Caries management symposium

Microbiome and dental caries: 2018 update

When
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Business School
University of Sydney
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Caries and the oral microbiome

Presented by
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Microbiome
Oral microbiome

- Ubiquitous
- Diverse
- Ecosystem
- Dental caries
- Periodontal disease
- Systemic health
Changing concepts in caries microbiology
Bacterial Culture

Cloning and Sequencing

Next Generation Sequencing

Single Species

Non-Specific/Multiple Species

Ecology
Specific plaque hypothesis

Culture Technique

Streptococcus mutans

Specific plaque hypothesis

Evidence S. mutans caries

- S. mutans could induce caries in animals fed a high sucrose diet
- S. mutans is highly aciduric
- S. mutans is ‘sticky’

Specific plaque hypothesis

S. mutans vaccine

- 30+ years
- Protein
- DNA

- Experimental and animal evidence
  (Hamada, 1991, Oral passive immunization against dental caries in rats by use of hen egg yolk antibodies specific for cell-associated glucosyltransferase of Streptococcus mutans)

- Lack of clinical evidence in humans
Evidence against *S. mutans* in caries

1. Culture methods can only identify \( \sim 50\% \) of bacteria
2. The bacteria *S. mutans* is ubiquitous in the oral cavity
3. The bacteria *S. mutans* is not always present in biofilms associated with caries
4. Other aciduric bacteria involved in carious lesions
Non-specific plaque hypothesis

Overall activity of total plaque microbiota

Genetic methods

- Extract DNA
- Amplify a gene (16S rRNA gene)
- Clone and sequence
- Identify bacteria, fungi, viruses and archea
Non-specific plaque hypothesis

- Multiple caries associated species
- Supported the findings from culture studies
- Revealing a greater diversity
- Caries a polymicobial disease
- Did not correlate the bacteria with environment

Ecological plaque hypothesis

Ecological plaque hypothesis - Oral microbiome

Next Generation Sequencing

High bacterial diversity

600 – 4200 bacterial species

(Kejiser et al., JDR, 2008, Yang et al., ISME, 2012, Zaura et al., BMC Microbiology, 2009)

High inter-individual variation

High site specific diversity
Caries oral microbiome

No ‘caries specific’ taxa (Belda et al., ISME, 2012, Yang et al., ISME, 2012)

Changes in overall oral microbiota composition

Varied by caries stage

Changes in function

- Health associated with antibacterial functions
- Caries with mixed acid fermentation
Caries oral microbiome evolution

Hunter-gatherer
200,000 – 10,000 years

Agriculturist
10,000 – 200/150 years

Industrialisation
200/150 years – today
Past dietary change


Ecological plaque hypothesis - Oral microbiome, pH

Gaps in knowledge

Outstanding Questions

Host genetics versus environment?

Function versus composition?

Immunisation and antimicrobials to prevent caries?

Relationship of bacteria to fungi and viruses?
Childhood caries oral microbiome study
Genetic and environmental influences on the oral microbiome in childhood

To determine how host genetic and environmental factors drive variation in composition of the developing oral microbiome, leading to either dental decay or oral health in childhood

NHMRC, APP1062911, 2015-2019

Adler C (CIA), Hughes T (CIB), Townsend G (CIC), Arora M (CID)
Study population

- Twin cohort (MZ and DZ)
- 400 individuals
- Longitudinal (3 months - 10 years of age)
- Australia wide
- Oral health assessment: International Caries Detection and Assessment System
- Oral biofilm samples
- Survey data
Question 1: Health versus caries

- 400 Children, ~50% health and ~50% caries
- Biofilm: hard and soft tissue
- 3 time points
- 2 samples per time point
- Total samples ~2400
- 16S, ITS Illumina and metagenomics
- Causation
Question 2: Genetic and environmental influences

- Twins: MZ and DZ
- Structural Equation Modelling
  \[ r(MZ) = 1.0, r(DZ) = .5 \]
  
  \[ A = \text{Additive genetic} \]
  \[ C = \text{Common environment} \]
  \[ E = \text{Unique environment} \]
- Longitudinal
Question 2: Genetic and environmental influences

- **Prenatal:** Pre-eclampsia, twin-to-twin transfusion syndrome, mothers’ drinking during pregnancy, placental type and parental age at conception
- **Neonatal:** Type of birth, birth weight, early feeding practices and smoke exposure
- **Early childhood/childhood:** Diet, oral hygiene, medications and BMI
Caries mycobiome (fungi)

Interaction between fungi and bacteria
**Translational potential**

1. **Prevention**

Identification of high risk individuals

Informing when preventative measures are required

Development of early detection methods - Biomarkers

2. **Treatment - Oral biofilm modulation**

Antimicrobial development

Probiotics development and testing
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