MASTER OF PUBLIC POLICY
CAPSTONE PROJECT

The Effectiveness of Education Based Programs Delivered by Nondental Professionals for Preventing Early Childhood Caries

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Executive Summary: Early childhood caries is the most common chronic infectious disease in children, yet completely preventable with proper oral hygiene. With Severe ECC, children require costly dental surgery, especially for those from low socioeconomic families. This is due to the fact that children under five years of age do not routinely encounter a dental care provider until it is too late. Nondental healthcare providers, on the other hand, are uniquely positioned to intervene. The objectives of this literature review was to determine whether dental health education programs provided by nondental care providers could improve outcomes related to early childhood caries for low-income children. And secondly, to identify effective dental education programs for caries prevention. A comprehensive review of current literature was conducted to meet these objectives. Home visitation delivered by nurses was found to be an effective and cost-efficient ways to deliver dental education. When support in terms of screening, oral hygiene instruction, and dental referrals are combined with education, the positive impact on early childhood caries increased. In conclusion, policymakers should implement oral health promotion programs using a combination of education and support delivered by nursing staff in client's homes. Programs can be embedded into existing healthcare services across the province. However, services should be concentrated in low socioeconomic status communities and regions within Alberta. Furthermore, nurses must collaborate across disciplines to ensure seamless integration of oral health with general health and push for more rigorous research in this area to guide best practice. In conclusion, a combination of tailored approaches is necessary to achieve a sustained improvement in oral health throughout early childhood.

Introduction

Early childhood caries, ECC, is defined by the Canadian Dental Association (CDA) as "the presence of one or more decayed (non cavitated or cavitated lesion), missing (because of caries), or filled tooth surfaces in any primary tooth in a preschool-age child between birth and 71 months of age" (Canadian Dental Association, 2010). It is the most common chronic infection of childhood worldwide (Melvin, 2006). In Canada, the prevalence of ECC is as little as 6%-8% in urban areas to as high as over 90% in certain disadvantaged communities (Rowan-Legg, 2013). A recent survey conducted in 2002 revealed that 41% of children in B.C. experience dental caries before they reach kindergarten, while one quarter remain at risk (BC Ministry of Health Services, 2011). Even in Alberta, ECC affects a significant portion of children at a substantial cost.

Similarly, studies conducted in other parts of the world have found that more than 50% of children in some communities are suffering from ECC (Schroth et al., 2010). By the time these children reach adolescence, 80% will have acquired the disease (Mouradian, Wehr, & Crall, 2000). The sustained high prevalence and incidence of ECC worldwide sheds light on the oral health crisis affecting early childhood. Unfortunately, access to preventative dental care is extremely limited in this age group; which is part of the problem.

Despite a lack of access to timely dental care, primary care providers such as pediatricians, family physicians, nurse practitioners, community health nurses, and

physician assistants are often afforded the opportunity to examine young children long before dental personnel see them. In many communities, immunizations are provided on a regular basis through community health nurses and physicians. These health care providers are in a unique position to complement the work of dental health professionals by emphasizing oral health as part of their health promotion activities. Furthermore, they may be able to provide oral health screenings, and arrange referrals to dental health professionals.

Preventing ECC through non-dental professionals is a viable option. These providers can educate parents on oral health practices during a general health visit and subsequently reduce bacterial levels. Educating parents or increasing parental knowledge works by promoting preventative behavior and reducing cariogenic practices. Studies have demonstrated an inverse relationship between health behavior knowledge of mothers and cariogenic feeding behaviors (Ismail, 1998). In other words, improved health knowledge corresponds with fewer and less frequent caries causing feeding behavior. As a result, protective factors outweigh disease causing ones, halting caries development or progression and in some cases reversing it. A shift in ECC prevention towards a model of primary care provider delivered education could generate long-term improvements that continue into adulthood and reduce the need for surgery.

Over the last decade, the literature continues to support this approach, but little has been done to resolve discrepancies between program components and their preventative effect. This information is crucial for policymakers and healthcare leaders in

order to effectively address the ECC epidemic. A literature review could address this knowledge gap by identifying existing evidence and extracting information in a transparent way.

The objective of this literature review is to determine the effectiveness of education-based interventions administered by a nondental health professional for preventing ECC in high-risk children under five years of age. To determine intervention effectiveness, the influence of context, program design, and personnel on ECC will be evaluated. We hypothesize that adding an in-home oral health education program initiated before one year of age to existing nursing services will have the greatest impact on ECC over time. This review will expand our knowledge and understanding of education based ECC prevention strategies while guiding policies and programs related to pediatric oral health. Specifically, it will inform key stakeholders in Alberta about program components relevant to ECC prevention and whether they should be implemented, piloted, or require further research.

Literature Review

***Pathophysiology**:*

Caries are small holes in the teeth caused by the presence of bacteria (Leung, 1986). Bacteria colonize on oral surfaces like teeth but can also be found prior to tooth eruption on the furrows of the tongue (Berkowitz, 2003). The bacterial culprits of this process are *Streptococcus mutans*, *Streptococcus sobrinus*, and lactobacillus species

(Parthasarathy and John, 2008). However, *S. mutans* is particularly critical in ECC development as it inoculates before a child's first birthday. ECC is believed to be a virulent form of caries (Marrs, Trumbley, & Malik, 2011).

S. mutans metabolizes carbohydrates or sugar left behind after a meal, releasing the by-products lactic, citric, and pyruvic acid (Kay, Young, & Posner, 1964). These organic by-products demineralize the crucial protective component of enamel, carbonated hydroxyapatite. Hydroxyapatite's strength lies in the arrangement of bonds between calcium, phosphate, and hydroxyl groups into a complex crystal lattice structure (Kay, Young, & Posner, 1964). During the process of cavity formation, essential hydroxyl groups are broken off the hydroxyapatite crystal, leaving behind a small hole or cavity (Leung, 1986). Over time, the bacteria rapidly multiply and spread to adjacent teeth. In children the caries process progresses with the order of tooth emergence, initially affecting the primary maxillary incisors and later appearing on the occlusal surfaces, and primary maxillary molars (Berkowitz, 2003).

Etiology:

Many have described caries as the disease process for ECC, a chronic disease of childhood (Arora et al., 2011). The interaction between the bacteria, the host, and the substrate are all essential factors in the development of caries (Parthasarathy and John, 2008). However, progression can be stopped or even reversed when the protective factors outweigh the pathological ones (Kagihara, Niederhauser, & Stark, 2009). Some pathological factors include but are not limited to the following: vertical transmission of

bacteria from mom by utensil sharing, pre-chewing or pre-tasting food; dietary sugar intake; prolonged or night-time bottle use; prolonged or night-time breast feeding; frequent meals; minimal or lack of fluoride exposure; poor dental hygiene; and no or irregular use of dental services (Gussy et al., 2006; Kagihara, Niederhauser, & Stark, 2009). Conversely, protective factors could be: good dental hygiene, fluoride supplements or varnishes, community water fluoridation, xylitol, chlorhexidine use to suppress microflora in moms, establishing a dental home, dietary modification, and improved feeding practices (Gussy et al., 2006; Kagihara, Niederhauser, & Stark, 2009; Marrs, Trumbley, and Malik, 2011). These protective and pathological behavioral factors play an important role in disease progression and hence prevention (Fung et al., 2013). In active caries the process will result in new and recurrent lesions without intervention (Ng & Chase, 2013). If the balance is altered in favor of protective factors, the caries process will slow down or even stop (Ng & Chase, 2013). In other words, ECC prevention delays the spread of *S. mutans* by reducing the bacterial load in children. For example, improvements in diet, oral hygiene practice, and fluoride exposure could help tip the scale, reducing caries risk over time (Fung et al., 2013).

Consequences of Untreated Oral Disease:

If left untreated, caries can have an increasingly larger impact over time on the physical, psychological, and social well-being of a child. Some of these symptoms include: chewing difficulties, speech disorders, malocclusion, discomfort, infection, abscesses, bacteremia, sepsis, gastrointestinal disorders, malnutrition, failure to thrive,

premature tooth loss, developmental delays, growth retardation, loss of permanent dentition, low self-esteem, and severe pain (Kagihara, Niederhauser, & Stark, 2009; Parthasarathy and John, 2008; Smith and Reidford, 2013). As a result of pain, many children experience psychological trauma, anxiety, depression, irritability, fatigue, learning difficulties, and miss school days (Spencer, 2007). Overall, children suffering from ECC experience a considerable loss in quality of life.

Epidemiology:

Several studies on risk factors for ECC have identified high-risk populations. In particular, children from disadvantaged groups like ethnic minorities, indigenous peoples, and immigrant groups are at higher risk (Schulter at al., 2007; Kressin et al., 2009). However, children of low socioeconomic status are the most vulnerable group regardless of ethnicity (Berkowitz, 2003). There is strong, consistent evidence worldwide demonstrating an inverse relationship between ECC and socioeconomic status. (Gussy et al., 2006). Depending on where they fall on the graph, children can have twice or up to five times as many instances of caries as their counterparts and be more likely to forego treatment (Pierce et al., 2002; Kagihara, Niederhauser, & Stark, 2009). ECC also disproportionally affects infants whose parents are less than high school educated (Melvin, 2006). Each additional risk factor has a synergistic effect on cumulative risk. Infants in families experiencing poverty, with low parental education, and a sugary diet are 32 times more likely to suffer from ECC (Yost & Li, 2008). In Alberta, day surgery

rates for children from the least affluent neighborhoods were 3.9 times higher and 8.6 times for Aboriginal communities (Canadian Institute for Health Information, 2012).

Treatment:

Caries that have progressed to severe ECC require immediate restorative care (Arrow, Raheb, & Miller, 2013). Dental extractions and restoration is the current standard of care for severe ECC. Extractive and restorative treatment requires hospitalization, intravenous antibiotics, and general anesthesia because this population is young and uncooperative (Arora et al., 2011; Mouradian, Wehr, & Crall, 2000). Pediatric dental surgery for ECC is the most common day surgery accounting for 31% of operations in this population (CIHI, 2013). Between 2010 and 2012, 3,463 pediatric dental surgeries were performed in Alberta translating to a rate of 8.8 per 1,000 children receiving this treatment (CIHI, 2013).

Cost of Treatment:

The cost of this treatment places a significant economic burden on parents, government, medical welfare agencies, insurance companies, and the healthcare system (Berkowitz, 2003). Compared to other provinces in Canada, Alberta has the highest average cost per day surgery and one of the highest associated average anesthesia cost, $1,963 and $329 dollars respectively (CIHI, 2013). Overall, $2.3 million is spent annually in Alberta, and $21.2 million in Canada for ECC day surgery. However, this is estimate is only a fraction of the total cost because the cost of travel and care providers like surgeon fees are not included. This figure is also considerably large in other parts of

the world. For example, a similar treatment in the United States is estimated to be US $3,500 (Berkowitz, 2003). Moreover, long waiting lists increase the burden of ECC; only 50% of patients are treated within a reasonable length of time (Arora et al., 2011; Rowan-Legg, 2013).

The cost of rehabilitative treatment is exacerbated in rural and remote areas since treatment facilities are located in urban areas. In these cases, travel and lodging costs are added to medical care and general anesthesia (Berkowitz, 2003). In Alberta, 9.3% of the day surgeries require more than 120 minutes of travel time, one way (CIHI, 2013). In 1993, a retrospective study on Aboriginal preschool children in Manitoba found that cost of travel was the biggest contributor to total expenditure on ECC (Milnes et al., 1993). Unfortunately, the cost of ECC is expected to increase due to growing facility and anesthesia costs (Rowan-Legg, 2013).

Furthermore, disease prognosis is poor, even postoperatively. Several studies demonstrated that approximately 50% of children relapse and experience recurrent decay within 4-6 months after treatment (Berkowitz, 2003; Gunay & Dmoch-Bockhorn, 1998; Irvine et al., 2011). Even eighteen months after treatment, the risk of developing new carious lesions increases by 28 times (Leroy & Declerck, 2013; Scavuzzie et al., 2007). However, only an opportune few receive this treatment; ECC often goes unnoticed and thus untreated for many others. Interestingly, aggressive treatment can be avoided with simple preventative measures.

Prevention Efforts:

Primary prevention is likely the best long-term solution for ECC since restorative treatment is challenging and costly, especially for those from remote communities. Primary prevention of dental disease not only preserves healthy teeth but decreases the current tremendous demand for restorative care. With ECC being the result of the relationship of oral substrate and host, as well as environmental conditions; prevention strategies should balance the positively and negatively contributing factors. To address the family, economic and social conditions of the environment, community development and determinants of health focus should be incorporated in these strategies. Doing this, along with disease prevention can be used to sustain change.

Fluoride is recognized as one strategy in the prevention and control of caries. Multiple products provide fluoride like topical applications, supplements, sealants, and toothpaste. Community water fluoridation can also provide fluoride exposure. It differs from the other measures in that it provides equitable access to low-levels of fluoride regardless of socioeconomic status. Effectiveness of toothpastes requires adherence while access to dental care is needed for varnishes. Both, systemic and topical fluoride exposure is the most widely used strategy to address caries (Davies et al., 2001). It has been used alone and with support from other approaches like education. Xylitol and chlorhexidine gum is also available to suppress microflora in moms, reducing the opportunity for vertical transmission.

Given the evidence for vertical transmission of bacteria from mother to child, educating parents on oral health practices and involving parents in the prevention process

can assist in the prevention or delay of ECC. Education can focus on correcting the following behaviors: utensil sharing, pre-chewing or pre-tasting food; dietary sugar intake; prolonged or night-time bottle use; prolonged or night-time breast feeding; frequent meals; and poor dental hygiene. Education can also be used to help parents recognize the early signs of ECC. Lastly, appropriate access to dental care providers can mitigate development or progression of the disease. Prevention programs often include a combination of these measures.

Education-Based Prevention:

Targeting environmental and host factors is an important prevention strategy. The environment or the external factors determine whether a child will come in contact with disease causing agents. This is not essential to the caries process but can play a pivotal role in the progression and prevention of the disease, an example of this is parenting practices (Smith and Reidford, 2013). Oral hygiene habits, diet, and dental care are generally established early on and modeled through parental behaviors (Van den Braden et al., 2013). Furthermore, infants and young children depend on their parents to carry out oral care tasks (Plonka et al., 2012). Thus, depending on their practices, beliefs, and behaviors, parents can either protect or harm the health and welfare of their child (Freudenthal & Bowen, 2010). Thus, more and more oral health programs are focusing on health education to address ECC. Educating parents about the disease could motivate behavior change (Freudenthal & Bowen, 2010). Studies have shown that children of uninformed mothers experience higher rates of ECC compared to children whose mothers

are educated about the caries process (Ismail et al., 2011). Moreover, there is an inverse relationship between dental health education and the mean number of decayed, missing, and filled teeth (dmft) (Ismail, 1998).

Types of Education:

Conventional education is the current gold standard for education delivery. This includes normative advice in the form of pamphlets, posters, media campaigns, or one-on-one with a healthcare provider (Goa et al., 2013). Dental knowledge is almost always improved with this strategy (Goa et al., 2013). Various other education delivery strategies can be utilized to enhance information uptake and lead to behavior change such as motivational interviewing or anticipatory guidance (Weinstein, Harrison, & Benton, 2006). Motivational interviewing differs from traditional education in that it is a brief counseling technique that involves establishing rapport, discussing options, and using strategies to address barriers to change (Weinstein, Harrison, & Benton, 2006). Anticipatory guidance prepares a patient for an anticipated life stage or event (Goa et al., 2013). Proactively providing counseling or guidance allows parents to maximize their child's developmental potential and identify potential needs early on.

Access to Dental Care:

Social gradients associated with oral health are suggested to occur because low-income groups practice risky health behaviors that are damaging to their health (Norlund, 2005). For example, the consumption of harmful foods, substances, and underutilization of preventative care results in health inequalities (Norlund, 2005). However, this theory is

insufficient for explaining ECC. Low socioeconomic groups are not necessarily less interested in protecting their health but instead have poor access to care (DiMarco Huff, & Kendra, 2009). National data from the United States found a correlation between children who did not have 6-month dental visits and low-income, uninsured, uneducated, black families.

The American Academy of Pediatric Dentistry (AAPD) and the CDA recommend that children begin dental visits before 1 year of age or within 6 months of eruption of the first tooth; whichever occurs first (Canadian Dental Association, 2010). Opportunity for timely, early intervention is critical as ECC can rapidly progress in as little as 6 to 12 months (Kagihara, Niederhauser, & Stark, 2009). However, most children do not receive dental care until they reach school age or require serious intervention. This is especially true for low socioeconomic status children facing the highest risk for ECC and the greatest barriers to accessing health services overall (Kressin et al., 2009).

In the U.S., preschoolers fall behind all other age groups where three quarters of children from 3 to 4 years old have not seen a dentist (Kagihara, Niederhauser, & Stark, 2009). Yet, a primary health care provider frequently sees low socioeconomic children in this age group, approximately 80% of children at multiple visits (DiMarco Huff, & Kendra, 2009). If ECC risk is assessed before a low-income child reaches 1 year of age, professionals can provide timely interventions to prevent further progression and or development of the disease (Hale, 2003). Compared to other health care providers, nurses

are usually the first and most frequent health care professionals that families encounter (Skeie et al., 2011).

Nondental professional led programs focusing specifically on oral health are already being implemented. Many programs focus on school-aged children like *The Tooth Tutors* in Vermont (Melvin, 2006). This multidisciplinary program involves nurse, dental hygienist, and dentist presence in primary schools. After two years the team was able to cut restorative services in half. By increasing preventative care, the need for more costly restorative treatment declined, reducing overall costs. The results of this program and many others indicate that nurses could be the key to achieving a significant positive impact on ECC that is cost-effective.

Home visitation programs have been identified as one strategy to deliver health education in low-income populations (Plonka et al, 2012). In person clinic visits can be problematic due to a lack of transportation, inability to miss work due to financial constraints, and difficulty obtaining childcare for siblings (DiMarco Huff, & Kendra, 2009). Long-term health and economic outcomes have already been observed in various home visit interventions involving maternal health, parenting, child health, and behavior (Barnes-Boyd, Fordham, & Nacion, 2001). Perhaps, the home visitation model could also be applied to oral health to achieve reductions in ECC. Other methods of delivery include telephone contact and clinic visits.

Methodology

Search Strategy:

The methodology for this literature review was adapted from a protocol by Silva-Sanigorski (2012). The databases MEDLINE, PubMed, CINAHL, and EMBASE were electronically searched using terms related to the concept of caries, early childhood, intervention, and nurse. Some of the terms and keywords used include: child, preschool, early childhood caries, dental decay, nursing caries, baby bottle tooth decay, nursing bottle caries, milk bottle syndrome, baby bottle caries, baby bottle tooth decay, tooth decay, nurse, community health nurse, public health nurse, pediatric nurse, health promotion, health education, counseling, intervention studies, health prevention, control, population health, public health, and behavior change. Different search strings were explored using the Boolean operators AND, OR. Please refer to Appendix A for a detailed list of search terms. Studies were limited to randomized or quasi-randomized controlled trials (RCTs), cluster RCTS, controlled before-and-after studies, quasi – experimental studies, case control studies, and cohort studies.

Grey Literature:

This review required a grey literature search to locate published and unpublished research. This also included crossing checking reference lists of key articles identified in systematic reviews, Internet searches of key organizations websites, hand searching of key journals and conference proceedings. The following journals were hand searched: International Dental Journal, Community Dental Health, Health Promotion International,

Community Dental and Oral Epidemiology, Preventive Medicine, Family and Community Health, Journal of Public Health Management and Practice, Infants & Young Children, Home Healthcare Nurse, and Holistic Nursing Practice. We also searched the following websites for relevant publications and grey literature: Fraser Institute http://www.fraserinstitute.org; American Dental Association (ADA) http://www.ada.org; The American Academy of Pediatrics (AAP) http://www.aap.org/; The American Academy of Pediatric Dentistry (AAPD) http://www.aapd.org; Canadian Dental Association (CDA) http://www.cda-adc.ca; Google Scholar; Public Health Agency of Canada (PHAC) http://www.phac-aspc.gc.ca/; Health Canada http://www.hc-sc.gc.ca/; Canadian Institute for Health Information (CIHI) http://www.cihi.ca/; World Health Organization http://www.who.int/; International Association of Dental Research http://www.iadr.com; Alberta Health Services http://www.albertahealthservices.ca; Alberta Health http://www.health.alberta.ca; BC Health http://www.gov.bc.ca/health/; and Canadian Institutes of Health Research (CIHR) http://www.cihr-irsc.gc.ca.

Selection Criteria:

We included the settings in which children spend their time or have contact with health care providers such as: the home, community, childcare, health care, setting and clinic. Eligible participants included, children, infants, and toddlers under the age of 5 years old. Intervention delivery is restricted to at least one nondental health care professional which could include: Registered Nurses, Licensed Practical Nurses, physicians, researchers, volunteers, community lay workers, health workers, and others.

All studies had to include an education-based component but could have a host of other elements in the intervention package. Outcomes measures included health literacy, knowledge attitudes, and skills around ECC; measurement of dental caries by an oral health clinician or trained examiner (including early childhood caries, white spot lesions, decayed, missing, and filled teeth or surfaces, the decayed missing and filled teeth (dmft/DMFT) index of the decayed missing and filled surfaces index (dmft/DMFS); parent reported oral health status including measure of quality of life and oral pain (from survey or questionnaire data); and behaviors and practices (i.e. infant feeding and drinking habits and oral hygiene practices). Studies were limited to English language, human models, infant and preschool population, low socioeconomic status or immigrant status, developed and developing nations (first and second world countries), and interventions with an education component published from 2000 to present. Editorials, commentaries, letters, post-intervention studies, case series, descriptive studies, reviews, clinical trials, and interventions solely fluoride based or those not related to oral health were excluded.

Review Process:

The initial search strategy identified titles and abstracts. An initial screening of titles and abstracts was conducted to remove studies beyond the scope of this review. Full text manuscripts were then identified that met the inclusion criteria; duplicates were manually removed. Statically significant outcomes were reported individually. The main findings of the review are summarized and presented using a ‘summary of findings’ table.

The table incorporates findings for primary review outcomes, sample size, country, study design, and comparison groups. The heterogeneity of participants was examined along with length of intervention (long versus short term), intervention personnel, intervention type, intervention setting, age group, and socio-economic status.

Findings

A total of 596 papers were excluded at the initial stage, leaving 167 papers for possible inclusion. Following review, only 11 papers met the inclusion criteria. Exclusion of papers was based on failure to describe the intervention procedure or intervention outcomes, inclusion of children 6 years or older, participants that were not of low-socioeconomic status or immigrants, failure to describe participant demographics, lack of control or comparison group, and failure to describe interventionist characteristics. Table 1 summarizes the results of the 11 selected studies on dental health education interventions. In order to evaluate effectiveness, the 167 studies from the initial review and an additional grey literature search were used to supplement the findings of this literature review. The policy implications for each intervention component are summarized in Table 2. Analysis of evidence quality and level will focus on the 11 studies from Table 1.

Education Models:

Traditional Dental Health Education:

Five studies used interventions that involved traditional oral health education. Some of the key features of the education sessions included home visits, telephone contact, and clinic visits by a multitude of different health care professionals and volunteers. The oral health education included advice against addition of sugars (sugar, honey); impact of diet on child health; healthy breastfeeding and weaning; introducing solid food; reducing use of bottle or breastfeeding as pacifiers; limiting soft drinks, sweet, and savory snacks; substituting bottle with feeder cup, brushing teeth twice a day with fluoride toothpaste, and visiting a dentist regularly. Low-income participants were recruited from birth to 38 months in UK, Brazil, Thailand, and Australia. Both Feldens studies were randomized controlled trials; the other studies were quasi-experimental (Feldens, Vitolo, & Drachler, 2007; Feldens et al., 2010). Follow-up was generally one year but Kowash and Feldens had 3 and 4 years of follow-up, respectively (Feldens et al., 2010; Kowash et al., 2000). Control groups were all limited to routine care.

These programs saw a reduction in percentage of proportion of caries, number of children with caries, prevalence of severe-ECC, number of decayed surfaces, mean number of affected teeth, and or dmft compared to the control groups. Secondary outcomes such as reduction in cariogenic feeding habits, improved breastfeeding duration, later introduction of sugar, small probability of dietary sugar intake, lower probability of ingesting foods of high sugar density during first year of life, on demand drinking, reduced frequency of sweet consumption, improved frequency of tooth brushing, initiation of dental visit, reduction in nighttime feeding, increased tooth

brushing, improved brushing when child was uncooperative, less plaque on maxillary incisors, increased use of fluoridated toothpaste, and increased use of fluoride supplement were also observed. The cost benefit of dental health programs are also a significant outcome. One study reported a benefit to cost ratio of 5.6:1 for dental health education programs (Kowash, Toumba, & Curzon, 2006). This study involved home visits by dental health educators at one or three month intervals for children in low socio-economic areas.

Motivational Interviewing:

Motivational Interviewing was used in three studies to deliver health education. Freudenthal and Bowen (2010) measured effect after only 4 weeks and thus did not observe significant differences on frequency of cleaning or brushing teeth, cariogenic feeding practices, valuing dental health, permissiveness, convenience, and change difficulty or openness to health information. Even though, advice and information was provided based on individual client needs on three separate occasions, there was minimal impact on behavior. However, the other two studies were randomized trials over 2 years (Ismail et al., 2011; Weinstein, Harrison, & Benton, 2006). Both studies included 40-45 min motivational interviewing session, an instructional video, written information, and follow up via telephone. Differences involve interventionists, and age at enrollment. Ismail and colleagues found no significant effect on caries and toothbrushing behavior despite using master's level therapists (Ismail et al., 2011). Interestingly, the intervention using trained lay people in a 10-hour workshop found that MI had a protective effect even though the interventionists had less experience and training compared to the Ismail

study. Children in the MI group were 65% less likely to experience new carious lesions compared to the control group. These differences may be due to the age of enrollment. Ismail (2011) recruited children of a mean age of 4.63 years compared to 6-18 months by Weinstein, Harrison, & Benton (2006). As a result, intervening at a later age generates minimal impact on caries development.

Anticipatory Guidance:

Plutzer and Spencer (2008) also delivered information early, starting at 5-7 months of pregnancy. Three rounds of printed information and telephone consultation were compared to printed information alone. Both groups experienced significant reduction in incidence of S-ECC compared to the control group. There were no differences between the groups. This indicates that telephone consultation did not influence the incidence of S-ECC. The printed information differed from traditional brochures in that the information and counseling where specific to the child's stage of life and their needs during that stage. Each round offered information and support to mother's that was relevant to their child's oral development also known as anticipatory guidance. A substantial finding is that the odds ratio for developing S-ECC increased by 1.3 fold with each incremental delay in age at examination in months. This finding reiterates the importance of early intervention delivery.

Self-Determination Theory:

Weber-Gasparoni (2013) attempted a similar design but instead used self-determination theory to deliver a video message in clinics. This intervention had limited

success. Autonomy supported messages to motivate behavior change are ineffective in reducing caries rates. The message focused on tooth decay, oral hygiene, diet, and parental monitoring of cavitation. Even though, no differences in caries proportion were observed, tooth brushing at bedtime, using fluoridated toothpaste, and checking their child's teeth increased. The intervention had a substantial increase from baseline in as little as one month. Additionally, the intervention required minimal time and effort with a 15 min video shown in public health settings. Even the control group that delivered the same content except in a brochure format experienced a positive effect on the behaviors listed. The video intervention proved to be only slightly superior in effect at one and six months follow up compared to the brochure only group.

Content of Education:

Both Felden's studies did not include advice about oral hygiene (Feldens, Vitolo, & Drachler, 2007; Feldens et al., 2010). A focus on dietary education produces a smaller effect on caries incidence compared to oral health instruction combined with dietary education. Comparing the two, hygiene instruction alone had a slightly greater impact on caries rate. Remarkably, the oral hygiene instruction group had a low frequency of sweet consumption (more than once a day) compared to the diet education only group. This group also has higher frequency of tooth brushing and saw a dentist every 6 months. The only parameter the oral hygiene instruction group performed worse on was the rate of on demand drinking. However, when diet is combined with hygiene instruction the negative effect for on demand drinking was reduced. There was no difference in breast-feeding

frequency, nighttime bottle use, introduction of solid foods, and daily consumption of fruits and vegetables. Minimal differences were found for duration of breastfeeding, introduction of sugar, frequency of dietary sugar intake, and probability of ingesting foods of higher sugar density during first year of life. Kowash's (2000) data illustrate that fewer home visits focusing on diet and hygiene instruction produce similar effects as more frequent visits for hygiene or dietary advice alone. But, cariogenic feeding/dietary habits and poor oral hygiene is highest in the group with fewer home visits.

Mode of Delivery:

The *Resources, Education, and Care in the Home* (*REACH*) project used home visiting to reduce infant morbidity and mortality for low-income families (Barnes-Boyd, Norr, & Nacion, 1996). Registered nurses conducted 5 home visits at 2 weeks, 6-8 weeks, and 4, 8, and 12 months. Mothers received additional visits as necessary. The *REACH* program provided home visitation for 1,269 infants in six Chicago communities. After 12 months, Barnes-Boyd, Norr, and Nacion found positive effects on general infant health as well as lower mortality rate for REACH infants compared to control group, 4.7 versus 5.2-10.9 deaths per 1000 live births (1996). In conclusion, individualized, education delivered by nurses through home visitation has a positive impact on general infant health.

One RCT conducted home visits for 500 mothers within 10 days of birth, and at 6, 8, 10, and 12 months (Vitolo et al., 2012). Each home visit was approximately 1 hour of dietary guidance based on the child's age. The education program reduced the risk for

consumption of sugar dense foods by 67% after one year. Additionally, an older study by Holt et al. compared two experimental groups to no intervention (1985). The use of home visits and education through the post were the two experimental groups. Contact was made three times for both intervention groups from birth up to 18 months of age. After five years, 83% of the home visit group was caries free, had lower gingivitis scores and reduced mean deft compared to the control participants (Holt et al., 1985). No significant differences were found for these parameters between the control group and those that received education via post. The findings emphasize the need for home visits to effectively deliver education.

Similar results have reported home visitation as an effective intervention to support breastfeeding. A systematic review of breastfeeding support found that home visits in hospital and post-partum increased breastfeeding duration at 6 months and reduced the number of doctor's visits (Hannula, Kaunonen, & Tarkka, 2008). Home visits had been carried out by community health nurses in low-income women. A cost-benefit study on home visits for breastfeeding support demonstrated that costs were partially offset by savings on formula and health care services (Pugh et al., 2002). The intervention group had few sick days and used less medication compared to the control. Interestingly, the *Starting Well* program in Scotland found positive effects on oral care after general health education about parenting skills, home safety, and play. The program delivered home-based services to improve overall child health. After the intervention,

19.1% more *Starting Well* toddlers were registered with a dentist at six months compared to the control (Shute & Judge, 2005).

Comparing, home visits to telephone contact, Plonka (2012) demonstrates that fewer children show and develop carious lesions after a home visit compared to telephone contact. Despite significance, these differences were minimal. In fact, both methods demonstrated significantly reduced caries rates and fewer carious teeth compared to the controls. Furthermore, there was minimal difference between the home visit group and telephone group in terms of the following health behaviors: bottle taken to bed at night, bottle taken to bed for day naps at 24 months, number of mother's who brushed their child's teeth, number of mothers who persevered with brushing when their child was uncooperative, and plaque on maxillary incisors. An important pattern observed in all these studies was the minimal effect on feeding practices and dietary intake even if this was the main focus of the intervention. The only noteworthy reduction observed for diet related outcomes was a decline in utensil sharing (Freudenthal & Bowen, 2010; Weber-Gasparoni et al., 2013).

A study on dental health education reported a cost-effectiveness ratio of 1:24 for home visits by 8 months of age (Plonka et al., 2012). Home visits were performed at 6, 12 and 18 months in 30-minute intervals by oral health therapists. In Queensland, Australia, children were contacted over the telephone at 6, 12 and 18 months of age (Pukallus et al., 2013). Education, dietary advice, and hygiene instruction was given in 15-20 minute intervals. Assuming that caries probability is constant until 6 years of age,

the intervention prevented the development of 43 carious teeth. This translated into £69 964 dollars per 100 children in healthcare savings. One study compared home visits, phone contacts, and incentive based strategies (Reiss & Bailey, 1982). The incentive based programs had a larger number of families obtaining care, however the difference in completed care between groups is not significant. The costs on the other hand were considerably higher for the incentive based groups. In the same geographic region, a home visit costs $70 while telephone contact is only $8.92 (Oda et al., 1986).

Intervention Initiation, Duration and Frequency:

The impact of education programs was more pronounced in the long-term studies. For example, a 22% (RR 0.78) reduction in the proportion ECC and a 32% reduction in S-ECC are shown as a result of educational interventions (Feldens et al., 2010). Similarly, with Kowash (2000), a difference is shown between 0% of children with caries in the intervention group and 33% of controls. Interestingly, Kowash (2000) was able to produce similar effects as Feldens (2010) with a fewer number of home visits that were each shorter in length, three 15 minute visits compared to ten 30 minute visits. Within their own study, oral hygiene instruction and dietary education every 3 months for 2 years and then twice a year compared to once a year for three years had the same impact on caries prevalence, decayed surfaces (ds), mean caries score, and decayed, missing, and filled surfaces (dmfs). However, small differences were reported for on demand drinking, sweet consumption, tooth brushing frequency, and dental visitation for the group that

received more frequent home visits. This could be due to different interventionists of varying experience delivering the interventions. The cost also differs depending on age of first preventative dental visit. Costs were $262 for 0-1 years, $340 for 1-2 years, $450 for 2-3 years, $492 for 3-4 years, and $547 for 4-5 years (Savage et al., 2004).

Interventionists:

The use of interventionists also varied between studies. Four studies utilized community members who shared a similar culture, background, and language as the clients (Feldens, Vitolo & Drachler, 2007; Feldens et al., 2010; Harrison & Wong, 2003; Weinstein, Harrison, & Benton, 2006). All these studies exhibited a significant reduction in ECC occurrence over time. Two of these studies were able to produce an effect on caries with lay people delivered interventions (Feldens, Vitolo, & Drachler, 2007; Feldens et al., 2010). Nevertheless these lay people were educated undergraduate nutrition students with considerable knowledge and had received extensive training. The students had previous training on health feeding of infants and counseling skills, plus received an additional 16 hours of theoretical and practical training, and were supervised on a weekly basis. From this, we may not be able replicate these results using non-educated lay people from the community.

The difficulty of delivering oral health interventions with lay people is demonstrated in the Vichayarant (2012) study. Village health volunteers or lay workers attended extensive training workshops including a multi-media presentation, demonstrations, and role-play carried out by dentists and dental hygienists. Even with

extensive training, caries increased in both groups. Interventionists that have used by other studies include: health care professionals, nurses, dental hygienists, dental health educators, therapists, and researchers. For instance, studies using health professionals with minimal training demonstrated markedly fewer decayed surfaces, no carious lesions, and a greater percentage of caries free children (Harrison & Wong, 2003; Weinstein, Harrison, & Benton, 2006). Kowash (2000) used a dental hygienist and pediatric nurse; both were given the same amount of training. There were no differences in caries outcomes between the visitors. This indicates the importance of health professional interventionists over community lay-workers when delivering oral health programs. Also health professionals can be just as effective as dental personnel in delivering oral health prevention messages.

Into the Mouths of Babes, a North Carolina ECC prevention program trained 1,595 medical providers (Rozier, Bawden, & Slade, 2003). Half of the providers were physicians while the other half included registered nurses, nurse practitioners, and physician assistants. A dental package was added to medical visits where physicians were reimbursed for a risk assessment, oral screenings, dental referrals, fluoride varnish applications, and oral health education. Training required completion of a one and a half hour continuing medical education course with course enhancements such as written materials and a fluoride varnish starter kit.

An RCT examined the impact of home visitation provided by nurses compared to paraprofessionals on child health (Olds et al., 2002). 1178 low-income women were

recruited from private and public care settings. Both home visit groups received an average of 6 home visits from birth to two years. The paraprofessionals lacked professional training and post-secondary education but were provided structured guidelines, extensive training and supportive supervision. In the end, the paraprofessionals did not have a statistically significant effect on child health whereas the nurse-visitors had a meaningful impact. A nurse-led telephone service for school aged children is relatively inexpensive. Phone call service averaged 27.7 minutes and $8.92 per family for 2,792 families (Oda et al., 1986). In this study, families without dental insurance showed the greatest positive intervention effect.

Strategic Approach:

Vichayanrat (2012) employed a comprehensive strategy that also included oral health screening, fluoride supplements, free toothbrush and toothpaste, social support (information, appraisal, and emotional), and community involvement (group discussion, community representatives, and member education). Lay health volunteers, trained in a one-day workshop, delivered the program. Remarkably, the intervention resulted in an increase in dental caries prevalence despite clinic services and home visit follow up every 3 months. Still, a similar intervention with clinic visits and telephone follow up found a positive sustained impact on decayed surfaces and the percentage of caries free children (Harrison & Wong, 2003). Key differences included intervention follow/up period, method of delivering education, and interventionist. Harrison and Wong (2003) measured the effect of counseling delivered by a registered nurse after 7 years.

Like Vichayanrat (2012), Harrison and Wong (2003) developed a comprehensive program aimed at the individual, family, and community. They involved community members to participate in an environmental scan, and all phases of project planning and development. Community initiatives included video presentations to parents in local community centers, an article on dental health featured in a local magazine, child dental health booths at local festivals, a neighborhood health fair, a brochure for nurses, and window displays near bus stops. This program offered support along with counseling to mothers, utilizing an anticipatory guidance approach. Counseling for oral health was tailored to the child's age and accompanying gifts were provided such as a toothbrush, training cup, and soothers. This program continued to experience success years after the intervention. After five and seven years, the mean decayed, extracted, and filled surfaces (defs) of children were significantly lower than baseline at 0.06, 2.6, and 9.5 respectively. This was the longest follow up reported in the literature to date.

In 2003, Belgium added oral health education to standard care that consisted of three home visits and 11 clinic consultations (Van den Braden et al., 2013). There were no significant differences in caries prevalence between the control and experimental group. This may have been because an education only intervention was used, and so effects were limited.

Table 1: Summary of Education Based ECC Prevention Strategies

Author, Year	Study Design Country; population	Sample Size; Age at Enrolment; Follow-up	Intervention: type of education, delivery of education	Intervention frequency and length of intervention; individual delivering intervention	Control Group	Caries Findings	Other Dental outcomes
Feldens, Vitolo, & Drachler, 2007	Randomized Trail Brazil, low socio-economic setting	378 participants From birth 1 year	A: Dietary advice (not including oral hygiene); OHE Home visits with verbal and written (leaflet) information;	10 visits (from birth- 12 months) plus routine assistance 12 Fieldworkers, Portuguese speakers (6h of training)	B: Routine Assistance for both groups	A: 10.2 % (OR = 0.52) of with caries. 0.37 mean ds B: 18.3 % with caries. 0.63 mean ds (P = 0.03)	A: longer duration of exclusive breastfeeding, later introduction of sugar, small probability of dietary sugar intake.
Feldens et al., 2010	Randomized Trial Brazil, low socio-economic setting	340 participants From birth 4 years	A: Nutritional advice; OHE Home visits;	10 visits (from birth- 12 months) 30 min visits 12 Nutrition students	B: Routine Assistance for both groups	A, B: 3.25, 4.15 mean # of affected teeth. 53.9%, 69.3% with ECC (RR = 0.78). 29.1%, 44.27% with S-ECC (RR = 0.68)	A: 31.2% consulted dentist. Longer duration of breastfeeding, later introduction of sugar, lower frequency of dietary intake, B: 34.2% had consulted a dentist
Freudenthal & Bowen, 2010	Quasi experimental USA (Idaho), low income	78 participants 6-24 months 4 weeks	A: MI regarding oral health strategies Delivery not reported, telephone f/u 1,2 weeks	Contact 3 times (telephone and other) for 20 to 30 min Delivered by researcher (trained with workshop and workbook by dental expert)	B: No formal education, pamphlets were available if desired	Not measured	A: Frequency of cleaning and brushing teeth (pretest 2.80, posttest 3.70). Reduction in sharing utensils with their child for Group A posttest. B: No difference found
Harrison & Wong, 2003	Quasi experimental	41 participants 22.7 to 25.3	A: counselling sessions for oral health practices	5 visits between 2 -18 mo with telephone f/u after each session.	B: Vietnamese children from neighbouring	A, B: 4 year ds 1.1, 1.9 (5.1 baseline) and 93.3%, 42.9% caries	A: Sleep-time bottle 13.3% (69.2% baseline) and daytime comfort bottle 6.3%

	Canada (BC), low income Immigrants	months 4,5,6,7 years	A: clinic visits with telephone f/u, support from community	Length unknown A Vietnamese health worker and a dental hygienist	communities	free (50% baseline). At 5 and 7 years, mean defs 0.06 and 2.6 (baseline 9.5).	(83.3% baseline). B: Sleep-time bottle 55.6% and daytime comfort bottle 55.6%
Ismail et al., 2011	Randomized Trial USA (Detroit); low-income African Americans	1021 participants 0 to 5 years 6 months, 2 years	A: MI, 15 min DVD, and a brochure Location not reported, telephone f/u, mailed brochure at 7 mo	Number of visits and written reminders unknown. MI sessions were 40 min Therapists from community, with 2-day training	B: DVD (15 min) only and written list of recommendations to maintain oral health	No significant effect on development of new non-cavitated, cavitated, and total new untreated disease	A, B: At 6 months report checking for pre-cavities (59.2%, 57.67%) and reported 6 monthly dental visit (57.86%, 52.33%). A: At 2 years caregivers check for pre-cavitated lesions (OR = 2.7).
Kowash et al., 2000	Quasi-experimental UK, low socio-economic suburb	228 participants 8 months 3 years	A (diet): education B (OH): Oral hygiene instruction - toothpaste C (diet + OH) D (yearly): dental health education	A, B, and C every 3 months for the first 2 year, then twice/ year in year 3 D: once a year for 3 years Home visits were 15 min Two dental health educators	E (control): No dental health education and never visited	A: 4% caries, 0.29 ds, 0.29 dmfs B,/C,/D: 0% caries, 0 ds, 0 dmfs E: 33% with caries, 0.78 ds, 1.75 dmfs	A, B, C, D, E: 11%, 17%, 10%, 31%, 52% on demand drinking,; 9%, 0%, 2%, 8%, 33% >once/day sweet consumption; 0%, 0%, 0%, 6%, 33% none/rarely tooth brushing, 11%, 8%, 16%,, 8%, 43% never had dental visit
Plonka et al., 2012	Controlled, longitudinal study Australia, low socio-economic status	228 participants 42 days 24 months	OHE Home visits (A) and telephone contact (B)	Contacts at 6, 12, and 18 months Consultations were 30 min in duration Oral health therapists	C: Control group received no contact	A: 1.5% with caries, 1.3 mean # of carious teeth B: 6.8% of with caries, 3.0 mean # of carious teeth C: 22.5% of children with caries, 3.0 mean # of carious teeth in children with caries	A, B, C: 5%, 5%, 25% Bottle at night; 5%, 3%, 25% Bottle for day naps at 24 months; 98%, 100%, 85% Mother brushed child's teeth; 73%, 67%, 43% >2 brushing of child's teeth; 75%, 80%, 55% mothers did not persevere with brushing when child was uncooperative, 20%, 30%,

							43% plaque on maxillary incisors
Plutzer & Spencer, 2008	Randomized controlled trial Australia, limited socio-economic status	649 participants 5-7 months of pregnancy 18 months	AG A: Printed info and telephone contact B: Printed info only	3 Info rounds up to 12 mo and telephone consultation Telephone contact - length varied. Interventionist not reported	C: Control group did not receive any intervention	A: 1.6% of S-ECC B: 1.8% of S-ECC C: 9.6% S-ECC. OR=6.8 (95% CI 2.1-21.9). S-ECC odds for age (months) at exam OR= 1.3 (95% CI 1.1-1.5)	No other dental outcomes were measured
Vichayanrat et al., 2012	Quasi-experimental design Thailand, low income families	114 participants 6-38 months 1 year	OHE and services at health centers, and community mobilization process Home visits and clinic visits	In clinic services and home visits every 3 months. Duration of visits not reported Lay health workers, One-day training workshop by dentists and dental hygienists.	B: Control group did not receive clinic or home based intervention	A: 69.4% tooth eruption at baseline. 47.6% caries and 2.34 dmft. 1year - 60.7% and 3.04 dmft. B: 79.6% tooth eruption at baseline. 34.7% caries and 2.22 dmft. 1-year caries 63.6% and 3.49 dmft.	A, B, C: Any tooth brushing during the previous week 93.5% (baseline 59.7%), 80.4% (45.1% baseline). Use of fluoridated toothpaste 85.5% (baseline 30.6%), 59.6% (baseline 32.7%). Use of fluoride supplement 80.3% (baseline 25.4%), 13.7% (baseline 13.0%)
Weber-Gasparoni et al., 2013	Cohort study USA, low income women	415 participants 12-49 months 1 and 6 months	Autonomy supportive psychoeducational OHE A: video message for public health settings	One point of delivery 15 min video Public health setting staff delivered interventions	B: Same content as video but delivered as a neutral paper brochure	No difference in proportion of children with carious lesions caveated lesions, and/or presence of visible plaque after 6 months.	A+B: 1 mo. increased toothbrushing at bedtime, using fluoridated toothpaste, and checking teeth. A+B: 6 mo. toothbrushing maintained. Checking teeth higher in A, 81% (54% baseline, P=0.004). A, utensil sharing 13% (27% baseline).

Weinstein, Harrison, & Benton, 2006	Randomized Trial Canada (BC), Punjabi speaking (South Asian) immigrants	240 participants 6-18 months 2 years	MI to discuss behaviour change A: Pamphlet, videotape, and counselling session at initial visit. With f/u telephone and postcards	Initial, 3 and 6 mo (telephone call/postcard reminder). And f/u telephone call as needed 45 min session, 11 min video. Trained health workers and professionals (south Asian), 10-hour workshop.	B: Pamphlet and videotape only	A: New carious lesions (OR = 0.35, 95% CI). 35.2% new carious lesions (baseline 15.2%) B: 52.0% new carious lesions (baseline 26%)	A: Higher number of fluoride varnish applications more than B.

dmfs – decayed, missing, filled surfaces; dmft = decayed, missing, filled teeth; deft = decayed, extracted, filled teeth; defs = decayed, extracted, filled surfaces; ds = decayed surfaces; S-ECC = severe early childhood caries. MI = motivational interviewing; OHE = oral health education; AG = anticipatory guidance; OR = odds ratio, RR = relative risk

Discussion

Table 2. Summary of ECC prevention program recommendations

Program Component	Recommendations
Education Model	Implement a non-traditional dental education model
Fluoride	Implement fluoride products or treatments only in support of dental health education if resources are available.
Content of Education	Implement oral hygiene focused instruction supplemented with education around diet and feeding practices
Delivery	Pilot a home-visit program with telephone contact follow-up and in-person support as needed. Measure cost, impact, and feasibility of varying number of home visits and telephone calls.
Initiation	Implement preventative services before 1 year of age
Duration	Evidence is inconclusive, further research required. Controlled studies that examine the cost-benefit and ECC impact of varying durations of each visit over the long-term are needing
Frequency	Evidence is inconclusive, further research required. Controlled studies that examine the cost-benefit and ECC impact of varying number of visits over the long-term are needed.
Interventionist	Pilot a public health nurse program in community health clinics and other existing nursing services where feasible. This can be a nurse-only or a nurse-managed model. Measure cost, impact, and feasibility of the two models and the different practice settings.
Strategic Approach	Implement a targeted-high risk approach with comprehensive, multi-level interventions throughout the community. Integrate oral health screening and dental referrals to support education.

Fluoride-Delivery:

Up until now, fluoride has been an effective strategy in combatting decay. The literature demonstrates a marked decrease in the proportion of dental decay, particularly in children as a result of community water fluoridation and fluoridated toothpaste (Davies et al., 2001). However, using fluoride in isolation of other strategies has reached its limits in

preventing caries, especially in young children. In fact, disease rates in the larger school-aged population, 6 to 19 years old, has declined but dramatically increased by 15.2% in early childhood (Kagihara, Niederhauser, & Stark, 2009; Schroth et al., 2010). Even in areas where fluoride is more rigorously used, half of infants and preschoolers still have caries (Fisher-Owens et al., 2007). Segmenting the population reveals that fluoride may have solved the caries problem in older children but has had minimal success in preschoolers. Lastly, since the psychological and behavioral factors for dental decay are different for preschool and older children, they should be treated as separate populations with distinct needs (Kagihara, Niederhauser, & Stark, 2009). In conclusion, a shift away from fluoride-focused ECC prevention is needed.

In general, dental health education programs have higher cost-benefit and cost-effectiveness ratios compared to slow release fluoride devices in children, community water fluoridation, and fissure sealant (Kowash, Toumba, & Curzon, 2006). Fluoride based interventions are costly because they require technical equipment and specialized staff. Also, treatment must be continued indefinitely. Fluoride sealants are an important strategy but only treat the symptoms of ECC. Education can be more cost effective because the root cause is targeted and healthy behaviors are sustained over time. Fluoride exposure can be used to supplement other dental health education but should not be the sole strategy.

Education Models:

The literature points to the importance of education-based interventions but suggests that not all types of education are equally effective. Conventional health education has had

limited success in preventing decay (Arrow et al., 2013; Gao et al., 2013; Van de Braden et al., 2013). The traditional normative approach to information delivery is ineffective for populations reluctant to change and does not result in sustained benefits (Gao et al., 2013). Even though the traditional model can improve dental knowledge, other education delivery models have proved to be more effective. Anticipatory guidance and motivational interviewing are two examples of modified education strategies. This can enhance the effect of traditional education on ECC rates. Anticipatory guidance provides information based on the child's developmental stage while motivational interviewing is a client-centered counseling technique to help identify and overcome barriers (Arrow et al., 2013). These approaches are a clear contrast to the traditional delivery model. Education alone has had minimal short-term success. But, education can be used in combination with support at the individual and community level to sustain improved oral health (Watt, 2005). Overall, cost-effectiveness studies of oral health education programs have shown considerable savings especially for nontraditional education programs. Savings are the result of relatively inexpensive programs that reduce the need for costly dental treatment. Use of non-traditional dental health education could generate even greater cost savings.

Content of Education:

An additional challenge with all education grounded interventions is improving diet related behaviors (Feldens et al., 2010). A focus group with parents acknowledged the importance of diet to oral health but admitted that these choices are difficult to implement at home (Schroth et al., 2010). Individual, community, and cultural factors dictate these oral

practices. For example, many communities do not have access to healthy food. A lack of supermarkets and conveniently located fast food vendors can make dietary recommendations difficult to achieve (Skeie et al., 2007). For low-income families, high costs of fresh produce serves as an additional barrier. In immigrant and ethnically diverse populations, dietary preferences can have cultural and tradition importance (Skeie et al., 2007). In certain cultures, tooth decay is not viewed as an illness and in others oral health care is not valued (Hallas et al., 2011). Parents are aware of (Ismail, 1998) the association between dietary practices and decay but continue the unhealthy behavior. A study found that parents of children suffering from ECC were aware of cariogenic liquids and 78% had tried to use water at bedtime (Berkowitz, 2003). Other oral health promotion practices may be easier to implement. Results of a questionnaire indicated that caregivers are more likely to brush their child's teeth with fluoridated toothpaste than change dietary or feeding habits (Harrison, 2003). Thus oral hygiene instruction and education regarding caries process and identification are more effective than educating parents about cariogenic feeding.

Mode of Delivery:

This review found that home visits are an effective method of education delivery. Even though this literature review presents a body of literature illustrating the effectiveness of home visits, many studies have been found claiming the opposite effect. For example, one case compared home visit to telephone contact using public health nurses for 1654 children 0 through 7 years of age (Oda, Heilbron, & Taylor, 1995). No difference was detected between

the home visit, telephone contact, and control group who received no intervention. In other words, well-established home visits were reported to have the same effect as no intervention.

It is difficult to determine what makes a home visit successful since many studies such as this did not report intervention characteristics. More controlled research is needed to make sense of these contradictory findings. Yet, home visits allow programs to be tailored to the community and the individual based on communication preference, learning style, and sensitivity to cultural and demographic differences like income (Barnes-Boyd, Norr, Nacion, 2001). Along with personalized messages, this allows for investment in developing rapport and trusting relationships that are believed to promote learning and change (Barnes-Boyd, Norr, Nacion, 2001). Aside from home visits, oral health education can be delivered through nurses in well-baby clinics using a multifaceted intervention.

Despite, cost savings, education programs still present a significant cost to the system. Home visit costs in particular are considerably larger. Visiting a client's home is labor intensive and requires skilled professionals with significant salaries. Due to scarce government funds, we must scrutinize what to include or exclude in these programs. Sometimes benefits can be important but difficult to measure like an increase in quality of life gains (Kowash, Toumba, & Curzon 2006; Pukallus et al., 2013). Other indirect effects are: reduction in pain, social acceptability, educational benefits, recovered family time, and prevention of income lost to attend treatment (Kowash, Toumba, & Curzon, 2006; Pukallus et al., 2013). Lastly, improvements in oral health will spill over into other areas of general health. For instance, a healthy diet will result in optimal growth and development.

The use of telephone contacts, as mentioned before, is shown to help contain costs. Telephone and mail can be used to supplement home or clinic visits. Some studies have described this follow-up as boosters. The boosters should utilize the same modified education approach as the home visits. Reducing the number of home visits with follow-up phone calls could substantially contain costs. More importantly, replacing costly home visits with inexpensive telephone contact reduces costs without diminishing program benefits (Reiss & Bailey, 1982). Lastly improving cost effectiveness with dental auxiliaries like referrals should not be overlooked (Plonka et al., 2012). The number of dentists available significantly impacts access to services for low-income families (Savage et al., 2004).

Initiation, Duration, and Frequency of Intervention:

This review consistently found effective oral health programs begin early in life, usually less than one year of age. The AAP recommends that the first caries risk assessment occur at 6 months of age during the well child visit by a child healthcare professional. They also recommend that the first dental visit should occur within 6 months of primary tooth eruption and no later than 1 year (Kagihara, Niederhauser, & Stark, 2009). In fact, the AAPD advises that caries risk be identified as early as possible (Kagihara, Niederhauser, & Stark, 2009).

Some preventive programs begin prenatally and continue after birth. These programs show long term-sustained effect on caries rates and dft as a result of education (Gomez & Weber, 2001). Prenatal interventions have also been shown to improve home visit efficacy

(Larson, 1980). One group received home visits beginning prenatally while the other received them postpartum, 6 weeks after birth. The average home visit was 60 minutes long for the postpartum group, but only lasted 30 min in the prenatal group. The prenatal group benefited in terms of child health and development, while the postpartum group was not signification from the control. Larson's study reiterates the importance of intervention timing and the sensitivity of intervention outcomes to the timing of recruitment (1980). Overall, interventions initiated around three years of age or later have not been successful in ECC prevention (Rowan-Legg, 2013). From the literature, it is clear that early intervention is necessary. However, the frequency and length of interventions is still unclear. More research needs to be conducted in this area to determine best practice. When home visitation is used, at least one home visit with other modes of follow up contact has been noted.

Various methods have been suggested to overcome cost barriers with ECC prevention programs like the age at first preventative dental visit. This has a positive influence on cost because children who had their first preventative dental visits from 0-1 year were less likely to have subsequent restorative and emergency visits, resulting in lower costs. Furthermore, children in the youngest age group were also more likely to continue preventative visits after the intervention. This preventative pattern was not observed in the older age groups (Savage et al., 2004). Creating healthy practices early on instead of modifying unhealthy ones may be critical to the success of ECC prevention (Feldens et al., 2010). Thus home visit efficacy can be improved and maintained by beginning interventions at an early age.

Interventionist:

A home visit model can be successfully integrated and implemented using a nondental health professional like nurses. Evidence from other areas like general child health showed similar results. Earlier trials also showed a positive impact of nurses on child abuse, neglect, and injuries in this population. Olds and his colleagues suggested that unlike nurses, paraprofessional lack engagement and persuasive power. Moreover, nurses are one of the most trusted healthcare professionals in the eyes of the public (Olds et al., 2002). Since they are viewed as honest and ethical it allows for greater engagement and increases the likelihood of behavior change (Olds et al., 2002). The nurse presence also allows for much needed inter-professional collaboration along with the expertise in coordination and planning.

Yet, a study comparing registered nurse administered home visits to a nurse managed community worker program reported no difference in infant mortality between the two (Barnes-Boyd, Norr, & Nacion, 2001). Both programs were able to achieve health benefits compared to the control group. An all nurse model can be costly and does not necessarily improve community participation. Lower skilled professionals could be used instead of healthcare professional to reduce these costs. In fact, the community worker was better at establishing trust and conveying information than the nurses in some instances (Barnes-Boyd, Norr, & Nacion, 2001). The lay workers add knowledge of the community and its members to support tailored programs and establish credibility of the team. But a closer inspection reveals issues with lay health workers in terms of costs of extensive training and poor effectiveness compared to healthcare professionals.

The lay worker is not without drawbacks; the community workers had high turnover rate, poor performance, high absenteeism, limited work experience, complex personal lives, and were unable to work as a team (Barnes-Boyd, Norr, & Nacion, 2001). Another drawback is that home visits were conducted in pairs with two community workers or one community worker and one nurse. Conversely, nurses conduct home visits by themselves. This implies that perhaps the lay worker model does not generate the major cost savings suggested. Savings are probably modest when training, caseloads, and health outcomes are built-in. These results illustrate the importance of professional designation to achieve program effectiveness.

Compared to other health care providers nurses play a unique role in the health care system, carrying out several functions. Public health nurses can be found in well-baby or well-child clinics, doctor's offices, outpatient clinics, and in various community health centers (Yost & Li, 2008). In Alberta, well-child or well-baby visits can occur on average 12 times before the infant turn 3 years old (Healthwise, 2013). As a result, public health nurses are strategically positioned to provide oral health education, screening, and referrals (Marrs, Trumbley, and Malik, 2011; Skeie et al., 2011). Some of these functions include education to increase awareness of diseases and prevention efforts; screening and assessment for risk and disease processes; case management to help clients navigate the system and monitor overall health; and an advocator role for funding of programs to improve health equity (Marrs, Trumbley, and Malik, 2011).

A holistic, client-centered, promotion framework that uses collaborative and comprehensive care is essential for successful integration of oral health services into the existing system (Hallas, 2009). Since nursing practice is already guided by this model, it would be appropriate to integrate oral health into present nurse-based services. Integration can emphasize the importance of oral health to overall health (Harrison & Wong, 2003). With a family-centered approach, nurses can provide individualized, tailored care to each client and their unique needs. Tailored care is critical for ECC prevention as unhealthy behaviors and capacity to implement preventative practices can vary widely between families. For example, Schulter and his colleagues found that maternal oral health practices differ between ethnic subgroups (2007). This hints to the complexity of ECC and emphasizes that a "one size fits all" approach will not be effective.

Nurses could present dental health as an important issue to be valued from birth to positively impact caregiver understanding of ECC risk, prevention, and process (Harrison & Wong, 2003; Yost & Li, 2008). Nurses are also well positioned to promote oral health because they are already familiar with providing health services to vulnerable, disadvantaged groups (Fellona & DeVore, 1999). As a result, they have a better understanding and sensitivity to the barriers faced by this population. Therefore, nurse-based ECC prevention could effectively improve oral health in this population and narrow the gap in oral health inequality.

Studies conducted using other professionals like family physicians in medical clinics have also shown a significant impact on ECC. The *Into the Mouths of Babes* intervention

implies that non-dental professionals can successfully incorporate preventative oral health activities into practice. Nevertheless, physicians reported a lack of time in providing these services and thus service delivery was below optimal level. One study reported that physicians would need to cut patient load in half in order to meet the recommended guidelines (Rozier, Bawden, & Slade, 2003). Therefore, implementation in physician-based practices may not be feasible.

Strategic Approach:

Various preventative strategies have been suggested to target children at risk for ECC. The most successful of these strategies favor a targeted approach over a population approach. The population approach aims to reduce risk in the entire population while the targeted approach focuses on high-risk subgroups (Watt, 2005). These subgroups can be identified using epidemiological data or screening tests (Watt, 2005). A combination of both methods is recommended to best define and identify those at risk. This would mean focusing on infants and toddlers with the most severe dental decay within the high-risk populations (Rozier, Bawden, & Slade, 2003). One study described this as, "changing the 25% of children who have 80% of caries…rather than aiming to decrease the prevalence of ECC by 50% among all preschool children" (Harrison, 2003). These programs have the largest cost-benefit and the greatest impact. For example, in one study, targeting families without insurance resulted in a larger health benefit and greater cost savings.

Limitations:

Overall, the 11 studies on ECC interventions lack scientific rigor. First, studies often lacked sufficient details to assess similarities or differences between interventions. Some important details that were not mentioned include: the content of the education session, method of communicating the content, the individual delivering the content, total time spent on the educational session, frequency of the educational session, and the training of the individual to deliver the content. Furthermore results were not consistent as a variety of aims were used in different settings. Second, fidelity to the models and interventions used is called into question, especially with multiple interventionists and sites.

Lastly, the effectiveness of the various types of interventions is also difficult to calculate. Most interventions used a combination of methods, making it difficult to separate the specific effects of each element of an intervention. For example, home visitation was rarely the only intervention used. Trials on single-level approaches are needed to demonstrate the effectiveness of multi-level approaches. Although a limiting factor, packages should still be implemented. Each component of a multifaceted program addresses a different aspect of ECC prevention. The best way then to develop a successful intervention is to use various types of interventions combined with support.

Study Design:

This review found that studies were of poor or fair quality. Many studies were non-randomized controlled trials with baseline differences between the control and experimental group. The randomized trials reported did not outline the method of randomization thus preventing identification of potential bias and reducing the potential for replication. Blinding

was usually one sided but is generally difficult to control for this type of intervention. Ideally a cluster randomized controlled trail would be optimal to test the effectiveness of various education-based interventions to prevent ECC.

Sample Size:

All the studies experienced loss to follow up, with the long-term studies experiencing greater issues maintaining contact with families. Even relatively low attrition makes it difficult to interpret results due to already small sample sizes. Weak sample size reduces the statistical power and thus statistical significance of the results. Consequently, overestimation of effect size, inability to determine true effect, and low reproducibility of results occurs. More importantly, generalizability of the results to other settings and populations is compromised.

Time Frame:

It may not be possible for one intervention to sustain a long-term reduction in disease. Short time frames like 4 weeks or even a year are not long enough to assess behavior change and test for sustained change. Some programs are only effective as long as clients are in contact with the service.

Participant Biases:

Many participants opted to change their intervention, creating potential for biased results. Furthermore, demographic differences between the two groups were noted in terms of education, number of children, dental cavitation at baseline, etc. Also, the definition and classification of low-income groups differs across nations. Most studies did not describe the

income or socioeconomic status of their subjects, contributing to the difficulty of comparing studies. Some even recruited participants from a different community for the reference group, increasing the risk of selection bias. Most studies recruited participants attending health clinics. This may be an easier group to reach but applicability of these results to challenging and hard to reach groups is limited. Across studies, it is also difficult to assess the variability of routine care, which was the most common control group. In certain communities, it is standard to receive one home visit, as in Alberta.

Non-Dental Outcomes:

Results of non-dental outcomes were collected through self-reported interviews and questionnaires. The questionnaires used differed between studies. Because women in the experimental group were asked to discuss oral health more than the control, reporting may have been affected. Risk of recall and social desirability response bias of self-reports warrants caution in interpreting the data. Variation in outcomes and data measured is also reflected in this review.

Dental Outcomes:

Issues also arose with data on dental outcomes. For example, a validated tool was not used in the examination of white spot lesions and cavitation, assessing caries risk, and caries prevalence. Certain studies used blinded examiners with a detailed examination procedure. The definition of caries used by each study is also unclear, slight variations have been noted in the literature. Different definitions of ECC can result in either an overestimation or underestimation of the true effectiveness of the intervention. Regardless, errors in diagnoses

within each study is likely minimal and equally distributed between examiners and experimental groups. Future studies should use validated tools using reliability and validity criteria to assess outcomes. Community specific interventions should utilize focus groups with relevant stakeholders to ensure acceptability and feasibility of the intervention.

Future Studies:

The lack of scientific rigor is a limitation for the strength of these findings. Currently, a limited body of literature pertaining to ECC with contradictory findings exists. These data however, reflect the summary of the best evidence available to date. Additional research is needed in this area. Future studies of ECC interventions should attempt to follow high quality standards of randomization, analysis, and reporting (Trenter & Creason, 1986). Studies of what barriers exist at the levels of the patient, provider, and healthcare system and they can be overcome are also needed. It is yet unknown, how beneficial and cost-effective these programs are in real-life health care settings. However, this review provides encouraging evidence that educational programs and support services provided in public health settings can improve oral health in preschoolers.

Despite the poor quality of the 11 studies reviewed. The use of the other 167 studies and grey literature provide compelling evidence for the recommendations provided in Table 2. A broader look at program components like home-visits and nurse-led interventions guided our thinking. Looking at related areas like breast feeding and general pediatric health offered further evidence for ECC prevention. Furthermore, despite an apparent lack of consistency between the studies, examining a large body of evidence allowed us to establish

patterns. For example, the recommended age to initiate ECC prevention was pervasive and consistent across all the studies. Thus, despite the issue with each individual study the collective body of evidence provides valuable information. This was also true in the area for dental health education and the content of education. Studies parameters differed in terms of the outcomes measured, the intervention, and the level and type of impact. Regardless, dental health education and a positive impact as a result of it was always the common denominator. Whether this positive impact will be large or small can be dictated by the program specific such as: mode of delivery, interventionist, and the strategic approach. Here we have provided guidance where to pilot, implement, or investigate further. We have identified home visitation and nurse focused programs as promising areas. For these areas the data also indicates effectiveness but there is not adequate information around the best way to achieve this. Consequently, piloting allows policy makers to determine how an ECC prevention program would work in the Alberta context. This will provide valuable insight regarding barriers to success and design issues before launching a province-wide program.

Policy Implications

Estimating Cost Savings:

ECC places a large burden on children and the families it affects. Based on cost benefit and cost effectiveness analyses from previous studies, the Government of Alberta could potentially save $2.2 million annually on pediatric dental surgery costs. More conservative ratios estimate $1 million in savings through ECC prevention programs

(Kowash, Toumba, & Curzon, 2006). The vast indirect benefits of oral health promotion are not included in these estimates but should be kept in mind. Additional research is needed to estimate the cost-benefit ratios in terms of overall health and oral health and whether the benefits in the first year of life are maintained (Feldens, Vitolo, & Drachler, 2007).

Barriers to Preventing ECC

Table 3 Recommendations to address barriers to successful ECC prevention

Level	Barriers	Recommendations
Nurse	Lack of time, Lack of knowledge Negative attitudes Not sufficiently engaged Competing demands	Multifaceted interventions Dental screenings Integrating oral health Hands on in-service training Administrative and management support Communication skills and tools
Individual	Lack of transportation Lack of education High cost of services Lack of cooperation from child Lack of public financing	universal, publicly administered dentistry comprehensive government-subsidized programs encourage dental care providers to take on publicly funded patients
System	Lack of advocacy Minimal policy activity Weak evidence base	An integrated approach and a shared vision Improve funding for ECC research

Barriers to Preventing ECC – Nurse Level:

In programs like North Carolina's *Into the Mouths of Babes* physicians reported a lack of time, yet nurses would also face a demand on their time. This is apparent in nurse practice settings that have already integrated oral health into practice. In these settings nurses only spent on average 10 minutes or less on the topic (Van den Braden et al., 2013). More urgent problems frequently arose in the restricted time available. As a result, nurses will also

face time barriers to integrating oral health into practice. To overcome this barrier, Rozier, Bawden, and Slade (2003) recommend multifaceted interventions over single-interventions with minimum time dedicated towards oral health education.

Many qualified nurses, including family physicians and pediatricians report lack of adequate knowledge as a primary barrier to providing oral health care (Adams, 1996; Kayser-Jones et al., 1996). Oral healthcare training receives little to no attention in undergraduate and postgraduate nursing curricula (Arvidson-Bufano, 1996; Nicol et al., 2005). When training does occur, nurse colleagues instead of dental specialists teach sessions (Adams, 1996). An analysis of long-term care nurses' shows minimal understanding and awareness of oral care issues (Arvidson-Bufano, 1996). Other studies report pervasive, negative attitudes of nurses towards oral care (Wardh, Anderson, Sorenson, 1997). In this project, the reviewer was met with vehement opposition from public health nurses when nurse delivered oral health education was proposed. Interestingly, opposition was expressed even though oral health education was provided in the past. Lack of time was mentioned as the main barrier to offering this service (Fellona & DeVore, 1999). To address time issues, dental screenings are useful tools to achieve a health impact in a busy clinic (Skeie et al., 2011).

In clinics where nurses are already providing oral health, children's teeth are only occasionally examined and oral health is a low priority. Nurses are not sufficiently engaged in the topic; likewise parents do not bring it up (Skeie et al., 2011). For 0-2 year old children, nutrition (with a minor focus on sugar), breastfeeding, and child development are the main counseling priorities. This opportunity should be used to demonstrate the relationship

between nutrition, ECC, and growth. Integrating oral health into other health topics should address the issue of competing counseling demands. Still, integration alone is insufficient. Eighty-five percent of mothers report receiving no oral health advice despite several contacts with healthcare professionals on multiple occasions (Plutzer & Keirse, 2014). Children with dental providers also received little information.

In service training can be used to educate and create awareness amongst nursing staff to improve patient health (Nicol et al., 2005). A 30-minute training lecture significantly improved accuracy in assessment and the number of assessments performed (Arvidson-Bufano, 1996). Yet, merely closing the gap in knowledge and awareness doesn't ensure change in practice (Wardh, Anderson, Sorenson, 1997). Support from administration and management is also necessary for sustained improvement in nursing knowledge and attitudes (Paulsson et al., 1998). Oral health education offered to nursing personal should favor theoretical aspects and relationship building with clients (Kayser-Jones et al., 1996; Paulsson et al., 1998).

Providing clinicians with communication skills and tools to deliver patient-centered counseling can reduce ECC risk (Kressin et al., 2009). In one study, experts in dentistry trained eligible physician and nurses in a one-hour session offered at multiple times. After one year, children at the interventions site received more counseling and were 77% less likely to develop ECC versus the comparison group (Kressin et al., 2009). Providers were eager to incorporate the training into their practice with minimal, low cost education. It is clear that without positive attitudes, hand-on practical training, integration into the work

environment, and evaluations, behavior change is unlikely (Arvidson-Bufano, 1996; Skeie et al., 2011; Wardh, Anderson, Sorenson, 1997).

Barriers to Preventing ECC – Individual Level:

Even with an integrated, comprehensive oral health program, vulnerable children still face geographic, linguistic, educational, and cultural barriers. Lack of transportation, cost of services, and issues with getting their child to cooperate with oral hygiene are some identified challenges (Schroth et al., 2010). Dental care in contrast to general health is not universal or publicly administered. Instead, dental services financed through private or third party insurance and directly out of pocket (Rowan-Legg, 2013). Not surprisingly, 50% of Canadians in the lower income bracket do not have dental insurance. Few government-subsidized programs in Alberta like the Alberta Child Health Benefit, Assured Income for Severely Handicapped, Family Support for children with disabilities, and Foster Care offer care (Rowan-Legg, 2013). Public financing of dental services in Canada is disturbingly low, plummeting from 20% in the 1980s to 4.9% today (Rowan-Legg, 2013). These programs provide limited coverage that is only offered by a few dentists. This is because of a low reimbursement scale; many dentists do not accept publicly funded patients (Rowan-Legg, 2013).

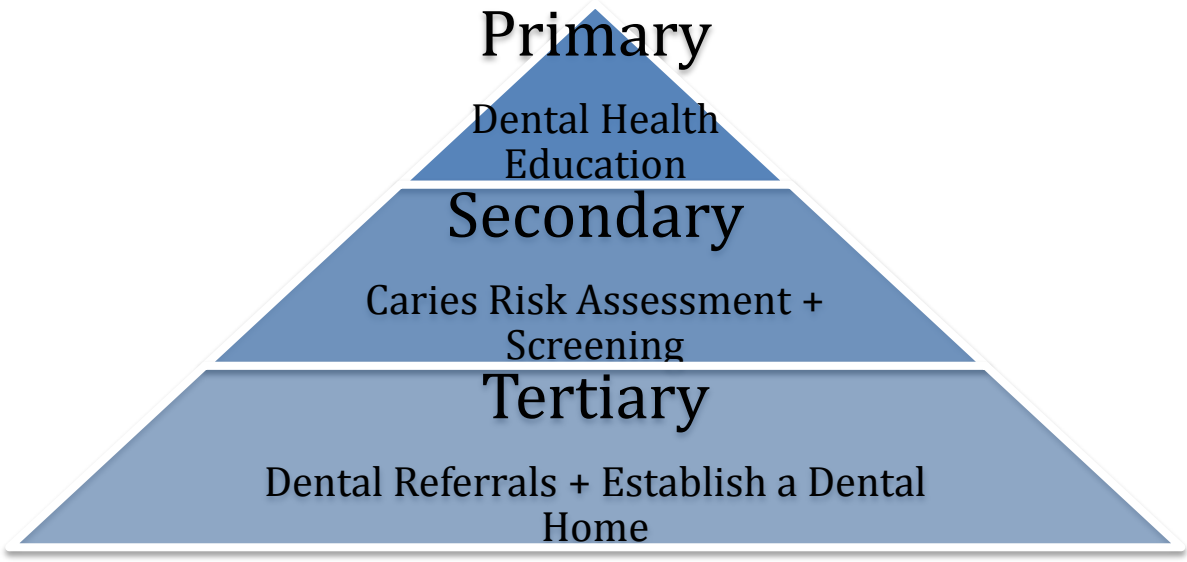
Barriers to Preventing ECC – Systems Level:

Systemic barriers to ECC prevention involve a lack of advocacy for new initiatives by dental and non-dental organizations (Ismail, 1998). Accordingly, there is minimal policy activity in this arena since political leaders are currently uninterested (Ismail, 1998). Services

and policies for dentistry, health, social, nutritional, and economic issues are also dealt with separately (Ismail, 1998). Without an integrated approach and a shared vision on planning and implementing ECC prevention, little will be done. Even with an integrated approach, there is weak scientific evidence to support ECC prevention strategies. Without concrete data it will be difficult to model a program and get buy-in from stakeholders and policymakers. Lastly, dental health is not a priority issue at most levels of government. In fact, many provinces like Alberta don't measure parameters related to ECC. In Canada, dental health is not even classified as "health" based on the Canada Health Act.

Preventative Services:

Based on our analysis there is a clear need for an integrated comprehensive approach is required that employs primary, secondary, and tertiary prevention. The triangle below illustrates the main features for each prevention level.



Primary Prevention:

Primary prevention should begin with dental health messages directed towards children from low-income families (Harrison, 2003). Dental health counseling and education must occur each time healthcare professionals come in contact with children (Yost & Li, 2008). Education can be delivered as anticipatory guidance; using empathy and reflective listening to deliver messages (Harrison, 2003). For infants or prior to tooth eruption, parents should be taught to wipe the infant's mouth and gums with damp washcloth after feedings and before bed, avoid bedtime feeding especially with beverages other than water, avoid utensil sharing, clean pacifiers, and begin weaning from bottle to cup (Hale, 2003; Parthasarathy & John, 2008; Yost & Li, 2008). After tooth eruption, parents should progress to toothbrushing twice a day with fluoridated toothpaste, use proper brushing technique, begin flossing once teeth come into contact, avoid carbonated beverages, reduce fruit juice intake, and limit between meal snacking (Hale, 2003; Parthasarathy & John, 2008; Yost & Li, 2008). Parents should also be informed about the etiology, prevention and treatment of ECC.

Secondary Prevention:

Secondary prevention efforts should involve screening for ECC risk. Risk is defined as the probability of carious lesions development or progression (Curtis et al., 2008). The caries risk assessment tool (CAT) is recommended by the AAP and the AAPD for child health professionals (Hallas et al., 2011; Appendix B). The CAT asks questions directed towards the parents' dental history, diet, nonnutritive oral habits, general health conditions, environmental characteristics, fluoride exposure, oral hygiene, and the utilization of dental

services (Hale, 2003). The tool also requires examination of teeth for caries, presence of plaque, tooth eruption, dental irregularities, and white spot lesions (AADP, 2014). Our review of the literature suggests that nurses should examine teeth for caries as early as 6 months and no later than 12 months of age (Kagihara, Niederhauser, & Stark, 2009). Examinations can be done with the child supine or while the child is sitting on the parent's lap (Parthasarathy & John, 2008). Practitioners must lift the lip and dry teeth with gauze to examine for signs of caries. Caries initially present as chalky white spots near the gum margin, later turning brown in color (Marrs, Trumbley, & Malik, 2011). Detecting white spot lesion is important since they can be reversed if detected early one (Feldens et al., 2010). In the event that plaque is found, it should be pointed out to parents and removed with a toothbrush (Marrs, Trumbley, & Malik, 2011).

Employing a high-risk and directed population approach screening children from poor families is an effective strategy. Screening is an important step, as only some of these children will have high ECC risk (Hale, 2003). Low socioeconomic status is an important predictor for ECC but research has shown that these predictors can lack accuracy (Kling & Norlund, 2005; Peres et al., 2009). Also, the lack of consensus in measuring SES in a meaningful way further reduces its predictive ability (Gussy et al., 2006). Secondly, screening for risk ensures that intervention costs are recovered with dividends (Olds et al., 2012). Once screened, health care professionals should refer to the evidence-based Caries Management Protocol to determine appropriate action (Appendix C). These protocols refine

treatment based on age, risk factors, and compliance with prevention behavior (AAPD, 2014). Standardized decision-making reduces costs and ensures consistent, best practice.

Pierce, Rozier, and Vann (2002) measured the accuracy of ECC screening by pediatric primary care providers'. After a limited two-hour training session they achieved an adequate level of accuracy, 0.76 (95% CI) sensitivity and 0.95 (95% CI) specificity (Pierce, Rozier, and Vann, 2002). Specificity and sensitivity could be improved with further training, but accuracy at the individual tooth level is not necessary. More importantly, steps should be taken to avoid false negatives because these children will not receive needed treatment (Pierce, Rozier, and Vann, 2002). Lessons from this study illustrate the ability and accuracy of non-dental providers in caries screening despite minimal training. The AAP has developed several training modules regarding oral health for by nondental professionals that are easily accessible online (Hallas & Shelley, 2009).

Tertiary Prevention:

Tertiary prevention involves dental referrals for individuals in the 'high-risk" category of the CAT. However, the Pierce, Rozier, and Vann (2002) study found that pediatric primary care providers tend to under-refer. This supports the need to refer if in doubt as false-positives will not suffer harm. Moreover, the AAP recommends that children from a risk group should be referred to a dentist as early as 6 months and no later than 6 months after the first tooth erupts or 12 months of age – whichever comes first (Kagihara, Niederhauser, & Stark, 2009; Parthasarathy & John, 2008). The AAPD defines high risk categories as: children with special health care needs, children with caregivers or siblings

have caries, children with caries or plaque, children with poor dietary or feeding habits, and children in families of low socioeconomic status (Kagihara, Niederhauser, & Stark, 2009; Parthasarathy & John, 2008). Thus, AAP policy recommends dental referrals for all low socioeconomic children or all children for clinics serving low-income communities. Establishing a dental home results in earlier preventative services and routine oral care (Hallas et a., 2011).

The dental home provides accessible, comprehensive, family-centered, coordinated, compassionate, and culturally effective care delivered by primary dental care providers (Hale, 2003). The dental home should also conduct risk assessments, provide education, provide individualized treatment, and refer to dental specialists as needed. But, referrals aren't effective unless a child actually visits the dentist (Parthasarathy & John, 2008). The nurse should follow up with parents to determine if a dental home has indeed been established (Hallas et al., 2011). They can also link parents to a dental home if they haven't already. Though, nurses themselves will also experience difficulty navigating the system without an established referral system (Tentuan, McGlasson, & Meyer, 2005).

Referral issues occur when dental providers are hesitant to accept young patients because of poor training and education (Irvine et al., 2011). Access to dental care is even more problematic for children in rural and remote communities (Schroth et al., 2010). A limited number of dental providers are available especially for Aboriginal reservations (Blinkhorn et al., 2012) and experts forecast that demand for dentists in the future will increasingly outweigh supply (Government of Alberta, 2014). Referring patients when there

are inadequate numbers of dentist and poor access to services would violate ethical code. Plus, oral health programs will only increase demand for dental services. The referral environment is one of the most important factors in determining whether children will receive a referral (Hallas & Shelley, 2009). Existing community resources should be contacted and new ones established to determine where to send patients (DiMarco, et al., 2009). New technologies too could allow for seamless coordination and collaboration of care between nondental and dental professionals (Hallas & Shelley, 2009).

Delivering Preventative Services in Alberta:

In Alberta, all newborns receive at least one home visit from a public health nurse within the first 10 days of life. Twenty public health centers across Alberta offer home visits through the healthy beginnings postpartum program (AHS, 2015). Around 2 months, care is transferred to nurse run well-baby clinics. Visits occur in tandem with immunization schedules at 2, 4, 6, 12, and 18 months (Government of Alberta, Alberta Health. 2015). In Alberta, 26 well-baby and well-child clinics are located throughout the province (Inform Alberta, 2014). Once the child reaches school age, a designated school nurse manages immunizations. In areas where residents do not have access to a public health centers, follow-up care and immunizations are managed by a family physician instead. Collaboration with these existing public health programs and involving the appropriate providers are necessary next steps.

The healthy beginnings postpartum program could incorporate oral health as an added component to their counseling topics. It has been reported that mothers are more receptive to

health promotion interventions early on (Spencer, 2007). If time and understaffing is an issue giving print materials allows mothers to examine the information in private, at a suitable time. Print brochures also allow for information sharing with the family, and retrieval for future review (Spencer, 2007). Once the infant reaches 2 months of age, care will be continued in well-baby clinics. These nurses should conduct oral health screenings, provide education using anticipatory guidance, and conduct referrals. Follow-up for high-risk children could be continued over the telephone or until the next scheduled visit. Nurses must also work with family physicians and dental providers to ensure all infants and toddlers have access to preventive services (AAP, 2008). ECC prevention could even begin at birth for difficult to reach populations. Hospital discharge checklists for newborns already educate parents about many different health issues like vitamin D, jaundice, and feeding. Postpartum nurses could use this moment to initiate the discussion around oral health prevention and promotion (Hallas et al., 2011).

Programs can be concentrated in neighborhoods and communities that experience a higher poverty index. For instance, Greenwood/Greenbrier, Highland Park, Chinatown, Downtown East Village, Bridgeland/Riverside, Alberta Park/Radisson Heights, Forest Lawn, Rosscarrock, and Manchester have the highest poverty index in the city (United Way, 2011). Clinics serving families living in these communities should offer a comprehensive ECC prevention program. The percentage of poor children is highest in Edmonton (21.7%) followed by Lethbridge (19.1%), Medicine Hat (17.3%), Red Deer (16.5%), Camrose (16.2%), Drumheller (16.0%), and Calgary (15.1%) (Poverty Reduction Coalition, 2007).

Based on the reported children poverty statistics, the concentration of oral health services should be distributed accordingly.

Key Highlights of Delivering Preventative Services in Alberta:

1. Collaborate with existing public health services and care providers
2. Concentrate programs to areas with a high poverty index.
3. Implement a comprehensive, holistic approach

Current Oral Health Promotion Initiatives in Alberta:

In some clinics in Alberta, fluoride varnish programs are already being provided to preschool children based on family income status. The most exciting program to date offers pediatric oral health care at the Mosaic Primary Care Network (MPCN) (VanMalsen & Siry, 2014). This program incorporates dental hygienists into a multidisciplinary team. Over 3500 preschool children have been screened, given fluoride varnish treatment, and offered education using anticipatory guidance (VanMalsen & Siry, 2014). A dental referral system has also been set up with support from local dentists (VanMalsen & Siry, 2014). Lastly, ECC related oral health messages will be delivered through Health Unlimited Television in over 230 clinics, hospitals, and health facilities (VanMalsen & Siry, 2014).

Important lessons can be learned from this program and others like it in Alberta. For example, displaying oral health video messages in well baby clinic waiting areas could reduce the time needed to deliver education. If clinic visits were more efficient, fewer additional nursing staff would be required to deliver the intervention. However, policymakers should not be quick to generalize data from the MPCN program to other clinics. One glaring difference is that care is not targeted to low-income populations and high-risk individuals.

The effectiveness of this program in all children cannot be simplified to the low-income subgroup. This program may be preventing ECC however; the targeted approach outlined in this review will prove to be more cost effective and will result in a greater impact in ECC rates.

Another major difference between this review and the MPCN program is that dental hygienists were employed instead of nurses. This issue with this approach is that oral health is still being considered and treated separately from the rest of the body (US Department of Health and Human Services, 2000). The need for access to oral health care should be treated as important as general healthcare. Targeting oral health in isolation results in duplication of effort along with inconsistent messaging (Watt, 2005). Duplication occurs because low-income children are disproportionally affected by a host of child health problems such as growth and developmental delays, abuse or neglect, and asthma. Many of the health issues listed have common risks and similar education topics as ECC (Watt, 2005). Furthermore, the general approach ignores the social, economic, and environmental context impacting the individual, family, community, and population (Fischer-Owens et al., 2007). Even if a comprehensive approach is taken, a shift in the conceptualization of the broader framework is necessary. Also the cost of providing adequate dental provider delivered services to remote communities, where nurses and physicians already exist, would be wasteful of scarce resources (U.S. Department of Health and Human Services, 2000). An integrated approach targeting the common risks and their underlying social determinants of health will be more efficient and effective (Watt, 2005).

Multilevel Oral Health Promotion:

The *Ottawa Charter* identifies five key areas of health promotion action as the following: building healthy public policies, creating supportive environments, strengthening community action, developing personal skills, and reorienting health services (Harrison & Wong, 2003). Personal skills and reorientation of health services will be achieved with the implementation of an oral health program that piggybacks dental health education onto existing services. This model emphasizes the multilevel nature of factors influencing oral health. Fischer-Owens and colleagues expanded on the components identified in the *Ottawa Charter* (2007). They determined five domains of determinants of oral health: genetics and biology; social environment; physical environment; health influencing behaviors; and health services; all at the child, family, and community level. For instance, at the family level genetic and biological health of parents; socioeconomic status and support networks of the social environment; health behaviors, practices, and behaviors of the family; culture and composition of the family; and family function all contribute to oral health (Fischer-Owens, 2007). Recognizing the appropriate model is essential to guide health policy development.

Creating supportive environments and strengthening community action as outlined by the *Ottawa Charter* must also be integrated into the oral health program. Interdisciplinary and intersectoral partnerships with communities, service providers, and organizations are the building blocks of health promotion (Mouradian et al., 2007). These partnerships enhance community development and build on the capacity of existing resources rather than creating new ones (Schroth et al., 2010). Focus groups could be held to engage community members

as key participants (Schroth et al., 2010). Utilizing community strengths such as support networks, norms, and trust can be just as important as individual risk factors (Mouradian et al., 2007). Reflective listening can help address community and family needs and obtain input from community members to tailor interventions to the needs of the community (Spencer, 2007). This process should occur continually over time. This process helps align resources based on the strengths of each community. Playing off of the community's strengths can empower members and foster sustainability.

Creating Healthy Public Policies:

The last stage is developing healthy public policies. The WHO recommends adhering to the following criteria when developing healthy public policy: empowering, participatory, holistic, intersectoral, equity, evidence-based, sustainable, multi-strategy, and evaluation (Watt, 2005). The proposed program adheres to most of these criteria. Focusing on vulnerable high-risk children promotes oral health equity and empowers families, engaging communities and various professionals ensures policies are participatory and intersectoral, focusing on social determinants of oral health ensures a holistic, multilevel strategy, and lastly appropriate measures should be put in place to evaluate the program for effectiveness if implemented. Policies and legislation can appoint a regulatory body to implement, monitor, and evaluate clinics. The final stage should ensure long-term sustainability and focus on improving the evidence behind oral health promotion strategies.

Policy Strategy Summary Box:

- Building healthy public policies to comprehensively integrate oral health into general health
- Creating supportive environments to assist parents and care providers in address ECC
- Strengthening community action with accessible resources and support services
- Developing personal skills to help providers recognize and treat ECC
- Reorienting health services by piggybacking oral services onto existing health services

Comprehensive Oral Health Integration:

In Alberta, the MPCN is partnering with the University of Calgary and AHS to offer family medicine residents oral health rotations (VanMalsen & Siry, 2014). Linking dentistry and nursing professional schools could too allow for appreciation and integration of the disciplines (Coleman, 2005). Nurse lack the knowledge needed to promote oral health while dentists are missing pediatric training and education about child health like abuse and neglect (US Department of Health and Human Services, 2001). Nurse training in oral health does not need to be limited to pediatric dentistry; long-term care nurses could also benefit (Fellona & DeVore, 1999). General topics addressed should include etiology and pathophysiology of oral health disease, oral pharmacology, health promotion and prevention, oral care, assessments, care planning, and dental services (Fellona & DeVore, 1999). Clinical rotations should include experiences led by experts in the corresponding fields (Mouradian, Wehr, & Crall, 2000). Cross-disciplinary training will encourage consolidation and coordination of programs in overlapping areas (Mouradian, Wehr, & Crall, 2000). The New York University recently combined their Nursing and Dental divisions. Their findings report a surprising 38% total or partial overlap in core competencies between the professions (Spielman et al., 2005). Thus, academic institutions can achieve synergies by merging the disciplines. Accreditation

standards and scopes of practice for both professions should also be updated to reflect a need for understanding oral health and pediatric health, respectively (US Department of Health and Human Services, 2001). Both disciplines must first recognize that interdisciplinary partnerships will result in improved patient outcomes that will transcend oral health. As patient advocates, nursing leaders should drive oral health discourse with positive messages about: oral health valuing, identifying barriers to change, and awareness of shared values with dentistry (Coleman, 2005).

Improving the Evidence-Base:

Research and funding is needed to identify and test different programs for preventing ECC. Particularly, the use of nurses in these programs and their training needs must be developed (Coleman, 2005). For example, nursing evidence doesn't justify the use of tools and practices for maintaining oral health (Trenter & Creason, 1986). To support research, a combination of public and private sources of funding, and partnerships with academic researchers are needed. Possible sources could include Health Canada, Alberta Health Services, Alberta Health, Canadian Institutes of Health Research, and the Natural Sciences and Engineering Research Council of Canada. Governments can also look within the current health services to identify opportunities service integration. Partnerships between the Canadian Dental Association, Canadian Association of Pediatric Dentistry, Public Health Agency of Canada, Alberta Dental Association and College, College of Alberta Dental Assistants, College and Association of Registered Nurses in Alberta, and the Alberta College of Family Physicians should not be overlooked. Also, encouraging nurses and ECC lobbyists

to participate in oral health and general pediatric health initiatives will help push for the inclusion of oral health goals (Mouradian et al, 2007). Federal support may be difficult to acquire as health is provincially managed (Mouradian et al., 2007).

Conclusion:

In conclusion, ECC prevention requires a comprehensive intersectoral approach in the planning, implementation, and monitoring of oral health programs. This review provides one example of an ECC prevention program, but several different approaches could be taken. These approaches should include dental health education and support focusing on the underlying determinants of oral disease. Embedding the dental health education and support into existing services will be the most efficient and cost effective strategy. Children who have been determined to be at high risk for ECC and those who fall into recognized risk groups should be directed to a dental home. But, intervention alone is not sufficient to battle ECC. All levels of governments must engage relevant stakeholders, organizations, and professionals to create sustainable change. In a speech the US Surgeon General Richard Carmona described the issue of ECC and the necessary policies in the following statement:

> "The burden of oral infection and conditions…is so broad and extensive that the dentists can't do it alone; the hygienists can't do it alone; government agencies can't do it alone. It will take all of use working together to continue to make progress in advancing oral health of this country. And we will need to invite and entice new partners to join us" (Tentuan, McGlasson, & Meyer, 2005).

Multidisciplinary oral health promotion programs must also be supported with healthy public policies and appropriate legislative action. Nondental health care professionals and primary health care providers should share ECC management. Together, they can address the growing issue of ECC in Alberta.

Bibliography

Adams, R. (1996). Qualified nurses lack adequate knowledge related to oral health, resulting in inadequate oral care of patients on medical wards. *Journal of Advanced Nursing*, *24*(3), 552-560.

Alberta Health Services. (2015). Health Beginnings Postpartum Program. Retrieved from http://www.albertahealthservices.ca/services.asp?pid=service&rid=5808

American Academy of Pediatrics. (2008). Policy on early childhood caries (ECC): classifications, consequences, and preventive strategies. *Pediatric Dentistry*, *30*(7), 40.

American Academy of Pediatric Dentistry. (2014). Guideline on Caries-risk Assessment and Management for Infants, Children, and Adolescents. Chicago, Il: American Academy of Pediatric Dentistry, Council on Clinical Affairs. Retrieved from January 6, 2015, from http://www.aapd.org/media/Policies_Guidelines/G_CariesRiskAssessment.pdf

Arora, A., Scott, J. A., Bhole, S., Do, L., Schwarz, E., & Blinkhorn, A. S. (2011). Early childhood feeding practices and dental caries in preschool children: a multi-centre birth cohort study. *BMC Public Health*, *11*(1), 28.

Arrow, P., Raheb, J., & Miller, M. (2013). Brief oral health promotion intervention among parents of young children to reduce early childhood dental decay. *BMC public health*, *13*(1), 245.

Arvidson-Bufano, U. B., Blank, L. W., & Yellowitz, J. A. (1996). Nurses' oral health assessments of nursing home residents pre-and post-training: A pilot study. *Special Care in Dentistry*, *16*(2), 58-64.

Barnes-Boyd, C., Norr, K. F., & Nacion, K. W. (1996). Evaluation of an interagency home visiting program to reduce postneonatal mortality in disadvantaged communities. *Public Health Nursing*, *13*(3), 201-208.

Barnes-Boyd, C., Fordham Norr, K., & Nacion, K. W. (2001). Promoting infant health through home visiting by a nurse-managed community worker team. *Public Health Nursing*, *18*(4), 225-235.

Batliner, T., Fehringer, K. A., Tiwari, T., Henderson, W. G., Wilson, A., Brega, A. G., & Albino, J. (2014). Motivational interviewing with American Indian mothers to prevent early childhood caries: study design and methodology of a randomized control trial. *Trials*, *15*(1), 125.

Berkowitz, R. J. (2003). Causes, treatment and prevention of early childhood caries: a microbiologic perspective. *Journal-Canadian Dental Association*, *69*(5), 304-307.

Blinkhorn, F., Brown, N., Freeman, R., Humphris, G., Martin, A., & Blinkhorn, A. (2012). A phase II clinical trial of a dental health education program delivered by aboriginal health workers to prevent early childhood caries. *BMC public health*, *12*(1), 681.

BC Ministry of Health Services. Dental Survey of Aboriginal Kindergarten-Aged Children 2009- 2010: A Provincial and First Nations School Analysis. Victoria, BC: British Columbia Ministry of Health and Services, 2011.

Canadian Dental Association. (2010). Position Statement on Early Childhood Caries. Retrieved from http://www.cda-adc.ca/_files/position_statements/earlyChildhoodCaries.pdf

Canadian Institute for Health Information. (2013). Treatment of preventable dental cavities in preschoolers: A focus on day surgery under general anesthesia. Retrieved from https://secure.cihi.ca/free_products/Dental_Caries_Report_en_web.pdf

Coleman, P. (2005). Opportunities for nursing-dental collaboration: addressing oral health needs among the elderly. *Nursing Outlook*, *53*(1), 33-39.

Curtis, B., Evans, R. W., Sbaraini, A., & Schwarz, E. (2008). The Monitor Practice Programme: is non-invasive management of dental caries in private practice effective?. *Australian dental journal*, *53*(4), 306-313.

Davies, G. M., Worthington, H. V., Ellwood, R. P., Bentley, E. M., Blinkhorn, A. S., Taylor, G. O., & Davies, R. M. (2002). A randomised controlled trial of the effectiveness of providing free fluoride toothpaste from the age of 12 months on reducing caries in 5-6-year-old children. *Community dental health*, *19*(3), 131-136.

de Silva-Sanigorski, A., Prosser, L., Hegde, S., Gussy, M. G., Calache, H., Boak, R., ... & Barrow, S. (2012). Community-based, population level interventions for promoting child oral health. *The Cochrane Library*.

DiMarco, M. A., Huff, M., Kinion, E., & Kendra, M. A. (2009). The pediatric nurse practitioner's role in reducing oral health disparities in homeless children. *Journal of Pediatric Health Care*, *23*(2), 109-116.

Duane, B. (2012). Home visits or telephone contacts may help prevent early childhood caries. *Evidence-based dentistry*, *13*(2), 39-40.

Feldens, C. A., Vítolo, M. R., & Drachler, M. D. L. (2007). A randomized trial of the effectiveness of home visits in preventing early childhood caries. *Community dentistry and oral epidemiology*, *35*(3), 215-223.

Feldens, C. A., Giugliani, E. R. J., Duncan, B. B., Drachler, M. D. L., & Vítolo, M. R. (2010). Long-term effectiveness of a nutritional program in reducing early childhood caries: a randomized trial. *Community dentistry and oral epidemiology*, *38*(4), 324-332.

Fellona, M. O., & DeVore, L. R. (1998). Oral health services in primary care nursing centers: opportunities for dental hygiene and nursing collaboration. *Journal of dental hygiene: JDH/American Dental Hygienists' Association*, *73*(2), 69-77.

Fisher-Owens, S. A., Gansky, S. A., Platt, L. J., Weintraub, J. A., Soobader, M. J., Bramlett, M. D., & Newacheck, P. W. (2007). Influences on children's oral health: a conceptual model. *Pediatrics*, *120*(3), e510-e520.

Freudenthal, J. J., & Bowen, D. M. (2010). Motivational interviewing to decrease parental risk-related behaviors for early childhood caries. *American Dental Hygienists Association*, *84*(1), 29-34.

Fung, M. H. T., Wong, M. C. M., Lo, E. C. M., & CH, C. (2013). Early Childhood Caries: A Literature Review. *Oral Hyg Health*, *1*(107), 2.

Gao, X., Lo, E. C. M., McGrath, C., & Ho, S. M. Y. (2013). Innovative interventions to promote positive dental health behaviors and prevent dental caries in preschool children: study protocol for a randomized controlled trial. *Trials*, *14*(1), 118.

Gomez, S. S., & Weber, A. A. (2001). Effectiveness of a caries preventive program in pregnant women and new mothers on their offspring. *International Journal of Paediatric Dentistry*, *11*(2), 117-122.

Government of Alberta. (2014). Alberta's Occupational Demand and Supply Outlook. Retrieved from http://work.alberta.ca/documents/occupational-demand-and-supply-outlook-2013-2023.pdf

Government of Alberta, Alberta Health. (2015). Routine Immunization Schedule. Retrieved from http://www.health.alberta.ca/health-info/imm-routine-schedule.html

Guise, J. M., Palda, V., Westhoff, C., Chan, B. K., Helfand, M., & Lieu, T. A. (2003). The effectiveness of primary care-based interventions to promote breastfeeding: systematic evidence review and meta-analysis for the US Preventive Services Task Force. *The Annals of Family Medicine*, *1*(2), 70-78.

Günay, H., Dmoch-Bockhorn, K., Günay, Y., & Geurtsen, W. (1998). Effect on caries experience of a long-term preventive program for mothers and children starting during pregnancy. *Clinical oral investigations*, *2*(3), 137-142.

Gussy, M. G., Waters, E. G., Walsh, O., & Kilpatrick, N. M. (2006). Early childhood caries: current evidence for aetiology and prevention. *Journal of paediatrics and child health*, *42*(1-2), 37-43.

Hale, K. J. (2003). Oral health risk assessment timing and establishment of the dental home. *Pediatrics*, *111*(5 Pt 1), 1113-1116.

Hallas, D., & Shelley, D. (2009). Role of pediatric nurse practitioners in oral health care. *Academic pediatrics*, *9*(6), 462-466.

Hallas, D., Fernandez, J., Lim, L., & Carobene, M. (2011). Nursing strategies to reduce the incidence of early childhood caries in culturally diverse populations. *Journal of pediatric nursing*, *26*(3), 248-256.

Hannula, L., Kaunonen, M., & Tarkka, M. T. (2008). A systematic review of professional support interventions for breastfeeding. *Journal of clinical nursing*, *17*(9), 1132-1143.

Harrison, R. L., & Wong, T. (2003). An oral health promotion program for an urban minority population of preschool children. *Community dentistry and oral epidemiology*, *31*(5), 392-399.

Harrison, R. (2003). Oral health promotion for high-risk children: case studies from British Columbia. *Journal-Canadian Dental Association*, *69*(5), 292-297.

Holt, R. D., Winter, G. B., Fox, B., & Askew, R. (1985). Effects of dental health education for mothers with young children in London. *Community dentistry and oral epidemiology*, *13*(3), 148-151.

Inform Alberta (2014). Alberta Province-Wide Service Directory. Retrieved from http://www.informalberta.ca/public/common/aboutUs.do

Irvine, J. D., Holve, S., Krol, D., & Schroth, R. (2011). Early childhood caries in Indigenous communities. *Pediatrics* 127.6 (2011): 1190-1198.

Ismail, A. I. (1998). Prevention of early childhood caries. *Community dentistry and oral epidemiology*, *26*(S1), 49-61.

Ismail, A. I., Ondersma, S., Jedele, W., Jenefer, M., Little, R. J., & Lepkowski, J. M. (2011). Evaluation of a brief tailored motivational intervention to prevent early childhood caries. *Community dentistry and oral epidemiology*, *39*(5), 433-448.

John, J. (2008). Home visits for dietary advice reduce caries. *Evidence-based dentistry*, *9*(1), 11-11.

Kagihara, L. E., Niederhauser, V. P., & Stark, M. (2009). Assessment, management, and prevention of early childhood caries. *Journal of the American Academy of Nurse Practitioners*, *21*(1), 1-10.

Kay, M.I., Young, R.A, & Posner. A.S. (1964). Crystal Structure of Hydroxyapatite. *Nature*, 204(1), 1050-1052.

Kayser-Jones, J., Bird, W. F., Redford, M., Schell, E. S., & Einhorn, S. H. (1996). Strategies for conducting dental examinations among cognitively impaired nursing home residents. *Special Care in Dentistry*, *16*(2), 46-52.

Klinge, B., & Norlund, A. (2005). A socio-economic perspective on periodontal diseases: a systematic review. *Journal of clinical periodontology*, *32*(s6), 314-325.

Kowash, M. B., Pinfield, A., Smith, J., & Curzon, M. E. J. (2000). Dental health education: effectiveness on oral health of a long-term health education programme for mothers with young children. *British dental journal*, *188*(4), 201-205.

Kowash, M. B., Toumba, K. J., & Curzon, M. E. J. (2006). Cost-effectiveness of a long-term dental health education program for the prevention of early childhood caries. *European archives of paediatric dentistry*, *7*(3), 130-135.

Kressin, N. R., Nunn, M. E., Singh, H., Orner, M. B., Pbert, L., Hayes, C., ... & Henshaw, M. M. (2009). Pediatric clinicians can help reduce rates of early childhood caries: effects of a practice based intervention. *Medical care*, *47*(11), 1121.

Larson, C. P. (1980). Efficacy of prenatal and postpartum home visits on child health and development. *Pediatrics*, *66*(2), 191-197.

Leroy, R., & Declerck, D. (2013). Impact of caries onset on number and distribution of new lesions in preschool children. *International Journal of Paediatric Dentistry*, *23*(1), 39-47.

Leung, A. K. C. (1986). Fluorides in the prevention of dental caries." *The Journal of the Royal Society for the Promotion of Health*, 106,(6), 216-218.

Marrs, J. A., Trumbley, S., & Malik, G. (2011). Early childhood caries: determining the risk factors and assessing the prevention strategies for nursing intervention. *Pediatr Nurs*, *37*(1), 9-15.

Melvin, C. S. (2006). A collaborative community-based oral care program for school-age children. *Clinical Nurse Specialist*, *20*(1), 18-22.

Milnes, A. R., Rubin, C. W., Karpa, M., & Tate, R. (1993). A retrospective analysis of the costs associated with the treatment of nursing caries in a remote Canadian aboriginal preschool population. *Community dentistry and oral epidemiology*, *21*(5), 253-260.

Mouradian, W. E., Huebner, C. E., Ramos-Gomez, F., & Slavkin, H. C. (2007). Beyond access: the role of family and community in children's oral health. *Journal of Dental Education*, *71*(5), 619-631.

Mouradian, W. E., Wehr, E., & Crall, J. J. (2000). Disparities in children's oral health and access to dental care. *Jama*, *284*(20), 2625-2631.

Nicol, R., Petrina Sweeney, M., McHugh, S., & Bagg, J. (2005). Effectiveness of health care worker training on the oral health of elderly residents of nursing homes. *Community dentistry and oral epidemiology*, *33*(2), 115-124.

Ng, M. W., & Chase, I. (2013). Early childhood caries: risk-based disease prevention and management. *Dental Clinics of North America*, *57*(1), 1-16.

Nolan, L., Kamoie, B., Harvey, J., Vaquerano, L., Blake, S., Chawla, S., ... & Rosenbaum, S. J. (2003). The effects of state dental practice laws allowing alternative models of preventive oral health care delivery to low-income children.

Oda, D. S., Fine, J. I., & Heilbron, D. C. (1986). Impact and cost of public health nurse telephone follow-up of school dental referrals. *American journal of public health*, *76*(11), 1348-1349.

Oda, D. S., Heilbron, D. C., & Taylor, H. J. (1995). A preventive child health program: the effect of telephone and home visits by public health nurses. *American journal of public health*, *85*(6), 854-855.

Olds, D. L., Robinson, J., O'Brien, R., Luckey, D. W., Pettitt, L. M., Henderson, C. R., ... & Talmi, A. (2002). Home visiting by paraprofessionals and by nurses: a randomized, controlled trial. *Pediatrics*, *110*(3), 486-496.

Parthasarathy, P., & John, R. (2008). Early prevention and identification of childhood caries. *The Nurse Practitioner*, *33*(9), 40-48.

Paulsson, G., Fridlund, B., Holmen, A., & Nederfors, T. (1998). Evaluation of an oral health education program for nursing personnel in special housing facilities for the elderly. *Special care in dentistry*, *18*(6), 234-242.

Peres, M. A., Barros, A. J., Peres, K. G., Araújo, C. L., & Menezes, A. (2009). Life course dental caries determinants and predictors in children aged 12 years: a population-based birth cohort. *Community dentistry and oral epidemiology*, *37*(2), 123-133.

Pierce, K. M., Rozier, R. G., & Vann, W. F. (2002). Accuracy of pediatric primary care providers' screening and referral for early childhood caries. *Pediatrics*, *109*(5), e82-e82.

Plonka, K. A., Pukallus, M. L., Barnett, A., Holcombe, T. F., Walsh, L. J., & SEOW, W. (2013). A controlled, longitudinal study of home visits compared to telephone contacts to prevent early childhood caries. *International Journal of Paediatric Dentistry*, *23*(1), 23-31.

Plutzer, K., & Keirse, M. J. (2014). Influence of an Intervention to Prevent Early Childhood Caries Initiated before Birth on Children's Use of Dental Services up to 7 Years of Age. *The open dentistry journal*, *8*, 104.

Plutzer, K., & Spencer, A. J. (2008). Efficacy of an oral health promotion intervention in the prevention of early childhood caries. *Community dentistry and oral epidemiology*, *36*(4), 335-346.

Poverty Reduction Coalition. (2007). Alberta Poverty Facts. Retrieved from http://libguides.jibc.ca/content.php?pid=97212&sid=2226901

Pugh, L. C., Milligan, R. A., Frick, K. D., Spatz, D., & Bronner, Y. (2002). Breastfeeding duration, costs, and benefits of a support program for low‐income breastfeeding women. *Birth*, *29*(2), 95-100.

Pukallus, M., Plonka, K., Kularatna, S., Gordon, L., Barnett, A. G., Walsh, L., & Seow, W. K. (2013). Cost-effectiveness of a telephone-delivered education programme to prevent early childhood caries in a disadvantaged area: a cohort study. *BMJ open*, *3*(5).

Reiss, M. L., & Bailey, J. S. (1982). Visiting the dentist: A behavioral community analysis of participation in a dental health screening and referral program. *Journal of applied behavior analysis*, *15*(3), 353-362.

Rowan-Legg, A., & Community Paediatrics Committee. (2013). Oral health care for children–a call for action. *Paediatrics & child health*, *18*(1), 37.

Trenter, P., & Creason, N. S. (1986). Nurse administered oral hygiene: is there a scientific basis?. *Journal of Advanced Nursing*, *11*(3), 323-331.

Savage, M. F., Lee, J. Y., Kotch, J. B., & Vann, W. F. (2004). Early preventive dental visits: effects on subsequent utilization and costs. *Pediatrics*, *114*(4), e418-e423.

Scavuzzi, A. I. F., Junior, A. D., Caldas, F., Couto, G. B. L., Vasconcelos, M., DE, M. B. V., ... & Valenca, P. A. M. (2007). Longitudinal study of dental caries in Brazilian children aged from 12 to 30 months. *International Journal of Paediatric Dentistry*, *17*(2), 123-128.

Schroth, R. J., Edwards, J. M., Moffatt, M. E., Mellon, B., Ellis, M., & Harms, L. (2010). Healthy Smile Happy Child: evaluation of a capacity building early childhood oral health promotion initiative. *University of Manitoba, Canada*.

Schroth, R. J., Dahl, P. R., Haque, M., & Kliewer, E. (2010). Early childhood caries among Hutterite preschool children in Manitoba, Canada. *Rural Remote Health*, *10*(4), 1535.

Schluter, P. J., Durward, C., Cartwright, S., & Paterson, J. (2007). Maternal Self‐Report of Oral Health in 4‐Year‐Old Pacific Children from South Auckland, New Zealand: Findings from the Pacific Islands Families Study. *Journal of Public Health Dentistry*, *67*(2), 69-77.

Shute, J. L., & Judge, K. (2005). Evaluating "Starting Well," the Scottish national demonstration project for child health: outcomes at six months. *Journal of Primary Prevention*, *26*(3), 221-240.

Skeie, M. S., Skaret, E., Espelid, I., & Misvær, N. (2011). Do public health nurses in Norway promote information on oral health?. *BMC oral health*, *11*(1), 23.

Smith, G. A., & Riedford, K. (2013). Epidemiology of early childhood caries: clinical application. *Journal of pediatric nursing*, *28*(4), 369-373.

Snow, P., & McNally, M. E. (2009). Examining the implications of dental treatment costs for low-income families. *Journal (Canadian Dental Association), 76*, a28-a28.

Spielman, A. I., Fulmer, T., Eisenberg, E. S., & Alfano, M. C. (2005). Dentistry, nursing, and medicine: a comparison of core competencies. *Journal of Dental Education, 69*(11), 1257-1271.

Tetuan, T. M., McGlasson, D., & Meyer, I. (2005). Oral health screening using a caries detection device. *The Journal of school nursing, 21*(5), 299-306.

United Way. (2011). Mapping Poverty in Calgary. Retrieved from http://www.calgaryunitedway.org/main/sites/default/files/mapping.pdf

U.S. Department of Health and Human Services. (2000). The face of a child: Surgeon general's workshop and conference on children and oral health. Retrieved from http://www.nidcr.nih.gov/DataStatistics/SurgeonGeneral/Conference/ConferenceChildrenOralHealth/

Vichayanrat, T., Steckler, A., Tanasugarn, C., & Lexomboon, D. (2012). The evaluation of a multi-level oral health intervention to improve oral health practices among caregivers of preschool children. *Southeast Asian Journal of Tropical Medicine and Public Health, 43*(2), 526-39.

Van den Branden, S., Van den Broucke, S., Leroy, R., Declerck, D., Bogaerts, K., & Hoppenbrouwers, K. (2013). Effect evaluation of an oral health promotion intervention in preschool children. *The European Journal of Public Health*, ckt204.

Van den Branden, S., Van den Broucke, S., Leroy, R., Declerck, D., & Hoppenbrouwers, K. (2013). Evaluating the implementation fidelity of a multicomponent intervention for oral health promotion in preschool children. *Prevention Science*, 1-10.

VanMalsen, J., & Siry, B. (2014). Healthy mouth, healthy child: An innovative approach within Mosaic Primary Care Network. *InTouch The College of Registered Dental Hygienists of Alberta.* Retrieved from http://www.crdha.ca/media/80309/intouchapril2803.pdf

Vitolo, M. R., Bortolini, G. A., Campagnolo, P. D. B., & Hoffman, D. J. (2012). Maternal dietary counseling reduces consumption of energy-dense foods among infants: a randomized controlled trial. *Journal of nutrition education and behavior*, *44*(2), 140-147.

Wårdh, I., Andersson, L., & Sörensen, S. (1997). Staff attitudes to oral health care. A comparative study of registered nurses, nursing assistants and home care aides. *Gerodontology*, *14*(1), 28-32.

Watt, R. G. (2005). Strategies and approaches in oral disease prevention and health promotion. *Bulletin of the World Health Organization*, *83*(9), 711-718.

Weber-Gasparoni, K., Warren, J. J., Reeve, J., Drake, D. R., Kramer, K. W., Marshall, T. A., & Dawson, D. V. (2013). An Effective Psychoeducational Intervention for Early Childhood Caries Prevention: Part II. *Pediatric dentistry*, *35*(3), 247-251.

Weinstein, P., Harrison, R., & Benton, T. (2006). Motivating mothers to prevent caries: confirming the beneficial effect of counseling. *Journal of the American Dental Association (1939)*, *137*(6), 789-793.

Yonemoto, N., Dowswell, T., Nagai, S., & Mori, R. (2014). Schedules for home visits in the early postpartum period. *Evidence-Based Child Health: A Cochrane Review Journal*, *9*(1), 5-99.

Yost, J., & Li, Y. (2008). Promoting oral health from birth through childhood: prevention of early childhood caries. *MCN: The American Journal of Maternal/Child Nursing*, *33*(1), 17-23.

Appendix

Appendix A: Key Search Terms

Concept	Synonym
Infant population	Infant, toddler, child, preschool, baby, paediatric, early life, newborn, early childhood, preschool children,
Caries	Early childhood caries, dental decay, nursing caries, cavities, oral health, dental caries, dental caries, baby bottle tooth decay, microbiology, streptococcal infections, dental care, cariogenic, oral care, dental health, oral hygiene, caries risk, dental services, nursing bottle caries, milk bottle syndrome, baby bottle caries, baby bottle tooth decay, dental screening, tooth disease, tooth decay, oral disease
Nurse	Primary care nurse, Registered nurse, Licensed practical nurse, nurse, community health nurse, public health nurse, nursing, nurse specialist, paediatric nurse, clinical nurse specialist, paediatric nurse practitioner,
Health promotion	Community health clinic, health promotion, community development, health education, public health dentistry, health behaviour, motivational interviewing, counselling, intervention studies, prevention, control, primary prevention, population health, public health, behaviour change, anticipatory guidance, community intervention, oral health policies, dental screening, dental referral, community health,
Home visit	Home visit, home visitation, home visitor, telephone contact, consultation, home follow-up,

Appendix B: Caries Risk Assessment Tool

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

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

	High Risk	Low Risk
Biological		
Mother/primary caregiver has active cavities	Yes Yes Yes	
Parent/caregiver has low socioeconomic status	Yes Yes Yes	
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 a recent immigrant		
Protective		
Child receives optimally-fluoridated drinking water or fluoride supplements		Yes Yes Yes
Child has teeth brushed daily with fluoridated toothpaste Child		Yes
receives topical fluoride from health professional Child has		
dental home/regular dental care		
Clinical Findings		
Child has white spot lesions or enamel defects	Yes Yes Yes	
Child has visible cavities or fillings		
Child has plaque on teeth		

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 (eg, 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 (eg, 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 ☐

Table 3. Caries-risk Assessment Form for ≥6 Years Olds [60-62] **(For Dental Providers)**

Factors	High Risk	Moderate Risk	Low Risk
Biological			
Patient is of low socioeconomic status	Yes		
Patient has >3 between meal sugar-containing snacks or beverages per day	Yes		
Patient has special health care needs		Yes	
Patient is a recent immigrant		Yes	
Protective			
Patient receives optimally-fluoridated drinking water			Yes
Patient brushes teeth daily with fluoridated toothpaste			Yes
Patient receives topical fluoride from health professional			Yes
Additional home measures (eg, xylitol, MI paste, antimicrobial)			Yes
Patient has dental home/regular dental care			Yes
Clinical Findings			
Patient has ≥1 interproximal lesions	Yes		
Patient has active white spot lesions or enamel defects	Yes		
Patient has low salivary flow Patient	Yes		
has defective restorations Patient		Yes	
wearing an intraoral appliance		Yes	

Circling those conditions that apply to a specific patient helps the practitioner and patient/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 (eg, ≥1 interproximal lesions, low salivary flow) in determining overall risk.

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

Appendix C: Caries Risk Management Protocols

Table 1. Example of a Caries Management Protocol for 1-2 Year Olds

Risk Category	Diagnostics	Interventions		Restorative
		Fluoride	Diet	
Low risk	– Recall every six to12 months – Baseline MS [a]	– Twice daily brushing	Counseling	– Surveillance [x]
Moderate risk parent engaged	– Recall every six months – Baseline MS [a]	– Twice daily brushing with fluoridated toothpaste [b] – Fluoride supplements [d] – Professional topical treatment every six months	Counseling	– Active surveillance [e] of incipient lesions
Moderate risk parent not engaged	– Recall every six months – Baseline MS [a]	– Twice daily brushing with fluoridated toothpaste [b] – Professional topical treatment every six months	Counseling, with limited expectations	– Active surveillance [e] of incipient lesions
High risk parent engaged	– Recall every three months – Baseline and follow up MS [a]	– Twice daily brushing with fluoridated toothpaste [b] – Fluoride supplements [d] – Professional topical treatment every three months	Counseling	– Active surveillance [e] of incipient lesions – Restore cavitated lesions with ITR [f] or definitive restorations
High risk parent not engaged	– Recall every three months – Baseline and follow up MS [a]	– Twice daily brushing with fluoridated toothpaste [b] – Professional topical treatment every three months	Counseling, with limited expectations	– Active surveillance [e] of incipient lesions – Restore cavitated lesions with ITR [f] or definitive restorations

Table 2. Example of a Caries Management Protocol for 3-5 Year Olds

Risk Category	Diagnostics	Interventions			Restorative
		Fluoride	Diet	Sealants[1]	
Low risk	– Recall every six to 12 months – Radiographs every 12 to 24 months – Baseline MS[a]	– Twice daily brushing with fluoridated toothpaste[g]	No	Yes	– Surveillance[z]
Moderate risk parent engaged	– Recall every six months – Radiographs every six to 12 months – Baseline MS[a]	– Twice daily brushing with fluoridated toothpaste[g] – Fluoride supplements[d] – Professional topical treatment every six months	Counseling	Yes	– Active surveillance[e] of incipient lesions – Restoration of cavitated or enlarging lesions
Moderate risk parent not engaged	– Recall every six months – Radiographs every six to 12 months – Baseline MS[a]	– Twice daily brushing with fluoridated toothpaste[g] – Professional topical treatment every six months	Counseling, with limited expectations	Yes	– Active surveillance[e] of incipient lesions – Restoration of cavitated or enlarging lesions
High risk parent engaged	– Recall every three months – Radiographs every six months – Baseline and follow up MS[a]	– Brushing with 0.5 percent fluoride (with caution) – Fluoride supplements[d] – Professional topical treatment every three months	Counseling	Yes	– Active surveillance[e] of incipient lesions – Restoration of cavitated or enlarging lesions
High risk parent not engaged	– Recall every three months – Radiographs every six months – Baseline and follow up MS[a]	– Brushing with 0.5 percent fluoride (with caution) – Professional topical treatment every three months	Counseling, with limited expectations	Yes	– Restore incipient, cavitated, or enlarging lesions