

# Feature Article

## Mutans Streptococci

### Acquisition and Transmission of Mutans Streptococci

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#### abstract

*Dental caries is an infectious and transmissible disease. The mutans streptococci and some Lactobacillus species are the two groups of infectious agents most strongly associated with dental caries. Earlier studies demonstrated that infants acquire mutans streptococci from their mothers and only after the eruption of primary teeth. More recent studies indicate that mutans streptococci can colonize the mouths of predentate infants and that horizontal, as well as vertical, transmission does occur. These findings will likely facilitate the development of clinical strategies to prevent or delay infant infection by these organisms, thereby reducing the prevalence of dental caries.*

The mouth of a normal predentate infant contains only mucosal surfaces exposed to salivary fluid flow. Mutans streptococci could persist in such an environment by forming adherent colonies on mucosal surfaces or by living free in saliva and multiplying at a rate that exceeds the washout rate caused by salivary flow. Because the oral flora averages only two to four divisions per day<sup>1</sup> and swallowing occurs every few minutes, it is reasonable to assume that bacteria cannot maintain themselves free in saliva solely by proliferation, but instead must become attached to an oral surface.

Previous studies, reviewed by Gibbons and van Houte (1975),<sup>2</sup> have demonstrated that mutans streptococci have a feeble capacity to become attached to epithelial surfaces. Therefore, it seemed unlikely that these organisms could colonize the mouth of a normal infant before the eruption of teeth. Earlier clinical studies reported that mutans streptococci could not be detected in the mouths of normal predentate infants<sup>3-8</sup> but could after the insertion of acrylic cleft-palate obturators or eruption of primary teeth.

A longitudinal investigation by Carlsson<sup>3</sup> and coworkers reported that mutans streptococci were detected in five of 25 (20 percent) infants age 12 months to 16 months. In addition, these organisms were not detected in any of the 25 subjects during their first year of life. Although Carlsson and colleagues did not report the stage of dental development, the age range of 12 to 16 months is compatible with an infant having six to 10 primary teeth. Berkowitz and coworkers<sup>4</sup> reported that mutans streptococci were detected in 9 of 20 (22 percent) infants who had only primary incisor teeth. In a subsequent study,<sup>5</sup> Berkowitz and colleagues reported that these

organisms were detected in 3 of 43 (7 percent) infants (mean age = 8.9 months) with one to five primary incisor teeth and 12 of 42 (29 percent) infants (mean age 13.8 months) with six to eight primary incisors. Likewise, Stiles and coworkers<sup>6</sup> detected these organisms in 12 of 56 (22 percent) of infants (median age = approximately 14 months) with six to eight primary incisors and one of 38 (2.6 percent) of infants (median age = approximately 9 months) with two to four primary incisors. Catalanotto and colleagues<sup>7</sup> were unable to isolate these organisms from 10 infants who had only primary incisor teeth; mutans streptococci were detected only after the eruption of primary first molars.

A more recent study by Caufield and coworkers<sup>8</sup> reported that 25 percent of their infant population (n = 46) acquired mutans streptococci by 19 months of age. Extrapolation of Caufield and colleagues' data from a figure depicting the cumulative probability of mutans streptococci acquisition as a function of age indicated that approximately 5 percent of their study population acquired these organisms by approximately 9 months of age and approximately 15 percent of the subjects were colonized by approximately 12 months of age. Accordingly, the concept that mutans streptococci required a nonshedding oral surface for its persistent oral colonization became a basic tenet of oral microbial ecology. However, more recent clinical studies<sup>9-11</sup> have demonstrated that mutans streptococci can colonize the mouths of preerupted infants. The furrows of the tongue appear to be an important ecological niche. Tanner and coworkers,<sup>12</sup> utilizing DNA probe technology, reported that mutans streptococci were found to be present in 55 percent of plaque samples and 70 percent of tongue scraping samples of 57 children age 6 to 18 months living in Saipan. These recent studies on acquisition of mutans streptococci raise doubts that a nonshedding oral surface is required for their oral colonization.

### Early Acquisition of Mutans Streptococci and Dental Caries

Early colonization by mutans streptococci is a major risk factor for future caries experience. Children were longitudinally assessed from age 2 to 4 by Alaluusua and Renkonen<sup>13</sup> for mutans streptococci colonization and dental caries; those children who harbored mutans streptococci in their plaque at age 2 were the most caries active by age 4. Their mean dmfs score was 10.6 as compared with children who were colonized later who had a mean dmfs score of 3.4 by age 4 (p < 0.005). Similar observations were made by Kohler and coworkers:<sup>14</sup> They observed that 89 percent of children colonized by mutans streptococci by age 2 had experienced caries lesions by age 4 and had a mean dfs score of 5.0. In contrast, 25 percent of children who were not infected with mutans streptococci prior to age 2 had experienced dental caries by age 4 and had a mean dfs score of 0.3. An additional longitudinal investigation<sup>15</sup> evaluated 786 children at age 1 for caries risk factors (mutans streptococci infection, fluoride exposure, dietary habits, oral hygiene) and re-examined them at 3.5 years of age for the presence of dental caries. The presence of mutans streptococci at age 1 was the most effective predictor for caries at age 3 1/2. These observations and other published results<sup>16,17</sup> clearly illustrate that early infection with mutans streptococci is a significant risk factor for future development of dental caries lesions.

### Vertical Transmission

The major reservoir from which infants acquire mutans streptococci is their mothers. The evidence for this concept comes from several clinical studies that demonstrate that mutans streptococci strains isolated from mothers and their babies exhibit similar or identical bacteriocin profiles<sup>18-20</sup> and identical plasmid or chromosomal DNA patterns.<sup>21-25</sup> Successful infant colonization of maternally transmitted mutans streptococci cells may be related to several factors

which, in part, include magnitude of the inoculum,<sup>26</sup> frequency of small dose inoculations,<sup>27</sup> and a minimum infective dose.<sup>28</sup> A study carried out by Berkowitz and coworkers<sup>26</sup> reported that the frequency of infant infection (58 percent) was approximately nine times greater when maternal salivary levels of the organism exceeded  $10^5$  colony-forming units per ml relative to the frequency of infant infection (6 percent) observed when maternal salivary reservoirs were less than or equal to  $10^3$  cfu per ml. Suppression of maternal reservoirs of mutans streptococci clearly showed that infection of the baby could be prevented or delayed;<sup>29</sup> only three of 28 (11 percent) babies whose mothers had their mutans streptococci reservoirs suppressed by dental treatment and topical antimicrobial therapy were infected by age 23 months. In contrast, 17 out of 38 (45 percent) babies in the control group whose mothers' levels of mutans streptococci were not suppressed were infected. In both groups, the percentage of infected babies increased with age; nevertheless at age 4 fewer babies were infected in the test group than in the control group.

### Horizontal Transmission

Two recent reports indicate that vertical transmission is not the only vector by which mutans streptococci are perpetuated in human populations. Mattos-Graner and colleagues<sup>30</sup> isolated mutans streptococci from groups of nursery school children (age 12 to 30 months) and genotyped the isolates utilizing primed polymerase chain reaction and restriction fragment-length polymorphism analysis. They reported that many children contained identical genotypes of mutans streptococci strains, which indicates that horizontal transmission may be another vector for acquisition of these organisms. In addition, van Loveren and coworkers,<sup>31</sup> utilizing bacteriocin typing, demonstrated that when a child acquires mutans streptococci after age 5, there may be similarity between mutans streptococci strains in mother, father, and child, indicating that horizontal transmission can also occur between family members.

### Clinical Significance

Knowledge regarding the natural history of an infectious disease facilitates a more comprehensive approach for prevention (e.g., yellow fever; acquired immunodeficiency syndrome). Studies by Kohler and colleagues<sup>14,29</sup> (discussed previously) utilized this concept to prevent and/or reduce dental caries in young preschool Swedish children by reducing the risk for vertical transmission via suppression of mutans streptococci reservoirs in their mothers. Recent information<sup>30,31</sup> indicates that horizontal transmission is another vector for acquisition of these bacteria. This finding is of importance given the socioeconomic changes in U.S. culture during the past two to three decades (for example, the utilization of day care facilities for preschool children of families where both parents are employed). In addition, recent studies<sup>9-12</sup> have reported that mutans streptococci may colonize the mouths of preterm infants. This finding implies that the timing of intervention strategies to prevent or delay transmission should take into consideration that a nonshedding oral surface (primary teeth) is probably not a requisite for oral colonization by these organisms. Collectively, this review indicates that further clinical trials are needed to translate knowledge regarding the acquisition and transmission of mutans streptococci into clinical interventions that will likely prevent dental caries.

### Summary

Dental caries is an infectious and transmissible disease. Detailed knowledge regarding the acquisition and transmission of infectious agents facilitates a more comprehensive approach

toward prevention. Mutans streptococci are important organisms in the initiation and pathogenesis of dental caries. Recent evidence demonstrates that these bacteria can colonize the mouth of pre-dentate infants and are acquired by vertical and horizontal transmission from human reservoirs. This information should facilitate the development of clinical strategies that prevent or delay infant infection, thereby reducing the prevalence of dental caries.

## Conclusions

- Primary oral infection by mutans streptococci may occur in pre-dentate infants.
- Infants may acquire mutans streptococci via vertical and horizontal transmission.
- Improvements in the prevention of dental caries may likely be realized through intervention strategies that focus on the natural history of this infectious disease.

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