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Early Childhood Caries: A Review

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ABSTRACT
Dental caries is a globally public health challenge especially amongst young children. Early childhood caries (ECC) is a serious public health problem in both developing and industrialized countries. At first time it appears as white spots along the gingival margin of maxillary primary incisors. As the disease progresses, the white spots develop into cavities which gradually enlarges resulting in complete loss of the crown structure. The major risk factors associated with the etiology of ECC are classified into microbiological factors, dietary factors and environmental factors and in addition to these, several other contributory factors have been identified. Factors like improper feeding practices, poor socioeconomic conditions, illiterate parents and inability to avail dental care can also contribute to the development of ECC. It is important to maintain the primary teeth in a healthy condition as it is essential for chewing, speech, facial beauty, preservation of space and prevention of a bad habits and most common immediate consequence of untreated dental caries is dental pain which disturbs the regular activities of children such as talking, eating, sleeping and playing and severe ECC can lead to functional, aesthetic and psychological disturbances of the child due to early loss of teeth. ECC is not self-limiting and hence requires treatment to remove infection and restore its function. The treatment of ECC includes educating and counseling of parents, fluoride application, oral hygiene measures, dietary guidance and therapeutic measures. Since oral health establishes an integral part of general health, ECC if left untreated can lead to major health issues. In this review, we give detailed information of ECC, from its diagnosis to management.

KEY WORDS: Early Childhood Caries, Prevalence, Risk Factors

I. INTRODUCTION

Dental caries is the most common chronic infectious disease of childhood, caused by the interaction of bacteria, mainly Streptococcus mutans, and sugary foods on surface of enamel. S. mutans can spread from mother to baby during infancy and can inoculate even pre-dentate infants. These bacteria break down sugars for energy, causing an acidic environment in oral cavity and result in demineralization of the enamel of teeth.[1] Early childhood caries (ECC) is a serious public health problem in both developing and industrialized countries.[2] Early Childhood caries is a form of rampant caries affecting the primary teeth of infants and toddlers. Dental caries in pre-school children and toddlers was described by several terms like baby bottle decay or nursing bottle caries. In 1978 the American Academy of Pedodontics and the American Academy of Pediatrics issued a joint statement [3] which stated that improper bottle feeding was responsible for the severe form of caries in toddlers and children. They suggested that to avoid nursing caries, bottle feeding should be stopped after the first birthday. However, over the next few decades it was recognized that improper bottle feeding was not the only causative factor of this caries and a multifactorial etiology was suggested. In 1994 the Center for Disease Control and Prevention recommended the term early childhood caries to focus attention on the various contributory factors that lead to caries in toddlers and children. Early Childhood Caries is defined as the presence of one or more decayed (cavitated or non-cavitated), missing teeth or filled tooth surfaces in any primary tooth in a preschool child between birth and 71 months of age. In children younger than three years of age any sign of smooth surface caries is an indication of severe early childhood caries. In children between three-years to five-years, severe ECC is recognized by the presence of one or more cavitated or missing teeth or filled tooth surface in primary maxillary anterior teeth. [4] The American Academy of Pediatrics demonstrates that dental and oral infections keep on infecting children and, specifically, very young children. In primary teeth, dental caries is a preventable and reversible disease if treated in early stages, but when left untreated it

will lead to pain, bacteremia, alteration in growth and development, premature tooth loss, speech disorder, increase in treatment costs, loss of confidence, and negatively affect successor permanent teeth. Dental caries in young children have a pattern; diverse terms and terminology have been utilized to express them.[5] The definitions used previously to describe this bacterial disease were related to cause and the improper utilization of nursing bottle. These terms are used interchangeably: "Early childhood tooth decay", "early childhood caries (ECC)", "bottle caries", "nursing caries", "baby bottle tooth decay", or "night bottle mouth".[6,7] The expression "ECC" was proposed more than 20 years ago during a workshop supported by the Centers for Disease Control and Prevention (CDC) trying to scope the consideration upon the various issues, such as financial, sociopsychological, and behavioral, which contributes to the formation of caries at such initial years, instead of attributing its manifestation solely on feeding bottles.[8] Its consequences can affect the immediate and long-term quality of life of the child and family.

PREVALENCE

The prevalence of ECC shows a wide variation between different continents and countries and its also varies with several factors like race, culture, ethnicity, socioeconomic status, lifestyle, dietary pattern and oral hygiene habits. Data collected from different parts of the world suggests that in most developed countries the prevalence of ECC is between 1 and 12%.[9] The prevalence of ECC is high in children of families belonging to low socioeconomic categories who also suffer from malnutrition.[10]The prevalence of early childhood caries is highest in Africa and South-East Asia.[11] The prevalence of ECC reported from USA and Europe is comparatively lower than the prevalence in Asia. The prevalence ranged from 11.4% in Sweden to 7 – 19% in Italy.[12] A high prevalence of ECC has been reported from some Middle Eastern countries, such as Palestine (76%) and the United Arab Emirates (83%).[13,14] A wide range of variation has been observed in the prevalence reported from various countries such as Greece (36%), Brazil (45.8%), India (51.9%), and Israel (64.7%).[15-18] According to another study,[19] the highest prevalence of ECC is found in the 3-4 years old age group and boys are significantly more affected than girls. In the United States, the CDC detailed that the predominance of dental decay between young children aged less than 2 years and not older than 5 years (between 2 and 5 years old) was 24.2% in 6 years between 1988 and 1994 and increased by about 3% (27.9%) between 1999 and 2004; this is according to the third National Health and Nutrition Examination Survey.[20,21] In developing nations, the prevalence of ECC shows an estimate of 1 to 12% in infants, and this increases to reach 85% that has been accounted for disadvantaged groups.[22-24] In the Western world, the pervasiveness at age 3 was about 20%, and solid affiliations were discovered with ethnicity and financial ability.[25] In the Japanese nationwide overview in 2007, 2.8% of the children aged around 18 months experience ECC, while 25.9% of the kids aged 3 years experience the same condition in Japan.[26]

ETIOLOGY

Research has confirmed that ECC is a multifactorial disease. As any caries lesion, ECC is caused by poor oral hygiene, bacterial invasion, bad diet habits, etc.[27,28] Also, the presence of enamel defects might contribute to the formation of lesion, such as hypoplasia, known as hypoplasia-associated severe early childhood caries.[29] This type of decay influences generally young kids at or beneath levels of poverty, teeth which are usually vulnerable to caries have structural damage.

RISK FACTORS

There are several factors that contribute to the formation of ECC, some of which will be discussed in this review.

MICROBIOLOGICAL RISK FACTORS

The ECC is a transmittable disease. Streptococcus mutans (SM) and Streptococcus sobrinus are the most widely recognized causative specialists. Lactobacilli additionally have a distinct role in the caries progression but not in its initiation.[30] Studies have shown that there are two ways for SM transmission: Vertical and horizontal transmission. Vertical transmission is carried between caregiver and child (i.e., mother or father to child).[31] Subsequently, poor maternal oral hygiene and higher sugar intake per day rise the chances of transferring the disease to the child by the mother.[32] Whereas, for horizontal transmission, neonatal factors may increase the chance of acquiring SM. Infant delivery by cesarean section transmits SM earlier than through natural deliveries.[33] The time of 13 to 16 months is roughly needed between SM colonization and caries lesion initiation and advancement.

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DIETARY RISK FACTORS

In addition to infection with SM bacteria, children who have high-sugared drinks also suffer from ECC. Sugar is processed by both SM and lactobacilli that will furthermore transform it into acid, which will cause demineralization of tooth structure. Evidence recommends that both cow's and human milk are considered to be less cariogenic than sucrose, with cow's milk being the least cariogenic. The cariogenic capability of newborn child equations fluctuated over the reviews, with some being as cariogenic as sucrose. On the contrary, the available evidence in the literature discussing the cariogenicity of breast milk is weak and lacks consistency, whereas the cariogenicity of milk formulas varies across studies. [34,35] The best accessible data show that low level of caries in nations is associated with sugar utilization between 40 and 55 gm per person in 1 day.[36] The connection among proper diet and dental caries has turned out to be weaker in contemporary society and this has been credited to the broad utilization of fluoride.[37]

ENVIRONMENTAL RISK FACTORS

Several studies have confirmed that when SM bacteria have been acquired at an early age, it will mostly lead to ECC, where other factors might contribute to caries progression or prevention, such as socioeconomic status of caregivers, water fluoridation, race, number of years of education, and dental insurance coverage.[38-40]

Relationship among ECC and the financial status has been very much reported. Children with a background marked by dental caries, whose parents and siblings have serious dental caries, are viewed as being at high risk of having dental caries in their future.[41,42] Additionally, kids involvement of financial burden influences grownup dental well-being.[43] Absence of access to dental care, deficient accessibility of preventive measures, for example, water fluoridation, fluoride supplementation, and dental sealants, and the absence of information of the significance of oral well-being are contributing elements to an oral well-being decrease in young children.

FEEDING PRACTICES

Inappropriate use of baby bottle has a central role in the etiology and severity of ECC. The rationale is the prolonged bedtime use of bottles with sweet content, especially lactose. Most of the studies have shown significant correlation between ECC and bottle-feeding and sleeping with a bottle.[44-46] Breastfeeding provides the perfect nutrition for infant, and there are a number of health benefits to the breastfed child, including a reduced risk of gastrointestinal and respiratory infections.[47] However, frequent and prolonged contact of enamel with human milk has been shown to result in acidiogenic conditions and softening of enamel. Increasing the time per day that fermentable carbohydrates are available is the most significant factor in shifting the re-mineralization equilibrium toward de-mineralization.[48] There appears to be a clinical consensus amongst dental practitioners that prolonged and nocturnal breastfeeding is associated with an increased risk of ECC, especially after the age of 12 months. These conditions explained by less saliva production at night result in higher levels of lactose in the resting saliva and dental plaque for longer than would be expected during the day. Thereby, balance is shifted toward de-mineralization rather than re-mineralization during the night because of the insufficient protection caused by reduced nocturnal salivary flow.[49,50]

SOCIO ECONOMIC FACTORS

Association between ECC and the socioeconomic status (SES) has been well documented. Studies suggested that ECC is more commonly found in children who live in poverty or in poor economic conditions,[51,52,5354,55] who belong to ethnic and racial minorities,[56] who are born to single mothers,[57] whose parents have low educational level, especially those of illiterate mothers.[51,58,59] In these populations, due to the prenatal and perinatal malnutrition or undernourishment, these children have an increased risk for enamel hypoplasia and exposure to fluorine is probably insufficient[56] and there is a greater preference for sugary foods.[60] The possible influence of SES on dental health may also be a consequence of differences in dietary habits and the role of sugar in the diet.[61] In their review on inequalities in oral health, Sheiham and Watt indicated that the main causes of inequalities in oral health are differences in patterns of consumption of non-milk sugars and fluoride toothpaste.[62]Weinstein[63] emphasizes the discrepancy in ECC prevalence rate: 1–12% in developed countries, whereas it as high as 70% in developing countries or within select immigrant or ethnic minority populations. Authors in Ref.[64] confirm that children with parents in the lowest income group had mean Decayed, Missing, and Filled Teeth (dmft) scores four times as high as children with parents in the highest income group.

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CONSEQUENCES OF UNTREATED DENTAL CARIES IN CHILDREN

The direct consequence of untreated dental caries is pain which affects children's regular activities such as eating, sleeping, talking and playing. Adequate duration of sleep is important for proper functioning of metabolic processes, hormonal processes and regulation of appetite. Lack of sleep can make an individual more susceptible to disease and moreover sleep is also important for recovery from illness. Severe ECC causes chronic pulpitis and this chronic inflammation affects erythropoiesis leading to anaemia. [65] The anaemia caused by chronic disease is also called anaemia of inflammation. Chronic disease may cause certain changes in the red blood cells. These changes can cause early death of the red blood cells and their production is slowed down. In anaemia of chronic disease, the iron that is normally recycled from old RBCs to make new RBC is retained within macrophages. This reduces the amount of available iron needed to form new cells. In addition, there is impairment of iron metabolism within the cells. Severe ECC can lead to the loss of the child's front teeth at an early age which may result in impaired speech development. The early loss of maxillary central incisors may cause incidents of taunting by the child's siblings, peers and family members which often results in poor self-esteem. Severe ECC often requires early extraction of molars which may lead to orthodontic problems in the future. Teeth affected by ECC may need expensive restorative treatments which may cause financial problems in the families of children affected by ECC.[66]

DIAGNOSIS

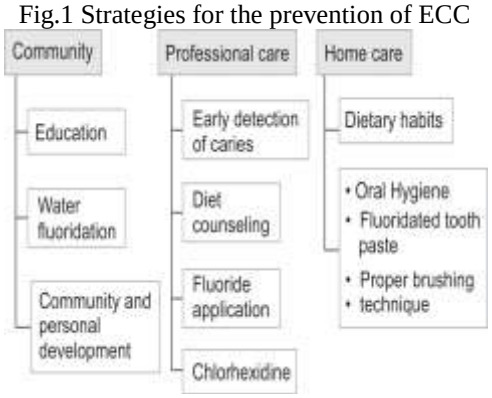
The ECC starts with a white spot lesion on the maxillary primary incisors along the cervical third of the crown (on the edge of the gingiva). In general, the decay is first seen on the primary maxillary incisors, and the four maxillary anterior teeth are often involved concurrently.[67] If the lesion is not arrested and disease continues, caries will progress to form a cavitation.[68,69] The lesion may appear on either facial or lingual surfaces or on both.[27] Young children that have ECC are more susceptible to caries infection in both primary and permanent dentitions.[70,71] The ECC is not only limited to oral health but is also widespread to cause several health problems. Children with ECC have a slower growth rate when compared with caries-free children, where also ECC may be affected with iron deficiency.[71] Moreover, the implementation of the new expression of ECC is now in use instead of the previous terminology of bottle caries, when at least one of the following criteria is accompanied by:

- Smooth surface caries in children ≤3 years
- In children between 3 and 5 years of age, any smooth surface of an anterior–posterior tooth, i.e., filled, missing (due to caries), or decayed
- The decayed, missing, and filled teeth index is equal to 4 or more for children 3 years of age, 5 for children 4 years of age, and 6 for kids 5 years of age.[72]

PREVENTION OF EARLY CHILDHOOD CARIES

There are three general approaches that have been used to prevent ECC (Fig 1). All three approaches include training of mothers or caregivers to follow healthy dietary and feeding habits in order to prevent the development of ECC.

Fig.1 Strategies for the prevention of ECC



PREVENTION OF MATERNAL BACTERIAL TRANSMISSION TO THE CHILD

The strategy to combat the early transmission of cariogenic bacteria from parents to their offsprings is often named primary prevention. The preventive intervention is most often directed to pregnant women and mothers of newborn babies. This includes the following. (A.). Reduce the bacteria in the mouth of the mother or caregiver. Earlier studies suggest that infants acquire SM from their mothers and only after the eruption of primary teeth.[73,74] Preventive interventions for the purpose of reducing the transmission of bacteria from mothers to children improve the likelihood of better oral health for the child.[75] Effective approach in the prevention of dental caries is the suppression of S. mutans in the mouth of the child's caregiver (usually the mother). Chemical suppression by use of chlorhexidine gluconate in the form of mouth rinses, gels, and dentifrices has been shown to reduce oral microorganisms.[76,77] (B.) Minimize the transmission of bacteria that cause dental caries. Minimizing saliva-sharing activities between

children and parents and caregivers limits bacterial transmission. Examples include avoiding the sharing of utensils, food, and drinks, discouraging a child from putting his/her hand in the caregiver's mouth, not licking a pacifier before giving it to the child, and not sharing toothbrushes. The goal is to prevent or delay children as long as possible from acquiring the bacteria that cause dental caries.

ORAL HEALTH EDUCATION

Dental caries cannot occur without the substrate component of sugar. Therefore, much of the professional advice and practical research has focused on modification of the infant diet and feeding habits through education of the parents.[78,79] Child health professionals, including but not limited to physicians, physician assistants, nurse practitioners, and nurses, can play a significant role in reducing the burden of this disease. While most children do not visit a dentist until the age of 3 years, children have visited a child health professional up to 11 times for well-child visits by this age.[78] Oral health education is a designed package of information, learning activities, and experiences that are intended to produce improved oral health.[80]With the primary goal of disease prevention, its purpose is to facilitate decision-making for oral health practices and to encourage appropriate choices for these behaviors. Effective health education may thus[81]

- Produce changes in knowledge;
- Induce or clarify values;
- Bring about some shift in belief or attitudes;
- Facilitate the achievement of skills; and
- Bring about change in behaviors or lifestyles.

Health promotion programs to stimulate tooth brushing have been among the most successful educational programs.[82,83] Cross-sectional surveys, clinical trials, and experiments for tooth brushing research studies involving populations of 1450–1545 children have found that tooth brushing with flossing twice a day resulted in increased tooth retention.[82]The American Academy of Pediatric Dentistry (AAPD) has given recommendations on anticipatory guidance, bottle-feeding habits to prevent ECC, and infant/toddler oral hygiene care.[84]

Avoiding caries-promoting feeding behaviors

I. Infants should not be put to sleep with a bottle containing fermentable carbohydrates.
II. Ad libitum breastfeeding should be avoided after the first primary tooth begins to erupt and other dietary carbohydrates are introduced.
III. Parents should be encouraged to have infants drink from a cup as they approach their first birthday. Infants should be weaned from the bottle at 12-14 months of age.
IV. Repetitive consumption of any liquid containing fermentable carbohydrates from a bottle or no-spill training cup should be avoided.
V. Between-meal snacks and prolonged exposures to foods and juice or other beverages containing fermentable carbohydrates should be avoided.

FLUORIDE

The use of fluorides for dental purposes began in the 19th century. Fluorides are found naturally throughout the world.[85] They are present to some extent in all foods and water, so that all humans ingest some fluoride on a daily basis. In addition, fluorides are used by communities as a public health measure to adjust the concentration of fluoride in drinking water to an optimum level (water fluoridation); by individuals in the form of toothpastes, rinses, lozenges, chewable tablets, drops; and by the dental professionals in the professional application of gels, foams, and varnishes. Fluoride varnish is a concentrated topical fluoride with a resin or synthetic base. At least 19 fluoride varnish reviews,[86] including a systematic review[87] and three meta-analyses,[88-90] have been published in English. In the last three decade, a great deal of research published that evaluated fluoride varnish efficacy in the permanent teeth of school-aged children,[91] regarding fluoride varnish differed for permanent and primary teeth. All of these studies stated, "The evidence for the benefit of applying fluoride varnish to permanent teeth is generally positive." Fluoride varnish works by increasing the concentration of fluoride in the outer surface of teeth, thereby enhancing fluoride uptake during early stages of de-mineralization. The varnish hardens on the tooth as soon as it contacts saliva, allowing the high concentration of fluoride to be in contact with tooth enamel for an extended period of time (about 1–7 days). This is a much longer exposure compared to that of other high-dose topical fluorides such as gels or foams, which is typically 10–15 minutes. The amount of fluoride deposited in the tooth surface is considerably greater in de-mineralized versus sound tooth surfaces.[92,93]Thus, the benefits of fluoride varnish are greatest for individuals at moderate risk or high

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risk for de-mineralization or tooth decay.[94] There is a global consensus that regular use of fluoride (F) toothpaste constitutes a cornerstone in child dental health. In fact, a global survey revealed that most experts addressed F toothpaste as the main reason for the dramatic decline in caries during the last decade of the 20th century.[95.] Moreover, toothpaste is probably the most readily available form of F and tooth brushing is a convenient and approved habit in most cultures.[96] Working groups within national Health Technology Agencies have independently and in parallel presented strong scientific evidence that daily tooth brushing with F toothpaste is the most cost-effective, self-applied method to prevent caries at practically all ages.[97-100] Because small children usually swallow 30% of the paste, it is important to limit the amount of toothpaste to a pea size or less.[101] According to Douglass et al.[1] the amount of toothpaste should not exceed the size of a rice grain or the tip of a pencil eraser for children as young as 6–12 months of age. Fluoride products such as toothpaste, mouth rinse, and dental office topicals have been shown to reduce caries between 30% and 70% compared with no fluoride therapy.[102,103] Because young children tend to swallow toothpaste when they are brushing, which may increase their exposure to fluoride, guidelines [Fig. 2] have been established to moderate their risk of developing dental fluorosis while optimizing the benefits of fluoride, by the American Dental Association (ADA) (2008)[104] The most common method for systematically applied fluoride is fluoridated drinking water shown to be effective in reducing the severity of dental decay in entire populations. Fluoridation of community drinking water is the precise adjustment of the existing natural fluoride concentration in drinking water to a safe level that is recommended for caries prevention. The United States Public Health Service has established the optimum concentration for fluoride in the water in the range of 0.7–1.2 mg/L.[105] Reductions in childhood dental caries attributable to fluoridation were approximately from 40 to 60% from 1949 to 1979, but in the next decade, the estimates were lower: from 18% to 40%.[78,100,105] This is likely caused by the increasing use of fluoride from other sources, with the widespread use of fluoride toothpaste probably being the most important factor.[78,99]

American Dental Association recommendation dosages for fluoride supplementation

	Water fluoride concentration (ppm)*		
Age of child	Less than 0.3	0.3-0.6	Greater than 0.6
Birth to 6 months	0	0	0
6 months to 3 years	0.25 mg	0**	0**
3 years to 6 years	0.5 mg	0.25 mg	0
6 years to 16 years	1 mg	0.5 mg	0

*2.2 ppm = 1 mg/L and 2.2 mg sodium fluoride contains 1 mg fluoride ion.
**Infants whose nourishment comes exclusively from breast milk need a 0.25 mg supplement

Fig.2 Recommended dosages for fluoride supplementation

TREATMENT

Treatment of ECC can be accomplished through different types of intervention, depending on the progression of the disease, the child's age, as well as the social, behavioral, and medical history of the child. Examining a child by his or her first birthday is ideal in the prevention and intervention of ECC.[84] During this initial visit, conducting a risk assessment can provide baseline data necessary to counsel the parent on the prevention of dental decay. Children at low risk may not need any restorative therapy. Children at moderate risk may require restoration of progressing and cavitated lesions, while white spot and enamel proximal lesions should be treated by preventive techniques and monitored for progression. Children at high risk, however, may require earlier restorative intervention of enamel proximal lesions, as well as intervention of progressing and cavitated lesions to minimize continual caries development.[106] The current standard of care for treatment of S-ECC usually necessitates general anesthesia with all of its potential complications because the level of co-operative behavior of babies and pre-school children is less than ideal. Stainless steel (preformed) crowns are pre-fabricated crown forms which can be adapted to individual primary molars and cemented in place to provide a definitive restoration.[107] They have been indicated for the restoration of primary and permanent teeth with caries, cervical decalcification, and/or developmental defects (e.g., hypoplasia, hypocalcification), when failure of other available restorative materials is likely (e.g., interproxima caries extending beyond line angles, patients with bruxism), following pulpotomy or pulpectomy, for restoring a primary tooth that is to be used as an abutment for a space maintainer, or for the intermediate restoration of fractured teeth. Another approach of treating dental caries in young children is Atraumatic Restorative Treatment (ART). The ART is a procedure based on removing carious

tooth tissues using hand instruments alone and restoring the cavity with an adhesive restorative material.[108-110] At present, the restorative material is glass ionomer. ART is a simple technique with many advantages, such as it reduces pain and fear during dental treatment,[111] it does not require electricity;[112] and it is more cost-effective than the traditional approach using amalgam.[113] It is an alternative treatment available to a large part of the world's population.[114] In addition, it is mostly indicated for use in children, as it is reportedly atraumatic because no rotary instruments are used and in most cases no local anesthesia is needed.[115]

II. CONCLUSION

Furthermore, dental practitioner need to build up the better approaches to offer preventive and clinically successful care. Logical advances must doubtful the boundary among dental and restorative practices. Dental practitioner must focus on utilizing existing techniques to distinguish indications of right on time and propelled early childhood caries and give guidance on the best way to counteract and control early childhood caries in patients.

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