31-53] All of the included studies were prospective in design, either beginning during early childhood or prenatally. Included articles were carefully scrutinized and data were extracted from each. Key findings from multivariate analyses in these publications appear in Table 4. Quality of the evidence assessment result can also be found in Table 4. Table 5 provides an overall synopsis of the evidence from the studies.

Figure 1 – PRISMA Flow Diagram

PRISMA 2009 Flow Diagram

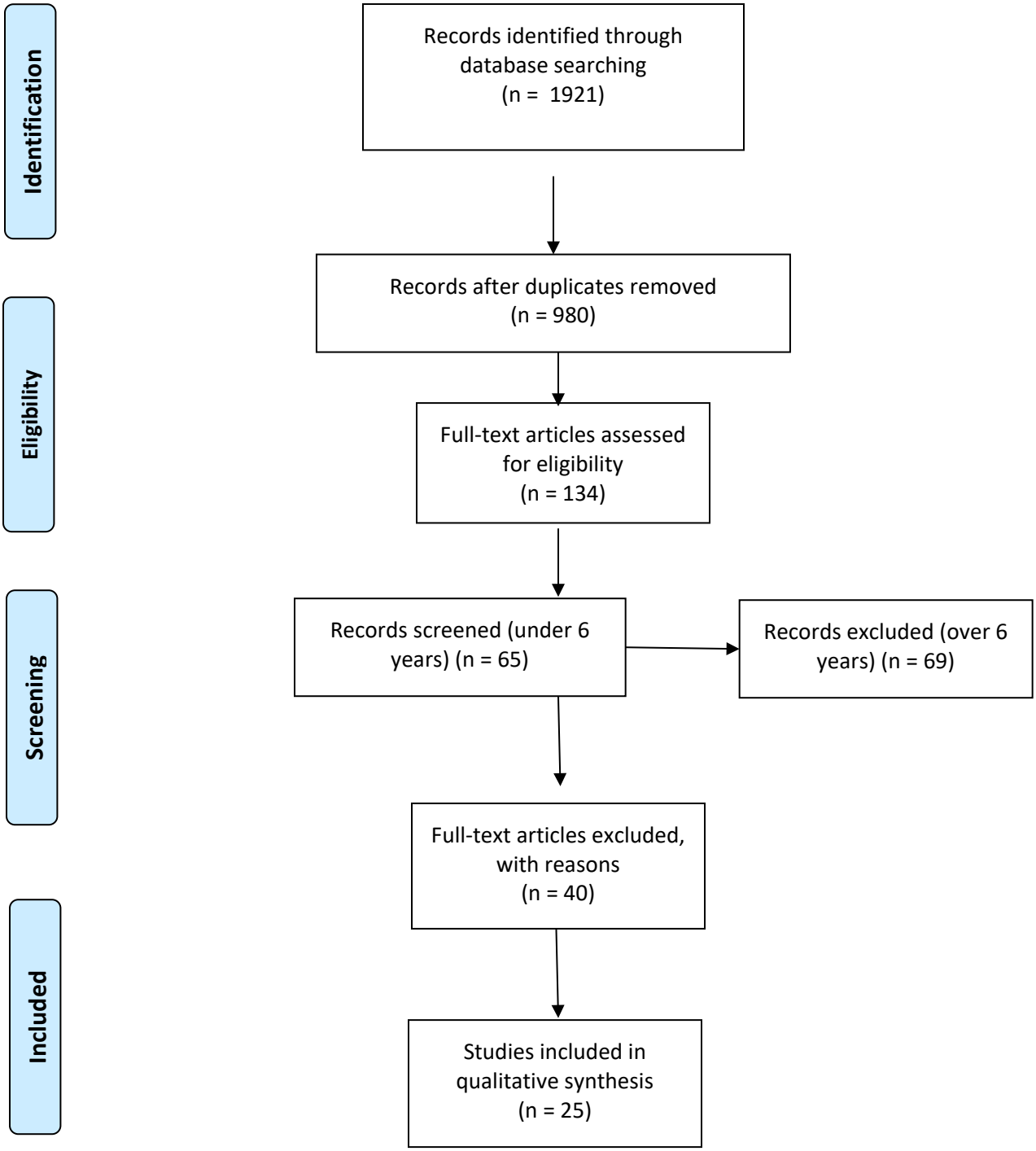


Table 4 – Summary of Included Articles in Systematic Review (modified from Mejàre et al[20])

Reference	Age at Start (years)	Possible Predictors of Risk Assessed	Outcome in Final Model	Quality of Evidence
Leverett et al 1997[47]	Birth cohort	Prenatal fluoride supplementation Sex	Poisson regression: No significant association of prenatal fluoride supplementation with caries at age 3 to 5 years	⊕⊕⊕⊕ **High**
Pienihakkinen et al 2004[31]	2 years at baseline	Mutans streptococcus from plaque Previous caries experience d1-3mfs Visible plaque Gingival Bleeding Fluoride use Frequency of candy consumption	Mutans streptococcus from plaque (OR 3.9) Previous caries experience d1-3mfs (OR 7.3) Frequency of candy consumption (OR 3.6)	⊕⊕○○ **Low**
Skeie et al 2004[53]	5 year olds	Previous caries experience	≥ 1 one caries lesion (d1-5mfs) on proximal surface or molars at 5 years of age (OR 4.4) Total d1-5mfs > one standard deviation above mean at 5 years of age (OR 3.8)	⊕⊕○○ **Low**
Ji et al 2006[33]	1.5 years at baseline	Cariostat completed for each child Breastfeeding Eat snacks while playing Frequency of snacks Brushing assistance by mother Set time for snacks	Risk factors at 18 months to predict caries at 42 months: Breastfeeding (OR 3.3) Eat snacks while playing (OR 2.3) Risk factors at 30 months to predict caries at 42 months: Eat snacks while playing (OR 1.6) No brushing assistance by mother (1.8)	⊕⊕○○ **Low**
Alaki et al 2008[37]	Birth cohort	Acute otitis media (medical claims)	Acute otitis media and respiratory tract	⊕⊕○○ **Low**

		Respiratory tract infections (medical claims) Urinary tract infections (medical claims Race Sex	infection at 0-12 months (HR 1.3) Male (HR 1.1) Hispanic (HR 1.8) African American (HR 1.6)	
Hong et al 2009[41]	0.5-2 years at baseline (Iowa Fluoride Study birth cohort)	Enamel hypoplasia Sex Childhood illness Gestational age Birth weight Breast-feeding for ≥ 6 months Fluoride concentration of home drinking water Average daily fluoride intake Average daily soda pop intake Daily toothbrushing frequency Previous caries experience	Logistic GEE model for caries at age 5 years: Enamel hypoplasia (OR 7.6) Dental exam age (OR 7.6) Breastfeeding < 6 months (OR 2.2) Average home tap water fluoride concentration 1.0 ppm (OR 2.4) Logistic GEE model for caries at age 9 years: Enamel hypoplasia (OR 5.2) Average daily toothbrushing frequency during 5-9 years old (OR 2.2) Logistic GEE model for caries incidence age 5-9: Previous caries experience (OR 5.1) Average daily fluoride intake during 5-9 years of age (OR 1.9) Average daily toothbrushing frequency during 5-9 years of age (OR 2.0)	⊕⊕◯◯Low
Warren et al 2009[38]	0.5-2 years at baseline (Iowa Fluoride Study birth cohort)	Age Presence of plaque Presence of Mutans streptococcus Sugar-sweetened beverage consumption	Age (OR 1.1) Presence of mutans streptococcus (OR 4.4)	⊕⊕◯◯Low

		Night time bottle feeding	Sugar-sweetened beverage consumption (OR 3.0)	
Gao et al 2010[44]	3-6 years	Age Sex Race Country of birth Parents' education level Housing condition Feeding histories Diet habits Oral hygiene Fluoride applications Dental attendance Systemic disease Parental knowledge and attitudes on oral health Plaque pH Mutans streptococcus levels Lactobacillus levels Past caries experience	Prediction Screening Model: Age (OR 1.0) Malay race (OR 1.8) Father's education level (OR 0.6) Months of breastfeeding (OR 1.0) Frequency of between-meal sweets (OR 1.4) No health problems (OR 2.9) Past caries experience (baseline) (OR 7.3) Plaque index (5.1) Full Prediction Model: Age (OR 1.1) Father's education level (OR 0.6) Months of breastfeeding (OR 1.1) Using fluorides (other than toothpaste) (OR 0.4) No annual dental check-up because teeth didn't bother child (OR 0.5) No health problems (OR 2.7) Past caries experience (baseline) (OR 3.9) Plaque index (8.9) Mutans streptococcus levels (OR 2.7) Lactobacillus levels (OR 2.3) Average pH (OR 0.01) Risk Screening Model: Age (OR 1.1) Months of breastfeeding (OR 1.0) Bedtime feeding (OR 1.5)	⊕⊕○○Low

			Frequency of between-meal sweets (OR 1.3) Bedtime sweets (OR 1.3) Never lived in non-fluoridated community (OR 0.7) Plaque index (9.1) Full Risk Model: Age (OR 1.1) Months of breastfeeding (OR 1.0) Plaque index (7.4) Mutans streptococcus levels (OR 2.6) Lactobacillus levels (OR 2.1) Average pH (OR 0.02) Community Screening Model: Age (OR 1.0) Malay race (OR 2.1) Using fluorides (other than toothpaste) (OR 2.6) Parent's belief that "tooth worm" as reason for caries (OR 0.1) Parents do not know that bedtime milk bottle is bad for teeth (OR 2.0) Child`s number of decayed teeth estimated by parent (OR 12.8)	
Chankanka et al 2011[43]	≤ 0.5 years (Iowa Fluoride Study birth cohort)	Powdered beverages Soda pop Juice drinks 100% juice Milk Water only Daily toothbrushing frequency Water fluoride level Proportion of new non-cavitated lesions to	General linear mixed models (GLMM) regression for non-cavitated caries: 100% juice exposure General linear mixed models (GLMM) regression for cavitated caries:	⊕⊕◯◯Low

		surfaces at risk (10% change) Proportion of new cavitated lesions to surfaces at risk (10% change) Socioeconomic status Sex Dentition	Powdered beverage exposure 100% juice exposure Multivariate General linear mixed models (GLMM) regression for non-cavitated caries: 100% juice exposure – middle and high frequency (↓37-50%) Tooth brushing frequency (↓33%) Proportion of new cavitated caries lesions to surfaces at risk (↑110%) High socieoeconomic status (↓42%) Multivariate General linear mixed models (GLMM) regression for cavitated caries: 100% juice exposure – high frequency (↓48%) Proportion of new non-cavitated caries lesions to surfaces at risk (↑253%)	
MacRitchie et al 2012[40]	1 year olds	Caries experience Mutans streptococcus Lactobacillus Yeasts Height Weight Head circumference Immunization status Ethnic origin Illnesses Medication Weaning	Model 1 – d1mft > 0 at age 4 years (“any caries risk” model): Health visitor opinion of caries risk Deprivation Category score Parental smoking Breastfeeding	⊕⊕◯◯Low

		Use of comforter (i.e. soother) Vitamin supplementation Feeding problems Family history Parental employment Parental health Parental smoking Housing status Health Visitor assessment if child at risk for caries Deprivation Category score Breast/bottle feeding Meals Drinks Snacks Toothbrushing Fluoride supplementation Sociodemographics	Use of comforter (i.e. soother) Model 2 – d3mft >0 at age 4 years ("any caries risk" model): Health visitor opinion of caries risk Parental smoking Food and drink at night Model 3 – d1mft ≥ 3 at age 4 years ("high caries-risk" model): Type of housing Use of a feeder cup Model 4 – d3mft ≥ 3 at age 4 years ("high caries-risk" model): Type of housing Health visitor opinion of caries risk Use of vitamins	
Gao et al 2013[22]	3 years old	NUS-CRA, Cariogram, AAPD CAT, CAMBRA Age Ethnicity Family socioeconomic status Infant feeding history Diet Fluoride Dental attendance Oral hygiene Past caries White spot lesions	CAT (screening) ≥ high (RR 2.0, 95% CI 1.1-2.5) CAT (screening) excluding ≥ high (RR 1.8, 95% CI 0.99-2.4) CAT (comprehensive) excluding socioeconomic factors (RR 2.2 95% CI 0.95-2.6)	⊕⊕◯◯Low

		Enamel defects Dental appliance Systemic health Medication Salivary flow rate Salivary buffering capacity Mutans streptococcus levels Lactobacillus levels	CAMBRA (screening) ≥ moderate (RR 2.3 95% CI 1.8-2.5) CAMBRA (screening) ≥ high (RR 2.4 95% CI 2.1-2.5) CAMBRA (comprehensive) ≥ moderate (RR 2.2 95% CI 1.9-2.4) CAMBRA (comprehensive) ≥ high (RR 2.3 95% CI 2.1-2.4) Cariogram (screening) ≥ 38.5% chance of caries (RR 2.2 95% CI 1.9-2.3) Cariogram (comprehensive) ≥ 37.6% chance of caries (RR 2.2 95% CI 2.0-2.4) NUS-CRA (screening) ≥ 32.8% chance of caries (RR 2.5 95% CI 2.3-2.5) NUS-CRA (comprehensive) ≥ 35.2% chance of caries (RR 2.5 95% CI 2.4-2.6)	
Hallett and O'Rourke 2013[52]	5-10 year olds (assessment included both primary and permanent teeth though)	CariScreen reading (to measure visible light release from dental plaque) Mutans streptococcus reading (CariCult) Visible plaque Visible cavitations present Fillings within previous 3 years Reduced saliva flow Exposed dentin	Visible cavitations (Multivariate mean 3.9 95% CI 3.0-4.9) Reduced saliva flow (Multivariate mean 3.6 95% CI 2.5-4.7) Orthodontic appliances (Multivariate mean 4.2 95% CI 2.5-5.9)	⊕⊕◯◯Low

		Deep enamel pits and fissures Radiographic proximal lesions White spot enamel lesions (incipient caries) Orthodontic appliances		
Schroth et al 2014[35]	Birth cohort. Assessed factors prenatally and in infancy	Low annual income Child's health status Infant's teeth being cleaned or brushed Enamel hypoplasia Household employment Government assistance (i.e. social assistance) Infant age at time of dental exam Bottle feeding Breastfeeding Season Prenatal vitamin D level	Enamel hypoplasia (OR 8.9) Infant age (≥ 14 months) (OR 5.0) Prenatal vitamin D level (OR 2.0)	⊕⊕◯◯Low
Abanto et al 2014[51]	1-12 year olds (assessment included both primary and permanent teeth though)	Caries risk Gingival bleeding index Dental plaque index Caries experience Lesion activity assessment Number of teeth with active non-cavitated lesions Sex Age Caregiver of child Use of dental floss Follow-up dental visits	Survival analysis for new initial caries lesions (adjusted model): Past caries experience (dmft index) (HR 1.9 95% CI 1.4-2.7) Follow-up dental visits (HR 0.2 95% CI 0.1-0.6) Number of teeth with active non-cavitated lesions (HR 9.5 95% CI 5.6-16.2) Survival analysis of active initial lesions (adjusted model): Number of teeth with active non-cavitated lesions (HR 1.3 95% CI 1.1-1.5) Male (HR 0.8 95% CI 0.6-0.9)	⊕⊕◯◯Low

			Follow-up dental visits (HR 0.1 95% CI 0.05-0.1)	
Peltzer et al 2014[34]	Birth cohort. Assessed factors prenatally and in infancy. First dental exam at 2 years	Drinking water in household Birthweight Height at 6 months Smoking during pregnancy Secondary smoke (at 1 year) Mother had dental cavitation(s) at baseline Mother's age at birth Mother's education at birth Household income Religious affiliation Single parent Family size Sex of child Frist child in family Psychological distress of mother Psychological distress of father Parenting style Family distress Family support index Spousal relationship (mother) index Spousal relationship (father) index Infant feeding (at 6 months) Nocturnal feeding at 12 months Introduction of soft drinks (at 12 months) Sleeping with bottle (at 30 months) Brushing teeth in past 2 weeks (at 12 months) Sweet candy in days in a week (at 30 months) Brush with toothpaste (at 12 months)	Drinking water in household (rain, well or other) (OR 2.0) Mother completed high school (OR 2.5) Mother completed post-high school (OR 3.2) Household income $100,000-$199,999 (OR 0.4) Household income ≥ $200,000 (OR 0.3)	⊕⊕◯◯Low

		Brushing teeth (at 26 months) Previous dental visit (at 30 months)		
Gao et al 2014[46]	3-5 year olds	Parent's education level Type of housing Age Sex Ethnicity Feeding history Diet habits Oral hygiene Fluoride exposures Dental attendance Parental knowledge, attitudes and self-efficacy in protecting children's teeth Mutans streptococcus levels Lactobacillus levels Past caries experience	Mutans streptococcus levels: Dentocult score 1 (RR 2.0) Dentocult score 2 (RR 3.4) Dentocult score 3 (RR 4.6) Lactobacillus levels: Dentocult score 1 (RR1.9) Dentocult score 2 (RR 2.7) Dentocult score 3 (RR 2.7) Past caries experience (RR 1.6) Model with Mutans streptococcus: Age (months) (OR 1.1) Malay race (OR 1.8) Father's education (OR 0.7) Months of breastfeeding (OR 1.0) Fluoridated toothpaste (OR 0.6) No health problems (OR 2.4) Past caries experience (OR 4.3) Plaque index (OR 5.2) Mutans streptococcus (OR 2.2) Model with Lactobacillus: Age (months) (OR 1.0) Father's education (OR 0.6) Months of breastfeeding (OR 1.0)	⊕⊕○○Low

			Frequency of sweet (OR 1.4) Fluoridated toothpaste (OR 0.6) No health problems (OR 2.4) Past caries experience (OR 4.8) Plaque index (OR 5.2) Lactobacillus (OR 1.9) Model with Mutans streptococcus and Lactobacillus: Age (months) (OR 1.1) Father's education (OR 0.6) Months of breastfeeding (OR 1.1) Fluoridated toothpaste (OR 0.6) No health problems (OR 2.2) Past caries experience (OR 3.0) Plaque index (OR 5.2) Mutans Streptococcus (OR 2.1) Lactobacillus (OR 1.9)	
Yokomichi et al 2015[39]	< 1 year of age	Sex Birth weight Age of mother Gestational age Birth order Number of teeth (at 18 months) Parental employment Bottle use (at 18 months) Dental fluoridation experience (at 3 years) Parental smoking (at 3 years) Sibling < 6 years (at 3 years) Someone who supports child rearing (at 3 years)	Boys (RRI 3) Birth weight ≥ 4,000 g (RRI 19) Birth weight < 2,500 g (RRI -5) Age of mother < 25 (RRI 17) Age of mother ≥ 35 (RRI 2) Not first born child (RRI 26) 14-20 teeth at 18 months (RRI 13) Both parents unemployed (at 3 years) (RRI 11) Bottle use (at 18 months) (RRI 4)	⊕⊕◯◯Low

		Parental brushing child's teeth (at 18 months) Parental brushing child's teeth (at 3 years) Drinking cow milk (at 18 months) Drinking cow milk (at 3 years) Irregular meals and snacks (at 18 months) Irregular meals and snacks (at 3 years) Watching TV or video daily (at 3 years)	Parental smoking (at 3 years) (RRI 15) No one supports child rearing (at 3 years) (RRI 17) Parents sometimes or never brushing child's teeth (at 18 months) (RRI 18) Parents sometimes or never brushing child's teeth (at 3 years) (RRI 22) Drinking cow milk (at 18 months) (RRI -12) Drinking cow milk (at 3 years) (RRI-5) Irregular meals and snacks (at 18 months) (RRI 16) Irregular meals and snacks (at 3 years) RRI 16	
Ghazal et al 2015[49]	< 2 years old	Age Sex Delivery type (standard, C-section, forceps, other) Premature delivery Birthweight Allergies Chronic systemic medical condition Acute illness in previous 6 months Breast fed Bedtime bottle Bottle use Beverages consumed (type, frequency, timing) Methods of drinking liquids other than water Amount of beverages consumed Toothbrushing Toothpaste Dental history Sources of drinking water	Model A – 3 year incidence: Premature delivery (< 37 weeks) (OR 0.2) 100% juice consumption ≥ 1 time per day (OR 0.4) Model B – Incidence from age 2 to 3 years: Greater daily frequency of toothbrushing at baseline (OR 0.3) Previous visit to dentist (OR 4.6)	⊕⊕◯◯Low

		Use of vitamin drops or tablets with fluoride History of dental problem Reason for last dental visit Presence of regular dentist		
Wagner and Heinrich-Weltzien 2016[42]	Birth cohort (< 12 months of age)	Caries experience Sex Migration background Socioeconomic status Single parent Mother/primary caregiver has active caries Family early childhood caries burden Preterm birth General disease/special health care needs Medication Systemic antibiotic medication No use of vitamin D supplements Child has > 3 between-meal sugar-containing snacks/beverages per day Child is put to bed with a bottle containing natural or added sugar Child's teeth were brushed daily with fluoridated toothpaste Child receives topical fluoride from health professional Child has dental home/regular dental care Enamel defects Plaque on teeth	Model of associations between caries experience of children and low socioeconomic status, family early childhood caries burden, systemic antibiotic medication, no use of vitamin D supplements, receives topical fluoride from health professional, child has regular dental care and child has plaque on teeth: Family early childhood caries burden (OR 2.2) No use of vitamin D supplements (OR 1.9) Child has regular dental care (OR 0.5) Plaque on teeth (OR 6.5)	⊕⊕◯◯Low
Hultquist & Bagesund 2016[17]	1 year olds	Siblings Siblings have dental caries	Siblings have dental caries (OR 4.8)	⊕⊕◯◯Low

		Child eat or drink anything except water at night Child still breastfed Child have illness/disease Child regularly takes medication Child drinks anything except water between meals Parent brushes child's teeth Number of teeth visible in mouth Mutans streptococcus counts	Child eats or drinks at night (OR 3.0) Child drinks anything except water between meals (OR 7.1) High level of Mutans streptococcus (score 2-3) (OR 3.4)	
Lin & Lin 2016[32]	Mean age 4 years at baseline who underwent pediatric dental surgery for ECC	Gender Age Father's education level Mother's education level Diet frequency per day Snacks/drinks between meals Bedtime sweet without brushing Brushing by child or parent Frequency of tooth brushing Buffer capacity of saliva Streptococcus mutans count Lactobacillus count Plaque index (oral hygiene status) Score of caries risk assessment	Score of caries risk assessment using Cariogram (OR 1.1)	⊕⊕○○Low
Wang et al 2016[36]	3-5 year olds	Caries status (dmft) Sex Age Parental education Parental occupation Income Eating habits Oral hygiene behaviours	Caries experience (OR 5.0) Parent helps child brush teeth daily (OR 0.9) Parents consider caries in primary teeth need to be treated (OR 1.3)	⊕⊕○○Low

Correa-Faria et al 2016[50]	4-7 year olds	Sex Caries Oral hygiene Place of residence Mother's education level Household income Age	Previous caries experience (RR 1.5)	
Wagner and Heinrich-Weltzien 2017[48]	Birth cohort (< 12 months of age)	Sex Age Migration background Socioeconomic status Age at start of tooth brushing Frequency of tooth brushing Supervision of tooth brushing/regular second brushing by parent Use of fluoride salt and/or fluoride toothpaste Age at first dental visit Number of dental visits/year Application of fluoride varnish Frequency of in-between meals Consumption of sugar-containing snacks/beverages per day Duration of breastfeeding Duration of bottle feeding Previous caries experience	Model of association between caries experience in children and low socioeconomic status, start of tooth brushing, supervision/regular second brush by parent, frequency of tooth brushing, first dental visit, frequency of dental visits, application of fluoride varnish, frequency of in-between meals, sugar-containing snacks/beverages per day, duration of breastfeeding > 1 year, duration of bottle feeding > 1 year: Low socioeconomic status (OR 10.4) Started brushing in first year of life (OR 0.2) Supervision/regular second tooth brushing by parent (OR 0.1) ≥ 2 dental visits per year (OR 0.1) Duration of breast-/bottle-feeding > 1 year (OR 6.2)	⊕⊕◯◯Low
Bernabe et al 2017[45]	1 year	Sex Birth order Birth weight	Age (coefficient 0.16, 95% CI 0.12-0.21)	⊕⊕◯◯Low

		Maternal age at birth Maternal education Breastfeeding duration Marital status Maternal smoking Parental employment Area deprivation Child's toothbrushing frequency	Final Linear Mixed Effects model: Birth weight (p=0.039) Parental employment (p<0.001) Maternal smoking (p=0.006) Maternal education (p<0.001)	

Note: Odds Ratio (OR), Relative risk (RR), Hazard Ratio (HR)

<u>Sociodemographic and Family Factors</u>:

Out of 11 studies that included age as a predictor, five studies reported that the age of the child was significantly associated with future caries risk with odds ratios ranging from 1.1-5.0 .[35, 38, 44-46] This would justify including "age" as a variable in a CRA tool. It is well recognized that the risk for caries increases as children get older as they have more teeth and these teeth have been subjected to periods of demineralization longer than younger children.

Three out of 16 studies that assessed sex reported that male children were at greater risk for caries development (HR 1.1, RR 3.0) and one reported that males were at lower risk (HR 0.8).[37, 39, 51] Thus, there is very limited evidence to suggest including "sex" as a variable in a CRA tool. Additionally, only three out of five publications that examined ethnicity indicated that ethnicity was associated with increased caries risk.[37, 44, 46] One study suggested that both Hispanic (HR 1.8) and African American (HR 1.8) children were at risk while two indicated that Malay (both OR 1.8) children were at risk. Given the limited information on ethnicity and the considerable variability that exists in determining ethnic background of children there is limited evidence to suggest its inclusion as a variable in a CRA tool.

A total of six out of eleven studies identified that household socioeconomic factors, including low SES (2.38X, OR 10.4)[43, 48], deprivation[40], parental employment status (RRI 11)[39, 45], and income (OR 3.3 < $200,000/year)[34] were significantly associated with caries risk. Living in a high SES home and having a high household income were protective against caries.[34, 43] Based on this evidence, low SES or other indicators of household income and employment should be part of a CRA tool. While these indicators should be included in the tool, it should be recognized that there is sensitivity in collecting household income information, and not all parents and caregivers may feel comfortable providing such information. Only one study out of three studies reported that the type of housing was associated with caries risk[40], which may be a proxy for SES of the family. Another study identified that the household drinking water sourced from rain or well water or other non-traditional sources was associated with increased caries risk (OR 2.0).[34] However, this may be a proxy measure of access to fluoridated drinking water and SES. Four out of seven articles identified parental education level as a risk factor for future caries development; two revealed associations with maternal education (OR 2.5 high school, OR 3.2 > high school) and two with paternal education (OR 0.6, OR 0.7).[34, 44-46] Given that educational attainment of parents is likely reflected in household SES, there is limited evidence to suggest it be incorporated separately into a CRA tools being developed. It could be included as part of a general question on household SES.

Only one of three studies reported on the age of the child's mother with children whose mothers were < 25 years of age (RRI 17) and those ≥ 35 years (RRI 2) of age being at higher risk for caries.[39] Therefore, there is limited evidence to support including maternal age as a variable in a CRA tool. Meanwhile, three out of four studies reported an association with parental

smoking; one reported that maternal smoking and two reported that parental smoking was associated with increased caries risk (RRI 15 at 3 years of age).[39, 40, 45] Overall, there appears to be limited evidence to support the inclusion of parental smoking into a CRA tool.

Few studies reported findings on the association between special health needs of the child and caries risk. One included study revealed that acute otitis media and and respiratory tract infection at 0-12 months were associated with increased caries risk.[37] Meanwhile, two other papers indicated that children without health problems were at increased risk.[44, 46] Four included studies reported results on the association between prenatal and birth characteristics and caries risk in young children. One study identified that low prenatal vitamin D concentrations during pregnancy were associated with caries in infants (OR 2.0).[35] Another study reported that premature delivery (< 37 weeks) was associated with lower risk for caries (OR 0.2).[49] Two out of five included studies revealed that birth weight may be associated with increased caries risk.[39, 45] One of these studies reported that low birth weights (< 2,500 g) (RRI 5) and birthweights ≥ 4,000 g are associated with caries (RRI 19).[39] Based on this current evidence there is limited evidence to support including any of these variables in a CRA tool.

Parental attitudes and knowledge can also influence childhood oral health. For instance, one study reported that a parent's belief that caries is a result of a "tooth worm" was found to lessen the risk for caries in their children.[44] Children of parents who are unaware that a bottle of milk at bedtime is bad for their child's teeth are at increased risk for decay.[44] Another study reported that parents who consider it necessary to treat caries involving primary teeth are more likely to have a child at risk for future caries.[36] Based on this limited evidence,

assessments of parental knowledge and attitudes towards early childhood oral health should not be included in a CRA tool.

Interestingly, some other child and family characteristics and dynamics may be associated with increased caries risk. For instance, one included study revealed that children who are not first born in the family (RRI 26) and those families who lack supports with child rearing (RR1 17) were more likely to have children at risk for future caries development.[39] Other variables that have been reported to be associated with caries risk include the family's ECC burden (OR 2.2) [48], siblings having dental caries (OR 4.8)[17], and health visitor opinions of children's risk for caries[40].

Considering the limited evidence, these potential factors do not presently warrant consideration for inclusion in a CRA tool.

Behavioural Factors:

Oral hygiene behaviours:

Several included studies examined toothbrushing behaviours and its association with caries risk. Three out of nine studies reported that the frequency of toothbrushing was directly associated with risk of developing caries with odds ratio ranging from 2.0 – 4.6.[41, 43, 49] One study reported that initiating brushing in first year of life was protective (OR 0.2) and reduced the risk of caries.[48] A total of four out of six studies reported on the association between parental supervision of or assistance with child toothbrushing with an OR ranging from 0.1 - 1.8 and a RRI 18 .[33, 36, 39, 48] One of these studies suggested that parents helping the child brush their teeth daily (OR 0.9) was associated with increased caries risk.[36] However, the other three concluded that supervised regular toothbrushing with the assistance of the parent was

protective against caries (OR 0.1)[48] while no parental involvement or infrequent involvement was associated with future caries development (OR 0.9 - 1.8).[33, 36] Overall, this suggests that a question about the frequency toothbrushing and/or the involvement of parents in supervising daily toothbrushing may be helpful if included in a CRA tool.

Exposure to fluorides was also reported in three out of eleven included studies. One study reported that use of fluoridated toothpaste was protective (OR 0.6).[46] Another study indicated that average daily fluoride intake was associated with caries (OR 1.9).[41] Access to fluoridated tap water is also a predictor of caries risk as fluoride levels in drinking water (OR 2.4)[41] and fluoridated water (OR 0.7)[44] can influence caries development. One of these studies also reported that fluoride use, other than toothpaste, is also associated with caries risk (OR 0.4).[44] However, this study did note that this could be a result of high caries burden at baseline.[44] Based on this evidence, an assessment of exposure to fluorides should be included in any CRA tool for preschool children.

Infant Feeding Behaviours:

Breast milk provides all the energy and nutrients that the infant needs according to the dietary references intakes. Health Canada and the World Health Organization recommend exclusive breastfeeding for the first six months and infants should then be offered nutrient dense and safe complementary foods, along with continued breast feeding. Several of the included studies reported on the association between infant feeding behaviours and caries risk, namely breastfeeding, feeding duration, and bottle feeding. Five out of ten studies provided evidence on breastfeeding and duration of breastfeeding.[33, 40, 41, 44, 46] Two studies revealed that breastfeeding was associated with an increased risk of caries.[33, 40] Another three studies on

breastfeeding duration, concluded that the months of breastfeeding (OR 1.0)[44, 46] and breastfeeding for fewer than six months (OR 2.2)[41] was associated with increased caries risk. Another study did not differentiate between feeding method, but reported that the duration of breast and bottle feeding for greater than one year increased the risk for caries (OR 6.2).[48] Only one study revealed that bottle use at 18 months of age was associated with caries (RRI 18).[39] One included study indicated that bedtime feeding was associated with caries risk (OR 1.5)[44] and the use of a feeding cup was also reported to increase childhood risk for caries.[40]

Based on this evidence it would be prudent for newly developed CRA tools to inquire about infant feeding practices and durations, but to separately ask about breastfeeding and bottle feeding.

Only one study reported that the use of a comforter or soother was associated with increased caries risk.[40] Based on this limited evidence, the use of a comforter or soother variable should not be included in a CRA tool.

Dietary Habits and Behaviours:

Snacking habits and behaviours were identified in eight out of eleven of the included studies. One study indicated that irregular meals and snacks increased the risk for caries (RRI 16 at 18 months).[39] Another revealed that eating snacks while playing increased risk (OR 2.3).[33] A third reported that the frequency of between-meal sweets was associated with greater risk for future caries development (OR 1.3).[44]

Two studies looked at the frequency of intake of sweets and reported associations with increased risk for decay; one indicated that the frequency of candy consumption was a risk factor (OR 3.6)[31] while the other revealed that the frequency of sweets increased risk (OR

1.4).[46] Three studies also mentioned that consuming foods and drinks at night increased children's risk for caries.[17, 40, 44] Eating and drinking food at night (OR 3.0)[17, 40] and sweets at bedtime (OR 1.3)[44] were all reported to increase caries risk.

The consumption of cow milk was found to be protective against caries at 18 months (RRI -12) and at 3 years (RRI -5). [39] Additionally, drinking anything except water between meals was associated with caries risk (OR 7.1)[17] several studies reported that a child's use of sugary beverages and frequency increased their risk for decay. Sugar-sweetened beverage consumption (OR 3.0)[38], use of powdered beverages[43], and exposure and frequency of 100% juice exposure (OR 0.4)[43, 49] were associated with future decay.

Based on this evidence, dietary practices and habits should be integrated into CRA tools. This includes the frequency of snack foods and sugary drinks between meals.

Only two studies revealed data on the use of vitamins. One study reported that the use of vitamins was associated with an increased risk for caries[40] while the other indicated that the absence of vitamin D supplementation (OR 1.9) increased a child's risk for decay[42].

<u>Dental Home and Dental Attendance Behaviours</u>:

Dental home and dental attendance behaviours were identified in six out of ten of the included studies. Three included studies reported that regular dental care is protective against caries.[42, 48, 51] One study indicated that follow-up visits to the dentists were protective (HR 0.1) another indicated regular dental care was protective (OR 0.5), while the other revealed that

two or more visits per year was protective against caries (OR 0.1).[42, 48, 51] An additional study reported that not seeking annual dental check-ups for their child because their teeth did not bother their child was protective against caries[44]. Meanwhile, another included study

reported that children with previous visits to the dentist were at greater risk for caries (OR 4.6).[49] The author noted that this association might be due to parent-identified need to see a dentist and/or refferals to dentists by the study team.[49] Hong et al (2009) reported that the child's age at the time of their dental exam was predictive of caries (OR 7.6).[41]

Based on this evidence, a history of dental visits and presence of a dental home should be considered in a CRA tool.

Clinical Factors:

Previous caries experience was the most commonly identified factor from the included studies with 9 of the 25 publications reporting its association with increased caries risk. [31, 36, 43, 44, 46, 50-53] Another study reported that the number of teeth with active non-cavitated caries lesions was also associated with future caries development (HR 9.5).[51] Therefore, there is ample evidence to include previous caries experience in any CRA tool for preschool children. The next most common clinical variable was presence of dental plaque or plaque index with an OR of 6.5, 8.9, 5.2 respectively.[42, 44, 46] Despite there being some evidence, any newly developed instrument should include an assessment of visible dental plaque. Only two of the included studies reported that enamel hypoplasia was a significant risk factor for future caries (OR 8.9 & 5.2).[35, 41] However, enamel hypoplasia has often been overlooked in past caries studies.

Fortunately, there is growing recognition that enamel hypoplasia increases the risk for caries. Therefore, enamel defects, including enamel hypoplasia, could be considered for inclusion in newly developed CRA tools.

One included study revealed that having 14-20 teeth by 18 months to be associated with increased caries risk (RRI 4). [39] Another study reported that the presence of an orthodontic

appliance was associated with caries development (Multivariate mean 4.2, 95% CI 2.5-5.9)[52] Due to this limited evidence, neither of these variables are worth considering including into a proposed new CRA tool.

Salivary & Bacterial Factors:

Overall, two out of four studies were found to report significant associations between saliva and oral pH and caries risk. One study reported that an average oral pH (stimulated saliva flow rate) was protective against caries development (OR 0.2)[44] and the other revealed that reduced salivary flow increased the risk for caries (Multivariate mean 3.6, 95% CI 2.5-4.7) [52]. Based on this limited information there is little value in adding saliva flow and oral pH as variables in a newly developed CRA tool for preschool children, especially for use by non-dental professionals.

A total of five out of nine studies included publications reported that levels of mutans streptococci were significantly associated with future caries development, suggesting that consideration of this variable is warranted in CRA instruments.[17, 31, 38, 44, 46] Meanwhile, only two out of five included studies revealed an association between lactobacilli levels and future caries risk. [44, 46] However, assessing cariogenic bacteria levels is not feasible or possible for CRA developed for screening purposes and use by non-dental professionals.

Overall, based on this systematic review of evidence on CRA the following variables should be considered when developing a new CRA tool for use with preschool children:

Sociodemographic Factors: child's age, SES of the family (i.e., low SES and household income, parental education level).

Behavioural Factors: Toothbrushing habits (i.e., frequency, involvement of parents in supervising daily toothbrushing), exposure to fluorides (i.e., fluoridated toothpaste, community water fluoridation), breastfeeding (i.e., frequency, duration > 12 months), bottle feeding (i.e., frequency, duration > 12 months, use at bedtime), dietary habits and behaviours (i.e., snacking and drinking between meals, intake of sugary beverages, intake of sweets), dental home and dental attendance (i.e., child has dental home, regular dental visits)

Clinical Factors: caries experience of the child (i.e., past and current caries experience, past treatment of caries), presence of visible plaque, developmental defects of enamel (i.e., enamel hypoplasia, enamel defects)

Salivary and Bacterial Factors:

Currently, assessments on saliva flow and bacterial levels are essentially limited to clinical settings (i.e., the dental office). Therefore, while salivary flow and levels of mutans streptococci and lactobacilli can be predictive of future caries risk, CRA tools that are designed for screening purposes and for use by persons outside of the oral health profession should not include assessments of these variables.

Table 5 : Summary of the evidence from the studies.

Factor/Variable	# of Studies that include that factor	# of Studies which show significant association	Range of effect sizes	Expert opinion on inclusion of this factor (yes/no)
Sociodemographic and family factors				
Age[35, 38, 44-46]	11	5	OR 1.1 – 5.0	Yes
Sex[37, 39, 51]	16	3	HR 1.1 – 3.0	No
Ethnicity[37, 44, 46]	5	3	HR 1.1, 1.8 OR 1.8, 2.1	No
Household socioeconomic factors[34, 39, 40, 43, 45, 48]	11	6	2.38X OR 0.3 - 10.4 RRI 11 p<0.001	Yes
Housing type[40]	3	1	Data not available	No
Household water[34]	2	1	OR 2.0	No
Parental education level [34, 44-46]	4	7	OR 0.6 - 3.2 P < 0.001	No
Maternal age [39]	3	1	RRI 2 , RRI 17	No
Parental smoking[39, 40, 45]	4	3	RRI 15 , p = 0.006	No
Acute Otitis media [37]	1	1	HR 1.3	No
No health problems [44, 46]	2	2	OR 2.2 – 2.9	No
Prenatal Vitamin D[35]	1	1	OR 2.0	No
Premature Delivery (< 37 weeks)[49]	2	1	OR 0.2	No
Birth weight[39, 45]	5	2	RRI -5, RRI 19 p= 0.039	No
Parent Attitude [36, 44]	3	2	OR 0.1 - 2.0	No
Child and Family Characteristics [32, 39, 40, 42]	4	4	RRI 17, RRI 26 OR 2.2, 4.8	No
Behavioural Factors				
Frequency of Toothbrushing [41, 43, 49]	9	3	OR 2.0 – 4.6	Yes

Initiating brushing in the first year of life[48]	1	1	OR 2.0	No
Parental supervision or assistance with toothbrushing [33, 36, 39, 48]	6	4	OR 0.1 – 1.8, RRI 18	Yes
Exposure to Fluorides[41, 44, 46]	11	3	OR 0.4 – 2.6	Yes
Evidence of Breastfeeding and duration of breastfeeding (BF)[33, 40, 41, 44, 46]	10	5	OR 1.0 – 6.2	Yes
Comforter or Soother [40]	1	1	Data not available	No
Snacking habits and behaviours [31-33, 39, 40, 43, 44, 46]	11	8	OR 1.4 – 7.1 RRI -5, RRI -12, RRI 16	Yes
Dental home and dental attendance behaviours [41, 42, 44, 48, 49, 51]	10	6	OR 0.1 – 7.6 HR 0.1	Yes
Clinical factors				
Previous caries experience [31, 36, 43, 44, 46, 50-53]	25	9	OR 3.0 – 7.3 RR 1.6, RR 1.5	Yes
Salivary Bacterial Factors				
Saliva and oral pH[44, 52]	4	2	OR 0.01, 0.02 multivariate mean 3.6	No
Mutans Streptococcus[17, 31, 38, 44, 46]	9	5	OR 2.1 - 4.4	Yes

Part B – Environmental Scan of Caries Risk Assessment Tools for Children < 6 Years of Age

We also undertook an environmental scan of existing caries risk assessment tools for children < 6 years of age. Our search approach included reviewing recognized tools developed by national and international dental, pediatric organizations, and experts (e.g., American Dental Association (ADA), American Academy of Pediatric Dentistry (AAPD), American Academy of Pediatrics (AAP), Caries Management by Risk Assessment (CAMBRA), and the Cariogram). We also searched the internet for other caries risk assessment tools that have been created. Caries risk assessment tools that were identified through our systematic literature review of caries risk factors were also reviewed.

Overall, we identified 22 different caries risk assessment tools that have been developed for use with young children (see Table 6). We modified a table developed by Gao[22] et al to identify and characterize the different variables and factors included in the caries risk assessment tools that we reviewed. More detailed descriptions of each of the caries risk assessment tools can be found in Table 7. Some of the notable and commonly recognized tools include CAMBRA, the American Dental Association's (ADA's) Caries Risk Assessment Form (Ages 0-6), the American Academy of Pediatric Dentistry's (AAPD's) tools, and the Cariogram.

While the majority of the identified caries risk assessment tools are paper-based, some are electronic-based. Copies of the caries risk assessment forms appear as figures at the end of this report. Caries risk assessment tools that are electronic-based programs include the Cariogram, MysmileBuddy, the EBHnow (McGill University) search engine, and the WesternU Axium tool.[54-57] These 22 tools present variations in the way tools are formatted, how questions are phrased, and how responses are used to assign a level of risk.

Two specific organizations were found to have two tools for use in children < 6 years of age. The AAPD has one tool for use by physicians and other non-dental health care providers for children 0-3 years of age, and another caries risk assessment tool for use by oral health providers for children 0-5 years of age.[16] AAPD created this tool based on the growing emphasis on caries risk assessment and the need to identify children before lesions reach the stage where they need to be restored. Meanwhile, the Texas Department of State Health Services has one tool for ages 6-35 months and another tool for children 3-5 years of age. Both of these tools created by Texas Health were adapted from other nationally recognized tools and were specifically designed for the population of Texas Medicaid children.

Upon review of Table 6, the most commonly considered variables incorporated into existing caries risk assessment tools included:

- Dietary habits and practices (21/22)
- Caries experience (Present and past caries experience, active caries (cavitated and non cavitated, and incipient (white spot) caries lesions) (20/22)
- Questions on oral hygiene and plaque (19/22)
- Exposure to fluorides (17/22)
- Caries experience of the child's caregiver or siblings (14/22)
- Infant feeding histories and behaviours (14/22)
- Child's age (13/22)
- Dental attendance and dental visit history (12/22)
- Toothbrushing habits and behaviours (10/22)
- Saliva flow (10/22)

- Special health care needs of the child (10/22)
- Systemic health (9/22)
- Socioeconomic status of the family (7/22)
- Enamel defects, including enamel hypoplasia (7/22)

While 10 caries risk assessment tools included assessments on saliva flow, this type of assessment is only conducive to caries risk assessments performed in clinical settings. It is not practical to include salivary flow, buffering capacity of saliva, oral pH concentrations, and levels of cariogenic bacteria (mutans streptococcus and lactobacillius) in caries risk assessment tools that are intended for screening purposes and for use by non-dental healthcare providers and for use by dental providers in non-clinical settings.

Overall, based on this environmental scan exercise it would be prudent to consider including the following variables when developing a new caries risk assessment tool for use with preschool children:

Sociodemographic:

- Child's age
- Caries experience of the child's caregiver or siblings
- Socioeconomic status of the family
- Special health care needs of the child

Behavioural:

- Dietary habits and practices
- Infant feeding histories and behaviours

- Oral hygiene and toothbrushing habits and behaviours
- Exposure to fluorides
- Dental attendance and dental visit history

Clinical:

- Past caries experience of the child
- Active caries (cavitated or non-cavitated) and white spot caries lesions
- Presence of plaque
- Enamel defects, including enamel hypoplasia

Table 6 – Inventory of identified caries risk assessment tools for children < 6 years of age

Factors	ADA	AAPD (age 0-3)	AAPD (age 0-5)	AAP	Bankel	CAB	CAMBRA	CF	CMS
Socio-demographic									
Age	✓			✓			✓		✓
Ethnicity									
Family SES	✓	✓	✓	✓					
Recent Immigrant		✓	✓						
Special health needs	✓	✓	✓	✓			✓	✓	
Caries experience of caregiver/siblings	✓	✓	✓	✓			✓	✓	
Educational level of caregivers/Health Literacy							✓		
Behavioural									
Infant feeding history		✓	✓	✓	✓		✓	✓	
Diet	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fluoride	✓	✓	✓	✓		✓	✓		✓
Dental attendance	✓	✓	✓	✓				✓	
Parental attitudes/beliefs								✓	
Tooth brushing Habits		✓	✓	✓			✓		✓
Clinical									
Oral hygiene/ Plaque	✓	✓	✓	✓		✓	✓	✓	✓
Past caries		✓	✓	✓	✓	✓	✓	✓	✓
White spot lesions or Active caries (cavitated/Non-cavitated)	✓	✓	✓	✓	✓	✓	✓	✓	✓
Enamel defects		✓	✓				✓		
Dental appliance	✓							✓	
Systemic health						✓	✓	✓	
Medication							✓	✓	
Other oral concerns (e.g. Gingivitis)				✓					
Protective factors (e.g. sealants)									
Salivary & Bacterial									
Saliva flow	✓					✓	✓	✓	
Saliva buffering capacity									
Mutans Streptococci			✓		✓		✓		
Lactobacilli							✓		
Reduced pH									

Factors	CG	DCRAM	EBHnow (McGill)	FDI	Maine	MSB	NUS	PRAT
Socio-demographic								
Age			✓	✓	✓		✓	✓
Ethnicity		✓					✓	
Family SES		✓		✓			✓	
Recent Immigrant		✓					✓	
Special health needs			✓					
Caries experience of caregiver/siblings		✓	✓	✓	✓	✓		
Education level of caregivers/Health Literacy				✓			✓	
Behavioural								
Infant feeding history		✓	✓			✓	✓	✓
Diet	✓	✓	✓	✓		✓	✓	✓
Fluoride	✓	✓	✓	✓		✓	✓	
Dental attendance			✓		✓	✓	✓	
Parent attitudes/beliefs		✓				✓	✓	
Tooth brushing Habits		✓			✓	✓		✓
Clinical								
Oral hygiene/ Plaque	✓	✓	✓	✓	✓		✓	✓
Past caries	✓		✓	✓	✓	✓	✓	✓
White spot lesions or active caries (Cavitated/Non-cavitated)	✓	✓	✓	✓	✓		✓	
Enamel defects			✓					
Dental appliance			✓					
Systemic health	✓	✓	✓				✓	
Medication	✓	✓		✓				
Other oral concerns (e.g. Gingivitis)	✓		✓		✓			
Protective factors (e.g. sealants)				✓				
Salivary & Bacterial								
Saliva flow	✓			✓				
Saliva buffering capacity	✓			✓				
Mutans Streptococci	✓	✓	✓				✓	
Lactobacilli	✓	✓	✓				✓	
Reduced pH				✓			✓	

Factors	SSC	Texas (6 -35 months)	Texas (3-5 years)	UCC (Ireland)	WesternU CDM	Total
Socio-demographic						
Age	✓	✓	✓	✓		13
Ethnicity						2
Family SES						7
Recent Immigrant						4
Special health needs		✓	✓		✓	10
Caries experience of caregiver/siblings		✓	✓		✓	14
Education level of caregivers/Health Literacy						3
Behavioural						
Infant feeding history		✓	✓		✓	14
Diet	✓	✓	✓	✓	✓	21
Fluoride		✓	✓	✓	✓	17
Dental attendance		✓	✓		✓	12
Parent attitudes/beliefs						4
Tooth brushing Habits				✓		10
Clinical						
Oral hygiene/ Plaque	✓	✓	✓		✓	19
Past caries	✓	✓	✓	✓	✓	20
White spot lesions or active caries (cavitated/Non-cavitated)	✓	✓	✓	✓	✓	20
Enamel defects		✓	✓	✓		7
Dental appliance					✓	4
Systemic health				✓	✓	9
Medication						5
Other oral concerns (e.g. Gingivitis)		✓	✓	✓		7
Protective factors (e.g. sealants)				✓		2
Salivary & Bacterial						
Saliva flow	✓	✓	✓		✓	10
Saliva buffering capacity	✓					3
Mutans Streptococci	✓					8
Lactobacilli	✓					6
Reduced pH						2

ADA – American Dental Association
AAPD- American Academy of Pediatric Dentistry (AAPD)
AAP- American Academy of Pediatrics
Bankel – Bankel et al.
CAB- Cabral, Hilgert, Faber, & Leal et al. (University of Brasilia)
CAMBRA- Caries Management by Risk Assessment
CF- CariFree
CMS – Caries Management System
CG- Cariogram (Electronic Program)
DCRAM- Dundee Caries Risk Assessment Model
EBHnow- (McGill University) Online Search Engine for CRA
FDI- World Dental Federation
Maine- Maine Oral Health Risk Assessment and Referral Tool
MSB- My Smile Buddy (Electronic iPad based program)
NUS- National University of Singapore Caries Risk Assessment
PRAT- Pediatric Risk Assessment tool (Shenkin et al.) Academy of General Dentistry
SSC- Sugar Snack Caries Risk Test
Texas - Texas Department of State Health Services
UCC- University College Cork (Ireland)
WesternU (CDM) – AxiUm Electronically Modified-Caries Risk Assessment Form 0-5 Years of Age

Table 7 – Specific contents of identified caries risk assessment tools for children < 6 years of age

CRA Tool	Year Developed	Variable/Risk Factor Considered
Texas Department of State Health Services (DHSH) (Ages 6-35 months/3-5 years)	Revised 2017	- Caries activity - Demineralized areas - Parent/primary caregiver - Family history- siblings - Presence of plaque, gingivitis - Fluoride exposure - Sugar consumption (including sippy cup use) - Dental home - Special conditions • Special needs patient • Enamel hypoplasia Impaired salivary flow
FDI World Dental Federation	2017	<u>Pathological Factors</u> - Frequent consumption of dietary sugars - Inadequate fluoride - Biofilm homeostatic imbalance - Salivary dysfunction <u>Protective Factors</u> - Tooth-healthy diet - Fluoride toothpaste twice daily - Professional topical fluoride - Preventive and therapeutic sealants - Normal salivary function <u>High caries Risk</u> - Demineralization- Disease (lesion progression) - 3 or more incipient or cavitated primary or secondary carries lesions in the last 2 years <u>Moderate Caries Risk</u> - 1 or 2 incipient or cavitated primary or secondary caries lesions in the last 2 years <u>Low Caries Risk</u> - Remineralization – health (lesion arrest or regression) - No incipient or cavitated primary or secondary caries lesions during the last 2 years and no change in the risk factors that may increase caries
EBHnow (McGill University) online search engine for caries risk assessment	2017	<u>Age</u> - Less than 6 months - 6-12 months - 1-3 years - 3-6 years <u>Fluoride concentration in drinking water</u> - Less than 0.3 ppm - 0.3 - 0.6 ppm

		- Over 0.6 ppm - Don't know <u>Presence of caries</u> - No incipient or cavitated primary or secondary carious lesions during the last 3 years - One of two incipient or cavitated primary or secondary carious lesions in last 3 years - Three or more incipient or cavitated primary or secondary carious lesions in last 3 years <u>Caries Risk Factors</u> - High titers of cariogenic bacteria - Poor oral hygiene - Prolonged nursing (bottle or breast) - Poor family dental health - Developmental or acquired enamel defects - Teeth genetically abnormal - Many multi-surface restorations - Chemotherapy or radiotherapy - Eating disorders - Drug or alcohol abuse - Irregular dental care - Cariogenic diet - Active orthodontic treatment - Exposed root surfaces - Restoration overhangs and open margin - Unavailability of performing proper oral health care - Xerostomia - Low socioeconomic status More than two of the above
WesternU CDM – AxiUm Electronically Modified-Caries Risk Assessment (0-5 years)	2016	<u>Contributing Conditions</u> - Are you exposed to fluoride (through drinking water, toothpaste, professional applications, supplements, etc.)? o Yes (low) o No (moderate) - Frequency of sugary, starchy foods or drinks (including juice, carbonated, noncarbonated soft drinks, energy drinks, medicinal syrups, etc.) o Primarily at mealtimes (low) o Frequently between meals (moderate) o Bottle or sippy cup with anything but water (high) - Caries experience of mother, caregiver, and or/other siblings o No carious lesions in last 24 months (low) o Carious lesions last seven to 23 months (moderate) o Carious lesions in the last six months (high) - Dental home: establishing patient of record, receiving regular dental care in dental office o Yes (low)

		o No (moderate) <u>General health conditions</u> - Special health care needs (including developmental, physical, medical or mental disabilities that prevent or limit adequate oral care) o No (low) o Yes (high) <u>Clinical conditions</u> - Visual or radiographically evident cavitated lesions o No active cavitated lesions in one year (low) o No active cavitated lesions or restorations in last six months (moderate) o Presence of lesions/restorations in last six months (high) - Non-cavitated ACTIVE carious lesions (e.g. active brown/white spot lesions) o No incipient active lesions in one year (low) o No incipient active lesions in last six months (moderate) o Presence of incipient non-cavitated lesions in last six months (high) - Teeth missing due to caries o No (low) o Yes (high) - Visible plaque o Yes (moderate) o No (low) - Dental/orthodontic appliances (fixed or removable) o No (low) o Yes (moderate) - Salivary flow o Visually adequate (low) Visually inadequate (high)
Sugar Snack Caries Risk Test (Tooth Saver Team)	2016	<u>Caries Activity/Risk Measurement</u> - 0 weeks Baseline, 5th week, 10th week, 14th week o Sugar snack test (SST) o Saliva Secretion Rate (SSR) o Plaque Score o Mutans Streptococcus (SM) o Buffering Capacity (BC) o Lactobacilli (Lb) o Diet o Decayed Teeth (DT) o Decayed, Missing, Filled Surfaces (DMFS) OHI, 1% NaF, 0.2% NaF, 0.2% CHX
MySmileBuddy (MSB)	2015	- Dietary cariogenicity • Frequency, duration, and timing of simple carbohydrate exposure

- iPad based interactive program		- Food grouping system and scoring method (timing, physical form, retention characteristics) - Dietary risk exposure scores - Fluoride exposure (eg. Toothpaste used) - Family history (eg. Parental experience with tooth decay) - Feeding practices (eg. Sippy cup use) Thoughts and feelings about oral health (eg. Confidence in reducing tooth decay)
American Academy of Pediatric Dentistry AAPD (0-3 year old – For physicians and non-healthcare providers)	2014	Scoring based on low or high risk <u>Biological</u> - Mother/primary caregiver has active caries - Parent/caregiver has low socioeconomic status (SES) - Child has >3 between meal sugar-containing snacks or beverages per day - Child is put to bed with a bottle containing natural or added sugar - Child has special health care needs - Child is recent immigrant <u>Protective</u> - Child receives optimally- fluoridated drinking water or fluoride supplements - Child has teeth brushed daily with fluoridated toothpaste - Child receives topical fluoride form health professional - Child has dental home/regular dental care <u>Clinical Findings</u> - Child has white spot lesions or enamel defects - Child has visible cavities or fillings - Child has plaque on teeth
Cabral, Hilgert, Faber, & Leal et al. (University of Brasilia)	2014	<u>Caries experience</u> - Dmft was considered higher or lower than average in relation to the age of the patient - Score 0-9 (min), 11-13 (max) <u>Related diseases</u> - Parents were asked if children presented diseases related to dental caries, such as asthma or others - Scores: 0 (min), 2-4 (max) <u>Sugar consumption</u> - Parents were asked about consumption of fermentable carbohydrates - Score: 0-5 (min), 13-20 (max) <u>Frequency of food consumption</u> - Parents were asked about children's diets- the quantity of meal/snacks consumed per day - Scores: 0-5 (min), 13-20 (max) <u>Oral hygiene</u> - Visible plaque index - Scores: 0-4 (min), 8-15 (max) <u>Fluoride Sources</u>

		- Parents were asked about fluoride availability - Score: 0-5(min). 10-50(max) <u>Salivary flow</u> - Suspicion of hyposalivation Score: 0-2 (min), 5-20 (max)
Maine Oral Health RA	2013	<u>Dental Home Assessment & Caries</u> - Does child have teeth? - Has child seen a dentist in the past year - Does child have his/her teeth brushed - Does the child have his/her teeth brushed daily with toothpaste - Has the child ever had cavities or fillings - Has the mother/primary caregiver had active/untreated cavities in the past year <u>Oral Evaluation and Plan</u> - Is there visible plaque on teeth - Are there signs of visible decay or white spot lesions on the teeth - Does the child have other oral conditions of concern (abscess, broken tooth, pain, etc.) <u>Oral Health Plan</u> - *Should consider Fluoride varnish if multiple risk factors* <u>For all children</u> - Prescribed fluoride supplement - Fluoride supplements not indicated <u>For children who have not seen a dentist in past year</u> - Completed CRA w/ Oral Evaluation - Applied Fluoride Varnish - Patient/Family declined Fluoride Varnish - Referred child to dentist <u>Referral Information</u> - Dentist name - Routine referral/Immediate referral - The child has special health care needs - There are factors that could hinder performing an oral health exam or x-rays for this child - Oral sensitivities - Difficulty following directions - Latex allergies - Difficulty swallowing - Difficulty sitting still - Does not tolerate knee-to-knee exam - Food sensitivities - Bruxism
Dundee Caries Risk Assessment Model (DCRAM)	2012	<u>Dental examination</u> - Direct vision and illumination by pen light <u>Microbiological saliva sampling (Tongue loop method)</u> - Mutans streptococci - Lactobacilli

		- Yeasts Health Visitor Questionnaire - Height, weight, head circumference, immunization status, ethnic origin, illnesses, medication, weaning, use of comforter, vitamin supplementation, feeding problems, family history, parental employment, parental health, parental smoking and housing status - Opinion on caries risk - Deprivation category score Parental Questionnaire - Breast/bottle - Feeding - Meals, drinks, snacks - Tooth brushing Fluoride supplementation
University College Cork (UCC) – Ireland	2012	Risk/Indicators - Age 0-3 with caries (cavitated or non-cavitated) - Age 4-6 with dmft >2 or DMFT >0 - Age 7 and over with active smooth surface caries (cavitated or non-cavitated) on one or more permanent teeth - New caries lesion in last 12 months - Hypermineralised permanent molars - Medical or other conditions where dental caries could put the patient's general health at increased risk - Medical or other conditions that could increase the patient's risk of developing dental caries - Medical or other conditions that may reduce the patient's ability to maintain their oral health, or that may complicate dental treatment Considerations: - Age 7-10 with dmft >3 or DMFT >0 - Age 11-13 with DMFT >2 - Age 14-15 with DMFT >4 - Deep pits and fissures in permanent teeth - Full medical card - Sweet snacks or drinks between meals more than twice a day Protective Factors - Fissure sealants - Brushes twice a day or more - Use toothpaste containing 1000ppm F or more Fluoridated water supply
American Dental Association Caries Risk Assessment ADA (0-6)	2011	Scoring based on low, moderate or high risk Contributing Conditions - Fluoride exposure • Through drinking water, supplements, professional applications, toothpaste - Sugary foods or drink

		• Including juice, carbonated or non-carbonated soft drinks, energy drinks, medicinal syrups - Eligible for Government Programs • WIC, Head Start, Medicaid or SCHIP - Caries experience of mother, caregiver, and/or other siblings - Dental home • Established patient of record in dental office <u>General Health Conditions</u> - Special health care needs (developmental, physical, medical or mental disabilities that prevent or limit performances of adequate oral health care by themselves or caregivers) <u>Clinical Conditions</u> - Visual or radiographically evident restorations/cavitated carious lesions - Non-cavitated (incipient) carious lesions - Teeth missing due to caries - Visible plaque - Dental/orthodontic appliances present • Fixed or removable - Salivary flow
American Academy of Pediatrics (AAP)	2011	<u>Risk Factors</u> - Mother or primary caregiver has had active decay in the past 12 months - Mother or primary caregiver does not have a dentist - Continual bottle/sippy cup use with fluid other than water - Frequent snacking - Special health care needs - Medicaid eligible <u>Protective Factors</u> - Existing dental home - Drinks fluoridated water or takes fluoride supplements - Fluoride varnish in last 6 months - Has teeth brushed twice daily <u>Clinical Findings</u> - White spots or visible decalcifications in the past 12 months - Obvious decay - Restorations (fillings) present - Visible plaque accumulation - Gingivitis (swollen/bleeding gums) - Teeth present - Healthy teeth <u>Assessment/Plan</u> - Caries risk • Low/high - Completed • Anticipatory guidance • Fluoride varnish

		• Dental Referral - Self management goals • Regular dental visits • Dental treatment for parents • Brush twice daily • Use fluoride toothpaste • Wean off bottle • Less/no juice • Only water in sippy cup • Drink tap water • Healthy snacks • Less/no junk food or candy • No soda • Xylitol
Bankel et al. "Carious lesions and caries risk predictors in a group of Swedish children 2 to 3 years of age. One year observation"	2011	<u>2 years of age</u> - Initial caries - Sugar intake o Scores: 1<14= 14-21, 3= 22-27, 4>27 sucrose containing items/week) - Breastfeeding at night o Score: 1 = none, 2 = breastfeeding - Salivary mutans streptococcus o Scores: 0 = none or few cfu per ml saliva, 1= <105 cfu per ml saliva, 2= 105-106 cfu per ml, 3= >106 cfu per ml saliva <u>3 years of age</u> - Initial caries - Sugar intake o Scores: 1<14= 14-21, 3= 22-27, 4>27 sucrose containing items/week) - Breastfeeding at night o Scores: 1 = none, 2 = breastfeeding - Salivary mutans streptococcus o Scores: 0 = none or few cfu per ml saliva, 1= <105 cfu per ml saliva, 2= 105-106 cfu per ml, 3= >106 cfu per ml saliva
Caries Management by Risk Assessment CAMBRA (0-5 years)	2011	Scoring: 1, 2 or 3 where 1 = high risk <u>Risk Factors</u> - Mother or primary caregiver has had active dental decay in the past 12 months - Bottle with fluid <u>other</u> than water, milk and/or formula - Continual bottle use - Child sleeps with bottle, or nurses on demand - Frequent (>3 times/day) between-meal snacks of sugars/cooked starch/sugared beverages - Saliva reducing factors are present including: • Medications (eg. Some for asthma [albuterol] or hyperactivity) • Medical (cancer treatment) or genetic factors

		- Child has developmental problems/CSHCN (child with special health care needs) - Caregiver has low health literacy , is a WIC participant and/or child participates in Free Lunch Program and/or Early Head Start <u>Protective Factors</u> - Child lives in a fluoridated community or takes fluoride supplements by slowly dissolving or as chewable tablets (note resident ZIP code) - Child drinks fluoridated water (eg. Use of tap water) - Teeth brushed with fluoridated toothpaste (pea-size) at least once daily - Teeth brushed with fluoride toothpaste (pea-size) at least 2x daily - Fluoride varnish in last six months - Mother/caregiver chews/dissolves xylitol chewing gum/lozenges 2-4x daily <u>Disease Indicators/Risk Factors – Clinical Examination of Child</u> - Obvious white spots, decalcifications enamel defects or obvious decay present on the child's teeth - Restorations present (past caries experience for the child) - Plaque is obvious on the teeth and/or gums bleed easily - Visually inadequate saliva flow - New remineralisation since last exam (List teeth) Child's overall caries risk (high, medium or low) Child bacteria and saliva test Caregiver: Bacteria/saliva test results Self management goals Treatment guidelines
NUS-CRA	2010	<u>Children's demographic background</u> - Age - Gender - Race - Country of birth <u>Socioeconomic status</u> - Parents education attainment - Housing condition <u>Children's oral health practice</u> - Feeding histories - Diet habits - Oral hygiene measures - Fluoride applications - Dental attendance Systemic disease Parental knowledge and attitudes on oral health
CariFree (CF) (Age 0-5)	2009	<u>Patient Use Only</u> Risk Factors - Plaque build up on my child's teeth - Child takes medication daily

		- Child sees the same dentist regularly - Child has special needs that prohibit adequate care at home - Child continuously sips on something other than water during the day, sleeps with a bottle , or nurses on demand - Child snacks 1-3 times daily between meals - Other health concerns: diabetes, asthma, allergies, or other <u>Clinician Use Only</u> - Mother/caregiver active caries - New/progressing visible cavitation's - New/progressing approximal radiographic radiolucencies - New/active white spot lesions - Decay history is a concern <u>Professional Assessment Summary</u> - Risk factors are a concern - Disease indicators are a concern <u>Risk identification</u> Low/moderate risk – moderate risk- high/extreme risk - Risk factors - Disease indicators
Caries Management System (CMS)	2009	10-step non-invasive strategy to arrest and remineralize early lesions 1. Diet assessment 2. Plaque assessment 3. Bitewing radiographic survey 4. Diagnosis and caries risk assessment - Diet - Fluoride exposure - Clinical examination o Plaque distribution o Examination using ICDAS II criteria (International Caries Detection & Assessment System) 5. Case presentation to the patient 6. Diet advice and oral hygiene coaching - Emphasize value of fluoridated water - Bottle feeding of sugar-containing products discouraged - Discourage sugary foods, especially around bedtime - 7. Clinical management 8. Monitoring of patient's progress 9. Recall programme tailored to caries risk status <u>Criteria for Caries Risk for Child with Primary Dentition</u> - Low o DMFS = 0 o ICDAS II code <2 o No radiolucencies o No sites with Plaque Index = 3 o < 1 new lesion per year and no progression of existing lesions

		- At Risk o DMFS > 0 o Demineralized enamel – ICDAS II codes > 1 o C1 or greater radiolucencies o 1 new lesion per year and/or progression of existing lesions o Any site with Plaque Index = 3 in cases where DMFS = 0 - High o Any site with Plaque Index = 3 in cases where DMFS =0 o >1 new lesion per year
Cariogram (CG)	2004	<u>Circumstances</u> - Caries experience • Past caries experience (cavities, fillings and missing teeth due to caries) • DMFT & DMFS - Related diseases • General disease or conditions associated with dental caries • Medical history • Medications <u>Diet</u> - Diet content (weekly diet diary) • Estimation of cariogenicity of the food, in particular fermentable carb. content • Diet history • Lactobacillus test count - Diet frequency (weekly diet diary) • Estimation of number of meals and snacks per day, mean for a normal day • 24 hour recall or 3 days dietary recall <u>Bacteria</u> - Plaque quantity • Estimation of hygiene • Silness-Loe Plaque Index (PI) • Crowded teeth leading to difficulties in removing plaque interproximally should be taken into account - Streptococcus mutans • Estimation of mutans streptococci (streptococcus mutans, streptococcus sobrinus) in saliva, for example using strip mutans test <u>Susceptibility</u> - Fluoride program • Estimation of as to what extent fluoride is available in the oral cavity over the coming period of time (fluoride exposure- interview patient) - Salivary secretion (stimulated saliva test)

		• Estimation of amount of saliva, for example using paraffin-stimulated secretion and expressing results as ml saliva per minute - Saliva buffer capacity • Estimation of capacity of saliva to buffer acids, for example using Dentobuff test Clinical judgement Opinion of dental examiner, 'clinical feeling'. Examiners own clinical and personal score for the individual patient
Pediatric Risk Assessment Tool (PRAT)	2002	- Risk based on point system o Low Risk = 0-4 points o Moderate Risk = 5-10 points o High Risk > 10 - 11 components: o Number of drinking occasions o Evening/night soft drink consumption o Oral Hygiene o Previous history of dental caries o Total formula/milk o Total juice/juice drinks o Total regular pop/Kool-Aid, sports drinks, other sugar beverages o Total water, other sugar-free beverages o Hard or chewy candy, regular gum (occasions) o Baked starch/sugar (occasions)
AAPD (aka CAT) (0-5 year old – For dental providers)	2002 (Revised 2014)	Scoring based on low, moderate, or high risk <u>Biological</u> - Mother/primary caregiver has active caries - Parent/caregiver has low SES - Child has >3 between meal sugar-containing snacks or beverages per day - Child is put to bed with a bottle containing natural or added sugar - Child has special health care needs - Child is recent immigrant <u>Protective</u> - Child receives optimally- fluoridated drinking water or fluoride supplements - Child has teeth brushed daily with fluoridated toothpaste - Child receives topical fluoride form health professional - Child has dental home/regular dental care <u>Clinical Findings</u> - Child has >1 decayed/missing/filled surfaces - Child has active white spot lesions or enamel defects - Child has elevated mutans streptococci levels ▪ Child has plaque on teeth

Some Canadian Context – Risk Factors for ECC in the Canadian Literature:

While outside the scope of this systematic review of evidence on caries-risk, we felt it was important to review the Canadian literature on ECC to identify common risk factors associated with ECC in cross-sectional studies. This was undertaken to provide some "Canadian context" in identifying factors to include in a Canadian style caries-risk assessment tool. We reviewed literature since the establishment of a case definition for ECC in 1997. Cross-sectional studies were considered. Only those studies reporting risk factors associated with ECC using logistic regression analyses were considered.

A total of six articles were identified to have reported variables associated with ECC in Canadian literature following logistic regression analyses.[35, 58-62] The main risk factors identified in these studies appear below in Table 8. Based upon these data it could be justified to include the following variables into a caries-risk assessment tool for use by non-dental professionals in Canada:

- Age of child,
- Existence of a dental home and past dental attendance,
- Lack of dental insurance,
- Family income, specifically low income,
- Family size,
- Frequency of snacking,
- Inappropriate bottle use and infant feeding habits,
- Brushing habits of child,
- Parental ratings or perception of child's dental status,

- Presence of enamel hypoplasia,
- Presence of plaque on teeth.

Table 8 – Variables associated with ECC and S-ECC in Canadian studies following logistic regression

Study	**Risk Factors for ECC**	**Risk Factors for S-ECC**
Schroth & Cheba[60]	• Male child • Age at first dental visit (> 23 months) • Low monthly income (≤ $2,000) • History of failed dental appointment • Not being single parent	
Tiberia et al[61]	• Leaving bottle with child • Problems brushing • Holding liquids in mouth for prolonged time	
Werneck et al[62]	• No insurance • No family dentist • Frequency of snacks • (≥ 2/day)	
Schroth et al[63]	• Age of child • Maternal rating of child's teeth • Number of children in household	
Schroth et al[54]	• Enamel hypoplasia • Infant age • Prenatal 25(OH)D level	
El Azrak et al[64]	• Age of child • Parent thinks child has dental problems • Enamel hypoplasia	• Debris score • Parent thinks child has dental problems • Enamel hypoplasia

Poon and colleagues embarked on a caries risk assessment tool development project in 2007/2008, which included a literature review, a review of best-practices, consultations with dental public health staff and a review of recommendations from the British Columbia (BC)

Early Childhood Dental Programs Evaluation Subcommittee.[63] Despite this undertaking they were unable to develop a standardized caries risk assessment tool for children aged 0-5 years of age in BC.

Part C – Proposed Caries Risk Assessment Tool for Screening Purposes for Preschool Children in Canada

The intent of this project was to ultimately identify those factors that should be included in an early childhood caries risk assessment tool for use by non-dental providers and to develop a draft of such tool. However, while it is important to have such a tool for use for screening purposes in Canada, there is considerable utility in developing a complementary tool for use by dental professionals. The drafted caries risk assessment tool in this report could theoretically be used by both non-dental and dental providers. The development of this tool was informed by Project A (systematic review of the literature) and Project B (environmental scan of existing caries risk assessment tools). Canadian literature on risk factors for ECC was also considered to provide some "Canadian context" of potential risk factors for caries that are currently not included in some of the existing caries risk assessment tools.

The caries risk assessment tool that has been developed as part of this project appears in Figure 2. This is the first caries risk assessment tool that has been developed for use in Canada with children < six years of age. While this is a very exciting and promising development for early childhood oral health in Canada, some caution should be exercised. Prospective studies involving Canadian preschool children are needed in order to validate and determine the sensitivity and specificity of this caries risk assessment tool to predict caries risk.

Figure 3 presents versions of the draft caries risk assessment tool arising from the March 2018 stakeholder meeting. Focus group pilot testing of this drafted tool is currently underway and results will be discussed at a November 2018 meeting of the stakeholder group.

Figure 2 – Draft Caries Risk Assessment Tool

CANA-P – Canadian Pediatric Caries Risk Assessment Tool (< 6 years) OR
PE-CAN – Pediatric Canadian Caries Risk Assessment Tool (< 6 years)

Child's Name_____ Date _____

Child's Date of Birth_____ Age (in months)_____

DRAFT – DRAFT – DRAFT – DRAFT – DRAFT	High Risk		Low Risk		Comments
Sociodemographic/Biological Factors					
Age of child (e.g., ≥ 24 months of age)	☐	Yes	☐	No	Age is a predictor of caries, but at this time it is unclear how best to assign risk.
Child's family is of low socioeconomic status (i.e., low income, receiving government assistance/welfare)	☐	Yes	☐	No	
Parent/caregiver has low education/limited education	☐	Yes	☐	No	
Child has special health care needs†	☐	Yes	☐	No	Would need to define this. Further discussion required.
Inappropriate bottle feeding (i.e., bottle feeding > 12 months, frequent bottle use, bedtime bottle with contents other than water)	☐	Yes	☐	No	Need to determine how best to phrase this question.
Child usually snacks or drinks sugary beverages between meals	☐	Yes	☐	No	
Parent/caregiver or siblings have experienced caries or have active caries†	☐	Yes	☐	No	
Child may have limited access to care (i.e., no dental insurance; First Nations, Inuit, or Metis; lives rurally; low-income household; newcomer/refugee to Canada)*	☐	Yes	☐	No	
Protective Factors					
Child regularly breastfed (with an oral hygiene routine established)	☐	No	☐	Yes	Do we want to weigh into the politics or duration of breastfeeding? After some time it can become a risk factor
Child has existing dental home and receives regular dental care	☐	No	☐	Yes	
Child has teeth brushed daily with fluoridated toothpaste (i.e., supervised brushing of child by parent/caregiver)	☐	No	☐	Yes	
Child's fluoride exposure (i.e., lives in fluoridated community, drinks fluoridated water, take fluoride supplements, uses fluoridated toothpaste, or receives regular fluoride varnish)	☐	No	☐	Yes	
Clinical Factors					
Child has caries (including white spot lesions) or past dental treatment for caries	☐	Yes	☐	No	
Child has visible enamel defects or enamel hypoplasia	☐	Yes	☐	No	
Child has visible plaque on teeth	☐	Yes	☐	No	

†Based on environmental scan of existing caries risk assessment tools
*Based on risk factors in the Canadian literature (limited evidence)

Overall caries risk status _____

Figure 3a and 3b – Draft Caries Risk Assessment Tool Arising from March 2018 Stakeholder Meeting

CANA-P – Canadian Pediatric Caries Risk Assessment Tool (< 6 years) *OR*
PE-CAN – Pediatric Canadian Caries Risk Assessment Tool (< 6 years) *OR*
CAN-CART Canadian Caries Risk Assessment Tool (< 6 years)

DRAFT VERSION A- April 2018

Child's Name _____
Child's Date of Birth_____
Parent/caregiver's name _____
Date _____

FACTORS	RISK LEVEL		RECOMMENDED ACTIONS
Clinical Factors	**High Risk**	**Low Risk**	**Actions**
Child has cavities (including white spot lesions) and/or has fillings for past cavities	☐ Yes	☐ No	
Child has visible plaque on top front teeth	☐ Yes	☐ No	
Biological/Behavioral Factors	**High Risk**	**Low Risk**	**Actions**
Infant feeding practices that can increase the risk for cavities: - bottle feeding > 12 months, - frequent bottle use, - bedtime bottle with contents other than water, - bottle or breastfeeding after solid foods have been introduced, without a good oral hygiene routine established	☐ Yes	☐ No	
Child usually snacks or drinks sugary and acidic beverages between meals (including fruit juices and sports drinks)	☐ Yes	☐ No	
Protective Factors	**High Risk**	**Low Risk**	**Actions**
Child has teeth brushed daily (by parent/caregiver), at least twice a day for two minutes	☐ No	☐ Yes	
Child is exposed to fluoride (i.e., uses fluoridated toothpaste daily, drinks fluoridated water, or receives *regular* fluoride varnish)	☐ No	☐ Yes	

Overall caries risk status _____

CARIES MANAGEMENT *Low Risk:*	*High Risk:*

- Refer to dental home (by 12 months/6 months after eruption of 1st tooth)
- Recommend 2x daily brushing with fluoridated toothpaste:
  ○ Smear (grain of rice size) of toothpaste for 0-3 years of age
  ○ Pea size of toothpaste for 3-6 years of age
- Caregiver Education/Anticipatory Guidance
	- Refer to dental home (by 12 months/6 months after eruption of 1st tooth)
	- Recommend 2x daily brushing with fluoridated toothpaste:
	  ○ Smear (grain of rice size) of toothpaste for 0-3 years of age
	  ○ Pea size of toothpaste for 3-6 years of age
	- Professional Fluoride varnish applications at each visit
	- Caregiver Education/Anticipatory Guidance

**Based on AAPD Caries Management, Establishment of the Dental Home & CDA Position Statements on ECC, First Visit, Use of Fluoride in Caries Prevention*

CANA-P – Canadian Pediatric Caries Risk Assessment Tool (< 6 years) *OR*
PE-CAN – Pediatric Canadian Caries Risk Assessment Tool (< 6 years) *OR*
CAN-CART Canadian Caries Risk Assessment Tool (< 6 years

DRAFT VERSION B- April 2018

Child's Name _____
Child's Date of Birth_____
Parent/caregiver's name _____
Date _____

Factors	High Risk	Low Risk	Actions
Sociodemographic/Biological/Behavioral Factors			
Child's family is of low socioeconomic status (low income, receiving government assistance/welfare, parent/caregiver has low education/limited education)	☐ Yes	☐ No	
Infant feeding practices that can increase the risk for cavities: - bottle feeding > 12 months, - frequent bottle use, - bedtime bottle with contents other than water, - bottle or breastfeeding after solid foods have been introduced, without a good oral hygiene routine established	☐ Yes	☐ No	
Child usually snacks or drinks sugary and acidic beverages between meals (including fruit juices and sports drinks)	☐ Yes	☐ No	
Protective Factors			
Child has teeth brushed daily (by parent/caregiver), at least twice a day for two minutes	☐ No	☐ Yes	
Child is exposed to fluoride (i.e., uses fluoridated toothpaste daily, drinks fluoridated water, or receives regular fluoride varnish	☐ No	☐ Yes	
Clinical Factors			
Child has cavities (including white spot lesions) and/or has fillings for past cavities	☐ Yes	☐ No	
Child has visible plaque on top front teeth	☐ Yes	☐ No	

Overall caries risk status _____

CARIES MANAGEMENT *Low Risk:*	*High Risk:*

- Refer to dental home (by 12 months/6 months after eruption of 1st tooth)
- Recommend 2x daily brushing with fluoridated toothpaste:
  ○ Smear (grain of rice size) of toothpaste for 0-3 years of age
  ○ Pea size of toothpaste for 3-6 years of age
- Caregiver Education/Anticipatory Guidance
	- Refer to dental home (by 12 months/6 months after eruption of 1st tooth)
	- Recommend 2x daily brushing with fluoridated toothpaste:
	  ○ Smear (grain of rice size) of toothpaste for 0-3 years of age
	  ○ Pea size of toothpaste for 3-6 years of age
	- Professional Fluoride varnish applications at each visit

Appendix

American Dental Association Caries Risk Assessment FormAge 0-6 years

ADA American Dental Association®
America's leading advocate for oral health

Caries Risk Assessment Form (Age 0-6)

Patient Name:				
Birth Date:			**Date:**	
Age:			**Initials:**	
		Low Risk	Moderate Risk	High Risk
Contributing Conditions		Check or Circle the conditions that apply		
I.	**Fluoride Exposure** (through drinking water, supplements, professional applications, toothpaste)	☐ Yes	☐ No	
II.	**Sugary Foods or Drinks** (including juice, carbonated or non-carbonated soft drinks, energy drinks, medicinal syrups)	Primarily at mealtimes ☐	Frequent or prolonged between meal exposures/day ☐	Bottle or sippy cup with anything other than water at bed time ☐
III.	**Eligible for Government Programs** (WIC, Head Start, Medicaid or SCHIP)	☐ No		☐ Yes
IV.	**Caries Experience of Mother, Caregiver and/or other Siblings**	No carious lesions in last 24 months ☐	Carious lesions in last 7-23 months ☐	Carious lesions in last 6 months ☐
V.	**Dental Home**: established patient of record in a dental office	☐ Yes	☐ No	
General Health Conditions		Check or Circle the conditions that apply		
I.	**Special Health Care Needs** (developmental, physical, medical or mental disabilities that prevent or limit performance of adequate oral health care by themselves or caregivers)	☐ No		☐ Yes
Clinical Conditions		Check or Circle the conditions that apply		
I.	**Visual or Radiographically Evident Restorations/ Cavitated Carious Lesions**	No new carious lesions or restorations in last 24 months ☐		Carious lesions or restorations in last 24 months ☐
II.	**Non-cavitated** (incipient) **Carious Lesions**	No new lesions in last 24 months ☐		New lesions in last 24 months ☐
III.	**Teeth Missing Due to Caries**	☐ No		☐ Yes
IV.	**Visible Plaque**	☐ No	☐ Yes	
V.	**Dental/Orthodontic Appliances Present** (fixed or removable)	☐ No	☐ Yes	
VI.	**Salivary Flow**	Visually adequate ☐		Visually inadequate ☐

Overall assessment of dental caries risk: ☐ Low ☐ Moderate ☐ High

Instructions for Caregiver:

American Academy of Pediatric Dentistry

Age 0-3 years & Age 0-5 years

Table 1. Caries-risk Assessment Form for 0-3 Year Olds[59,60]

(For Physicians and Other Non-Dental Health Care Providers)

Factors	High Risk	Low Risk
Biological		
Mother/primary caregiver has active cavities	Yes	
Parent/caregiver has low socioeconomic status	Yes	
Child has >3 between meal sugar-containing snacks or beverages per day	Yes	
Child is put to bed with a bottle containing natural or added sugar	Yes	
Child has special health care needs	Yes	
Child is a recent immigrant	Yes	
Protective		
Child receives optimally-fluoridated drinking water or fluoride supplements		Yes
Child has teeth brushed daily with fluoridated toothpaste		Yes
Child receives topical fluoride from health professional		Yes
Child has dental home/regular dental care		Yes
Clinical Findings		
Child has white spot lesions or enamel defects	Yes	
Child has visible cavities or fillings	Yes	
Child has plaque on teeth	Yes	

Circling those conditions that apply to a specific patient helps the health care worker and parent understand the factors that contribute to or protect from caries. Risk assessment categorization of low or high is based on preponderance of factors for the individual. However, clinical judgment may justify the use of one factor (e.g., frequent exposure to sugar containing snacks or beverages, visible cavities) in determining overall risk.

Overall assessment of the child's dental caries risk: High ❒ Low ❒

Table 2. Caries-risk Assessment Form for 0-5 Year Olds[59,60]

(For Dental Providers)

Factors	High Risk	Moderate Risk	Low Risk
Biological			
Mother/primary caregiver has active caries	Yes		
Parent/caregiver has low socioeconomic status	Yes		
Child has >3 between meal sugar-containing snacks or beverages per day	Yes		
Child is put to bed with a bottle containing natural or added sugar	Yes		
Child has special health care needs		Yes	
Child is a recent immigrant		Yes	
Protective			
Child receives optimally-fluoridated drinking water or fluoride supplements			Yes
Child has teeth brushed daily with fluoridated toothpaste			Yes
Child receives topical fluoride from health professional			Yes
Child has dental home/regular dental care			Yes
Clinical Findings			
Child has >1 decayed/missing/filled surfaces	Yes		
Child has active white spot lesions or enamel defects	Yes		
Child has elevated mutans streptococci levels	Yes		
Child has plaque on teeth		Yes	

Circling those conditions that apply to a specific patient helps the practitioner and parent understand the factors that contribute to or protect from caries. Risk assessment categorization of low, moderate, or high is based on preponderance of factors for the individual. However, clinical judgment may justify the use of one factor (e.g., frequent exposure to sugar-containing snacks or beverages, more than one dmfs) in determining overall risk.

Overall assessment of the child's dental caries risk: High ❒ Moderate ❒ Low ❒

American Academy of Pediatrics (AAP) Oral Health Risk Assessment Tool

Oral Health Risk Assessment Tool

The American Academy of Pediatrics (AAP) has developed this tool to aid in the implementation of oral health risk assessment during health supervision visits. This tool has been subsequently reviewed and endorsed by the National Interprofessional Initiative on Oral Health.

Instructions for Use

This tool is intended for documenting caries risk of the child, however, two risk factors are based on the mother or primary caregiver's oral health. All other factors and findings should be documented based on the child.

The child is at an absolute high risk for caries if any risk factors or clinical findings, marked with a ⚠ sign, are documented yes. In the absence of ⚠ risk factors or clinical findings, the clinician may determine the child is at high risk of caries based on one or more positive responses to other risk factors or clinical findings. Answering yes to protective factors should be taken into account with risk factors/clinical findings in determining low versus high risk.

Patient Name:_____ Date of Birth:_____ Date:_____

Visit: ☐ 6 month ☐ 9 month ☐ 12 month ☐ 15 month ☐ 18 month ☐ 24 month ☐ 30 month ☐ 3 year ☐ 4 year ☐ 5 year ☐ 6 year ☐ Other_____

RISK FACTORS

⚠ Mother or primary caregiver had active decay in the past 12 months
☐ Yes ☐ No

- Mother or primary caregiver does not have a dentist
  ☐ Yes ☐ No
- Continual bottle/sippy cup use with fluid other than water
  ☐ Yes ☐ No
- Frequent snacking
  ☐ Yes ☐ No
- Special health care needs
  ☐ Yes ☐ No
- Medicaid eligible
  ☐ Yes ☐ No

PROTECTIVE FACTORS

- Existing dental home
  ☐ Yes ☐ No
- Drinks fluoridated water or takes fluoride supplements
  ☐ Yes ☐ No
- Fluoride varnish in the last 6 months
  ☐ Yes ☐ No
- Has teeth brushed twice daily
  ☐ Yes ☐ No

CLINICAL FINDINGS

⚠ White spots or visible decalcifications in the past 12 months
☐ Yes ☐ No

⚠ Obvious decay
☐ Yes ☐ No

⚠ Restorations (fillings) present
☐ Yes ☐ No

- Visible plaque accumulation
  ☐ Yes ☐ No
- Gingivitis (swollen/bleeding gums)
  ☐ Yes ☐ No
- Teeth present
  ☐ Yes ☐ No
- Healthy teeth
  ☐ Yes ☐ No

ASSESSMENT/PLAN

Caries Risk:
☐ Low ☐ High

Completed:
☐ Anticipatory Guidance
☐ Fluoride Varnish
☐ Dental Referral

Self Management Goals:

☐ Regular dental visits	☐ Wean off bottle	☐ Healthy snacks
☐ Dental treatment for parents	☐ Less/No juice	☐ Less/No junk food or candy
☐ Brush twice daily	☐ Only water in sippy cup	☐ No soda
☐ Use fluoride toothpaste	☐ Drink tap water	☐ Xylitol

Bankel et al.

	2 years of age				3 years of age			
ID	Caries defs plus d_i [a]	Sucrose-intake 1, 2, 3 & 4 [b]	Breastfeeding at night 1 & 2 [c]	MS in saliva score 0-3 [d]	Caries defs plus d_i [a]	Sucrose-intake 1, 2, 3 & 4 [b]	Breastfeeding at night 1 & 2 [c]	MS in saliva score 0-3 [d]
1	2	1	2	0	2	1	1	0
2	18	1	2	1	19	1	2	0
3	3	4	2	0	9	2	1	2
4	1	4	2	3	7	4	1	3
5	2	4	1	1	8	4	1	3
6	0	4	1	0	1	1	1	0
7	0	4	1	0	7	3	1	1
8	0	4	1	3	0	1	1	1
9	0	4	1	0	0	3	1	0
10	0	4	1	0	0	3	1	0
11	0	4	1	0	0	1	1	0
12	0	4	1	0	0	1	1	0
13	0	4	1	0	0	2	1	0
14	0	4	2	0	0	3	2	0
15	0	4	1	0	0	1	1	0
16	0	4	1	1	0	2	1	1
17	0	4	1	0	0	4	1	0
18	0	4	2	0	0	3	1	0
19	0	1	2	0	0	1	1	0
20	0	1	2	2	0	4	1	0
21	0	2	2	0	0	3	2	0
22	0	1	2	0	0	1	1	0
23	0	1	1	3	0	1	1	2
24	0	1	1	1	2	2	1	2
25	0	1	1	2	0	2	1	0

a) di = initial caries, b)1<14, 2=14-21, 3=22-27, 4>27 sucrosecontaining items/wk; c) 1=none, 2=breastfeeding; d) Score 0 = none or few cfu per ml saliva, score 1=<105 cfu per ml saliva saliva, score 2=105-106 cfu per ml and score 3=>106 cfu per ml saliva

Cabral, Hilgert, Faber & Leal (University of Brasilia)

Variable	Description	Instrument used	Scores			
			Minimum		Maximum	
Caries experience	dmft was considered higher or lower than average in relation to the age of the patient	dmft	0	9	11	13
Related diseases	Parents were asked if children presented diseases related to dental caries, such as asthma or others	Questionnaire	0		2	4
Sugar consumption	Parents were asked about the consumption of fermentable carbohydrates	Questionnaire	0	5	13	20
Frequency of food consumption	Parents were asked about childrens' diets - the quantity of meals/snacks consumed per day	Questionnaire	0	5	13	20
Oral hygiene	Visible Plaque Index	Visible plaque index	0	4	8	15
Fluoride Sources	Parents were asked about fluoride availability	Questionnaire	0	5	10	50
Salivary flow	Suspicion of hyposalivation	Clinical Examination	0	2	5	40

dmft=decayed, missing, filled teeth

Figure 2- Variables assessed, their description, the instrument used and the scores of each variable according to severity

Caries Management by Risk Assessment (CAMBRA)

TABLE 2

CAMBRA — Caries Risk Assessment Form for Age 0 to 5 Years

Patient Name:_____ ID#_____ Age:_____ Date:_____

Assessment Date:_____ Please circle: BASELINE, three-month follow-up or six-month follow-up

	1	2	3	
NOTE: Any one Yes in Column 1 signifies likely "High Risk" and an indication for bacteria tests	Yes =CIRCLE	Yes =CIRCLE	Yes =CIRCLE	Comments:
1. Risk Factors (Biological Predisposing Factors)				
(a) Mother or primary caregiver has had active dental decay in the past 12 months*	Yes			
(b) Bottle with fluid <u>other</u> than water, plain milk and/or plain formula		Yes		Type of fluid:
(c) Continual bottle use		Yes		
(d) Child sleeps with a bottle, or nurses on demand		Yes		
(e) Frequent (>3 times/day) between-meal snacks of sugars/cooked starch/sugared beverages		Yes		#times/day:
(F) Saliva-reducing factors are present, including: 1. medications (e.g., some for asthma [albuterol] or hyperactivity) 2. medical (cancer treatment) or genetic factors		Yes		
(g) Child has developmental problems/CSHCN (child with special health care needs)		Yes		
(h) Caregiver has low health literacy, is a WIC participant and/or child participates in Free Lunch Program and/or Early HeadStart		Yes		
2. Protective Factors				
(a) Child lives in a fluoridated community or takes fluoride supplements by slowly dissolving or as chewable tablets (note resident ZIP code)			Yes	
(b) Child drinks fluoridated water (e.g., use of tap water)			Yes	
(c) Teeth brushed with fluoridated toothpaste (pea size) at least once daily			Yes	
(d) Teeth brushed with fluoride toothpaste (pea size) at least 2x daily			Yes	
(e) Fluoride varnish in last six months			Yes	
(f) Mother/caregiver chews/dissolves xylitol chewing gum/lozenges 2–4x daily			Yes	
3. Disease Indicators/Risk Factors – Clinical Examination of Child				
(a) Obvious white spots, decalcifications enamel defects or obvious decay present on the child's teeth*	Yes			
(b) Restorations present (past caries experience for the child)*	Yes			
(c) Plaque is obvious on the teeth and/or gums bleed easily		Yes		
(d) Visually inadequate saliva flow		Yes		

Child's Overall Caries Risk* (circle): High Moderate Low

Child: Bacteria/Saliva Test Results: MS: LB: Flow Rate: Ml/min: Date:

Caregiver: Bacteria/Saliva Test Results: MS: LB: Flow Rate: ml/min: Date:

Self-management goals:

1)_____

2)_____

VISUALIZE CARIES BALANCE

*Assessment based on provider's judgment of balance between risk factors/disease indicators and protective factors.

CRA FORM

First name: _____ Last name: _____ Date: _____

Children Age 0-5

Due to new research on cavities and what causes them, we know everyone is at risk of developing decay at some point during their lifetime. The goal of this assessment form and the bacterial screening test is to determine your likelihood of experiencing new decay in the next 12 months. Please fill out the "Patient Use" section of this form to the best of your ability. These items will be discussed with your dental professional during your appointment today. Questions about this form? See the back for Q&A.

Would you like a free assessment for your child to help determine his/her risk for cavities?	**yes**		**no**
If diagnosed at risk for cavities today, would you be interested in discussing treatment options for your child?	yes	maybe	no
If needed, are you willing to modify your child's dietary habits?	yes	maybe	no

RISK FACTORS

I notice plaque build-up on my child's teeth.	no	yes
My child takes medication daily. (#____)	no	yes
My child sees the same dentist regularly.	no	yes
My child has special needs that prohibit adequate care at home.	no	yes
My child continuously sips on something other than water during the day, sleeps with a bottle, or nurses on demand.	no	yes
My child snacks 1-3 times daily between meals.	no	yes
Do any of these other health concerns apply to your child? (check all that apply) ☐ Diabetes ☐ Allergies ☐ Asthma ☐ Other	no	yes
Inadequate saliva flow	no	yes
Appliances present	no	yes

DISEASE INDICATORS

Mother/Caregiver Active Caries	no	yes
New/Progressing Visible Cavitations	no	yes
New/Progressing Approximal Radiographic Radiolucencies	no	yes
New/Active White Spot Lesions	no	yes
Decay History is a Concern	no	yes

PROFESSIONAL ASSESSMENT SUMMARY

Risk Factors are a Concern	no	yes
Disease Indicators are a Concern	no	yes

RISK IDENTIFICATION Transfer information above to boxes below to determine risk.

N Y	N Y	N Y
☐ ☐ Risk Factors	☐ ☐ Risk Factors	☐ ☐ Risk Factors
☐ ☐ Disease Indicators	☐ ☐ Disease Indicators	☐ ☐ Disease Indicators
LOW/MODERATE RISK	**MODERATE RISK**	**HIGH/EXTREME RISK**
1	**2**	**3**

☐ RECOMMENDED ☐ PROVISIONAL ☐ DECLINE

BIOFILM CHALLENGE (OPTIONAL)

CariScreen Bacterial Assessment is a concern (0-1500 low, 1501-9999 high)	low	high

Caries Management System (Evans & Dennison, 2009)

Table 1. Ten-step summary of the Caries Management System

1	Diet assessment
2	Plaque asssment
3	Bitewing radiographic survey
4	Diagnosis and caries risk assessment
5	Preparation of oral care plan
6	Case presentation at which patient is informed about: • Dental caries ○ Arrest ○ Reversal/Natural repair (Remineralization) ○ Prevention ○ Number and status of current lesions ○ Role of dental practitioner in caries management ○ Role of home care in caries prevention ○ Current caries risk status • Result of diet assessment and recommendatons
7	Oral hygiene coaching
8	Clinical management • Topical fluoride application (both professional and home care) • Sealant or GIC application
9	Monitoring of plaque control and treatment outcomes at each visit
10	Recall programme tailored to caries risk status

Table 3. Criteria for caries risk for a child who has a primary dentition only

Caries risk	New patient	Recall patient
Low	• dmfs = 0 • ICDAS II codes < 2 • No radiolucencies • No sites with Plaque Index = 3	• < 1 new lesion per year* and no progression of existing lesions
At-risk	• dmfs > 0 • Demineralized enamel – ICDAS II codes > 1 • C1 or greater radiolucencies	• 1 new lesion per year* and/or progression of existing lesions • Any site with Plaque Index = 3 in cases where dmfs = 0
At-risk – High	• Any site with Plaque Index = 3 in cases where dmfs = 0 • Not assigned to new patient	• > 1 new lesion per year*

*... on approximal surfaces as diagnosed by bitewing scores C1 or greater or else on other surfaces diagnosed as ICDAS II code 2 or greater.

Cariogram

Caries related factors according to the program

Factor	Comment	Info/data needed
Caries experience	Past caries experience, including cavities, fillings and missing teeth due to caries. Several new cavities definitely appearing during preceding year should score '3' even if number of fillings is low.	DMFT, DMFS, new caries experience in the past one year.
Related general diseases	General disease or conditions associated with dental caries.	Medical history, medications.
Diet, contents	Estimation of the cariogenicity of the food, in particular fermentable carbohydrate content.	Diet history, (lactobacillus test count).
Diet, frequency	Estimation of number of meals and snacks per day, mean for a normal day.	Questionnaire results (24-h recall or 3 days dietary recall).
Plaque amount	Estimation of hygiene, for example according to Silness-Löe Plaque Index (PI). Crowded teeth leading to difficulties in removing plaque interproximally should be taken into account.	Plaque index.
Mutans streptococci	Estimation of levels of mutans streptococci (Streptococcus mutans, Streptococcus sobrinus) in saliva, for example using Strip mutans test.	Strip mutans test or other similar test.

Cont. next page.

Continued Cariogram…

Fluoride programme	Estimation of as to what extent fluoride is available in the oral cavity over the coming period of time.	Fluoride exposure, interview the patient.
Saliva secretion	Estimation of amount of saliva, for example using paraffin-stimulated secretion and expressing results as ml saliva per minute.	Stimulated saliva test - secretion rate.
Saliva buffer capacity	Estimation of capacity of saliva to buffer acids, for example using the Dentobuff test.	Dentobuff test or other similar test.
Clinical judgement	Opinion of dental examiner, 'clinical feeling'. Examiners own clinical and personal score for the individual patient.	Opinion of dental examiner, 'clinical feeling'. A pre-set score of 1 comes automatically.

Dundee Caries Risk Assessment Model

Data collection

Dental examination. This used a combination of direct vision and illumination by a pen-light, with the child in the supine position at age 1 year (and upright position for the remaining years). Examination was carried out within 1 month of the child's birthday wherever possible. Caries detection was at the d_1 caries into both enamel and dentine threshold. All lesions were recorded according to the criteria developed for the Dundee selective threshold methods for caries detection/detection (25). All children were examined by a calibrated, single examiner (HBM).

Microbiological saliva sampling. The tongue-loop method of saliva sampling (26) was carried out by the child's health visitor (HV), and mutans streptococci, lactobacilli and yeasts were cultured and analysed as described previously (23, 24).

Health Visitor Questionnaire (HVQ). This annual questionnaire was completed by the child's HV, as an addition to their routine child health monitoring programme, at the same time as saliva sampling or at a later date. HVs are qualified nurses working within the community with a wide remit that includes child health monitoring. All 57 HVs employed in Dundee at that time participated in the study. The HVQ provided data such as height, weight and head circumference; immunization status; ethnic origin, illnesses, medication, weaning, use of comforter, vitamin supplementation, feeding problems, family history, parental employment, parental health, parental smoking and housing status. One of the initial questions asked the HVs to give their opinion as to whether the child was at caries risk (Yes/No). This was a subjective assessment (hunch) and involved no specific training or calibration. The Deprivation Category (DEPCAT) score (27), a measure of deprivation, was also obtained from information provided by the questionnaire.

Parental Questionnaire. This annual questionnaire was given to the parent/guardian of the study child by the HV at the time of saliva sampling. This provided data on breast/bottle feeding, meals, drinks, snacks, toothbrushing, fluoride supplementation as well as other sociodemographic variables.

EBHnow -Online Search Engine (McGill)

http://ebhnow.com/apps/0120/index.php

Age

- less than 6 months
- 6-12 months
- 1-3 years
- 3-6 years

Fluoride concentration in drinking water

- Less than 0.3 ppm
- 0.3 - 0.6 ppm
- Over 0.6 ppm
- Don't know

Presence of caries

- No incipient or cavitated primary or secondary carious lesions during the last 3 years
- One of two incipient or cavitated primary or secondary carious lesions in last 3 years
- Three or more incipient or cavitated primary or secondary carious lesions in last 3 years

Caries Risk Factors

- High titers of carogenic bacteria
- Poor oral hygiene
- Prolonged nursing (bottle or breast)
- Poor family dental health
- Developmental or acquired enamel defects
- Teeth genetically abnormal
- Many multisurface restorations
- Chemotherapy or radiotherapy
- Eating disorders
- Drug or alcohol abuse
- Irregular dental care
- Cariogenic diet
- Active orthodontic treatment
- Exposed root surfaces

Federation Dentaire International (FDI) Caries Prevention and Management Chairside Guide

Caries Prevention Partnership

Making prevention a priority

www.fdiworlddental.org

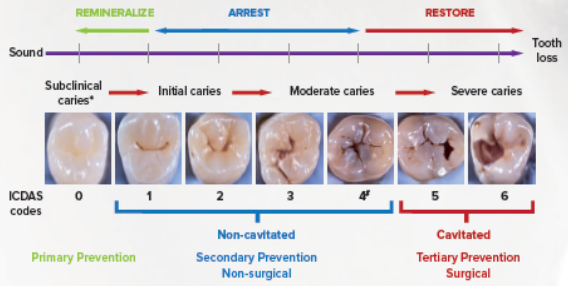
Colgate

Caries Prevention and Management Chairside Guide

The goal is to reduce the impact of caries development by intervening as soon as possible to manage further tooth destruction, and reversing the caries process in favour of remineralization. Ideally, the management of early caries lesions should involve the least invasive approach capable of preventing disease progression and empowering the patient ***to improve and maintain their own oral health.***

Understanding Lesion Activity

The essential challenge is to differentiate between firstly a lesion which is active today and continuing to suffer net loss of mineral, with demineralization being out of balance with remineralization, as opposed to a lesion of similar severity which has been "switched off" and become **inactive**, i.e. arrested or remineralized. The clinical and economic implications of making the correct activity assessment are profound.



ICDAS Dental Terms	Sound	First visual change in enamel	Distinct visual change in enamel	Localized enamel breakdown	Underlying dentine shadow	Distinct cavity with visible dentine	Extensive cavity with visible dentine
ICDAS Detection	0	1	2	3	4#	5	6

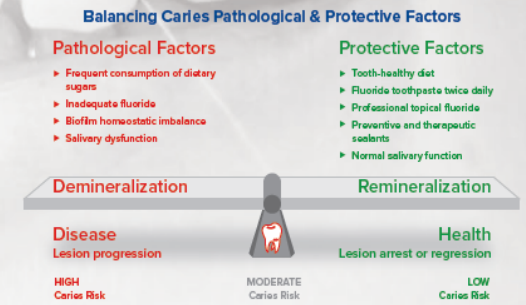
*caries refer to carious lesions #dentine shadow may require surgical treatment in some cases

Determining Caries Risk

Assessing a patient's caries risk is essential in determining the appropriate level of preventive care. Previous caries experience is often the best indicator but several other factors should be considered when assessing risk.

HIGH	MODERATE	LOW
3 or more incipient or cavitated primary or secondary caries lesions in the last 2 years	**1 or 2** incipient or cavitated primary or secondary caries lesions in the last 2 years	**No** incipient or cavitated primary or secondary caries lesions during the last 2 years and no change in the risk factors that may increase caries
Additional preventive measures are indicated: • Patient education (oral hygene, dietary counselling) • Protective factors (fluoride, sealants, salivary stimulation)		No additional interventions indicated

Balancing Caries Pathological & Protective Factors



Action Points

- ✓ Assess lesion activity
- ✓ Target appropriate level of intervention
- ✓ Prevent more damage
- ✓ Assess caries risk
- ✓ Favour preventive measures
- ✓ Minimize surgical intervention
- ✓ Convert actively progressing lesions into arrested controlled ones
- ✓ Improve patients' oral health behaviours

The following caries risk assessment system is age-specific to account for varying risk factors throughout life

AGE	0–5 years	6–11 years	12–17 years	18–69 years	70 years & older
Universal risk factors	• Active or previous caries lesions • Low socio-economic status • Frequent consumption of dietary sugars		• Reduced salivary flow or salivary pH • Poor oral hygiene • Suboptimal fluoride exposure	• Familial risk factors (educational level of parents'/sibling's oral health status)	
1 Caries risk assessment	• Long-term consumption of sweetened medication • Obesity • Illness or disability > dexterity and/or compliance problems	Post eruption of permanent teeth: • Fixed orthodontic appliance • Developmental dental conditions (MIH, amelogenesis imperfecta etc.)	• Alcohol and tobacco consumption • Poor oral health knowledge • Information about education/school system (canteen, boarding school) • Unhealthy diet • Eating disorders • Medical history (existing condition or disability) • Wisdom teeth eruption • Mouth guard	• Genetic background • Mouth piercing • Drugs • Cariogenic diet • Medical history (general and oral health pathologies/comorbidities) • Polypharmacy • Suboptimal restorations, dental prosthesis and dentures	• Family framework and support network • Desocialization: loss of hygiene concept • Taste disturbance and change in dietary habits (risk of dietary deficiencies and increasing sugar consumption) • Functional problems with eating • Dietary advice balances patient needs and expectations • Increased level of dependance, reduction in fine motor skill or possible disabilities • Removable prosthesis history: tooth- or implant-borne denture • Complex existing restorations with poor oral health
2 Professional maintenance	• For all children aged 3 and above, 22,600 ppm fluoride varnish application at least twice per year up to 4 times a year for high-risk children	• Fissure sealants should be placed upon eruption of first permanent molars	• In case of high caries risk, professional cleaning at least twice a year • In case of high caries risk, first and second permanent molars sealing • In case of high caries risk, 22,600 ppm fluoride varnish application every 3 months during 1 year	• Non-cavitated caries lesions: 22,600 ppm fluoride varnish application 4 times a year • Remineralization agents, resin infiltration techniques or therapeutic sealants as possible remedies • Lesions requiring restoration: preserve tooth structure where possible; ensure topical fluoride (gel/foam/varnish) treatment is delivered after restoration • Seal or repair defective restorations where possible. Replace only when necessary	• Care-facility programme relying on patients' needs and abilities • Prophylactic cleaning with removal of plaque retentive features • Filling of sealants and lesions by bio-active fluoride seals • Antiseptic varnish application on purified surfaces with/or 22,600 ppm fluoride at least twice per year up to 4 times a year
3 Patient & education maintenance	• Twice daily (after breakfast and just before bed) supervised brushing with fluoride toothpaste (parents/guardians) RANGE OF FLUORIDE TOOTHPASTE*: • 6–12 months: 1,000 ppm fluoride below rice size on compress or baby toothbrush • 1–3 years old: 1,000 ppm fluoride below rice size • 3–6 years old low caries risk: 1,000 ppm fluoride pea size • 3–6 years old high caries risk: 1,450 ppm fluoride pea size RICE SIZE PEA SIZE	• Twice daily (after breakfast and just before bed) partial supervised brushing with fluoride toothpaste (parents/guardians) RANGE OF FLUORIDE TOOTHPASTE*: • Low caries risk: 1,000/1,500 ppm fluoride • High caries risk: 1,500 ppm fluoride from 6–10 years old & 2,500 ppm fluoride from 10–12 years old	• 2 minutes twice-daily brushing (after breakfast and just before bed) with fluoride toothpaste: **do not rinse but spit** RANGE OF FLUORIDE TOOTHPASTE*: • 1,500 ppm fluoride RANGE OF FLUORIDE TOOTHPASTE*: • Up to 2,800 ppm fluoride till 16 years old and up to 5,000 ppm fluoride (upon prescription or professional recommendations from 16–18 years old) in case of very high risks	RANGE OF FLUORIDE TOOTHPASTE*: • Up to 5,000 ppm fluoride (upon prescription or professional recommendations) in case of very high risks In case of dry mouth or hyposalivation, sugar-free chewing gum and salivary substitutes	• Fluoride mouthwash, dental floss and interdental brushes, tongue brushing and specific toothbrush • Denture hygiene • Soft tissue care • Chlorhexidine or fluoride rinsing mouthwash at different times
! RECALL	2 times a year for children *(please also consult European Academy of Paediatric Dentistry guidelines and national guidelines for high-risk children)*		ALL PATIENTS: 1 time a year - High risks: 2 times a year to be adapted *(please consult national guidelines for high-risk patients*)*		

DISCLAIMER: • Please also consult national guidelines on fluoride • In case of fluorosis risk, it is recommended to use a "smear" (equivalent to 0.1 mg F) of 1,000 ppm toothpaste for young children. The fluoride concentrations mentioned in this guideline comply with FDI recommendations

Maine Oral Health Risk Assessment and Referral Tool

Maine Oral Health Risk Assessment and Referral Tool—Primary Care **Version 15**
For Children 0 to <3 Years Old

PRACTICE NAME			PHONE	FAX
Patient Name			Medical Record #	Today's Date
Date of Birth	Age	M F	Provider Name	
Parent/Guardian Name_____ Relationship to Child ☐ Mother ☐ Father ☐ Other_____ Best Phone Number to Call			Dental Insurance ☐ None/Self-Pay ☐ MaineCare ID# _____ ☐ Other Insurance	

Section A: Oral Health Risk Assessment Questions

DENTAL HOME ASSESSMENT & CARIES RISK SCREENING QUESTIONS
May Be Administered by Clinical Support Staff

Q1. Does the child have teeth? ☐ NO → **STOP & Reassess at next well child visit** ☐ YES → **Continue to Q2 of Risk Questions (below)**	**Answers in shaded boxes below indicate Presence of Risk Factor***	
Q2. Has the child seen a dentist in the past year?	☐ YES	☐ NO
Q3. Does the child have his/her teeth brushed daily with toothpaste?	☐ YES	☐ NO
Q4. Has the child ever had cavities or fillings?	☐ YES	☐ NO
Q5. Has the mother/primary caregiver had active/untreated cavities in the past year?	☐ YES	☐ NO

Section B: Oral Evaluation and Plan

ORAL EVALUATION
Must Be Performed by Primary Care Provider

Q6. Is there visible plaque on the teeth?	☐ YES	☐ NO
Q7. Are there signs of visible decay or white spot lesions on the teeth?	☐ YES	☐ NO
Q8. Does the child have other oral conditions of concern (abscess, broken tooth, pain, etc.)?	☐ YES	☐ NO

ORAL HEALTH PLAN
Must Be Performed or Delegated by Primary Care Provider
***Consider fluoride varnish for one or more Risk Factors from Sections A and/or B**

Caries Risk Assessment
☐ **Low** (No Risk Factors)
☐ **Moderate/High** (1+ Risk Factors)

For all children: ☐ Prescribed Fluoride Supplement (circle dose) **0.25mg 0.5mg 1.0mg** ☐ Fluoride Supplements not indicated
☐ Provided Oral Health Anticipatory Guidance ☐ Completed Caries Risk Assessment w/Oral Evaluation ☐ Other:

For children who have not seen a dentist in past year (Q2):
☐ Completed Caries Risk Assessment w/Oral Evaluation
☐ Applied Fluoride Varnish if moderate/high risk (D1206) ☐ Patient/Family declined Fluoride Varnish
☐ Referred Child to Dentist (see Section C)

Section C. Referral Information

This section to be completed by referring physician and faxed to dentist

Dentist Name	Phone	Fax
☐ Routine Referral ☐ Immediate Referral	This child has special health care needs. ☐ N/A ☐ Yes Explain:	
There are factors that could hinder performing an oral health exam or X-rays for this child. ☐ N/A ☐ Oral sensitivities ☐ Difficulty following directions ☐ Other/Comments ☐ Difficulty sitting still ☐ Does not tolerate knee-to-knee exam		
Physician Name	Physician Signature	Date

This section to be completed by dentist and faxed back to referring physician

Date of Dental Appt.	Summary of Dental Findings/Plan
Dentist Signature	Date

Maine Draft 2/27/2013 v12 Adapted from the North Carolina PORRT Form 8/4/09 – Version 7 and the Washington State Oral Health Risk Assessment Tool

My Smile Buddy

Table 1

MYSMILEBUDDY PARENT EARLY CHILDHOOD CARIES RISK ASSESSMENT RESPONSES (N=35)

Child cavity in the last 12 months (n=35)		
	N	%
Yes	6	17.1
No	23	65.7
Don't Know	6	17.1
Child routine dental checkup in the last 12 months (n=35)		
	N	%
Yes	15	42.9
No	20	57.1
Paste type (n=26)		
	N	%
Adult Fluoride	4	15.4
Child Fluoride	13	50.0
Non Fluoride	9	34.6
Child tooth brushing (n=28)		
	N	%
None	14	50.0
Once	3	10.7
Twice or More	11	39.3
How often to bed with a bottle or sippy cup with caloric beverage? (n=35)		
	N	%
Always	5	14.3
Often	2	5.7
Sometimes	4	11.4
Never	24	68.6
Number of risky dietary exposures (n=35)		
	N	%
None	21	60.0
1 to 2	13	37.1
3 to 4	1	2.9
Who brushes (n=33)		
	N	%
Both	11	33.3
Child	1	3.0

J Health Care Poor Underserved. Author manuscript; available in PMC 2015 August 04.

(My Smile Buddy) Continued....

Parent	21	63.6

Parental toothache in last 12 months (n=34)		
	N	%
Yes	8	23.5
No	26	76.5

I am confident that I can reduce the chances of my child getting tooth decay (n=35)		
	N	%
Agree	23	65.7
Disagree	4	11.4
Not Sure	8	22.9

It is often difficult to cut back on the number of sweets my child eats because they get upset (n=34)		
	N	%
Agree	12	35.3
Disagree	15	44.1
Not Sure	7	20.6

In general, how much of a problem have you or your other children had with tooth decay? (n=33)		
	N	%
A Lot	3	9.1
Some	10	30.3
Few	11	33.3
None	9	27.3

National Singapore CRA (NUS-CRA)

Table 1. Various Models Constructed

	Models Constructed**				
	Prediction Model		Risk Model		
	Screening	Full-blown	Screening	Full-blown	Community-screening Model
Outcome variable					
1-year increment (Δdmft > 0 or = 0)	√	√	√	√	
Baseline dmft > 2 or ≤ 2					√
Independent variables*					
Features	All features	All features	Selected features	Selected features	All features
Categories	Demographic Socio-economic Behavioral Clinical	Demographic Socio-economic Behavioral Clinical Biological	Demographic Socio-economic Behavioral Clinical	Demographic Socio-economic Behavioral Clinical Biological	Demographic Socio-economic Behavioral
Source of information	Questionnaire Clinical examination	Questionnaire Clinical examination Biological tests	Questionnaire Clinical examination	Questionnaire Clinical examination Biological tests	Questionnaire

* The independent variables are described in the Appendix.

** Two types of models, prediction models and risk models, were explored, involving all features and selected features (age, gender, and etiological factors for caries), respectively (Bratthall and Petersson, 2005). For each of the two types (prediction models and risk models), both full-blown and screening models were built, with and without information from biological tests, respectively. These four models were all "any-risk" models, with "any caries increment in 1 year (Δdmft > 0 or = 0)" as the dichotomous outcome variable. In addition, for screening the high-risk children in the community setting without a clinic visit, a community-screening model was explored, with all features excluding the clinical and biological categories. This model is a "high-risk" model for identifying about 25% of children with high caries burden (Beck *et al.*, 1992) (baseline dmft > 2 in this population) through a questionnaire.

Table 2. Caries Risk Assessment Models and Their Performance

	Odds Ratio (95% Confidence Interval)*					
	Prediction Models		Risk Models			
Factors/Indicators (X)	Screening	Full-blown	Screening	Full-blown	Community-screening Model	Cariogram**
Age (mos)	1.045 (1.017-1.073)	1.060 (1.009-1.113)	1.058 (1.029-1.087)	1.060 (1.009-1.114)	1.042 (1.015-1.072)	Related diseases
Malay race	1.837 (1.174-2.876)				2.053 (1.269-3.308)	Diet frequency
Father's education level	0.645 (0.542-0.767)	0.606 (0.436-0.841)				Diet content
Months of breastfeeding	1.037 (1.012-1.063)	1.067 (1.016-1.120)	1.033 (1.010-1.057)	1.027 (1.008-1.087)		Plaque amount
Bedtime feeding			1.484 (1.106-1.928)			Fluoride applications
Frequency of between-meal sweets	1.368 (1.102-1.698)		1.338 (1.007-1.685)			Lactobacilli level
Bedtime sweets			1.332 (1.006-1.682)			Mutans streptococci level
Never lived in non-fluoridated community			0.676 (0.576-0.796)			Saliva flow rate Saliva buffering capacity
Using fluorides (other than fluoride in toothpaste)		0.420 (0.202-0.876)			2.633 (1.188-5.796)	
No annual check because teeth did not bother the child		0.475 (0.256-0.781)				
Age regarded by parents as appropriate for dental check		1.300 (1.071-1.639)				
Parent's belief of 'tooth worm' as reason for caries ***					0.103 (0.012-0.837)	
Parents do not know bedtime milk bottle is bad for teeth					1.999 (1.228-3.326)	
Child's number of decayed teeth estimated by parent					12.835 (8.908-18.673)	
No health problems	2.869 (1.737-4.736)	2.669 (1.198-5.945)				
Past (baseline) caries	7.316 (5.135-10.423)	3.948 (1.933-8.060)				
Plaque Index	5.050 (3.263-7.814)	8.902 (3.822-20.726)	9.061 (6.548-12.461)	7.367 (4.102-12.987)		
Level of mutans streptococci		2.700 (2.025-3.599)		2.555 (2.016-3.335)		
Level of Lactobacilli		2.272 (1.587-3.471)		2.123 (1.481-3.304)		
Average pH		0.010 (0.004-0.024)		0.016 (0.008-0.031)		

Pediatric Risk Assessment (Shenkin)

Patient's Name: _____ Date: _____

Patient DOB: _____ Present Caries Risk: Low Moderate High

Last Caries Risk: Low Moderate High N/A

SAMPLE Pediatric Risk Assessment Tool (PRAT)

Components*	Score† 0 points	1 point	2 points
1. Number of drinking occasions Including with meals and snacks	3–5	6–9	>9
2. Evening/night soft drink consumption	No soft drinks in evening or nighttime	Evening/before bedtime soft drinks	Nighttime/at or during bedtime soft drinks
3. Oral hygiene	Brushes 2X day	Brushes 1X day	Brushes <1X day
4. Flossing (if older than 6)	Daily	Occasionally	Never
5. Previous history of dental caries	none	1–3 lesions	>3 lesions
6. Total formula/milk	18–32 oz	<18 oz; 33–48 oz	>48 oz
7. Total juice/juice drinks	0–8 oz	9–16 oz	>16 oz
8. Total regular pop/Kool-Aid, sports drinks, other sugar beverages	0–8 oz	9–16 oz	>16 oz
9. Total water, other sugar-free beverages	>32 oz	17–32 oz	0–16 oz
10. Hard or chewy candy, regular gum (occasions)	0–2	3–4	>4
11. Baked starch/sugar (occasions)	0–2	3–4	>4

Composite Score: Sum of Points (Range: 0–22)_____

0–4 low risk
5–10 moderate risk
>10 high risk

* Components are average daily values. † Scores are based on daily standards.

Fig. 3. Sample Pediatric Risk Assessment Tool.

Sugar Snack Caries Test

CARIES ACTIVITY/RISK MEASUREMENTS	TEST RESULTS *			
	0 Weeks Baseline	5th Week	10th Week	14th Week
Sugar Snack Test (SST)	5	5	4	3
Saliva Secretion Rate (SSR)	3	1	1	1
Plaque Score	5	2	3	1
mutans Streptococcus (SM)	5	5	3	1
Buffering Capacity (BC)	4	4	4	3
Lactobacilli (Lb)	5	5	5	5
Diet	5	5	5	5
Decayed Teeth (DT)	0	0	0	0
Decayed, Missing, Filled Surfaces (DMFS)	53	53	53	53
* shading & enlarged number font represent a change in the test result from the previous test		OHI	OHI 1% NaF	OHI 0.2% NaF 0.2% CHX
		Treatments Between Tests		

TABLE 4. SUMMARY OF CASE REPORT TEST RESULTS

Texas Department of State Health Services
Texas Health Steps First Dental Home Caries Risk Assessment Tool

Age 6- 35 months

Texas Health Steps Caries Risk Assessment Tool

FACTOR	LOW	MODERATE	HIGH
Caries Activity	None	Within 24 months	Within 12 months
Demineralized Areas	No white spots	1 white spot	> 1 white spot
Family History - Mother	No decay	Low caries rate	High caries rate
Family History - Father	No decay	Low caries rate	High caries rate
Family History - Siblings	No caries activity	Low caries rate	High caries rate
Presence of plaque, gingivitis	None	Moderate	Visible plaque on anterior teeth
Fluoride Exposure	Optimal	Low to optimal	Low
Sugar Consumption (Including bottle or sippy cup use)	With meals only	1-2 between meals	> 3 between meals
Dental Home	Established	Irregular use	None
Special Conditions			Enamel hypoplasia Special needs patient Impaired salivary flow

Texas Department of State Health Services

Texas Health Steps First Dental Home Caries Risk Assessment Tool

Age 3-5 years

Patient Name _____
Age_____ Date of Visit _____
Dentist Signature_____

Caries Risk Assessment Tool - Ages 3 through 5 years

FACTOR	LOW	MODERATE	HIGH
Caries Activity	None	Within 24 months	Within 12 months
Demineralized areas	No white spots	Inactive white spot	Active white spots
Parent/Primary Caregiver	No decay	Low caries rate	High caries rate
Family History – Siblings	No caries activity	Low caries rate	High caries rate
Presence of plaque, gingivitis	None	Moderate	Visible plaque on anterior teeth
Fluoride exposure	Optimal	Low to optimal	Low
Sugar consumption (including sippy cup use)	With meals only	1-2 between meals	> 3 between meals
Dental home	Established	Irregular use	None
Special conditions		Special needs patient	Enamel hypoplasia Impaired salivary flow

Overall assessment of the dental caries risk: ☐ Low ☐ Moderate ☐ High

TEXAS Health and Human Services | Texas Health Steps

University College Cork – Ireland Caries Risk Assessment Checklist

Caries Risk Assessment Checklist

Dentist's name: _____ **Date:** _____

Child's name: _____ **School:** _____ **First assessment Y / N**

Risk Factors/Indicators **A "YES" in the shaded section indicates that the child is likely to be at high risk of or from caries**	Please circle the most appropriate answer	
• Age 0–3 with caries (cavitated or non-cavitated)	**Yes**	No
• Age 4–6 with dmft>2 or DMFT>0	**Yes**	No
• Age 7 and over with active smooth surface caries (cavitated or non-cavitated) on one or more permanent teeth	**Yes**	No
• New caries lesions in last 12 months	**Yes**	No
• Hypomineralised permanent molars	**Yes**	No
• Medical or other conditions where dental caries could put the patient's general health at increased risk	**Yes**	No
• Medical or other conditions that could increase the patient's risk of developing dental caries	**Yes**	No
• Medical or other conditions that may reduce the patient's ability to maintain their oral health, or that may complicate dental treatment	**Yes**	No
The following indicators should also be considered when assessing the child's risk of developing caries		
• Age 7–10 with dmft>3 or DMFT>0	**Yes**	No
• Age 11–13 with DMFT>2	**Yes**	No
• Age 14–15 with DMFT>4	**Yes**	No
• Deep pits and fissures in permanent teeth	**Yes**	No
• Full medical card	**Yes**	No
• Sweet snacks or drinks between meals more than twice a day	**Yes**	No
Protective Factors **A "NO" in this section indicates the absence of protective factors which may increase the child's risk of developing caries**		
• Fissure sealants	Yes	**No**
• Brushes twice a day or more	Yes	**No**
• Uses toothpaste containing 1000 ppm F or more	Yes	**No**
• Fluoridated water supply	Yes	**No/Don't know**

Is this child at high risk of or from caries?	**YES**	**NO**

ge 0–3: Any child under the age of 4 who shows any evidence of caries – with or without cavitation should be considered high risk, as the consequences of any caries for this age group can mean recourse to general anaesthesia for treatment.

WesternU- CDM

WesternU CDM – AxiUm Electronically Modified-Caries Risk Assessment Form 0–5 Years of Age

Contributing conditions

1. Are you exposed to fluoride (through drinking water, toothpaste, professional applications, supplements, etc.)?
   a. Yes (low) b. No (moderate)
2. Frequency of sugary or starchy foods or drinks (including juice, carbonated or noncarbonated soft drinks, energy drinks, medicinal syrups, etc.)
   a. Primarily at mealtimes (low)
   b. Frequently between meals (moderate)
   c. Bottle or sippy cup with anything but water (high)
3. †Caries experience of mother, caregiver and/or other siblings
   a. No carious lesions in last 24 months (low)
   b. Carious lesions last seven to 23 months (moderate)
   c. Carious lesions in the last six months (high)
4. Dental home: Established patient of record, receiving regular dental care in dental office.
   a. Yes (low) b. No (moderate)

General health conditions

1. Special health care needs (including developmental, physical, medical or mental disabilities that prevent or limit adequate oral care)?
   a. No (low) b. Yes (high)

Clinical conditions

1. ‡Visual or radiographically evident cavitated lesions
   a. No active cavitated lesions in one year (low)
   b. No active cavitated lesions or restorations in last six months (moderate)
   c. Presence of lesions/restorations in last six months (high)
2. ‡Non-cavitated ACTIVE carious lesions (e.g. active brown/white spot lesions)
   a. No incipient active lesions in one year (low)
   b. No incipient active lesions in last six months (moderate)
   c. Presence of incipient noncavitated active lesions in last six months (high)
3. Teeth missing due to caries
   a. No (low) b. Yes (high)
4. Visible plaque
   a. Yes (moderate) b. No (low)
5. Dental/orthodontic appliances (fixed or removable)
   a. No (low) b. Yes (moderate)
6. Salivary flow
   a. Visually adequate (low) b. Visually inadequate (high)

TOTAL (auto-calculates electronically): High, moderate or low caries risk assessment.

†If the child showed improvement after six months with no change in the parent's caries experience, the child was noted as "moderate" risk.

‡DentaQuest ECC Phase III definition of low, moderate and high caries risk assessment associated with cavitated or noncavitated lesions.

Uncategorized References

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