

The Oral Microbiome and Early Childhood Caries: Applications to the Education of Primary Care Physicians

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Objectives

- State applications of oral microbiome knowledge to patients in the primary care setting
- Summarize applications of oral microbiome knowledge for an interprofessional approach to oral health and disease prevention.

Introduction

Early Childhood Caries (ECC):

Cavitory lesions that develop in the primary dentition (baby teeth) of children up to 6 years of age.

ECC is the most common chronic disease of childhood in the United States and is 100% preventable. It is the mission of pediatricians and dentists to promote evidence-based interventions to prevent this disease. Due to recent advances in molecular methods and biochemical research, information regarding the etiology and pathogenesis of ECC may be paired with these interventions to further the effectiveness of preventative techniques.

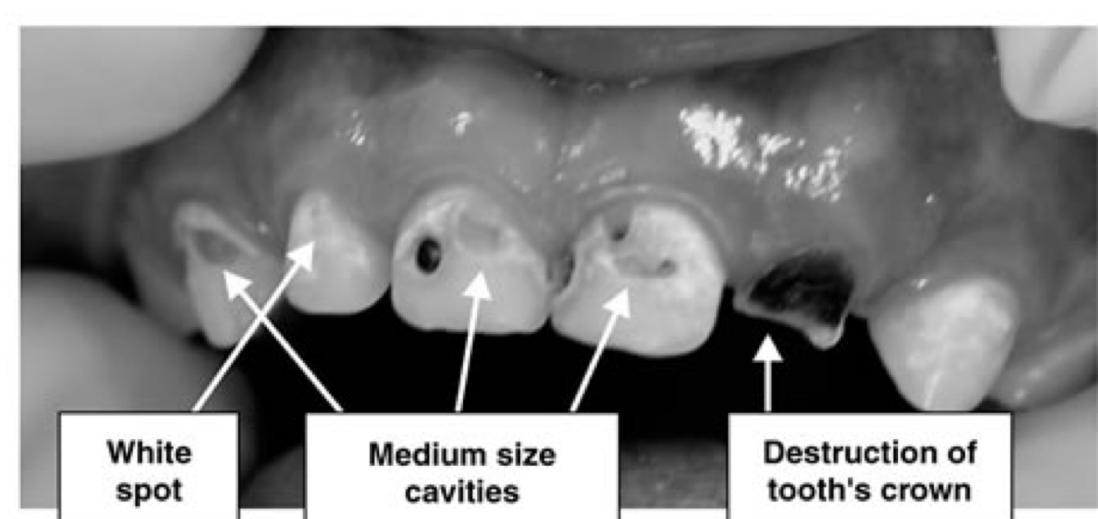
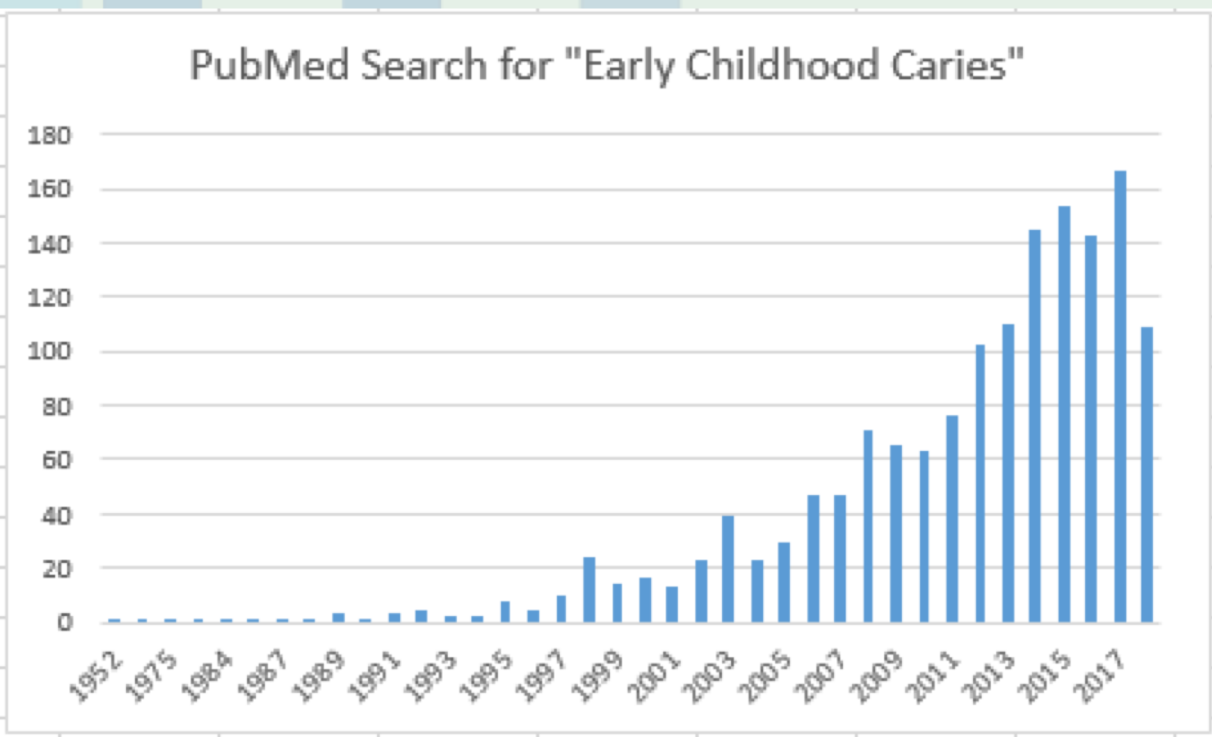


Figure 1 - Clinical appearance of oral cavity in a 4-year-old child with severe early childhood caries. Observe the different phases of development



The Human Oral Microbiome Project

was established to identify both the normal and pathogenic bacteria in the incredibly diverse oral cavity. The genomic sequences of the oral microbiome are being

elucidated on a daily basis with a current taxa count of approximately 770. This meteoric rise in information has enhanced understanding of the types and distribution of bacteria in the oral cavity in both physiologic and pathologic states. This cutting edge research in the taxonomy of bacteria does, however, require translational research efforts to correlate this data with applications for both providers and patients to improve oral health.

Purpose of this project: With the newly available technology allowing for the identification of microbes found in pathological processes, there is a need to perform a review of the current knowledge of the microbes that contribute to the development of Early Childhood Caries. While there are microbes that have historically been understood as key instigators in the pathophysiology, understanding which bacteria assume a similar role in the absence of these major pathogens may lead to insights in the prevention of these processes.

Methodology

Fifteen bacteria were selected from the Human Oral Microbiome Database for further investigation due to their documented virulence and established biologic and genetic characteristics. A PubMed search was then initiated using the search terms: "Early Childhood Caries; Early Childhood Cavities; Early Childhood Dental Disease."

Results

Microbe	Characteristics	# of Hits
<i>Abiotrophia spp</i>	Gram (+) cocci. Nonmotile, nonsporulating, Catalase (-), Oxidase (-). Facultatively anaerobic with complex growth requirements. Grows as satellite colonies adjacent to <i>Staphylococcus epidermidis</i>	3
<i>Actinomyces spp.</i>	Gram (+). Facultatively anaerobic. Form branched networks of hyphae.	14
<i>Bifidobacterium spp.</i>	Gram (+) rod, non-motile, non-sporulating, anaerobic	1
<i>Campylobacter spp.</i>	Gram (-), Oxidase (+). Cells of most species are motile with characteristic corkscrew like motion with a single polar unsheathed flagellum.	2
<i>Candida spp.</i>	Yeast, dimorphic fungus, glucose fermenting, lactose nonfermenting,	1
<i>Capnocytophaga spp.</i>	Gram (-) long, thin bacilli. Facultatively anaerobic and require enrichment with CO2	2
<i>Fusobacterium spp.</i>	Gram (-) rods, nonsporulating and obligately anaerobic. Metabolize peptone or carbohydrates in PY-glucose to produce butyrate, often with acetate and lower levels of lactate, propionate, succinate, and formate.	2
<i>Gemella spp.</i>	Gram (+), ovoid shaped, nonmotile, nonsporulating, facultatively anaerobic, Catalase (-), Oxidase (-)	0
<i>Granulicatella spp.</i>	Gram (+) Non-spore forming rod. Facultatively anaerobic and requires enrichment with CO2.	3
<i>Lactobacillus spp.</i>	Gram (-) aerobic diplococci. Oxidase (+), Catalase (+) with polysaccharide capsule and pili.	1
<i>Neisseria spp.</i>	Gram (-) anaerobic bacterium	1
<i>Prevotella spp.</i>	Gram (+) bacillus, non-motile, nonsporulating, ability to ferment glucose, sucrose and galactose. Acidogenic, aciduric and acid tolerant.	2
<i>Scardovia wiggsiae</i>	Gram-indeterminate motile crescent-shaped, ferments glucose and lactate.	2
<i>Selenomonas spp.</i>	Gram (+) coccus, cell division in chains, oxidase (-), catalase (-), facultative anaerobes,	11*
<i>Veillonella spp.</i>	Gram (-) anaerobic cocci, lactose fermenting	11

Characterization of the Diversity of Microbes involved in the development of ECC

Affirming the Understanding of Key Microbes in ECC Lesions

As seen from the plethora of past and current research, *Streptococcus mutans* and *Lactobacillus spp.* are major players in the development of childhood caries. More recently it has been shown that *S. mutans* biofilm factors contribute to increased biofilm formation in the presence of other microbes and create a microenvironment that harbors other acidogenic microbes *Only a portion of the recent research on streptococcus was include because it was representative of the whole.

Adding Microbes that Play a Role in the Development of Primary Lesions

Fusobacterium spp. have been widely accepted as a dominant microbe in the oral flora and having a significant relationship with the development of ECC. While not being an isolated contributor to ECC, it was concluded that measuring the relative abundance of *Fusobacterium periodonticum* would be useful in predicting a child's risk of developing caries and this association has also been seen in *Actinomyces*, *Veillonella*, *Candida*, *Scardovia wiggsiae* and others.

Secondary Lesions: Bacteria that provide the same Pathogenesis in the Absence of Dominant Microbes

In absence of the primary bacteria associated with ECC, certain bacteria have been seen in relative abundance in these unique lesions. *Campylobacter*, *Neisseria* and *Selenomonas* are among these bacteria that may be able to independently precipitate an environment that could lead to the development of ECC. Microbes such as *Selenomonas spp* have the ability to ferment both glucose and lactate and not exclusively one or the other, suggesting there is a complex cascade of events and factors needed for the development of caries.

Discussion

The interaction between humans and our oral microbiome is an intensely complicated and generally synergistic relationship. More integrated research into the well over 700 bacteria so far discovered in the human mouth will allow for more targeted management of ECC and improved prevention. As more bacteria are discovered every day, we have only scratched the surface of the bacterial interactions that lead to ECC. This shows promise for the development of targeted treatments to interrupt the pathogenesis of ECC; however our investigation helped show that due to the complex interactions between each bacteria listed the removal of one or the other may not prevent ECC.

Importance of Homeostasis

Now that there are more microbes that have been identified as having a significant association for the development of ECC, this emphasizes the principle that the removal or excess of one element found in normal physiology can lead to dysfunction of the oral microenvironment.



Applications

Public Health Applications

- Dental appointment - 1st visit by age 1 reduces incidence
- Aged/staged prevention methods before eruption of primary teeth
- Mother/primary caregiver - to - child transmission on strain level
- Congenital/transplacental microbiological/immunological
K00.81 Newborn Affected by Periodontal Disease in Mother

Interprofessional Practice: PCP's role in Oral Health

- Coding exists
99188 Application of topical fluoride varnish by a physician or other qualified health care professional
D1310 Nutritional counseling for the control of dental disease
- Oral fluoride supplementation/varnish application
- Emphasize standard oral care rather than OTC oral health supplements
- Effects on overall oral microbiome remain unknown.
- Due to vaccination requirements, almost all children see a PCP before age 5
- SMILES for Life education program

Acknowledgements

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