Dental Caries:
The infection, transmission, & prevention

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Definitions
Caries is a **bacterial** disease.

There is abundant evidence that the initiation of caries requires a relatively high proportion of mutans streptococci within dental plaque. Infection with \textit{s} mutans usually happens early in childhood by transmission from the mouths of parents or playmates.

Two other types of bacteria are also associated with the progression of caries through dentin. These are several species of lactobacillus, and actinomyces viscosus.
Dental caries is a transmissible, infectious disease (medical model) in which interventions can be applied to prevent and control this infection.
Besides using all possible techniques to increase host resistance (fluoride, sealants) and decrease exposure to fermentable carbohydrates (for example, use of sugar substitutes), dentists must treat caries as infectious and transmissible. Antimicrobial agents are recommended.
Dentistry, Dental Practice, & the Community

• Dental caries is a **bacterial** disease. Bacteria are a necessary condition for its occurrence, and regardless of any other factor, it cannot occur in the absence of bacteria.

It is a **transmissible** disease, usually passed along from mother to child.
HOST MICROFLORA

CARIES

DIET

TOOTH BACTERIA CARIES SUGAR

TIME

TIME

TIME
The infection
Specific Plaque Hypothesis

- The Specific Plaque Hypothesis states that disease results from the action of one or several specific pathogenic species and is often associated with a relative increase in the numbers of these organism found in plaque.
The culprit: Mutans Streptococcus

Or is it?
How important is MS?

- Cariogenicity depends more on diet than the prevailing mutans streptococcal species

Streptococcus Sobrinus

- Has been implicated in dental caries
- It does not appear to be horizontally transmitted
- Is it significant? Can it cause caries without S. Mutans?
How is sobrinus related to caries?

- High levels of *S. mutans* but not *S. sobrinus* was related to maternal caries.
- The highest number of children with dft had high maternal salivary levels of both *S. mutans* and *S. sobrinus*.

Does MS always lead to caries?

• At 18 months, all the children with caries had detectable *S mutans*, but only 47.9% of the children with *S mutans* had caries.

Does MS always lead to caries?

• At the end of the follow-up period (24 months), 77% of the children were classified as colonized and in 33% MS was found as a transient microorganism.

• After 24 months, there were no dental caries, and 77% of children remained caries-free.

What is it about MS?

- The main virulence factors associated with MS are adhesion, acidogenicity and acid tolerance. These properties work together to modify the physico-chemical properties of the biofilm resulting in ecological changes.

When is the “window of infectivity”?

- In 29 (of 33) of the children's samples, the first positive culture for MS occurred at 15.3 +/- 4.6 months.
- Not consistently reported.

Does type of delivery make a difference?

- Among infants who became infected, those delivered by Caesarean section acquired S. mutans 11.7 months earlier than did vaginally delivered infants.
- C-section infants harbored a single genotype of S. mutans that was identical to that of their mothers.

Li Y, Caufield PW, Dasanayake AP, Wiener HW, Vermund SH. Mode of delivery and other maternal factors influence the acquisition of Streptococcus mutans in infants. J Dent Res. 2005 Sep;84(9):806-11
Pre-term vs. Full-term babies

• Compared with the pre-term, full-term infants showed a higher prevalence of S. mutans as well as developmental nodules.
• In both groups, S. mutans was positively associated with numbers of developmental nodules in a dose-response relationship and with maternal salivary levels of the bacteria.

Streptococcus mutans
Transmission

Transmission
Communicable?

• The World Health Organization (WHO) and Canada now classify dental caries as a non-communicable disease.

• Is this just semantics?

• Or are they saying the bacteria are transmissible, but the disease isn’t?
• It should be noted that dental caries is an infectious, communicable disease resulting in destruction of tooth structure by acid-forming bacteria found in dental plaque, an intraoral biofilm, in the presence of sugar.
How are bacteria transmitted?

• Vertical transmission – mother to child?

• Horizontal transmission?

• Both?
Vertical Transmission?

- Unlike most infectious diseases, transmission was found to be vertical (i.e. from parent to child when the child first gets teeth) rather than horizontal (from child to child). A recent review of all available English-language studies reveals 15 showing high correlations between a mother’s and child’s specific cavity-causing bacterial type but few suggesting a father-to-child linkage.

- Additional studies show a correlation between the levels of bacteria in mothers’ saliva and their children, suggesting that the mother is not just the principal source of bacteria, but that the extent of the disease in a child is also dictated by the level of bacterial in the mother’s mouth at the time of transmission.
More support for mother to child

• The production of bacteriocins by 314 Streptococcus mutans isolates from 20 mother-infant pairs was studied to test the likelihood of maternal transmission of this species.

• The number of infant strains (per infant isolates) matching maternal strains within each mother-infant pair were 10/10, 10/10, 10/10, 12/12, 2/3, 10/10, 10/10, 10/10, 3/3, 5/10, 8/8, 3/3, 8/8, 3/3, 7/7, 4/4, 3/3, 8/8, 3/3 and 4/4 for pairs 1-20, respectively. (p=.0001)

More support for mother to child

- DNA fingerprinting has demonstrated that the source of transmission [of dental caries] is usually the mother.

- Here we report for the first time that MS is acquired by infants during a defined period in the ontogeny of a child.

Can MS transmission occur before teeth erupt?

- The adhesion, invasion and survival abilities within human oral cells (predentate infants) may be considered S. mutans and S. sobrinus virulence mechanisms to colonize and persist in the oral cavity in the absence of tooth surface.

Transmission from father to child?

- Transmission of MS was found between child and mother (33.3%), child and father (8.3%) and child and others including amongst the children (58.4%), but no evidence of MS transmission from nursery caretakers was found. Two children acquired MS from intra- and extra-familial transmission.

The case against maternal transmission

• There is **insufficient** evidence to conclude that childhood caries is caused by transmission of bacteria, i.e Strep Mutans from mother to their children.

• Various maternal caries risk factors influence caries acquisition in their children but there remains no clear evidence in the literature to support this topic.

Transmission of Streptococcus mutans, a major dental caries pathogen, occurs mainly during the first 2.5 years of age.

This study prospectively analysed initial S. mutans oral colonization in 119 children from nursery schools during a 1.5-year period and tracked the transmission from child to child, day-care caregiver to child and mother to child.

Identical S. mutans genotypes were found in four nursery cohorts. No familial relationship existed in three of these cohorts, indicating horizontal transmission. Despite high oral levels of S. mutans identified in most of the caregivers, none of their genotypes matched those identified in the respective children. Only 50% of children with high levels of S. mutans carried genotypes identified in their mothers. The results support previous evidence indicating that non-familial sources of S. mutans transmission exist, and indicate that this bacterium may be transmitted horizontally between children during the initial phases of S. mutans colonization in nursery environments.

More on horizontal transmission

• A 2010 study investigated the possible transmission of mutans streptococci genotypes from child to child in kindergarten. They studied 96 children (ages 5-6 yrs) in three San Francisco Bay Area public schools.

• Two children (not siblings) in each of the three schools (6%) shared an identical amplitype of S. mutans, unique to each pair. The 19 S. sobrinus amplitypes were found in 12 children, and all were unique to each child. The presence of matching genotypes of S. mutans demonstrates horizontal transmission of this species between unrelated children aged 5-6 years.

Horizontal transmission in older kids

- Significant relationship among number of genotypes, caries index value, and MS levels.

- School children (age 6-7 studied) may be the source of mutual transmission of *S mutans*.

Transmission from caregivers

- Habits of the caregivers that might lead to transmission of bacteria to the toddler differed by race/ethnicity.

- Hispanic caregivers were less likely than Non-Hispanic African-American and Non-Hispanic White caregivers to put the toddler’s pacifier in their own mouth which was also associated with higher education but not with income but was more common with those reporting a higher income.

- Tasting the child’s food or drink using the same fork/spoon or glass was common in all race/ethnicity groups.

Prevention
The WHO Statement

• High relative risk of oral disease relates to socio-cultural determinants such as poor living conditions; low education; lack of traditions, beliefs and culture in support of oral health.

• Control depends on fluoride exposure, access to dental care, and behavioral modifications.

http://www.who.int/oral_health стратегии/en/
The Keyes Model

APPLICATION (self-care)

Oral Health

INFORMATION

MOTIVATION
Key points

• Preventing maternal transmission or reducing maternal levels of MS appears to affect MS levels in children.

• The role of MS definitively causing caries without other factors is unclear.

• Therefore, is not established that maternal transmission of MS will lead to caries in children.
Maternal Intervention

• There is fairly good evidence reinforcing the fact that different interventions done in mothers to decrease strep mutans count proves beneficial in children by deceasing MS count, delaying MS colonization and reducing caries. Use of xylitol chewing gum, fluoride and CHX varnish show promising results.

Maternal Intervention

• First-time mothers who had a high salivary number of Strep mutans [greater than or equal to $10^6$ colony-forming-units (c.f.u.) per ml] were selected. Every second mother was given a special preventive programme to reduce her salivary level below $3 \times 10^5$ c.f.u. per ml.

• Where a reduction of Strep. mutans was achieved in the mother, the establishment of Strep. mutans in her infant was prevented or delayed.

ECC is related to the mother???

• Presence of maternal caries is significantly associated with ECC.

• Maternal low literacy or low education was significantly associated with ECC.

• Maternal caries and maternal sugar consumption was significantly associated with ECC.

What about caregivers?

- Caregivers’ caries levels were modestly correlated with children’s caries. However, higher caries prevalence among caregivers significantly increased the risk of caries prevalence among their children.

What came first, the chicken or the egg?

• What comes first, high levels of S mutans or caries?

S sobrinus

High MS levels

Caries

Confounders:
- Diet
- Plaque Control
- SES
- Other things
Two is too late?

• By the time the children were 2 years of age, 33.3% of the infants in the control group and 14.7% in the experimental group had caries activity.

• Maternal caries increase was a significant factor influencing the caries experience of the children.

Take-Home Messages
There is still a lot we don’t know about dental caries.
• S. sobrinus appears to have a clear role in caries.
• Colonization of S. mutans alone does not appear to cause caries (hence, non-communicable disease status).
Infection

• Babies delivered by C-Section seem to acquire S Mutans earlier.
• Full-term delivered babies seem to have a higher count S Mutans.
• The “window of infectivity” is not really known – pre-dentate, 15 months, 2-4 years?
Transmission

• There is sufficient evidence to show that S. mutans is transmitted both vertically and horizontally.

• There does not seem to be sufficient evidence to show how S. sobrinus is transmitted.
Prevention

• Preventing maternal transmission or reducing maternal levels of MS appears to affect MS levels in children.

• Therefore, is not established that maternal transmission of MS will lead to caries in children.
Prevention

- Early prevention – before the age of 2 – seems to be very important, especially in the prevention of ECC.