Effects of Primary Prevention on Early Childhood Caries in Canadian First Nations Children Ages 0-4 Years

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Abstract

Early childhood caries (ECC) in Canadian First Nations (FN) children is at disproportionately high levels compared to the national average. Current literature suggests a paradigm shift in approach to the causes and management of ECC can significantly decrease these levels. The purpose of this paper is to critically analyze the question “For Canadian First Nations children, ages 0-4 years, could the introduction of primary disease prevention and self management reduce levels of ECC compared with the present model of care?” Reviews, randomized-controlled-trials (RCT), guidelines, and articles were searched through bibliographic databases including Cochrane database, Ovid MEDLINE, and Cumulative Index to Nursing and Allied Health Literature (CINAHL). Results indicate primary disease prevention can significantly decrease levels of ECC in high risk children. Recommendations were developed to guide Nurse Practitioners (NPs) in the initiation and provision of primary preventative oral health care to FN mothers and infants.
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Anticipatory guidance: A pro-active, developmentally-based counseling technique that focuses on the needs of a child at a particular stage of life (Plutzer & Spencer, 2007).

dmft/DMFT: (d) diseased (m) missing (f) filled (t) teeth [deciduous]- (D) diseased (M) missing (F) filled (T) teeth [permanent].

Early childhood caries (ECC): The National Institute of Dental and Craniofacial Research (NIDCR) definition classifies a child under 71 months with one or more dmf surfaces, non-cavitated or cavitated, as having ECC. In children younger than 3 years of age any sign of smooth surface caries (cavitated or noncavitated) should be considered as severe ECC (S-ECC).

Parts per million (ppm): Refers to the parts per million of fluoride added to community drinking water. The recommended fluoride concentration ranges from 0.7 to 1.2 ppm.

Pyorrhea: Purulent discharge and inflammation of the gums.

Severe early childhood caries (S-ECC): One or more decayed, missing, or filled upper incisor teeth (dmft) being carious at the level of a cavitated or noncavitated lesion in children younger than 3 years (US National Institute of Health [USNIH]).

Stosstherapy: Treatment of a disease by a single massive dose of a therapeutic agent or short-term administration of large doses.

Note on terminology: In keeping with the terminology used by the Royal Commission on Aboriginal Peoples (1996) a variety of terms was used to refer to the indigenous inhabitants of Canada. The term “Aboriginal people” or “Aboriginal” or “First Nations” refers to the indigenous inhabitants’ pre colonization. The term “Indian” is used in reference to articles or documents that at that time referred to indigenous peoples as Indians.
Acknowledgement

The development of this paper has been a grand learning adventure with many highlights and participants. I would like to thank the following people for their much appreciated input.

I wish to thank Dr. J. Leake for his encouragement at the onset of this project to continue in my investigations of ECC in Canadian First Nations children. I wish to thank Dr A. Macnab for reinforcing the need to continue along this journey. He has shown that with support and collaboration children in all FN communities can have a “brighter smile”. I would like to thank Dr. J. Rogers for his encouragement of my desire to carry this project further. Their input reinforces the concept of an interdisciplinary approach to ECC having the greatest potential to increase success in the management of this insidious disease.

I wish to thank my supervisors Heather Correale RN, MSc and Davina Banner-Lukaris, PhD, BN (Hons), RN for their patience, support and suggestions as I made my way through the journey of synthesizing a large health issue into a manageable topic.

I wish to thank my husband, Duncan, for his continued support. We have had many wonderful adventures from the start to the completion of this project paper.

Thank you to the many others who contributed in many different ways to this project.
Chapter One: Introduction and Background

Evidence of the poor oral health of FN children has been apparent to me throughout my career as a nurse. While practicing in Yukon Territory I was not surprised to be awoken in the night by a caregiver presenting to the clinic with a distraught toddler holding the red edematous face of a dental abscess. Statistics support these sojourns by reporting high levels of ECC in FN children. Poor oral health of these children presents significant problems for Canadians. ECC is a preventable infectious disease that can have both direct and long-term effects. Deterioration in a child’s general health and development can occur both locally and systemically. Poor oral health is a major cause of hospitalization of young children requiring general anesthetics for dental care (Slavkin, 1999). ECC has been shown to increase the risk of developing future caries (Plutzer & Spencer, 2007) and it is now thought that the chronic inflammatory process inherent in poor oral health may predispose children to future increased incidences of diabetes, coronary artery disease, and premature labour (Brown, 2003; Macnab, Rozmus, Beaton, & Gagnon, 2008).

Oral health care is presently provided to eligible FN children by Health Canada utilizing a treatment-focused model. Children often have their first contact with services at age 4-5 years when levels of ECC have reached over 90% (Schroth, Moore, & Brothwell, 2005). Current literature indicates that a paradigm shift in approach to the causes and management of ECC can significantly decrease its prevalence in high risk children. This paper critically analyzes searched articles to answer the question, “For Canadian First Nations children, ages 0-4 years, could the introduction of primary disease prevention and self management reduce levels of ECC compared with the present model of care?” Evidence obtained is expected to support the initiation and provision of primary preventative oral health care by NPs to FN mothers and infants with a goal of decreasing the high levels of ECC seen in the children.
Colonization: Effects on Oral Health

History shows that colonization has had negative effects on the health of First Nations people. An indicator of poor health is a high prevalence of ECC in the most vulnerable members, children. Causes of poor health are known to be a complex web of physiological, psychological, sociological, and environmental factors. The health of any human population is dependent upon the balance and interaction of these factors (Waldram, Herring, & Young, 2007). Colonization disrupted the previously functioning balances within FN communities. Changes to dietary customs, introduction of residential schools, and reclassification of social structures all contributed to the poor oral health of FN children now seen in high levels of ECC.

Disruption of traditional diet

Dental caries is ubiquitous and the most prevailing infectious disease of man (Loesche, 1986; Lewis & Ismail, 1994). It is highly prevalent among FN children (Peressini, Leake, Mayhall, Maar, & Trudeau, 2004; Lin 2009). This was not always the case. Early 1900’s surveys show that Inuit and Aboriginal peoples had excellent dental health, minimal caries, and little tooth loss (Wein & McIntyre, 1999). Archeological and paleopathological investigations of North American Aboriginal peoples show that caries affected less than one per cent of the population before contact with European traders. Trading with settlers led to an erosion of the traditional diet and a pattern of dependence on refined foods including white sugar, white flour, polished white rice, sweetened jams, tinned milk and meats, processed food, and alcohol. Studies show that within one or more generations of living on processed foods infections and degenerative diseases, including pandemic dental decay and pyorrhea, become prevalent (Obomsawin, 2007). The diet of today’s FN children is more likely to be store bought and frequently has a high proportion of sugar snacks and highly cariogenic liquids (Leake, 1992).
Residential Schools

Colonization brought with it the philosophy that native peoples would be better off by being brought into the circle of civilized conditions (Castellano, Archibald, & DeGagné, 2008). This was aggressively accomplished by the introduction of residential schools which existed from 1831 until 1983 (Napier, 2000; Waldram, et al., 2007). The purpose of the schools was to reshape the identity and consciousness of the children. Expressions of Aboriginal language, spirituality, or ways of life were punished (Castellano, et al.). Mandatory attendance had the effect of removing children from their families, communities, and traditional teachings (Crowshoe, 2005). Leroy Little Bear (2000) describes the Aboriginal teachings and philosophy as being based on the belief that all existence consists of energy and all things are animate, imbued with spirit, and in constant motion. Arising out of this philosophy is the value of holism and the basis for the FN’s holistic view on medicine and healing traditions. The teachings given to the children in residential schools were based on western ways of knowing and rooted in academics, science, and literature. Children received formal, analytical, and secular teaching based on written facts. Holistic methodologies were lost (Crowshoe).

Waldram et al. (2007) state residential schools played a significant role in engendering irreversible changes within Aboriginal society of which many had a direct impact on their mental and physical well being. The poor oral health of FN children within residential schools was noted as early as 1966 in the Hawthorn Report (Hawthorn, 1966). Disproportionately high levels of ECC persist within FN children to this date.
Social Determinants of Health

Colonialism also brought with it inequalities for Aboriginal people. Poverty, inadequate education, and lack of access to health services are some of the issues affecting FN people. Inequalities in these determinants have been associated with poor health outcomes and influence health vulnerabilities, capacities, behaviours, and management (Loppie-Reading & Wein, 2009). The Royal Commission on Aboriginal Peoples (RCAP) (1996) gathered research indicating that factors other than the health care system and private lifestyle choices are significant in determining health. These factors include poverty, social, psychological and spiritual well being, and environmental conditions (Indian and Northern Affairs Canada [INAC], 2007). Poverty can lead to poor choices in food staples; inadequate education can lead to a deficit in knowledge of oral health; and lack of access can lead to increased dental disease. These inequities in the social determinants of health are implicated as high risk factors for development of ECC.

Colonization brought with it a change in the traditional diet of the FN people. Residential schools attempted to eliminate holistic teaching methods and traditional philosophies. Imposed social structure produced inequities in the determinants of health. The combination of these factors provided a fertile environment for increased risks in development of dental caries as seen in the high rates of ECC in FN children. A discussion of the causes and risk factors of ECC follows.

Dental caries

Causes

Dental caries is a complex multifactorial disease. It occurs as an interaction which takes place over time between an acid producing organism, a fermentable substrate, and the nonshedding surface of a tooth (Loesche, 1986; Slavkin, 1999; Gripp & Schlagenhauf, 2002).
Research in microbiology and immunology has greatly advanced the understanding of the molecular mechanisms inherent in the development of dental caries. It is now known that dental caries is a transmissible infectious disease which occurs because of an imbalance in the homeostasis between the host and their oral flora (Mattos-Graner & Smith, 2004). The normal growth of microbes in a human infant’s mouth follows a pattern of ecologic succession forming an oral biofilm (plaque). By adolescence the mouth will harbour more than 400 microbial species that live in equilibrium with their host. When the composition and metabolic activities of the biofilm are disturbed the proportion of disease causing bacteria increases (Slavkin). The bacterium Mutans Streptococci (MS) was identified in the 1960’s as the main pathogen responsible for causing ECC (Mattos-Graner & Smith). The fermentation of carbohydrates by MS produces lactic acid which decreases the mouth’s pH. This acidic environment leads to the removal of ions from the tooth’s enamel surface (demineralization). In a non acidic environment the ions are returned to the tooth’s surface via the mouth’s saliva (remineralization). If demineralization of the tooth’s surface exceeds remineralization a carious lesion begins. When remineralization predominates the result may be the arrest of caries progress.

In an acidic environment MS can establish dominance within the biofilm. Within three months this virulent bacteria can account for 75% of the oral flora (Slavkin, 1999, Center for Disease Control [CDC], 2001). Titley (2004), states that some forms of extremely virulent MS can rapidly spread the process of demineralization of primary incisors to the formation of abscess.

Research has shown that MS in infants is transferred from the caregiver, in most cases the mother, to the child through frequent and intimate contact. This vertical transmission of MS is the primary method of infection (Yost & Li, 2008). Li and Caufield (1995) found that the
genotypes of the bacteria identified in infants were identical to those found in their mothers 71% to 88% of the time. Slavkin (1999) feels these similarities in bacterial genotype might be related to the transfer of maternal immunoglobulins and the transmission of the mothers’ immune specificity. The maternal levels of MS affect the ability of the organism to vertically transmit. When the mothers’ salivary levels of MS exceeded $10^5$ colony forming units (CFU) per ml, as compared to maternal salivary MS levels of $10^3$ CFU per ml, the frequency of infant infection was found to be approximately nine times greater (Udin, 1999).

MS is a bacterium that requires a non-shedding surface on which to colonize and is generally only present in the mouths of infants following the eruption of teeth. The initial colonization period known as the ‘window of infectivity’ occurs between 19 and 31 months with a median age of 26 months. This timing corresponds with the eruption of the first and second primary molars which provide large surface areas for colonization (Li & Caufield, 1995; Udin, 1999; Slavkin, 1999). Later studies have indicated the transmission of MS can occur in infants as young as 6 months (Stewart & Hale, 2003).

Risk Factors

Risk factors for ECC have been identified as the bacterium MS, a cariogenic substrate, and a non-shedding tooth surface. To reduce high levels of ECC provided health care services must address all of the identified risk factors. A review of the present and proposed health care models follows.

Models of Oral Health Care

Health Canada: Present model

Health care provided to the FN peoples can be traced back to 1876 when the Indian Act was first passed by the Canadian government. The act divided the Aboriginal peoples into two
broad categories; those with status and those without (Waldram, et al., 2007). Most dental services provided by Health Canada and the studies noted in this paper pertain to status Indians presently referred to as First Nations peoples.

Evidence of the poor state of FN children's oral health was documented by the government in 1966. The Hawthorn report stated that the standard of health of many Indian children was marginal at best and the incidence of chronic low-grade infections due to inadequate diet and decaying teeth was high. The report suggested that children receive mandatory medical examinations prior to school entry with dental and eye exams annually (Hawthorn, 1966).

Dental services are presently provided to eligible FN and Inuit by Health Canada through the First Nations and Inuit Health Branch (FNIHB) under the Non-Insured Health Benefits program (NIHB) (Health Canada, 2009). The NIHB program provides specified dental services on an individual needs-based approach including diagnostic (examinations, x-rays), preventative (cleaning, polishing, scaling, fluoride treatments, and sealants.), restorative (fillings), endodontic (root canal treatments), periodontal (treatment of gums), prosthodontic (removal of dentures and fixed bridges), oral surgery (removing teeth), orthodontics (straightening teeth), and adjunctive services (i.e., sedation) (Brown, 2003; Health Canada, 2009). Dentists in private practice are the primary providers and represented 84% of all NIHB dental costs in 2001-2002 (Brown).

FN children frequently access this service for dental treatments following preschool assessments occurring between the ages of 4-5 years. By the first dental visit most children present with ECC (Leake 1992).

Limited oral health promotion is provided through the First Nations and Inuit Health Program Compendium's Primary Care program: Oral health care (OHC). OHC is comprised of
three elements: Support to the National School of Dental Therapy (NSDT), provision of oral health and dental therapy services to FN and Inuit, and the Children’s Oral Health Initiative (COHI). NSDT trains dental therapists with the goal of supporting the COHI program which is based on prevention of dental disease and promotion of good oral health. The COHI focus is pregnant women to school-aged children (5-7 years). Activities include dental screening, fluoride treatments, sealants, and assistance to improve oral hygiene (Health Canada, 2007). The program remains a very small part of the services provided by Health Canada. Attempts to expand the program have been thwarted over issues of licensing (Waldram, et al. 2007).

Provision of oral health care to FN children presently focuses on treating the effects of ECC. In a discussion with Dr. James Rogers, Health Canada’s regional dental officer for British Columbia, he stated the present yearly national expenditure for FN dental care is $170 million for treatment and $10 million for primary care. Dr. Rogers stated that a transfer of funds may be on the table for future discussion (personal conversation January 26, 2010).

Waldram et al. (2007) state the present dental programs focusing on pathology and treatments have had, at best, a marginal impact. Brown (2003, p. 5, ¶2) suggests that present dental treatments must be transformed “quickly to one focusing on wellness and prevention”. An examination of primary health care, the proposed model, follows.

Primary Health Care: Proposed Model

The concept of primary health care was first introduced to Canadians in 1974 by Marc Lalonde with his document “A New Perspective on the Health of Canadians”. The term health field introduced at this time included all matters that affect the health of individuals. Human biology, environment and lifestyle choices, and the organization of health care were all included in the definition. During that period the bulk of health expenditures were being spent on hospitals
and treatments despite research showing the main causes of sickness and death were rooted in the identified risk factors of human biology, environment, and lifestyle. The health field concept focused on reducing these identified risk factors (Lalonde, 1974).

In 1978 the World Health Organization (WHO) in its Declaration of Alma-Ata defined its concept of primary health care (PHC) and, like the health field concept, expanded the definition of health. Essential elements of PHC include education, adequate nutrition, safe water and basic sanitation, maternal and child health care, immunization, prevention and control of endemic diseases, appropriate treatment of common diseases and injuries, and provision of essential drugs (WHO, 1978). The conceptual underpinnings of PHC are population health, health promotion, disease prevention, and community focus (Tarlier, 2009).

The Ottawa Charter for Health Promotion (1986) expanded the concept of health promotion stating strategies and programs should be adapted to local needs while taking into account differing social, cultural, and economic systems. Five areas requiring action in the development of health promotion were identified: Building healthy public policy, creating supportive environments, strengthening community action, development of personal and social skills, and re-orienting health services toward prevention of illness and promotion of health (WHO, 1986). Continuing and increasing support by the WHO for globalized health promotion with an emphasis on government, community, and individual responsibilities for decreasing health inequities can be seen in the Jakarta Declaration (1997) and more recently in the Bangkok Charter (2005) (WHO, 1997, 2005).

The delivery of oral health care based on the principles of PHC would address the endemic levels of ECC within the population of FN children. Prevention of ECC would be based on current knowledge of ECC as a communicable infectious disease. Reorientation of services
towards disease prevention and health promotion within a supportive environment will provide individuals and communities with the knowledge to improve their oral health. Promotion of oral health through the development of public policy directed by individual FN communities would be encouraged and supported. A discussion of NPs role as primary health care providers follows.

*Nurse Practitioners Role*

The use of Nurse Practitioners as primary health care providers in Canada is evolving and expanding. Schober and Affara state that the emergence of the NP role developed over the past decade with the understanding “that optimizing the nursing contribution to health care through expanding their role is an effective strategy for improving health services” (Schober & Affara, 2006, p.2). An increased demand for access to primary health care and the need for integrated care became apparent in the 1990’s. Strains on health services include an ageing population, shortage of professionals, limited access to care, and increasing costs (Canadian Nurses Association [CNA], 2008). In 2000 the CNA responded by producing a “National Framework of Advanced Nursing Practice” adding a graduate degree requirement in 2002. This requirement prepares advance practice nurses to promote nursing research, generate new knowledge, and interpret and incorporate this knowledge into clinical practice (CNA). Nurse Practitioners are recognized by the CNA as advanced practice nurses who provide care to ethnically and culturally diverse populations throughout their life span (College of Registered Nurses of British Columbia [CRNBC], 2003).

NPs assess, diagnose, and manage their client’s health needs with a focus on health promotion and illness prevention. An increased scope of practice (SOP) allows NPs to order and interpret diagnostic tests, prescribe medications and treatments, and make appropriate referrals. Nurse practitioners, as primary health care providers, have additional knowledge, skills, and
primary preventative oral health care for FN mothers and infants. Such a service would fill the identified gap in oral health services directed at FN children, ages 0-4 years, and provide another link in the prevention of ECC.

**Purpose and Rationale**

**Purpose**

The purpose of this paper is to critically analyze searched articles to answer the question, "For Canadian First Nations children, ages 0-4 years, could the introduction of primary disease prevention and self management reduce levels of ECC compared with the present model of care?"

**Rationale**

The rationale is based upon what we know about ECC and FN children, and its risk factors. We know ECC is highly prevalent among FN children; that provided care is treatment-focused and access to oral health services occurs around at the age of 4-5 years. Risk factors include: the bacteria MS, which is vertically transmitted from mothers and colonized in their infants at approximately 2 year of age, a fermentable substrate, and a tooth surface. We also know that ECC is a preventable disease.

Current research suggests that a paradigm shift in the approach to the causes and management of ECC from a treatment-focused model to one which focuses on prevention of the transmission of MS from mother to infant has the potential to significantly decrease levels of ECC in high risk children.

It is expected the examined literature will also support the initiation of primary preventative oral health care by NPs to FN mothers and infants with the goal of decreasing present high levels of ECC. The approach to and findings of the research articles follows.
Chapter Two: Approach and Findings

**Search Strategy**

The approach to the project consisted of a comprehensive review of current published literature. The search strategy involved four separate activities including an electronic database search, a web site search, a search of reference lists, and contact with key informants.

Relevant databases were searched for literature published between 1990 and 2009 to include the first Canadian national report on oral health of FN children up to the most current literature. MeSH headings and keywords applicable to variables of interest; First Nations children, ECC, primary health care, and Health Canada, were used.

The following data sources were searched: Cochrane Database of Systematic Reviews, CINAHL (Cumulative Index to Nursing and Allied Health Literature), MEDLINE (Ovid), and National Guidelines Clearinghouse. See Table 1 for keywords used.

Table 1: Keywords for Electronic Database Search

<table>
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<th>Key Word</th>
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<tr>
<td>Canadian</td>
<td>Health Canada</td>
<td>Population health</td>
<td>Fluoride</td>
</tr>
<tr>
<td>First Nations</td>
<td>FNIHB: NIHB</td>
<td>Health promotion</td>
<td>Chlorhexidine</td>
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<tr>
<td>Oral health</td>
<td>Primary health care</td>
<td>Disease prevention</td>
<td>Prenatal</td>
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<tr>
<td>Early childhood caries</td>
<td>Nurse Practitioner</td>
<td><em>Mutans streptococcus</em></td>
<td>Holistic</td>
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Key words searched independently produced hits that reached many thousands.

Combinations of key words limited the articles to more manageable numbers.

Websites from government health sources and organizations were searched and include: Health Canada, Canadian Nurses Association (CNA), American Academy of Pediatric Dentistry (AAPD), Canadian Pediatric Society (CPS), Center for Disease Control (CDC), and World Health Organization (WHO).
Relevant papers were selected from bibliographies of searched articles. This was a valuable source of information. Chosen papers had references to the key concepts of ECC, health promotion, disease prevention, FN, and children.

Inclusion-exclusion criteria used to find relevant papers are presented in Table 2

Table 2: Inclusion-Exclusion Criteria

<table>
<thead>
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<th>Inclusion Criteria:</th>
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<tr>
<td>Published in English: Published between 1990 and 2009: Addresses - Canadian, US, Australian, New Zealand, or Western European Health Care System.</td>
</tr>
<tr>
<td>Addresses at least one of the following:</td>
</tr>
<tr>
<td>• Aboriginal/First Nations children</td>
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<tr>
<td>• ECC/dental caries: Prevalence, treatment of, health promotion, or disease prevention</td>
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<table>
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<th>Exclusion Criteria:</th>
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<tbody>
<tr>
<td>• Published in language other than English: Published before 1990</td>
</tr>
<tr>
<td>• Addresses health care systems other than Canadian, US, Australian, New Zealand, or Western European</td>
</tr>
</tbody>
</table>

A copy of “The National Oral Health Survey 1990-91” was sent to the author by Dr. J. Leake in 2008. A video on the “UBC Brighter Smiles Program” was given to the author by Dr. A. Macnab in July of 2009 and a discussion with Dr. J. Rogers concerning oral health services presently provided by Health Canada took place on January 26, 2010.

The depth of the key variables in the research question: FN children, ECC, primary health care, and Health Canada produced a plethora of information. To manage the information the literature was grouped using the four pillars of a PHC model: Population health, health promotion, disease prevention, and community focused.
The number of hits under the heading of population health, including Canadian FN children and dental caries, was 2280. Four relevant articles were selected for review based upon national content and ages of the children (< 6 years). The search for oral health promotion programs, including high-risk communities, produced 18,800 hits. Three relevant articles were chosen: One to provide an overview of health promotion, one to include Canadian FN children, and one including anticipatory guidance which is presently supported by the CDA (2009) and the AAPD (2009). Disease prevention, including fluoride and chlorhexidine, (CHX) produced 1060 hits. Articles on fluoride were limited to fluoride varnish, Canadian, high-risk children, and guidelines. Three relevant articles were selected. The search for reviews concerning CHX, maternal MS levels, and infant colonization provided studies conducted primarily in Europe. The studies selected included controlled trials with documented high levels of MS within the population of mothers and high levels of ECC in their children. These characteristics are similar to the population under study. Community focused oral health care, including Canadian and FN, produced 16,000 hits. The search was narrowed with the inclusion of collaborative and remote and limited to one article that reported success.

The total number of articles chosen for analysis was limited by the length of this paper. The selected articles were based on their potential to provide the most accurate picture of the current oral health of Canadian FN children and on their ability to provide information and evidence on current methods of oral health promotion and primary prevention of ECC.

**Review of Literature: Findings**

Searched literature was critically reviewed to provide evidence to answer the question, "For Canadian First Nations children, ages 0-4 years, could the introduction of primary disease prevention and self management reduce levels of ECC compared with the present model of
care?" The reviewed literature was grouped into categories of: Population health, health promotion, disease prevention, and community focused. Population health provides information on prevalence of dental caries, in FN children under the present system of care, supporting or rejecting need for change. The literature on health promotion examines overall effectiveness of oral health promotion. An analysis of a Canadian and an Australian study using differing oral health promotion programs follows this review. Literature on disease prevention examines the effectiveness and safety of current methods of preventing ECC including fluoride and antimicrobial treatments. Evaluation of community directed and focused care is reviewed with an analysis of a collaborative school-based oral health program provided in a remote Canadian First Nations community. The review of the examined literature follows.

**Population Health**

One useful method of determining a populations' oral health is to examine the dental disease burden among its most vulnerable population, infants and preschool children. These children are dependent on others for maintenance of good oral health (Schroth, 2006). The oral health of Canadian FN children will be assessed by reviewing two national surveys, one epidemiological study, and one cross sectional cohort study.

In 1990-91 the Faculty of Dentistry, University of Toronto produced the first “Report on the Oral Health Survey of Canada’s Aboriginal Children Aged 6 and 12”. The study, coordinated by Leake (1992), stated that dental caries among Canadian children has been declining since the 1970’s “but there are no data to estimate the extent of dental disease among Native children across Canada” (p.1). The purpose was to collect information on current health status, dental care levels and needs, and the preventative and risk behaviours of Aboriginal children living on reserve and in the, then, two territories. Information was gathered to provide a base line
to help in future planning. The survey was approved by the Medical Services Board (MSB), regional dental officers, and the dental director for Northwest Territories (NWT). There is no mention of approval from First Nations community councils.

A quantitative, non-experimental, cross-sectional design was used. The target population was Aboriginal children, including all children aged 6 and 12, living on reserve or in predominantly native communities. Excluded were children living in Yellowknife and children in remote areas where travel to the community was costly and there were fewer than 25 children. Communities not served by trained examiners, and those where leaders were not prepared to participate were also excluded. The sample size was 4058 including 6 year olds (n=2243) and 12 year olds (n=1815).

The interventions included examination of all the children’s teeth, a survey, and a questionnaire. All examiners were trained in the same manner and used a Field Survey Manual with coding criteria. Survey instruments were based on World Health Organization Oral Health Survey standards. Data analysis was checked for completeness and internal consistency. Key data was entered on computers using EPI INFO and transformed into readable files providing valid, reliable information that is generalized to the Canadian FN population.

The results demonstrated that 91% of the examined children were affected by dental decay. The 6 year old children had a decayed, missing, filled (deciduous and permanent) tooth (DMFT) score of 7.8 while the 12 year olds had a decayed, missing, and filled (permanent) tooth (DMFT) score of 4.4. This is compared with a provincial estimate among non-native 13 year old children in Ontario at 48% caries free and a DMFT score of 1.76. Though a study was not done on baby bottle tooth decay (BBTD), now referred to as ECC, it was observed to be prevalent. A
proxy measure of BBTD was shown to be severe with a 32% caries burden on anterior maxilla teeth.

The strengths of this study lie in the methodologies used and the important data gathered. A weakness is the exclusion of the more isolated and smaller communities as these populations are at probable higher risk for caries.

Community isolation, lack of access to dental care, lack of water fluoridation, and use of sugar-containing snacks were associated with high rates of caries. The authors state the "secular decline in dental caries seen in non-Native children in Canadian provinces has not occurred among Native children" and confirmed the benefits of community water fluoridation (Leake, [1992] p. 10, ¶ 6). The data pointed to the need for more treatment and prevention. The authors comment on their surprise by the low level of care evident among the six year olds but note that for many children this is their first regular exposure to the dental care delivery service.

Peressini, Leake, Mayhall, Maar, & Trudeau (2004) reporting on the second national survey on oral health of Aboriginal children in Canada, repeated in 1996-97, showed similar results. The mean decayed, extracted or filled, deciduous teeth (deft) score for 6 year olds increased significantly from 8.2 to 8.7 and the mean DMFT for 12 year olds changed slightly from 4.6 to 4.5.

Peressini, Leake, Mayhall, Maar, & Trudeau (2004) conducted a study "The Prevalence of Early Childhood Caries among First Nations Children, District of Manitoulin, Ontario". Its purpose was to determine the prevalence of ECC in 3- and 5-year-old children living on reserve to assist in developing effective dental health promotion strategies. The study used a quantitative, non-experimental, cross-sectional design to compare the prevalence of ECC in FN children with non-Aboriginal children living in approximately the same geographic area. This university
approved study was locally supported. Eighty-seven eligible children participated for a 78% response rate. All 3 and 5 year-old children living on reserve were included. Excluded children were accounted for.

Examinations measuring diseased, missing, filled primary teeth (dmft) were done by one experienced dental hygienist using Ontario Ministry of Health guidelines. The data was evaluated and computer analyzed.

The findings showed the levels of ECC high with 44% of 3 year olds and 57% of 5 year olds affected. The authors comment that these levels were three times higher than those of non-Aboriginal children living in approximately the same area.

The strengths of the study lie in its uniqueness in surveying preschool FN children and in the reliability of methods used. The small population size of 87 is a weakness.

The findings of this study are congruent with similar studies supporting the evidence of high levels of ECC found in preschool FN children. The authors recommend the need to consider behavioural, environmental, and socioeconomic factors.

Likewise a quantitative study done by Schroth, Smith, Whalen, Lekic, & Moffatt (2005) examined the prevalence of caries among preschool-aged children in northern Manitoba. The purpose of this study was to assess the prevalence and potential risk factors for ECC and to determine the influence of stosstherapy (vitamin D supplements) on the children's oral health to assist in developing effective dental health promotion strategies. The approved study took place in Garden Hill First Nations community 610 miles (980 km.) north of Winnipeg.

The design was a non-experimental, cross-sectional, and retrospective cohort study. The dependent variable was dental caries; the independent variable was vitamin D; and the control was no vitamin D. Intervention mothers were offered 100,000 IU of oral vitamin D
(ergocalciferol) at diagnosis of pregnancy and in their third trimester and their babies could receive the same dose of Vitamin D at 6 weeks of age. The inclusion criteria were children born in Garden Hill after 1994. Of the 179 eligible children only 98 participated (54.8%). Of these mother/child pairs 41 received stosstherapy, 30 did not receive therapy, and 27 did not know.

The children underwent a dental examination by a paediatric dentist. Mothers were interviewed regarding infant feeding practices, oral hygiene, dental care of their children, and their own health and nutrition during pregnancy. The dental examiner was blinded to the interview and chart reviews and the examinations were limited to primary dentition. Information was collected following WHO criteria.

Findings showed decayed, extracted and filled primary teeth (deft) of 13.7 ± 3.2. Only one child had a deft score of 0 with 98.9% of the children sampled having ECC.

High risk behaviours such as poor oral health and bottle feeding practices were noted as being routine within the cohort. Modified stosstherapy was found not to be associated with a reduction in dental caries.

The study’s strengths include the addition of reliable epidemiological data on the rates of ECC in preschool FN children. Weaknesses of the study include small population size, low participation rate, and retrospective design as many of the mothers could not recall specific required information.

The results of this study are consistent with the Peressini et al. (2004) study supporting the present high prevalence of ECC among FN children. Schroth, Smith, et al. (2005) recommend front line prevention efforts targeted at expectant mothers with screening of at-risk children within months of eruption of the first tooth.
The evidence from these studies show levels of ECC in FN children range from three times the national average to as high as 98.9% in remote communities. This information supports the need for a change in the present model of oral health services from treatment-focused to one focusing on primary disease prevention and health promotion. A PHC model provides a framework to support this change and NPs as PHC providers have the academic preparation and skills to introduce primary preventative oral health care for FN mothers and infants into clinical practice. The effects of health promotion on the rates of ECC will now be examined.

Health Promotion

With the Declaration of Alma-Ata (1978) the World Health Organization described health promotion as addressing the main health problems in a community. This includes education concerning prevailing health problems and methods of preventing and controlling them (WHO, 1978). The Ottawa Charter (1986) expands the concept of health promotion to include the process of enabling people to increase control over, and to improve their health (WHO, 1986). To understand the effectiveness of oral health promotion a systematic review on the efficacy of dental health education is reviewed. This is followed by an examination of health promotion programs provided in both Canada and Australia with each of the countries utilizing a different model.

Kay and Locker (1996) did a systematic review of current evidence examining the efficacy of dental health education. The question: “Do dental health education interventions reduce disease, and therefore lower the demand for health services and the resultant cost?” was addressed. The scope included all varieties of dental health education with a broad range of end goals. Dental literature from 1982-1994 was searched using the MEDLINE database (n=143). Search terms used were dental health education, oral health promotion, and effectiveness. Only
published papers were reviewed. There was no mention of language inclusion. Reference lists were searched and relevant references followed up. A preliminary review excluded 72 papers. The remaining studies were critically appraised by two independent researchers with the end result of 37 studies being included. Reasons for exclusion were listed.

An examination of the objectives of each investigation, the nature of the intervention, the types and numbers of the participants, and the outcomes of the interventions were undertaken. The studies were then placed into subgroups including: Plaque removal/gingival health ($n=15$), knowledge and attitudes ($n=14$), caries ($n=4$), and dietary change ($n=4$). Results and conclusions are presented in Table 3.

Table 3: Efficacy of dental health education

<table>
<thead>
<tr>
<th>Category</th>
<th>No. of papers included</th>
<th>No. showing +ve effect</th>
<th>No. showing no effect</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plaque removal/gingival health</td>
<td>15</td>
<td>8</td>
<td>7</td>
<td>Plaque removal programs are generally effective in the short term but no long term benefits are seen</td>
</tr>
<tr>
<td>Knowledge and attitudes</td>
<td>14</td>
<td>14</td>
<td>0</td>
<td>Knowledge levels are consistently raised by education</td>
</tr>
<tr>
<td>Caries</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>There is no evidence that dental health education affects caries levels</td>
</tr>
<tr>
<td>Dietary changes</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>Equivocal, no conclusion drawn on information obtained</td>
</tr>
</tbody>
</table>

Many limitations and weaknesses in the study were discussed by the reviewers including the use of only MEDLINE, which limits the articles retrieved; and the lack of non-published articles and "grey literature" which can affect conclusions. They remarked that the quality of the evidence pertaining to the effectiveness of dental health education was poor and the quantity of rigorous well designed research concerning dental health education was scarce.
Despite the lack of a positive effect on rates of dental caries, the ethical responsibility of health professionals to disseminate information about disease prevention to populations was discussed and promoted. The process of health promotion enables people to increase control over and improve their health. Front line health care providers are described as being in the best position to provide health promotion to individuals and communities. A review of two studies, one from Canada and one from Australia presenting the results of differing health promotion programs, follows.

An epidemiological study on the effects of a community-based prenatal nutrition program was done by Lawrence, Romanetz, Rutherford, Cappel, Binguis, & Rogers (2004). The purpose was to evaluate the effectiveness of community based dental preventative programs for ECC that took place in Sioux Lookout Zone (SLZ), Ontario in the 1990’s. The program was provided by dental hygienists in partnership with the Sioux Lookout First Nations Health Authority.

One-on-one home visits by trained educators provided nutrition and dental education to pregnant mothers, new mothers, and elders raising children. The program expanded in 1996 to include “Your Baby’s Smile” and the “Head Start Brushing Program”.

A non-experimental cohort design using both cross-sectional and longitudinal approaches was used. Sixteen communities were chosen based on their participation in ECC programs. Included were eight “high intervention” communities that had a participation rate of 70% or greater and eight “low intervention” communities that had a participation rate of 10% or less. All communities had similar characteristics and agreed to participate in the study.

Children born between June 1996 and February 1999 and their mothers/caregivers were included in the 2001 survey with a total of 471 participants, a 72% response rate. In 2002 a new cohort of 2 year old children and their caregivers were added for a total 705 participants, a 65%
response rate. Complete oral health data was compiled for 699 preschoolers. Reasons for non-response were indicated.

Clinical examinations were conducted by four teams of trained dental hygienists and recorders using the National Institute of Dental Research (NIDR) caries diagnostic criteria. Pilot-tested behavioural questionnaires concerning caregiver knowledge, beliefs, attitudes, and practices in relation to their child’s oral health were administered in 2001 and repeated in 2002. Data analysis consisted of bivariate statistics to determine any significant differences between the study groups. Statistical tests were two-tailed and interpreted using SPSS software.

The results showed that the education programs had a significant impact on the caregiver’s knowledge, beliefs, and attitudes in relation to their infant’s oral health. However, dental caries levels remained high with over 90% of the children in both the high intervention and low intervention groups having ECC. The authors compared the caries rate in 4 year old children in this study to those investigated in 1973 and 1983 and found increased caries rates.

The strength in this study lies in the large population, the high response rates, and the methodologies used. A weakness lies in the fact that it was not a blind study. The findings can still safely be generalized to the population under study. The authors’ recommendations include: A multifactoral approach to oral health, development of early preventative programs by first line providers, and community based programs.

A quantitative study on oral health promotion and incidence of ECC was done in Southern Australia by Plutzer & Spencer (2007). The purpose of the study was to test the efficacy of an oral health promotion program targeting nulliparous women on the level of severe early childhood caries (S-ECC) in their infants at 18 months. The research examined the effects of an oral health promotion program based on repeated rounds of anticipatory guidance provided to
first time mothers on the incidence of S-ECC in their children. The study was approved by the University of Adelaide and the five metropolitan teaching hospitals involved in the study. Subjects were recruited from expectant mothers in the waiting rooms of participating hospitals by one of the authors. Exclusion criteria were identified as high-risk pregnancies, multiple pregnancies, improperly completed questionnaires, and mothers' inability to comprehend written English. Excluded and lost participants were accounted for.

A RCT using a Zelen design was used to allocate women into test or control groups allowing participants to change groups. Only five women (0.08%) changed groups with all moving from control group to test group. The authors note that this would probably not affect blinding or loss of statistical power. From 814 women approached 649 responded (79.7%). Refusals were accounted for. Participants included \(n=327\) for the test group and \(n=322\) for the control group. There were minimal differences between the groups at baseline.

The program consisted of three rounds of information in the form of anticipatory guidance. Information was given prenatally on oral health during pregnancy, at 6 months on the oral health of infants, and at 12 months on the oral health of a year old child. There was no contact with the control group during this time. The potential for cross-over information from the mothers was stated as minimal due to the large geographic distance between participants.

Data collected included four standard questionnaires on maternal and child oral health and an examination of all the children’s teeth at the age of \(20 \pm 2.5\) months using the US National Institute of Health (NIH) definition of S-ECC. Comparability of examined children was tested and no significant differences were found.

Findings showed the incidence of S-ECC at 1.7% in the test group and 9.6% in the control group (Fisher’s exact test \(<0.05\)), a significant difference between the groups.
The strength of this study lies in the large numbers of participants and high retention rate. There are many weaknesses to this study including limited opportunities for enrollment and use of the Zelen design lacking randomization. The authors state that the oral examination of children at 20 months can be interpreted as a weakness as the disease process is still at an early stage. No test-retest reliability information was collected. All mothers were recruited and interventions were administered by the same author who conducted the dental examinations. Comments on these concerns were made by the authors with a call for a replication of the study with more emphasis on blinding and reliability.

Despite the many weaknesses in this study the characteristics of the population (prenatal mothers and their infants) and the purpose (oral health promotion) are applicable to the population and subject of this paper and can be considered valid.

The authors feel that the timing and regularity of delivery of information to first time mothers is an important element because new mothers are more receptive and motivated to provide the best possible care. The results of this study indicate that an oral health promotion programme provided to first time mothers in the form of anticipatory guidance can significantly reduce the incidence of S-ECC. Recent literature and guidelines on the prevention of ECC supports anticipatory guidance (AAPD, 2009; Lin, 2009; CDC, 2001).

The systematic review on the efficacy of dental health education by Kay & Locker (1996) has provided results which indicate oral health promotion programs increase oral health knowledge but do not decrease rates of dental caries. This is supported by Lawrence, Romanetz, et al. (2004) in the study on the effectiveness of oral health promotion programs provided to FN communities in SLZ. In contrast the quantative study by Plutzer & Spencer (2007) to test the
efficacy of an oral health promotion program targeting nulliparous women shows significant success in decreasing their infant’s levels of S-ECC.

Common themes that became apparent through the review of oral health promotion were the beliefs that health promotion must continue to be provided and it is the ethical responsibility of health care professionals to disseminate evidence-based information. Current information enables health care recipients to make informed decisions concerning their health issues. NPs as front line PHC providers are in a key position to introduce oral health promotion including anticipatory guidance to FN mothers with infants and young children. A review of primary disease prevention of ECC follows.

*Disease Prevention*

Dental infections are probably the most common bacterial infection in humans (Loesche, 1986) and they continue to be the most common chronic disease in children (Lin, 2009). Over the decades the most significant drop in dental caries in children followed the introduction of fluoride. In 1945 Grand Rapids, Michigan became the first city to fluoridate its drinking water. After only 11 years the city showed a 60% decrease in caries levels in children born post fluoridation (The Story of Fluoridation, (n.d.) [NIDCR, 2009]). With current knowledge on the infectious nature of ECC recent literature and studies are focusing more on the use of fluoride and antimicrobials for the primary prevention of early childhood caries.

Primary prevention is the process of preventing disease from occurring in persons without evidence of disease (Bickley, 2007). Primary primary prevention is a term seen in some current oral health literature describing treatments given to mothers to prevent the transmission of MS to their infants. (Gripp & Schlagerhauf, 2002). The phrase primary prevention used in this paper includes both definitions.
An examination of the safety and efficacy of fluoride includes a systematic review of fluoride varnish (FV) in caries prevention, a RCT on the effectiveness of FV in prevention of ECC in Canadian FN children, and a review of Canadian guidelines on the use of fluoride. FV was chosen for review as it is the recommended treatment for infants and toddlers who have a tendency to swallow gels and liquids. FV is easily applied and well tolerated (AAPD, 2009).

A review of antimicrobial treatments will examine two European studies on the effects of chlorhexidine (CHX) treatments given to mothers and the development of ECC in their children. The section will then provide a comment on the Prevention Management Model for Early Childhood Caries (MAYA project) completed in California in 2005.

**Fluoride**

Fluoride is the ionic form of the element fluorine which is the 13th most abundant element in the earth’s crust. It works to control dental caries in several ways. Cariogenic bacteria in the mouth are known to metabolize carbohydrates causing the release of acids. This action reduces the mouth’s pH which then stimulates the release of fluoride into the saliva. The released fluoride bonds with calcium and phosphate which is then taken up by demineralized tooth enamel establishing an improved enamel crystal structure. The remineralized enamel structure is more acid resistant and contains higher levels of fluoride. These cycles of demineralization and remineralization continue throughout the lifetime of the tooth.

Fluoride affects the activity of cariogenic bacteria by inhibiting the process by which bacteria metabolize carbohydrates to produce acid. Additionally fluoride affects the bacterial production of adhesive polysaccharides (CDC, 2001). Fluoride varnish was first developed and marketed in the 1960’s in the form of sodium fluoride (Duraphat®, Colgate, New York, NY). An examination of the literature on the effects of fluoride on dental caries follows.
Based on previous reviews, Azarpazhooh & Main (2008) did a systematic review of fluoride varnish (FV) and dental caries. The purpose was to develop scientifically current evidence-based protocols for the use of fluoride varnish in the prevention of dental caries among high risk children and adolescents with a focus on young children. The authors note that fluoride varnish provides prolonged contact between fluoride and tooth enamel with ease of application, relative safety, and effectiveness. The review addressed the efficacy of fluoride varnish, its application, the frequency and concentrations required, and the cost-effectiveness of treatments.

Articles were obtained through a search of relevant bibliographic databases. Journals, reference lists, published and unpublished articles were searched and reviewed. Inclusion criteria were: English, human, age 0-18 and publication from 2000-2007. Exclusion criteria were listed. Key words included: dental caries, children, and fluoride.

Forty-two articles were obtained, read, and scored using predetermined criteria leaving seven articles for inclusion. These articles were read and scored by two independent reviewers. Each of the seven studies had a population from 280 to 1275 with an overall total of 4731 participants. Control groups were equivalent to treatment groups. The strength and quality of the articles was determined by using the Canadian Task Force on Prevention and Health Care (Level I to Level III) and classified as to recommendations for preventative action (Grade A to E). Five of the seven studies included scored Level I - Grade A. The results of the studies are summarized under headings correlating to the five review questions: Efficacy, application, frequency, concentration, and cost effectiveness of fluoride varnish. Conclusions are drawn from studies and reviewed literature. No pooling of information or comparison was made between studies. From an objective analysis the authors made the following recommendations:
- For high risk populations fluoride varnish should be applied twice a year
- Single dose packaging of varnish should be used (cost, including labour, = $3.43)
- Oral health care programs should include complementary preventative strategies

The strength in this review lies in the quality of the papers and the number of participants. A noted weakness is the inclusion of English-only articles.

The majority of children in the reviews are from a low socioeconomic population with similar characteristics to the population in this paper. This review strongly supports the use of fluoride varnish along with preventative strategies in the treatment of high risk populations.

A 2-year RCT was done by Lawrence, Binguis, Douglas, McKeowan, Switzer, Figueiredo, & Laporte (2008) on fluoride varnish and ECC. This study was done in response to the study by Lawrence, Romanetz, et al. (2004) evaluating the effectiveness of the SLZ prenatal programs on caregiver’s beliefs and behaviours and subsequent prevalence of ECC’s. The results, which showed increased caregiver knowledge with no decrease in levels of caries, can be reviewed in a previous section under Health Promotion. The purpose of this trial was to measure the effectiveness, safety, practicality, and costs of a FV preventative intervention in a high risk population. Key concepts included: cluster analysis, dental caries, First Nations (Ojibwa), preschool child, randomized control trial, and topical fluoride.

A community-cluster-randomization design was chosen. The clusters were 20 out of 28 randomly selected communities within SLZ in Ontario. The unit of randomization was the community itself with all eligible participants randomly assigned to a treatment or control group. Inclusion-exclusion criteria and participants lost to follow-up were included. Increased funding allowed for an increase in the FV group yielding 8 communities in the control group and 12 communities in the FV group.
The population was identified as all FN children aged 6 months to 5 years living in a community in SLZ. A convenience sample of primarily non-Aboriginal children was recruited from a neighboring region providing a baseline for comparisons. Sample size included 1275 FN children and 150 non-Aboriginal children.

Caregiver counselling and standard restorative care was provided for both the test group and the control groups. The intervention, Duraflor®, a 5% w/v sodium varnish (FV) was applied to full primary dentition two or three times per year for two years on FN children in the test groups and on children in the comparison group.

Data collection points were at baseline, 12 months, and 24 months and measured in two formats; an oral examination and a structured interview. Data was collected by teams of calibrated dental hygienists and recorders using the National Institute of Dental and Craniofacial Research’s (NIDCR) diagnostic criteria. A structured questionnaire was used on all groups and translators were included as necessary. Computer analysis was undertaken to determine two year caries increments in children with comparisons between groups adjusted for intra-cluster correlation.

The findings showed an 18.3% reduction in ECC in FN children in the treatment group which increased to 24.5% with inclusion of the comparison group. These results provide strong evidence that fluoride varnish applied at least twice a year along with caregiver counselling is effective in decreasing ECC in Aboriginal children. The effects of this trial are compared with similar trials carried out in San Francisco and corroborate those findings which showed the incidence of caries two times higher in the counselling-only group.

The number of applications of varnish per year was discussed with recommendations of two treatments of FV per year as the most cost effective and efficient method. The researchers
generalized findings to all high-caries-risk children and suggest that results of this study have the potential to reduce inequities in oral health between Canadian Aboriginal and non-Aboriginal children.

This trial was examined by Azarpazhooh (2008) in the above review and scored Level I - Grade A. The population examined in this trial and populations discussed in this paper are similar. The evidence from this study supports the use of fluoride varnish treatments provided to high risk FN children at the eruption of their primary teeth as an effective measure in the prevention of ECC.

In September 2009 Health Canada posted an update of their Guideline Technical Document for fluoride in drinking water adding that “fluoridation of drinking water supplies, . . . is a decision typically made by municipalities, in consultation with the provincial or territorial government” (p.1, ¶ 1). The guideline for fluoride in drinking water is a Maximum Acceptable Concentration (MAC) of 1.5 mg/L. Health Canada’s Chief Dental Officer has determined the optimal concentration of fluoride in drinking water for dental health to be 0.7mg/L for communities who wish to fluoridate. This concentration is well below the MAC and is reported as providing optimal dental health benefits with no adverse effects (Health Canada, 2009).

In 2005, community-fluoridated drinking water was provided to approximately 43% of the Canadian population. Health Canada reported the 2006 provincial and territorial estimates for community water fluoridation coverage showing only 7.1% of the residents of Nunavut, 3.9% of British Columbians and 0% of Yukoners as receiving fluoridated water (Health Canada, 2009).

The Canadian Pediatric Society (CPS) in their 2009 document on the use of fluoride in infants and children states “there is no doubt the use of fluoride decreases dental caries” (p. 3) and recommends the addition of fluoride to municipal water supplies where natural
concentrations are less than 0.3 ppm. See Appendix for CPS recommendations for supplemental fluoride for children living in areas that have fluoride water levels less than 0.3 ppm.

A review of the literature on the effects of fluoride on ECC strongly supports its use. Recommendations encourage the fluoridation of municipal water as a safe, effective, and inexpensive method of preventing tooth decay (CPS, 2009). Well over half of the Canadian population is not provided with fluoridated water. Included in this are large areas of the country populated by FN communities. Recommendations provided to primary health care providers for the use of supplemental fluoride in non-fluoridated areas allow NPs as primary health care providers to deliver evidenced-based care. Reviews of the effects of topical antimicrobials on ECC follow.

Antimicrobials

Earlier discussions provided information on the role of high maternal salivary levels of the bacterium MS in the development of ECC. The approach to controlling infectious diseases generally focuses on inhibition and control of associated micro-organisms. Of the variety of chemotherapeutic agents examined for their ability to control oral micro-organisms, chlorhexidine (CHX) is currently the most potent agent against Mutans Streptococci and dental caries (Emilson, 1994). It is used in a topical format including gels and varnishes.

Two European studies investigating effects of CHX treatments given to mothers on colonization of MS and subsequent dental caries in their children are examined followed by comments on the recent California MAYA project (2005).

A paper titled “Effects of Chlorhexidine-Fluoride-Gel Treatments in Mothers on the Establishment of Mutans Streptococci in Primary Teeth and the Development of Dental Caries in Children” was done by Tenovuo, Håkkinen, Paunio, & Emilson in 1992. The study was based on
the concept that high numbers of MS in maternal saliva and frequent salivary contact increases the risk of early infections among infants. Reductions in salivary transmission of MS are likely to also reduce colonization of MS in infants and concomitantly susceptibility to dental caries.

This ethically approved study used an experimental approach with a three year longitudinal design. The design included three mother and babe groups: one experimental group and two controls. The mothers in the experimental group and control group 1 had baseline MS levels greater than $10^5$ CFU/ml. The mothers in control group 2 had baseline MS levels less than $10^5$ CFU/ml. Participants in the experimental group and those in control group 1 were randomly selected.

The study was an adjunct to regular dental care provided to Finnish children. The authors state the public health system provides a first dental visit at 6 months of age and a second visit at one year followed by yearly visits. All the mothers in the study were given information on the transmission of MS from mothers to infants. The mothers in the experimental group were given a chlorhexidine-fluoride gel treatment twice a year during a three year period when their children were 1-4 years old.

The population was identified as 252 mothers attending two dental clinics in Turku, Finland where the authors state the prevalence of MS is common with 95% of children showing positive for the bacteria by 6 months of age. Mothers were invited to participate in the study during the first dental visit when they were asked to provide a saliva sample. The sample was repeated the following visit. Based on the saliva samples three groups were formed. The total number of mothers having increased MS levels was 149 from which the experimental group and control group 1 were randomly selected. Final numbers of children in the three groups were: (1)
experimental group: \( n=56 \), (2) control group 1: \( n=50 \), and (3) control group 2: \( n=46 \). Exclusions and losses were accounted for.

Data was collected at baseline and yearly until the child reached 4 years of age. \( MS \) levels in maternal saliva were measured using commercial Dentocult® SM Strip mutans and reported in CFU/ml. The children’s colonization of \( MS \) was determined by plaque samples collected from all the children at ages 2-,3-, and 4-years which were then grown on agar plates with results expressed as positive (growth) or negative (no growth). The same dentist carried out all dental examinations and plaque collections throughout the study using equipped dental units.

Analysis was undertaken to assess the colonization of \( MS \) and the number of dental caries in the children. Differences in colonization rates were analyzed by \( \chi^2 \) or Duncan’s multi-range test and caries data by analysis of variance.

The highest \( MS \) colonization was found in children whose mothers had high levels of \( MS \) and did not receive CHX-fluoride gel (58%). The lowest colonization occurred in the children of mothers in the experimental group (50%) These differences were not statistically significant. However, the association of \( MS \) in children with subsequent development of caries was statistically significant with 5.7% of \( MS \) negative children and 28.4% of \( MS \) positive children developing caries \((p<0.001)\). Results showed the earlier the colonization of \( MS \) the higher the number of decayed teeth at age 4 years \((p<0.01)\). Children whose mothers received CHX-fluoride gel had less caries than children whose mothers did not receive the gel. Children who were \( MS \) negative, but yet had caries, had significantly less decayed teeth than children who were colonized by \( MS \).

The findings from this study confirm results of previous studies showing that dental caries in primary dentition is significantly associated with maternal salivary \( MS \) levels. In
discussing the studies weaknesses the authors’ state that CHX treatment given twice a year
allowed for recolonization of MS, occurring generally 3-5 months post treatment. Maternal MS
levels were not checked post-treatment and many of the children were infected at first sampling.
The authors recommend starting gel treatments for mothers at the time of their infant’s first tooth
eruption followed by regular treatments (3-4 per year) to maintain salivary MS at a low level.
Despite noted weaknesses these results can safely be generalized to include the population of FN
mothers and their infants presenting with similarly high rates of ECC.

Gripp & Schlagenhauf (2002) published their findings in an original paper titled
“Prevention of Early *Mutans* Streptococci Transmission in Infants by Professional Tooth
Cleaning and Chlorhexidine Varnish Treatment of Mothers”. The approved study was conducted
at the maternity hospital of the University of Tubingen, Germany. The foundation for the study is
built upon referenced research showing 95% of case-pairs of mothers and babies share the same
*MS* serotype which is transmitted through maternal saliva. The authors point out that high
*Mutans Streptococcus* levels cannot be lowered permanently by mechanical plaque removal and
dietary changes are often not feasible. The authors then note effective suppression of MS over an
extended period of time has been achieved only by the application of highly concentrated CHX
varnish. This study was conducted to evaluate the impact of professional tooth cleaning followed
by a CHX varnish application given to new mothers on the frequency of MS colonization in their
children at 2 years of age.

The study was an experimental longitudinal design with data collection every 3 months
until the infants reached 24 months. Similar to the study by Tenovuo et al. (1992) the mother and
infant pairs were assigned into three groups according to the mothers salivary MS levels. There
was no mention of randomization. Group 1, the treatment group, consisted of 16 mothers with
MS levels greater than $10^5$ CFU. Group 2, the positive control (PC) group, had 13 mothers also with MS levels greater than $10^5$ CFU. Group 3, the negative control (NC) group, had 15 mothers with low MS levels.

The population was identified as 44 women with a median age of 30 years who had delivered their infants in the participating university hospital. All mothers gave informed consent. Mothers in all groups received oral examinations and instructions on the role of MS in the origin of caries, the influence of feeding habits, oral hygiene, and the role of fluoride. Mothers in the treatment group received professional tooth cleaning with application of a 40% CHX varnish every three months.

Data for analysis of MS levels was collected from mothers and infants at baseline and every 6 months until the children reached 24 months. Evaluations of all infants were identical with each infant having a baseline edentulous MS count of zero. Salivary MS counts were also taken from mothers immediately before each treatment session.

MS levels were measured using a Mitis-Salivarius-Bacitracin (MSB) agar analysis and Dentocult® SM Strip mutans (DSM), commercially available, test strips. The authors remarked that the differences in the results between the two methods were small with the DSM test indicating the presence of MS more often than the laboratory produced agar tests.

Analysis of the test results addressed maternal salivary MS levels, infant’s MS levels, and the correlation between maternal MS scores and colonization levels in their infants. Statistical analysis was done using $x^2$ test with the level of significance set at $p<0.05$ and adjusted for multiple testing.

Findings revealed a significant decrease in maternal salivary MS levels in the CHX group when compared to baseline ($p<0.05$) with no statistically significant changes in MS levels seen in
mothers in the PC and NC groups. MSB agar analysis of the infants at 24 months showed that 19% of the CHX group and 20% of the NC group were positive for MS; while 54% of the PC group showed positive results. DSM test results showed 19% of the CHX group; 7% of the NC group; and 69% of the PC group positive for MS. The differences between the PC group and the other two groups were statistically significant ($p<0.05$). The correlation between maternal DSM scores and MS counts in their infants showed no infants of mothers with low MS levels colonizing the bacteria.

The findings indicate that the suppression of high MS counts in close contact persons by repeated professional tooth cleaning and CHX varnish application has a significant effect on the frequency of infants permanently harboring MS at two years of age. The correlation between high salivary MS counts of the mother and the likelihood of early MS transmission was confirmed.

Recommendations from the authors' include:

- The use of commercially available DSM tests which are reliable, easy to handle, and better suited for general practice
- Repeated evaluations of maternal salivary MS counts during early childhood

The strengths of this study include its assignment of participants based on maternal MS levels and methods of data collection and analysis used. Weaknesses identified are the small number of participants and the variations in eruption time of the infant's teeth which can lead to differences in total at-risk times.

The findings of these two studies support the biological cause of MS in the development of ECC and the use of CHX as an effective antimicrobial agent.
A study: “Prevention Management Model for Early Childhood Caries”, the MAYA Project, with a completion date of August 2005 was conducted by the University of California, San Diego and sponsored by the National Institute of Dental and Craniofacial Research (NIDCR). This area, located near the US-Mexican border, has a high population of low income pregnant women whose children are at high risk for dental disease. The purpose of the study was to determine if MS can be reduced or eliminated by treating mothers and their infants with CHX and fluoride varnish applications. This four year randomized clinical trial compares the efficacy of the prevention of ECC in two groups; a minimal intervention group with counselling alone; and a treatment group with counselling, a four-month regimen of CHX rinses for new mothers, and fluoride varnish applications for their infants and toddlers. The estimated enrollment was 512. The objectives were to increase knowledge of caries risk factors with a goal of decreasing the oral health disparities in high risk populations. This examined population more closely resembles the Canadian FN population. The results of this study, when available, will provide valuable additional information for guidelines on the prevention of ECC in FN children.

The findings of the presented studies are supported by Anderson’s (2003) review on the efficacy of CHX on dental caries. The review reported that, in the majority of the antimicrobial studies, chlorhexidine was found to be effective in controlling or reducing the microbial challenge associated with dental caries.

Some current literature suggests limited fluoride varnish programs are now being increasingly introduced to FN children attending preschools. No literature was found indicating the use of CHX in Canadian FN mothers with MS CFU >10^8 to reduce or eliminate the transmission and colonization of MS in their infants. Introduction of fluoride and CHX to high-risk FN mothers and infants can be accomplished at routine visits to their health care
professionals. Provision of primary preventative oral health care to FN mothers and infants by NPs including the use of fluoride and antimicrobials when indicated has the potential to decrease the high levels of ECC now seen within FN children.

The final section in this chapter covers a review of a recent community focused and directed oral health program in a remote Canadian First Nations community.

Community Focused and Directed

One of the principle concepts of primary health care presented at the WHO International Conference on Primary Health Care, Alma-Ata (1978) and restated in the Ottawa Charter (1986) addresses community and individual self-reliance. Communities should be encouraged to be involved in the planning, organization, operation, and control of primary health care and supported through appropriate education (WHO, 1978, 1986).

An original research paper by Macnab et al. published in 2008 provides 3-year results of a collaborative school-based oral health program in a remote FN community. The program, “Brighter Smiles”, continues as a collaborative partnership between the community of Gitga’at (Hartley Bay) and the University of British Columbia (UBC). The partnership developed following a request from the community for assistance in addressing their children’s health issues. Oral health was mutually agreed upon and had potential to show positive results within a short period of time. The two established goals were to provide a learning and service experience for UBC pediatric medical residents and to design and implement a program to improve the oral health of the community’s children (Harrison, 2006).

The hypothesis was that after 3 years of the program there would be a significant decrease in dmft/DMFT in the children. A quasi-experimental cross-sectional design was used. The population included 100% of the school children K-12: n=58, start, and n=40, finish.
The program consisted of two medical residents and their supervisor visiting Hartley Bay for three days every six to eight weeks where they provided well-child clinics as well as implementing and supporting the oral health program. Community leaders, teachers, parents, Elders, health care staff, pediatric residents, and dental and medical faculty from UBC were involved.

The interventions included daily school-based brush-ins, weekly fluoride rinses, and fluoride varnish applications every four months for children less than 9 years of age. Anticipatory guidance and health-related classroom presentations were given.

Dental examinations were done on 26 children preprogram and 40 children (100%) postprogram by a dentist not involved in the study. The primary outcome measures were dmfs/DMFS and cavity-free and caries-free status. Additional outcomes included assessment of oral hygiene and the responses of the community and university trainees to the experience. Data collected included dmfs/DMFS scores, cavity free and caries-free status, and a questionnaire concerning oral health habits. The hypothesis was tested using a Wilcoxon and Chi-squared test.

Among the children, assessed pre- and post-intervention, the dmfs/DMFS improved significantly \((p<0.005)\). Prior to the intervention 8% of the children were caries-free and three years following the intervention 32% were cavity-free. The hygienist reported that the children had visibly better oral hygiene and the “time required to treat” had decreased significantly \((p<0.001)\). Response from the community and the pediatric trainees was consistently positive. The study concluded that a community and university supported school-based collaborative oral health program improved oral health and knowledge among children in a remote FN community.

The strengths of the study lie in its success. Macnab, et al. (2008) state information gained from the 17th Annual Indian Health Service Research Conference (2005) has shown that
success in caries reduction in Aboriginal children has been elusive. The authors comment that this program may be the first to document efficacy and add “one additional element for the program that we will be proposing to the community is chlorhexidine varnish for new mothers, since this simple process has been shown by others to significantly reduce early childhood caries” (Macnab, et al., [p.6, ¶ 6] 2008).
Chapter Three: Discussion

Recommendations and Summary

Evidence obtained from the reviewed literature supports the need for the introduction of primary disease prevention and self management to FN children, ages 0-4 years, with a goal of decreasing high levels of ECC. Initiation and provision of primary preventative oral health care for FN mothers and infants by Nurse Practitioners as PHC providers is also supported by the evidence.

The recorded endemic levels of ECC in FN children at ages 4-5 years indicate these children were more than likely colonized with the bacterium MS contracted from their mothers around the age of 2 years. Studies report these same children receive a highly cariogenic diet and practice poor oral hygiene (Peressini, et al., 2004; Schroth, Smith, et al., 2005). This combination provides an environment for the unchecked fermentation of any cariogenic substrates on the existing tooth enamel by MS. This ongoing process of demineralization exceeding remineralization of the tooth enamel has begun long before many of these children are out of diapers.

The present model of oral health services expends energies and monies on treating the effects of this chronic disease. Despite the present knowledge of the infectious nature of ECC and the known “window of infectivity” minimal efforts and monies are being spent on prevention. To compound this problem it has been my experience that both health care recipients’ and health care providers are equally unaware of the infectious nature of ECC. The gap in preventative oral health services provided to FN children, ages 0-4 years, and the observed general lack of knowledge on the causes and treatment of ECC can be seen in endemic levels of ECC now occurring in Canadian FN children.
Quality health promotion programs provided to FN communities, focusing on nutrition and oral hygiene, have shown no effect on the levels of ECC. However, none of the Canadian programs reviewed provided information to the recipients concerning the infectious transmissible nature of ECC. For health education directed at decreasing or eliminating ECC to be successful all components of the disease process must be identified. Decreasing consumption of a highly cariogenic diet and professional removal of plaque is a short term and incomplete solution to the problem. The development of oral health promotion programs, which also include information on the infectious transmissible nature of ECC and its treatment, are needed.

Both fluoride and CHX have been shown to be effective in decreasing ECC. The literature indicates that most FN children do not have access to community fluoridated water nor do FN mothers have easy access to health care providers with the ability to assess and treat high levels of MS. For optimum success treatments of high maternal MS levels and the introduction of fluoride to their infants should coincide with the eruption of the child’s first tooth; normally occurring around 6 months of age. Once colonization has occurred MS thrives, increases in virulence, and is more difficult to effectively treat. Primary prevention is known to be more effective than secondary treatment.

There are multiple methods and guidelines for the use of fluoride and CHX in the prevention of ECC. Involvement of each community in decisions concerning the most appropriate forms and delivery of these treatments for their population is important. Provision of current knowledge to decision makers within a community can increase their ability to improve their population health. Well organized and empowered communities are highly effective in determining their health needs and in providing policies and practices to support health promotion (WHO, 2005).
The knowledge of ECC as a preventable disease is a cornerstone for both health care providers and health care recipients. While this information resides within the halls of academia the levels of ECC in First Nations children continue to escalate. These children and their families continue to suffer from unnecessary physical and emotional pain. The cost to taxpayers for treatment of ECC is staggering and continues to rise. The connection of ECC to chronic diseases, including diabetes and congestive heart failure, should make the commitment to decreasing ECC in FN children a high priority.

The complex issues inherent in the development of ECC have led the American Academy of Pediatric Dentistry to support the concept of a dental home (AAPD, 2009) referring to a primary care provider within the medical home providing all aspects of oral health to infants and young children (Hay, Levin, Sondheimer, & Deterding, 2009). The advanced training of Nurse Practitioners in primary health care prepares them to incorporate a dental home within their individual practices and within the communities in which they work. As front line providers NPs are able to provide continuity of care to their clients. The introduction of a formal evidenced-based oral health plan into prenatal, postnatal, and well-child assessments is within the NPs skill set. Ordering diagnostic tests to evaluate maternal salivary MS levels and provision of treatment for high MS levels, with appropriate antimicrobials, is within the scope of practice of NPs. In their role as providers of health promotion and disease prevention NPs provide current evidence-based education to their clients. They would include all aspects of the process of ECC: the bacteria, the substrate, and oral hygiene.

NPs working and living within FN communities are in a unique position to develop and foster community involvement. The involvement of the community in identifying the health issue of dental caries and their participation in the development of preventative strategies has
shown success (Macnab, et al., 2008). Collaboration with existing healthcare providers including nurses and dental hygienists in the initiation of oral health programs starting prenatally and continuing throughout school can support the important message of good oral health.

Community involvement can help to break the barriers which have developed over the years between FN peoples and health care providers brought on by past scattered and inconsistent care (Waldram, 2007).

The profile of the primary care NPs role includes the provision of integrated and accessible health care services by clinicians who are accountable for addressing personal health needs, developing a sustainable partnership with patients, and practicing within the context of family and community. The competencies of NPs emphasize accountability, a holistic approach to direct patient care, inclusion of health promotion and disease prevention, and development of a patient-clinician relationship predicated on mutual trust, respect, and responsibility. NPs use of professional caring with patients as partners in health care sets nursing’s contribution to primary care apart from other providers practice (Hamric, Spross, & Hanson, 2009). NPs are in a position to provide the leadership required in the promotion of primary disease prevention of ECC in FN children utilizing a multidisciplinary approach. Nurse Practitioners working in conjunction with parents, community support networks, nurses, dental hygienists, dentists and physicians can aid in the initiation and development of a seamless flow of preventative oral health care provided to FN children. Success in decreasing the levels of caries in these young children can then become an attainable goal.

To be successful a NP directed primary oral health promotion program must be supported within the profession and should encourage the provision of current evidence to health care recipients. This change can be precipitated by the following:
• A paradigm shift from education about and treatment of ECC to one focusing on the disease as a preventable infection transmitted from mother to child. This must be aggressively promoted and taught to NPs and nursing students; particularly those who have contact with pre and post natal mothers and their infants. CRNBC, CNA, and Health Canada would be required to support and promote this shift.

• Education and teaching tools appropriate for all health care providers focusing on the infectious and transmissible nature of ECC. NPs, as primary health care providers, require education on ECC risk assessment, infant oral examination, anticipatory guidance, and early intervention including use of antimicrobials and fluoride.

• Oral health assessment & examination of infants and mothers at infants’ age of 6 months.

• Follow up oral health assessment and examination of infants and mothers every 6 months.

• A multidisciplinary approach to oral health care.

Provision of primary disease prevention by NPs has the potential to lower the present high levels of ECC seen within FN children. Such a program could decrease emotional and physical suffering caused by ECC, decrease the financial burden on the taxpayers, and potentially decrease high levels of some of the chronic diseases suffered by FN adults. This would result in a win-win situation for both recipients and providers of health care in Canada.

Support for the introduction of primary preventative oral health care to FN infants and preschool children was garnered from Health Canada’s regional dental officer for BC, Dr. Rogers, when he stated that Nurse Practitioners are in a “perfect position to provide the kind of primary preventative care that is needed” (January 26, 2010). Recommendations for nurse practitioners preventative oral health care derived from the reviewed literature follows.
Table 4: Recommendations for Nurse Practitioner Practice

<table>
<thead>
<tr>
<th>Prenatal visit and risk assessment</th>
<th>6 months assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Maternal/family caries history and risk assessment: best predictor of future caries</td>
<td>• Infant oral examination, assess teeth &amp; gums</td>
</tr>
<tr>
<td>• Maternal oral exam</td>
<td>• Repeat maternal MS levels q 3-4 months in high-risk mothers, treat as required</td>
</tr>
<tr>
<td>• Identify mothers with high MS counts</td>
<td>• Assess fluoride sources &amp; recommend supplementation as required</td>
</tr>
<tr>
<td>• Referral to dentist if active caries apparent</td>
<td>• Anticipatory guidance: teething, nutrition, brushing and fluoridation</td>
</tr>
<tr>
<td>• Caries education: causes and transmission MS</td>
<td>• Assess &amp; utilize community oral health supports</td>
</tr>
<tr>
<td>• Anticipatory guidance: oral health during pregnancy</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Postnatal assessment</th>
<th>12 month &amp; ongoing q 6 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Review caries history and risk assessment</td>
<td>• Oral examination for tooth lesions &amp; gum health</td>
</tr>
<tr>
<td>• Maternal MS levels if not done in past 3-4 months - assess need for antimicrobial treatment; treat q 3-4 months as required</td>
<td>• MS counts and treatment on high risk mothers x 2 years</td>
</tr>
<tr>
<td>• Refer to dentist if active cavities apparent.</td>
<td>• Review of fluoride intake, supplement as required</td>
</tr>
<tr>
<td>• Anticipatory guidance: feeding habits and teething</td>
<td>• Anticipatory guidance: oral hygiene &amp; brushing, nutrition, preventable oral traumas</td>
</tr>
<tr>
<td></td>
<td>• Referral for first dental visit &amp; to community oral health programs</td>
</tr>
</tbody>
</table>
Summary

ECC is not a life-threatening disease but it is a life-altering disease caused by the effects of a known pathogen. Many FN children experience life-altering sequela as a direct result of early childhood caries. Some of these children are prevented from reaching their full potential. A treatable life-altering infectious disease that has the capabilities to cause such devastation to high-risk populations, including our own First Nations children, deserves our immediate and focused attention. Nurse Practitioners are in the privileged position of having the skills, SOP, and opportunity to champion a renewed multidisciplinary fight against ECC in high-risk Canadian FN children.


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Department of Community Dentistry, Faculty of Dentistry. Toronto: University of Toronto.


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Health Promotion into the 21st Century, meeting in Jakarta from 21 to 25 July 1997.


Appendix

*CPS's Recommended Supplemental Fluoride Concentrations for Children*

Fluoride concentration

<table>
<thead>
<tr>
<th>Age of child</th>
<th>&lt;0.3 ppm</th>
<th>&gt;0.3 ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-6 months</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>&gt;6 months - 3 years</td>
<td>0.25 mg/day</td>
<td>none</td>
</tr>
<tr>
<td>&gt;3 to 6 years</td>
<td>0.5 mg/day</td>
<td>none</td>
</tr>
<tr>
<td>&gt;6 years</td>
<td>1.0 mg/day</td>
<td>none</td>
</tr>
</tbody>
</table>