Early Childhood Caries: Determining the Risk Factors And Assessing the Prevention Strategies For Nursing Intervention

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The daily reality for children with untreated oral disease is often persistent pain, inability to eat comfortably or chew well, embarrassment at discolored and damaged teeth, and distraction from play and learning” (U.S. Department of Health and Human Services [DHHS] Office of disease Prevention and Health Promotion, 2001, p. 108).

Dental caries is the most common communicable disease of childhood, affecting 41% of children in the United States (American Academy of Pediatrics [AAP], 2009; Centers of Disease Control and Prevention [CDC], 2005a). In Oral Health in America: A Report of the Surgeon General (DHHS, 2001), the Surgeon General found that oral diseases are progressive and cumulative, and they become more complex over time. They can affect our ability to eat, the foods we choose, how we look, and the way we communicate. If the damage is severe enough, the toddler can lose front teeth, resulting in developmental delays in speech, delays in play and learning” (U.S. Department of Health and Human Services [DHHS] Office of disease Prevention and Health Promotion, 2001, p. 108).

An especially virulent form of caries is early childhood caries (ECC), affecting infants and toddlers from 12 to 18 months of age. However, if appropriate measures are applied early enough (beginning during pregnancy and infancy), this painful condition can be prevented (Douglass, Douglass, & Silk, 2004; Finn & Wolpin, 2005). The first dental examination is now recommended between six months and one year of age (AAPD, 2010c), but this is often unrealistic, especially among the poor and underinsured. Therefore, there is a huge need for preventive efforts by nurses and other health care providers who care for infants and young children. The purpose of this article is to review the literature on the risk factors and prevention strategies for ECC, and to discuss the role of nurses in preventing this disease process.

**Dental Caries Overview**

Dental caries is an infectious disease caused by the interaction of bacteria, mainly *Streptococcus mutans* (*S. mutans*), and sugary foods on tooth enamel. *S. mutans* are believed to be spread from mother to baby in saliva during infancy and can inoculate even predentate infants. These bacteria break down sugars for energy, causing an acidic environment in the mouth and resulting in demineralization of the enamel of the teeth and dental caries (Douglass et al., 2004).

ECC in particular is more common in children from low-socioeconomic groups with lower levels of maternal education (no high school diploma or GED certificate). It is also associated with pregnant mothers who have carious teeth, periodontal disease, high *S. mutans* levels, and a high rate of sugar consumption (National Institutes of Health Consensus Development Program, 2001; Peres, Peres, Traebert, Zabot, & de Lacerda, 2005; Silk, Douglass, Douglass, & Silk, 2008; Smith, Badner, Morse, & Freeman, 2002; Wan & Seow, 2001; Zanata, Gasparetto, & Conrado, 2003).

*S. mutans* are spread from mothers to their infants during a discrete window of infectivity. This period is believed to be during the time that teeth are erupting, from seven or eight months until 36 months, with the median age being 36 months (Caulfield, Cutter, & Dasanayake, 1993; Li & Caulfield, 1995). Some researchers have found bacteria to be present even before this in as many as 50% of infants six months of age (Wan et al., 2003), and in infants as young as three months of age (Wan et
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al., 2003). It is believed that the earlier the infant or young child contracts S. mutans, the more likely the child is to have dental caries (Kohler, Andreen, & Jonsson, 1988).

The Role of the Mother

As a Risk Factor in ECC

Good oral health during pregnancy allows for healthy eating habits and may decrease the child’s chance of having dental caries. However, experts say that one-fourth of reproductive-aged women in the U.S. have dental caries (Silk et al., 2008), with up to 40% of pregnant women having some form of periodontal infection (Boggess, 2008).

The possibility of decreasing dental caries in the offspring of a pregnant woman, who herself has severe dental caries and high S. mutans levels, exists according to some studies. Three international groups of researchers looked at treating pregnant women and mothers of infants with various chlorhexidine and fluoride preparations to decrease S. mutans levels, and thus, decrease colonization and caries incidence in their children (Brambilla et al., 1998; Kohler & Andreen, 1994; Tenovuo, Hakkinen, Paunio, & Emilson, 1992). Mothers and infants were tested for the bacteria after the interventions and were shown to have lower levels of S. mutans compared to control groups. The children of these mothers were tested late and were found to have less dental caries than control groups.

Several researchers have studied interventions on mothers begun during pregnancy and continued on the mother-child pair during their child’s early years and the caries experience in their children. Study groups in Germany, Chile, and Brazil evaluated the dental health, provided dental prophylaxis, and treated dental problems of more than 400 pregnant women. Topical fluoride was provided in varnishes or toothpaste, and in two studies, mouth-rinsing with an antimicrobial mouthwash was recommended. Pregnant women were taught about the causes of dental caries, good dental hygiene for themselves and their child, and a healthy diet. The above measures were continued along with the evaluation of the children until they were two to four years of age. In the Chilean and German studies, teaching during infancy also involved recommending measures to avoid salivary transfer from mother to baby, such as not kissing the baby on the mouth, not cleaning pacifiers by putting them in mother’s mouth and then giving them to the baby, not tasting the child’s food or using the same spoon for mother and baby, and not drinking from the same cup. Mothers were taught to clean the baby’s teeth as soon as they began erupting. In all three studies, children in the experimental groups had significantly fewer dental caries than those in the control groups (Gomez & Weber, 2001; Gunay, Dmoch-Bochhorn, Gunay, & Guertsen, 1998; Zanata et al., 2003).

Many experts recommend decreasing salivary contacts between mother and infant, as mentioned above, as a method of decreasing S. mutans transmission and thus lowering early childhood S. mutans levels and caries (Gomez & Weber, 2001; Gunay et al., 1998; Twetman, Garcia-Godoy, & Goepferd, 2000). However, the conclusion of the only readily available study on this topic was that children with increased salivary contacts have significantly lower levels of S. mutans and significantly fewer dental caries than children with less salivary contact. The authors suggested this may be due to protective immune mechanisms (Aaltonen & Tenovuo, 1994). This Finnish study was limited by the fact that of the 404 mothers interviewed, only 55 at the extreme ends of the spectrum were chosen for the final analysis, skewing the results.

The use of Xylitol, a sugar substitute found in chewing gum, has been studied for over 25 years in pregnant women and new mothers, and has shown to decrease their S. mutans levels. Young children up to two years of age whose mothers regularly chewed Xylitol gum have less dental caries when compared to control groups, probably because of decreased S. mutans transmission from mother to child (Lynch & Milgrom, 2005; Silk et al., 2008, Soderling & Isokangas, 2000).

In summary, possible useful measures during pregnancy and the postpartum period exist to decrease childhood caries, especially in early childhood, by decreasing maternal S. mutans. These involve good maternal dental hygiene, including the use of fluoride and/or chlorhexidine products and Xylitol gum, as well as other measures to limit salivary contact between mothers and infants.

Risk Assessment for Dental Caries in Young Children

Risk factors for ECC are multifactorial and include infrequent tooth brushing, recent fillings/extractions, dental pain/plaque, mother’s caries, low educational level/socioeconomic status, premature birth, and special healthcare needs (Douglas et al., 2004; Gibson & Williams, 1999; Harris, Nicoll, Adair, & Pine, 2004; Jamieson, Thomson, & McGee, 2004; Mattila et al., 2005; Perinetti, Caputi, & Varvara, 2005; Smith et al., 2002; Vanobbergen, Declerck, Mwalili, & Martens, 2001; Williams, Whittle, & Blinkhorn, 2004). Proctor and Gamble provides a diagram of contributing factors for caries (http://www.dentalcare.com/soap/oilcourse.htm). Low fluoride concentrations have also been linked to ECC.

Fluoride

Since the 1970s, the U.S. has seen a decline in dental caries due to community water fluoridation; however, 100 million persons in the U.S. still lack water fluoridation, and only 58% receive optimal levels through community water systems (DHHS, 2001). Fluoridated water continues to be the most cost-efficient and cost-effective method of community caries prevention (Hallett & O’Rourke, 2002; Touger-Decker, 2001; Twetman et al., 2000).

When giving anticipatory guidance to parents, the amount of fluoride in the water is an important consideration. If local fluoride levels are unknown, the CDC provides information at state levels (CDC, 2008). Optimal fluoride levels in drinking water is 0.7 to 1.2 parts per million. If fluoride levels are greater than two parts per million, children need to be provided with water from other sources. The American Dental Association (ADA) (2008) provides the following guidelines for parents:

- Use ready-to-feed formula during the first 12 months of age.
- Use fluoride-free water (purified, de-mineralized, de-ionized, distilled, or reverse osmosis) to mix with liquid concentrate/powdered infant formula.
- Remember sterilization will not remove fluoride.
- Use fluoride supplements daily (see Table 1 for recommended dosages).

In the 1980s, fluoride was added to commercial toothpaste and has become the most common method for controlling dental caries. Between the 1940s and late 1970s, more than 100 clinical trials were conducted on the effectiveness of fluoride at reducing dental caries. Fluoride varnishes (Marinho, Higgins, Logan, & Sheiham, 2001) and supervised use of fluoride
mouth rinses (Marinho, Higgins, Logan, & Sheiham, 2003) have supported the use of fluoride as a decay preventative. However, concern has been raised over dental fluorosis, which are enamel defects caused by children ingesting large amounts of fluoride during the major teeth forming years (birth to six years of age). ADA (2008) guidelines state that children two years of age and younger should not use fluoride toothpaste. Children over two years of age should use a pea-sized amount of fluoride toothpaste (0.4 mgm to 0.6 mgm fluoride, which is equal to daily recommended intake for children younger than two years old). Young children can also ingest enough of a toothpaste tube to receive a toxic dose. Flossing should begin when two teeth touch (AAP, 2009). Table 2 includes signs and symptoms of fluoride toxicity. Because children as young as six years of age have not developed a swallowing reflex, they should not use fluoride mouthwash. Without fluoridation, sugar becomes a more potent risk factor.

**Sugars**

Sugars contained in fermentable carbohydrates, such as milk, juice, and starches, are hydrolyzed by salivary amylase. This process leads to bacteria-producing acidic end products with subsequent demineralization of teeth (Barber & Wilkins, 2002; Touger-Decker & van Loveren, 2003) and increased risk for caries on susceptible teeth (AAPD, 2010a). Bawa (2005) and Sanders (2004) found a positive relationship between sugar intake and the incidence of dental caries where fluoridation was minimal and dental hygiene was poor. The etiology of dental caries is related to the length of time of exposure of the teeth to sugar; it is known that acids produced by bacteria after sugar intake persist for 20 to 40 minutes. Luke, Gough, Beeley, and Geddes (1999) studied the clearance of glucose, fructose, sucrose, maltose, and sorbital rinses, as well as chocolate bars, white bread, and bananas, from the oral cavity. Sucrose was removed the quickest, while sorbitol and food residues stayed in the mouth longer. Other factors included the retentiveness of the food and the presence of protective factors in foods (calcium, phosphates, fluoride).

Parents who put their children in bed with propped milk bottles contributed to the formation of dental caries in their infants because almost no saliva flows during sleep (AAPD, 2009; Hallett & O’Rourke, 2002; Lin & Tsai, 1999; Twetman et al., 2000). Bowen (1992) found that the worst offenders were bottles that contained sucrose (sugar water), and the least cariogenic were bottles filled with cow’s milk. Children who were bottle fed beyond 12 months of age and babies who are breast fed on demand and at night may be more prone to ECC (AAPD, 2009). Food is not the only source of sugar.

**Medicines and Dental Caries**

Medicines in general contain sugar to make them more palatable to young mouths, but the presence of sugar has caused some experts to be concerned about dental caries (Bigeard, 2000; Perlman, 2005). For example, in Uganda, the highest rate of caries was found in children with the longest periods of cough syrup consumption (Kiwanuka, Astrom, & Trovik, 2004). Nurses need to advise parents to choose and campaign for sugar-free medicines.

**Xylitol**

Xylitol, a natural substance found in fruits, vegetables, and plants, and produced by the human body by normal metabolism, has a cool soothing property that makes it useful in persons with dry mouth. As an anti-plaque agent in toothbrushes and gels, Xylitol has been used since the 1960s in such products as chewing gum, syrup, and mouthwashes. It is in the “Generally Recognized as Safe” category with the Food and Drug Administration (Life Sciences Research Office, 1986). Xylitol reduces tooth decay in as low a dose as 15 grams or less (gum and mints contain about one gram each) if used for at least five to 20 minutes, three to five times a day (Xylitol.org, 2010).

**Assessment of ECC**

Risk assessment tools, such as the AAPD Caries-Risk Assessment Tool (CAT) in Table 3, can help in the determination of reliable predictors and allow health care professionals to become more actively involved in identifying and referring high-risk children (AAPD, 2002). Beginning at one year of age, a dental visit should be performed on all children (Hashim Nainar & Straffon, 2003). Douglass, Tinanoff, Tang, and Altman (2001) found that fissure cavities of the molars were present as early as 13 to 15 months of age.

Nurses using the CAT should be able to visualize a child’s teeth and mouth, have access to a reliable historian, be familiar with footnotes, understand the risk classification system, and apply the tool periodically. It is very important to use this tool properly to be effective in preventing dental caries.

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**Table 1. Recommended Dosages for Fluoride Supplementation Chart**

<table>
<thead>
<tr>
<th>Age of Child</th>
<th>Water Fluoride Concentration (ppm)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth to 6 months</td>
<td>Less Than 0.3</td>
</tr>
<tr>
<td>6 months to 3 years</td>
<td>0.25 mg</td>
</tr>
<tr>
<td>3 years to 6 years</td>
<td>0.5 mg</td>
</tr>
<tr>
<td>6 years to 16 years</td>
<td>1 mg</td>
</tr>
</tbody>
</table>

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

**Source:** ADA, 2008.

**Table 2. Signs and Symptoms of Fluoride Toxicity**

<table>
<thead>
<tr>
<th>Sign</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diarrhea</td>
<td></td>
</tr>
<tr>
<td>Vomiting</td>
<td></td>
</tr>
<tr>
<td>Abdominal pain</td>
<td></td>
</tr>
<tr>
<td>Increased salivation</td>
<td></td>
</tr>
<tr>
<td>Increased thirst</td>
<td></td>
</tr>
</tbody>
</table>

*Signs and symptoms can begin in as little as 30 minutes and last for 24 hours.

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**Source:** Fluoride Action Network, 2008.
Each child's overall assessed risk for developing decay is based on the highest level of risk indicator circled above. (A single risk indicator in any area of the “high risk” category classifies a child as being “high risk.”)

Table 3.
American Academy of Pediatric Dentistry Caries-Risk Assessment Tool (CAT)

<table>
<thead>
<tr>
<th>Risk Factors to Consider</th>
<th>Risk Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>(For each item below, circle the most accurate response found to the right under “Risk Indicators”)</td>
<td>High</td>
</tr>
<tr>
<td><strong>Part 1 – History</strong> (determined by interviewing the parent/primary caregiver)</td>
<td></td>
</tr>
<tr>
<td>Child has special health care needs, especially any that impact motor coordination or cooperation</td>
<td>Yes</td>
</tr>
<tr>
<td>Child has condition that impairs saliva (dry mouth)</td>
<td>Yes</td>
</tr>
<tr>
<td>Child's use of dental home (frequency of routine dental visits)</td>
<td>None</td>
</tr>
<tr>
<td>Child has decay</td>
<td>Yes</td>
</tr>
<tr>
<td>Time lapsed since child's last cavity</td>
<td>Less than 12 months</td>
</tr>
<tr>
<td>Child wears braces or orthodontic/oral appliances</td>
<td>Yes</td>
</tr>
<tr>
<td>Child's parent and/or sibling(s) have decay</td>
<td>Yes</td>
</tr>
<tr>
<td>Socioeconomic status of child's parent</td>
<td>Low</td>
</tr>
<tr>
<td>Daily between-meal exposures to sugar/cavity-producing foods (includes on-demand use of bottle/sippy cup containing liquid other than water; consumption of juice, carbonated beverages, or sports drinks; use of sweetened medications)</td>
<td>Greater than 3</td>
</tr>
<tr>
<td>Child's exposure to fluoride</td>
<td>Does not use fluoridated toothpaste; drinking water is not fluoridated; and is not taking fluoride supplements</td>
</tr>
<tr>
<td>Times per day that child's teeth/gums are brushed</td>
<td>Less than 1</td>
</tr>
<tr>
<td><strong>Part 2 – Clinical Evaluation</strong> (determined by examining the child's mouth)</td>
<td></td>
</tr>
<tr>
<td>Gingivitis (red, puffy gums)</td>
<td>Present</td>
</tr>
<tr>
<td>Areas of enamel demineralization (chalky white-spots on teeth)</td>
<td>More than 1</td>
</tr>
<tr>
<td>Enamel defects, deep pits/fissures</td>
<td>Present</td>
</tr>
<tr>
<td><strong>Part 3 – Supplemental Professional Assessment</strong> (optional)</td>
<td></td>
</tr>
<tr>
<td>Radiographic enamel caries</td>
<td>Present</td>
</tr>
<tr>
<td>Levels of Streptococci mutans or Lactobacilli</td>
<td>High</td>
</tr>
</tbody>
</table>

1 Children with special health care needs are those who have a physical, developmental, mental, sensory, behavioral, cognitive, or emotional impairment or limiting condition that requires medical management, health care intervention, and/or use of specialized services. The condition may be developmental or acquired and may cause limitations in performing daily self-maintenance activities or substantial limitations in a major life activity. Health care for special needs patients is beyond that considered routine and requires specialized knowledge, increased awareness and attention, and accommodation.

2 Alteration in salivary flow can be the result of congenital or acquired conditions, surgery, radiation, medication, or age-related changes in salivary function. Any condition, treatment, or process known or reported to alter saliva flow should be considered an indication of risk unless proven otherwise.

3 Orthodontic appliances include both fixed and removable appliances, space maintainers, and other devices that remain in the mouth continuously or for prolonged time intervals and which may trap food and plaque, prevent oral hygiene, compromise access of tooth surfaces to fluoride, or otherwise create an environment supporting caries initiation.

4 National surveys have demonstrated that children in low-income and moderate-income households are more likely to have caries and more decayed or filled primary teeth than children from more affluent households. Within income levels, minority children are also more likely to have caries. Thus, socioeconomic status should be viewed as an initial indicator of risk that may be offset by the absence of other risk indicators.

5 Examples of sources of simple sugars include carbonated beverages, cookies, cake, candy, cereal, potato chips, French fries, corn chips, pretzels, breads, juices, and fruits. Clinicians using caries-risk assessment should investigate individual exposures to sugars known to be involved in caries initiation.

6 Optimal systemic and topical fluoride exposure is based on use of a fluoride dentifrice and American Dental Association/American Academy of Pediatrics guidelines for exposure from fluoride drinking water and/or supplementation.

7 Unsupervised use of toothpaste and at-home topical fluoride products are not recommended for children unable to expectorate predictably.

8 Although microbial organisms responsible for gingivitis may be different than those primarily implicated in caries, the presence of gingivitis is an indicator of poor or infrequent oral hygiene practices and has been associated with caries progression.

9 Tooth anatomy and hypoplastic defects (such as poorly formed enamel, developmental pits) may predispose a child to develop caries.

10 Advanced technologies, such as radiographic assessment and microbiologic testing, are not essential for using this tool.
Educational Programs

Educational programs have been used to decrease the number of dental caries in children, especially for disadvantaged and underserved groups (Gallagher & Rowe, 2001; Gomes, Fonseca, & Rodrigues, 2001) because they are twice as likely to have dental caries. Mexican-American children are also found to have the highest rate of ECC (CDC, 2005b).

Christensen, Peterson, and Bhambal (2003), and Sheahan (2000) recommend the best approach for health promotion is to develop a population versus individual approach, a multidisciplinary approach, and a policy-generating campaign. One example was a public health campaign aimed at the oral health needs of children, Breakers for Bottles (Andrew, 2004). Families were encouraged to bring their feeding bottles and exchange them for new ones to reduce the bacterial load the bottles might have due to poor hygiene practices (Andrew, 2004). A similar health campaign, Healthy Smiles, was a multidisciplinary, baby bottle, tooth decay prevention program that was very successful (King, 1998). Healthy Smiles, Healthy Children is the foundation arm of the AAPD and provides grant monies for projects that promote good dental health. Boost Better Breaks, a school-based interdisciplinary event, also promoted consumption of fruit and milk at break time. In all instances, the results were positive (Freeman, Oliver, Bunting, Kirk, & Sauderond, 2001).

A needs assessment has also been an important precursor to educational programs. The administration of cross-sectional surveys to determine needs (Szoitko, 2004; Wierzbicka, Peterson, Szatko, Dybizbanska, & Kalo, 2002), identification of slogans (Koelen, Hiekema-de Meij, & van der Sanden-Stoeilinga, 2000), and evaluation of effectiveness (Kallista, 2005) have all been used to improve the effectiveness of educational programs.

Health promotion programs to stimulate tooth brushing have been among the most successful educational programs (Curnow et al., 2002; de Almeida, Petersen, André, & Toscano, 2003; Jackson et al., 2005). Populations (1450 to 1545 children) studied in cross-sectional surveys, clinical trials, and experiments for tooth brushing research studies have found that tooth brushing with flossing twice a day resulted in increased tooth retention (Curnow et al., 2002).

Pediatric Nursing Implications

The pediatric nurse is often the first person parents and children encounter when they enter the health care environment. Pediatric nurses have several roles in the prevention of ECC. As educators, nurses can make children and parents aware of the causative agents for dental caries, ensuring they understand that dental caries is a communicable disease (von Burg et al., 1995).

Nurses should examine children’s teeth as early as six months of age so they can refer them for appropriate care. High-risk groups (Hispanic and African-American children) should be given special attention (DHHS Office of Disease Prevention and Health Promotion, 2001). Caries initially appear as white spots on the surface area of the tooth near the gum margin, later becoming yellow and turning to brown and then black in color. Caries affect teeth as they erupt, with molars being the last affected (AAPD, 2010a; Barber & Wilkins, 2002; Twetman et al., 2000).

In addition to caries, pediatric nurses should assess for the presence of plaque, tooth eruption/exfoliation, dental irregularities, and alignment of teeth. When performing an oral health risk assessment, nurses should also assess the mother’s/caregiver’s oral health, the child’s exposure to fluoride, and provide education on oral hygiene and diet (AAP, 2009).

Nurses also have a case manager role of assisting families to navigate the system to access dental care. Only 20% of children eligible for dental insurance under Medicaid received a preventive dental service, and only 9% are covered by public dental insurance (DHHS, 2001). Nationally, nurses also have an advocate role to fulfill by becoming involved in the political system to advocate for funding of programs to assist families in the prevention and treatment of dental caries. The advocacy role is continuous and needed.

Conclusions

Given the literature review, the most effective measures for children who are vulnerable to dental caries are:

- Fluoride toothpaste and fluoridated water (Hallett & O’Rourke, 2002).
- Supervised tooth brushings twice a day (Curnow et al., 2002).
- Educational programs (Szoitko, 2004).
- Access to primary care health care providers (AAPD, 2010c).
- Prevention of transmission of S. mutans from caregiver to infant (Silk et al., 2008).

A review of the literature with regard to ECC identifies some risk factors, prevention strategies, and nursing interventions needed to assist children and their families to remain caries-free. However, much research remains to be undertaken to identify additional predictors of caries, as well as establish clinical application (including customized periodicity schedules, preventive regimens, and treatment strategies) and clinical trials for fluoride varnish as a caries preventative. Pediatric nurses are in the best position to assist in research and the establishment of best practices that will make a difference in the lives of our most precious resource, children.

References


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Kohler, B., Andreen, I., & Jonsson, B. (1988). The earlier the colonization by mutans streptococcus, the higher the caries prevalence at 4 years of age. Oral Microbiology and Immunology, 3, 14-17.


Additional Readings
