

**A REVIEW OF STRATEGIES AND PROGRAMS FOR
THE PREVENTION OF EARLY CHILDHOOD CARIES**

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INTRODUCTION

The oral health of children in North America has improved significantly over the last forty years. However, Early Childhood Caries (ECC) has remained a challenge in socioeconomically disadvantaged populations as well as in certain cultural and ethnic groups.

ECC is the most recent name for a distinct form of a rampant dental decay in children aged 1 to 3 years, introduced at a workshop sponsored by the Centers for Disease Control and Prevention in September 1994 (1). For many years it has been known and is still often referred to as Baby Bottle Caries, Nursing Bottle Syndrome, Night Bottle Mouth or Nursing Caries.

Prevalence

Numerous studies have been conducted in Canada and the United States to determine the prevalence of ECC. The estimated prevalence rates range from 1 to 72 percent, and vary markedly between ethnic, cultural and socioeconomic groups (2-4).

The lower-end values are found in the urban communities: 1%, Los Angeles, California; 3.2%, Vancouver, British Columbia; 5%, Richmond, Virginia; 6%, City of North York, Ontario; 7.4% City of Toronto, Ontario; the middle-range values (11.5%-28%) in inner-city communities; and the upper-end values in minority and aboriginal populations.

In Canada, ECC is most prevalent in the Inuit population of the Northwest Territories: 55% by 30 months of age and 65% by 48 months of age are affected by the disease (5). In the United States, Native Indian and new immigrant Hispanic children appear to be at the highest risk for ECC. The prevalence rates in these populations are 42%-72% and 24%-30%, respectively (2-4,6).

The two main factors contributing to the variability of ECC prevalence data are: 1) the lack of the universally accepted definition and epidemiological index of ECC, and 2) the uneven distribution of the risk factors in the segments of the populations studied.

Clinical Appearance and Associated Health Effects

ECC always affects maxillary incisors, very often first molars and occasionally canines and second molars, in order of eruption; mandibular incisors usually remain sound (5,7,8). It starts as dull white bands along the gingival margin of the labial surface of maxillary incisors. Yellow

discoloration, cavitation and lateral and incisal extension of the lesions follow. When advanced, the cavities encircle the neck of the teeth in a brown or black collar and only a small area of sound enamel remains at the incisal edge. Crowns fracture easily, leaving decayed root stumps (3,7). When molars are affected, the occlusal surfaces are usually involved (7). Pattern of decay on the canines resembles that on the incisors (7). The lesions tend to be symmetrical and are generally most extensive and severe on the maxillary incisors (3,7).

Caries attack may be initiated as soon as the teeth erupt. The onset is always acute and the progression is usually very rapid (3,7). The exposure of the pulp may occur within six months to one year, causing pain and periapical infection. The latter can affect the permanent dentition and cause systemic sepsis (9). If not arrested, ECC destroys the dentition by the age of 30 months (7). The disfigurement of the teeth interferes with eating, speaking and aesthetics.

Children with ECC very often require orthodontic treatment (6), and are at a substantial risk for future dental decay (10). In severe cases, they fail to thrive and weigh below the average for their age (11,12). Speech and psychological consequences are not uncommon in these children (6).

Risk Factors

ECC, as it is with dental decay in general, occurs as a result of the interplay between: (1) cariogenic bacteria, (2) diet of refined carbohydrates, (3) decreased enamel resistance, and (4) time for the cavity to develop and progress.

Many factors have been implicated in the pathogenesis of ECC. The most common is a naptime, nighttime and/or 'at will' use of a nursing bottle with cariogenic content (milk, fruit juice, infant formula, vitamin supplements, sugared water, tea), beyond the age of one (3,13,14). A similar pattern of a sweetened pacifier use (15,16), as well as breast feeding (3,17) is also implicated, though less often. It has not yet been determined if these nursing practices are the result of parental overindulgence, neglect or lack of authority (3).

The majority of children with ECC have caregivers with a very high counts of *Streptococcus mutans* (17,18,19). They are themselves densely infected with this bacterium too, regardless of the severity of ECC (20).

ECC occurs more often in children with: 1) history of premature birth, labor and delivery abnormalities followed by nutritional disturbances, 2) maternal illnesses affecting the metabolism

of the fetus (toxemia, hyperemesis gravidarum, anaemia, significant medical conditions, and 3) recurrent early childhood diseases (3,7,12,21-24). Children with ECC also tend to have a background of a low income, single parent, recent immigrant and ethnic minority families (3,21,25-27).

Treatment and Treatment Cost

The treatment of ECC is usually extensive and costly. Often several teeth need to be treated, and it is not uncommon for pulpotomies, extractions, full crowns, and prostheses for space maintenance, esthetics and/or chewing to be indicated (3). The complexity of the procedure frequently requires a deep sedation or general anesthesia, exposing a child to the additional health risks.

The estimated treatment cost for moderate to severe ECC ranges from \$700 to \$1,200, and could be as high as \$3,000 (3,4,28). With the cost of transportation to and from a treatment facility, cost to care for other siblings and lost earnings to the parent(s), this figure is much higher. As a result, ECC represents a significant financial burden to society, in particular in the communities with a high prevalence of ECC since in these communities the majority of children rely on public health support.

Assuming the prevalence of 5 percent in the population of children aged one to three years and the average treatment cost of \$650, it has been estimated that in Ontario the annual ECC treatment expenditure is \$13,845,000 (29). Milnes has concluded that in Manitoba '...substantial sums of money are spent by Medical Services to provide dental treatment to pre-school aboriginal children with nursing caries...' (2).

OBJECTIVE

Bearing in mind that ECC has the potential to develop into a serious health condition, is more prevalent than many other childhood diseases, its risk factors are mainly modifiable, and that health treatment resources are becoming increasingly scarce, this project was undertaken to determine what has been done in scientific and professional communities to control this disease. In this context, the attempt was made to systematically review:

1. the strategies and programs for ECC prevention, currently implemented or being developed in Canada and the United States,

and

2. the studies undertaken to evaluate the effectiveness and/or cost-effectiveness of these interventions.

METHODOLOGY OF LITERATURE SEARCH

The English language literature from the years 1980 to 1996 was searched. The search strategies were: (1) a search of the computerized bibliographic data-bases including Medline, Dental Abstracts, Health Services Abstracts, PsychINFO, ERIC and Wilson Indexes to Journal Articles, (2) a search of the Index Medicus and the Index to the Dental Literature, (3) a hand search of journals known to publish information on ECC, and (4) a screening of bibliographies of documents retrieved by 1, 2 and 3 and follow-up of any relevant references. The information on unpublished materials was gathered via Internet communication (e-mail server "dental-public-health@list.pitt.edu") and personal correspondence with field experts.

The Medline was searched under the following Medical Subject Headings (MeSH): Dental caries, Preventive program/intervention, and Prevention of dental caries. The key-words and their combinations used were: dental caries, nursing caries, baby bottle caries, rampant caries, caries prevention, prenatal/postnatal care, infants, bottle feeding, and health education.

RESULTS

The literature collected in this project provides many suggestions for ECC prevention that are believed to be efficacious in controlling this disease. However, from the information gathered it is evident that to date only a few programs aimed at the prevention of ECC have been implemented and none has been evaluated for its effectiveness/cost-effectiveness. These programs are composed of primary prevention intervention(s), secondary prevention intervention(s), or both.

Primary prevention interventions have largely used the traditional health education approach. Psychologically-based interventions with cognitive behavioral components, such as stress management and self-efficacy training, have been also recommended to help the parent/caretaker to disassociate nursing from sleeping habits, but none has yet been used (26).

Programs using traditional health education approach provide parents and children's caretakers with information concerning ECC and its risk factors, and seek to promote weaning from the bottle and breast at the age of twelve months. They have mainly been delivered on an individual basis, most often in the form of prenatal classes and other prenatal groups, visits to obstetricians' offices, postnatal home visits, well-baby clinics and medical visits at about twelve months of age.

Secondary prevention intervention consists of the application of fluoride varnishes. The research in this area has been initiated recently, in a recognition of a need for a professional intervention in high-risk populations. The first pilot study completed has indicated a decrease in the prevalence of ECC in children of migrant workers in Yakima Valley, Washington, six months after their maxillary incisors had been treated with fluoride varnish (30); the results of a randomized clinical trial in the same population are expected soon (30,31). The application of fluoride varnishes has been used either as a preventive measure per se or as a component of more complex programs for ECC prevention.

Main findings

The United States - In the United States several national, state and local organizations and agencies have implemented or are developing programs for ECC prevention.

Aboriginal communities

Working with 12 Indian and Alaska Head Start programs, Bruerd *et al* (32) developed community-based interventions for the prevention of ECC in their respective Aboriginal populations. They resulted from a cooperative effort of the three agencies of the Department of Health and Human Services: Administration for Children, Youth and Families, Head Start Bureau; Indian Health Service, Dental Program; and Centers for Disease Control, Dental Disease Prevention Activity.

The project closely followed the PRECEDE model for planning, design and implementation of health education programs. In the first step, the prevalence of ECC was determined. The data were used to demonstrate to the local people that ECC represented a serious problem in their communities. It was followed by the behavioural study conducted to determine infant feeding

practices in these populations. Once excessive use of nursing bottle was determined, research on the values, attitudes, beliefs and parenting skills (overindulgence/neglect) surrounding this practice was undertaken. The information gained through the last two activities was used to design a culturally acceptable educational intervention. To conform the PRECEDE model, the whole community was involved in the development and delivery of the interventions: health professionals, tribal employees, parents volunteers and the local media.

The intervention focused on the elimination of bottle feeding by 12 months of age, while recognizing that nursing had special cultural significance for the Aboriginal mothers and that there was a very strong desire on the part of both mothers and grandmothers to continue bottle feeding beyond the child's age of one. Three modes were chosen to implement the intervention: person-to-person counseling, small-group sessions and a media campaign. Health professionals, tribal employees and parents volunteers were responsible for the program delivery on both an individual and group basis. The counselors were trained by professionals in adult education through 32 hours of instruction, discussion and role-playing. They were encouraged to individualize the information for their communities, according to the structure of society and its health system.

The educational materials included: 1. a slide presentation "Parents Helping Parents" about ECC and methods of its prevention; 2. a two-handled cup (tippee cup) imprinted with a "Stop BBTD" logo for the program participants; 3. "Stop BBTD" bumper stickers for the program participants; and 4. BBTD coupons for the program participants and their friends/relatives for trading nursing bottles for the cups at the local "swap shops".

The media campaign consisted of a series of posters, public service announcements and newspaper articles released quarterly over a 3-year-period concerning ECC and its prevention. The messages changed with each news release, and the target population varied to include parents, grandparents, siblings and other caretakers of young children.

The program implementation started in 1985 at four sites; in 1986 the remaining eight sites were included too. Data collected over the first four years following the program implementation showed a decrease in the prevalence of ECC in these communities, ranging between 43 and 57 percent. It indicated the possibility that these interventions are effective in preventing ECC. However, the definite time-trend has not been established since the follow-up data beyond this initial observational period are not available. Regardless, periodic survey data would be

insufficient to confirm the effectiveness of these interventions; it would require a study involving a comparison group.

The State of Washington

In the State of Washington, ECC preventive programs have been implemented at three sites: Seattle-King County, Yakima Valley and Spokane County.

Seattle-King County - In 1995, the Department of Public Health of Seattle-King County collaborated with the Women with Infant Children (WIC) program, a federal food program designed to assist low income mothers to get proper diet and nutrition counseling for themselves and their infants, to include a dental component into the periodic evaluations of program recipients(33). As a result, two activities were added to the visits to mothers with young children: 1. a discussion about bottle feeding practices, and 2. a screening for ECC using "lift the lip" technique. When carious changes are noted, from white spots to open decay, children are referred to the Department's clinics for fluoride varnish and/or glass ionomer treatment.

Yakima Valley - A program similar to that implemented in Seattle-King County has been operating in the Farm Workers Clinic, Yakima Valley, central Washington. This program targets recent immigrant families of Mexican descent (33).

Spokane County - In February 1995, a Dental Prevention Demonstration Project "ABCD - Access to Baby and Child" was launched in Spokane County. It involves oral health education and multiple applications of fluoride varnish for children from birth to five years of age, whose families are low income and are enrolled in the Medicaid program (34).

In September 1996, a study to evaluate the effectiveness and cost-effectiveness of the ABCD program was initiated. Using a non-equivalent control group design, this study is aiming to determine the differences in the dental services utilization rates between Spokane county and a county similar to Spokane county in all aspects but the ABCD program. These will be the indicators of the program's impact on the incidence of ECC as well as of its cost-effectiveness in preventing ECC.

The State of Texas

The Bureau of Dental Health Services of the Texas Department of Health, the WIC program and the Maternal and Child Health (M&CH) program have developed and implemented an intervention for ECC prevention, targeting Medicaid and Head Start recipients (35).

This statewide campaign involves the following preventive strategies: 1. monthly small-group ECC education sessions delivered by the WIC and MCH staff, accompanied with low-literacy pamphlets reinforcing the message: "No bottle at bed time", as a prerequisite for young mothers to obtain infant food supplements; 2. brochures about ECC given out at the time of child immunization; 3. ECC posters in all WIC and MCH clinics; 4. ECC pamphlets mailed to the Medicaid recipients; 5. tippee cups in exchange for nursing bottles; and 6. a series of articles about ECC in local newspapers on two occasions.

In addition, this campaign involves a five minute video presentation "Looking to Keep Decay Away" (36) to teach parents and non-dental health workers to diagnose incipient ECC using 'lift the lip' technique. It also implicates use of a nursing bottle as a major risk factor for ECC, encourages parents to wipe a child's teeth with a tiny bit of fluoride tooth paste daily and discusses mother's oral cross infectivity.

The Department has recently started planning another campaign, "Tooth White Spot Awareness". This program is going to be targeted at parents (through prenatal visits), non-dental health professionals most likely to see children before ECC develops, and dentists. In October 1996, this campaign was at a draft stage (36).

The State of Oklahoma

In the State of Oklahoma, most of the Head Start parents are involved in regular prenatal and well-baby clinics that offer a variety of ECC educational programs and materials (6). The Indian Health Services (IHS) medical staff and other health workers in Aboriginal communities receive in-service training on ECC and its prevention. They are encouraged to counsel parents on the effects of inappropriate bottle feeding.

The annual dental screening of program participants has not indicated a downward trend in the prevalence of ECC, raising doubts about the effectiveness of these preventive strategies (6).

The State of California

In the State of California, one program for ECC prevention has been implemented and one is being developed. Information concerning these programs is very limited

The program that is in place has been initiated by the California Dental Association as "an intensive informational campaign directed toward both the profession and the lay community" (1). Other than that involves informing parents about ECC through the news media, pediatrician's offices and well-baby clinics, details about this campaign are not available.

The Dental Services of the San Francisco Department of Public Health are developing a program which will use educational and clinical approaches, involving primary and secondary preventive measures. The following strategies are being considered: 1. oral health education for pregnant women; 2. training for pediatricians to detect incipient ECC; 3. annual dental screening and fluoride varnish application to children in preschool institutions in low-income communities; 4. fluoride varnish application for the younger siblings of children visiting the city clinics for the treatment of ECC (37).

Canada - In Canada, three programs for ECC prevention have been implemented so far. Of these, has been operating in the Province of British Columbia and two in the Province of Ontario.

The Province of British Columbia

The ECC prevention program gradually launched in a First Nations community in British Columbia between 1992 and 1996 (38) is very similar to the Bruerd's intervention (32). It is a community-based, culturally-sensitive program with the preventive activities developed according to the information about infant and toddler care and feeding practices gathered through interviews with young mothers. They are: (1) pamphlets and posters concerning clinical characteristics, health consequence and risk factors of ECC, and (2) oral health counseling incorporated into the visits to expectant mothers and regular well-baby visits by Public Health Nurses.

A step further to the Bruerd's intervention was made by establishing a Cradle Loan Service and constructing a smokehouse in this community. This was done in an effort to introduce the traditional aboriginal infant comforting practices that had been used to soothe fussy infants and toddlers before baby bottles were made available to the families in the First Nations communities: swinging in a cradle and sucking of smoked meat and fish.

Positive changes in infant feeding and comforting practices as well as a decrease in the prevalence and severity of ECC were observed four years after the initiation of this project. In 1996, 78% of children were off the bottle by the age of two, compared with 63% in 1992. The prevalence of ECC fell by 15%, while the average *def* and *defs* were reduced by 0.8 and 3.4 respectively.

The Province of Ontario

Simcoe County - In 1993, the Simcoe County District Health Unit and the Muskoka-Simcoe Dental Society initiated a project for ECC prevention, in a contribution to the Dental Health Month in their jurisdiction (39). A "Baby Bottle Decay" pamphlet was developed, depicting clinical characteristics, health consequences and risk factors for ECC. With the support of the executive committees and Boards of Health, this pamphlet has been mailed continuously to the families of all newborn children following the implementation of the campaign. The impact of this action on the prevalence of ECC is yet to be evaluated.

Sioux Lookout Zone - In Sioux Lookout Zone, an area in northwestern Ontario inhabited by First Nations' people residing in 24 communities, the implementation of an intervention aimed at ECC prevention was started in March 1997 (40). To date, 9 of these communities have had a dental component added to the nutrition program that targets pregnant women, mothers with newborn children and elders raising infants and toddlers. It involves the following ECC preventive activities: (1) home visits to newborns and small-group sessions for caretakers of young children by a community nutrition worker trained to advise on a proper use of nursing bottle and toothbrush as well as nutrition needed for healthy teeth, (2) ECC educational package "Your Baby Smile" provided to all new mothers within a month of a child's birth, and (3) tippee cups and toothbrushes as a six-month birthday present for all children. This program has been initiated by the Dental Department of Sioux Lookout Zone Hospital.

DISCUSSION

Considering that ECC has a potential to devastate the dentition of babies and toddlers, is very prevalent in ethnic minority communities and incurs high expenditures to individuals and society for its treatment, it is evident from the results of this project that there has been very little effort from scientific and professional communities to control this disease.

Very few programs for ECC prevention are being delivered and few are being developed in the United States and Canada. Furthermore, the majority of the programs implemented so far have used a traditional health educational approach exclusively. Since this preventive strategy has shown a very limited success in altering oral health habits and reducing the occurrence of dental disease (41), it is highly unlikely that these programs can have a significant effect on ECC. In conformity with this are the results of a study by Weinstein *et al* (26). They found that only 52.2% of the parents enrolled in the WIC program for Mexican migrant families in Yakima Valley, whose children were diagnosed with ECC but still using nursing bottle at nap/night time, could recall the information about the risk of this habit that had been provided in prenatal classes.

It is widely recognized that infant feeding practices, the most common risk factor for ECC, are influenced by various ethnic, cultural, familial and socioeconomic factors, and that individuals tend to comply not with professional advice but with these factors that are "...more central to their well-being..." (42). Therefore, these factors have to be integrated into the ECC preventive interventions if they are to be effective. However, none of the interventions implemented until now have had any of these factors incorporated in their preventive strategies. Instead, they are limited to providing a general information about ECC and recommendations for bottle/breast weaning by the age of twelve months to parents and other child caregivers in the targeted populations. The exceptions are programs developed by Bruerd (32) and Harrison (39), where the attempts have been made to involve the whole community as well as to develop culturally sensitive educational interventions.

The effectiveness of the interventions that are currently implemented is not known since none has been fully evaluated so far. The only available information concerning the effectiveness of these interventions has been gathered through period surveys, which is very weak evaluative design. It has been encouraging for community based interventions (32,39) solely.

The application of fluoride varnishes, recently introduced as a strategy for the prevention of ECC in high risk populations, seems promising given that it does not rely on parent's/caregiver's compliance. However, the research in this area is in a very early formative stage meaning that effects and potential side-effects of this approach to ECC prevention are not yet known.

CONCLUSION

Having that, on one hand, ECC is a serious childhood disease and a significant public health problem in several diverse sociocultural population groups and, on the other hand, that very little has been done in the United States and Canada for its prevention, the need to develop effective strategies to control this disease is compelling..

As it has been highlighted at the symposium "Needed - A research agenda for nursing caries", held at the 23rd Annual Meeting of the International Association of Dental Research, Seattle, Washington, 1994, as well as at the Early Childhood Caries Conference, held at the Natcher Center, National Institute of Health, Bethesda, Maryland, 1997, ECC preventive efforts should: (1) focus on high-risk populations, (2) consider the multifactorial origin of ECC, (3) incorporate knowledge on the health attitudes, beliefs and norms predominant in the respective community, and (4) involve the whole community (43,44). Provided that the application of fluoride varnishes is effective and safe, it should be included in the preventive programs too. The educational interventions should concern not only proper use of a nursing bottle but also methods of prevention of enamel hypoplasia caused by a compromised nutritional status during the formative stages of the primary dentition. Psychologically-based interventions with a cognitive-behavioural approach should be given more consideration when planning and designing ECC preventive programs since there are indications that they are effective in achieving permanent changes in health behaviours and the adoption of healthier lifestyles (41).

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