

Non-Restorative Caries Control

A Gross Distortion of Science and Medicine..?

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Lecture Outcomes

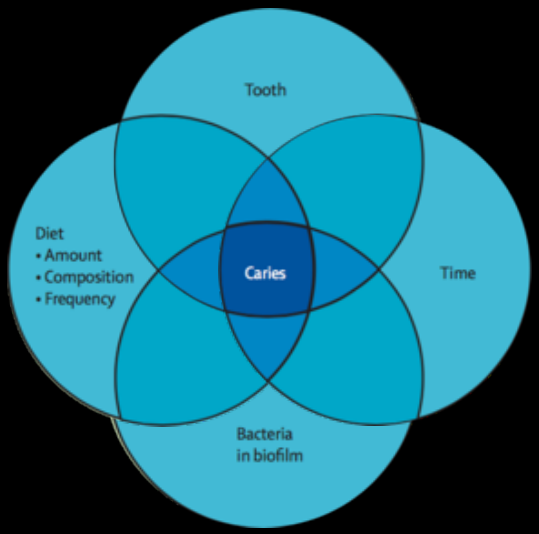
- Justify the use of non-restorative caries control methods
- Understand the different techniques and materials used in non-restorative caries control
- Explain the mechanism of action of different non-restorative caries control methods
- Determine the most appropriate method for different carious lesions in primary teeth

fuji 7 distal pit missed at 2:30

Mummy Calz at 4:25

Aetiology: Historical Perspectives





Newbrun 1982

Aetiology: Historical Perspectives



Review > Science. 1982 Jul 30;217(4558):418-23. doi: 10.1126/science.7046052.

Sugar and dental caries: a review of human studies

E Newbrun

PMID: 7046052 DOI: 10.1126/science.7046052

Abstract

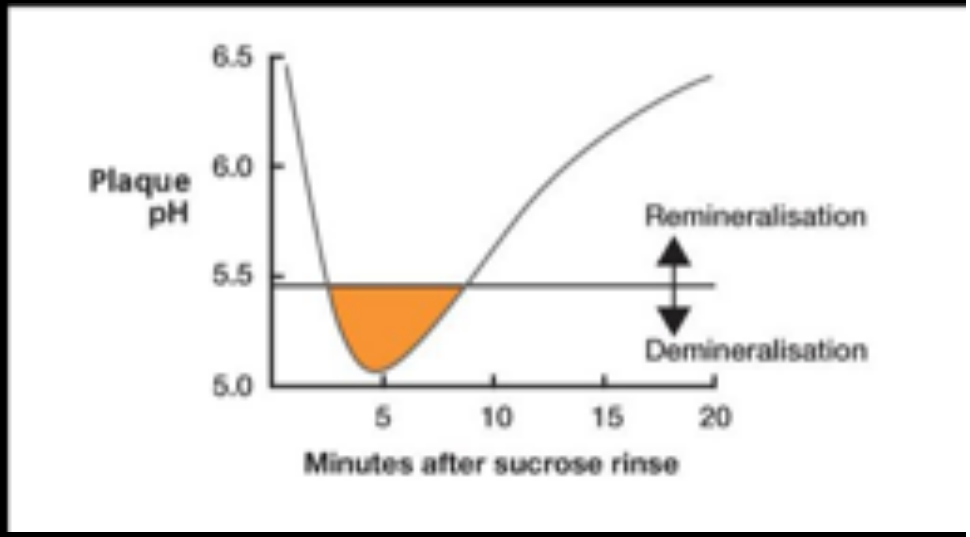
Studies of special population groups, epidemiological surveys, controlled longitudinal studies of humans, and longitudinal studies on the effect of sugar substitutes indicate that frequent or high intake of sugary foods predisposes to dental decay. The relation is not always clear-cut, and most studies have important methodological problems and limitations. Longitudinal measurements of caries increments combined with multiple dietary histories are needed to clarity the association between caries and eating habits. The relative cariogenicity of specific foods can be assessed by a combination of in vitro tests, human in vivo tests, and experimental caries in animals. Human diets, however, vary in food items eaten and the frequency and sequence of eating, and these factors can affect the cariogenicity of a food. Therefore, reported correlations must be interpreted with caution.

Newbrun 1982

Aetiology: Historical Perspectives



The Stephan Curve



Stephan and Miller 1943

Aetiology: Historical Perspectives



Odontology (2013) 101:2–8
DOI 10.1007/s10266-012-0092-z

REVIEW ARTICLE

The Stephan Curve revisited

William H. Bowen

Received: 6 August 2012 / Accepted: 6 November 2012 / Published online: 6 December 2012
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Abstract The Stephan Curve has played a dominant role in caries research over the past several decades. What is so remarkable about the Stephan Curve is the plethora of interactions it illustrates and yet acid production remains the dominant focus. Using sophisticated technology, it is possible to measure pH changes in plaque; however, these observations may carry a false sense of accuracy. Recent observations have shown that there may be multiple pH values within the plaque matrix, thus emphasizing the importance of the milieu within which acid is formed. Although acid production is indeed the immediate proximate cause of tooth dissolution, the influence of alkali production within plaque has received relative scant attention. Excessive reliance on Stephan Curve leads to describing foods as "safe" if they do not lower the pH below the so-called "critical pH" at which point it is postulated enamel dissolves. Acid production is just one of many biological processes that occur within plaque when exposed to sugar. Exploration of methods to enhance alkali production could produce rich research dividends.

Keywords Stephan Curve · Acid tolerance · Alkali generation · Polysaccharide · Plaque matrix

Introduction

For more than a century, oral microbiologists have focused on acid production by the oral flora as the primary etiological cause of dental caries. This line of research developed from the chemo-parasitic theory for the pathogenesis of dental caries proposed by Miller [1] and has been the core of much research into the etiology and pathogenesis of dental caries since.

Stephan [2, 3] became a leading proponent of the importance of acid production in the pathogenesis of dental caries. His early work investigated acid production by plaque removed from the tooth surfaces. These early observations, although an advance at the time, contributed little to the understanding of the processes occurring on the tooth surfaces and to the dynamics of acid production and other processes occurring at the plaque tooth interfaces. It is noteworthy that Stephan observed, "Nevertheless, the findings do not exclude of other factors other than pH which might produce or modify the decalcification of teeth in caries." Following the development of microelectrodes, it was possible to measure pH in dental plaques in situ, from multiple sites over time (for review see [4]). Data gleaned from such investigations lead to the construction of the Stephan Curve. The original published curve is shown in Fig. 1 (reproduced from J. dent Res with permission from Sage Publishing).

It is important to note that the Stephan Curve is a composite resulting from an average of numerous readings collected from many teeth.

Measurement of pH in plaque

A myriad of different approaches have been developed to determine pH values in dental plaque in situ. This review will examine just a few and illustrate the difficulties some of them present.

The most commonly used electrodes in early investigations were constructed from antimony or glass, iridium

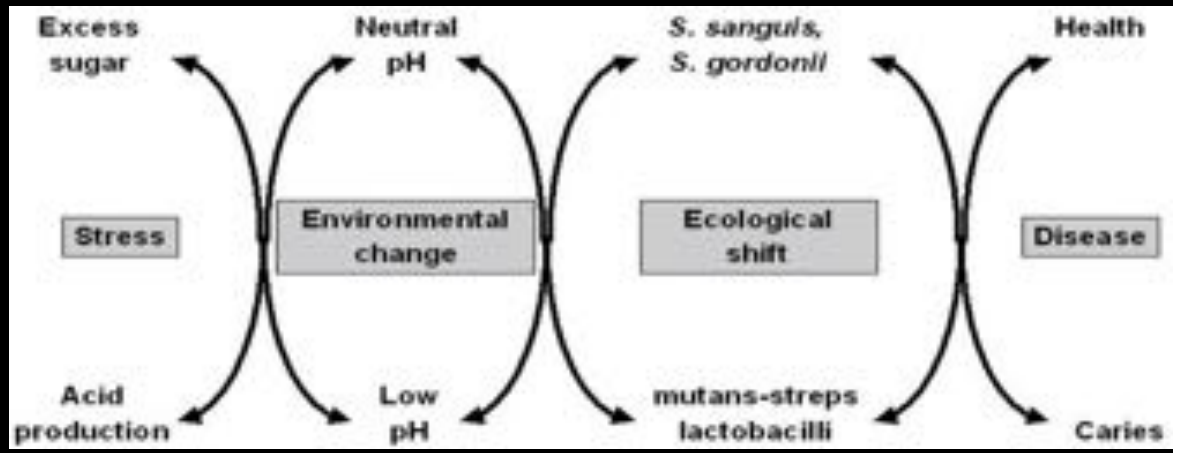
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Bowen 2013

Aetiology: Historical Perspectives



The Ecological Plaque Hypothesis



Marsh 1994

Aetiology



If we do not learn from history,
we shall be compelled to relieve it.
True.
But if we do not change the future,
we shall be compelled to endure it.
And that could be worse...

-- Alvin Toffler --

Aetiology: Historical Perspectives



"the pits and fissures should be probed with a sharp explorer to feel for 'soft sticky' substrate"

"dental caries is a bacterial infection that requires surgical treatment to be cured"

"one has to strive for as complete caries removal as possible prior to restoration"

"restorative treatment in children is futile…"

Dental Caries





Review > Caries Res. 2020;54(1):7-14. doi: 10.1159/000503309. Epub 2019 Oct 7.

Terminology of Dental Caries and Dental Caries Management: Consensus Report of a Workshop Organized by ORCA and Cariology Research Group of IADR

Vita Machiulskiene [1], Guglielmo Campus [2 3], Joana Christina Carvalho [4], Irene Dige [5], Kim Rud Ekstrand [6], Anahita Jablonski-Momeni [7], Marisa Maltz [8], David J Manton [9], Stefania Martignon [10 11], E Angeles Martinez-Mier [12], Nigel B Pitts [10], Andreas G Schulte [13], Christian H Splieth [14], Livia Maria Andaló Tenuta [15], Andrea Ferreira Zandona [16], Bente Nyvad [5]

Affiliations + expand

PMID: 31590168 DOI: 10.1159/000503309

Free article

Abstract

A 2-day workshop of ORCA and the IADR Cariology Research Group was organized to discuss and reach consensus on definitions of the most commonly used terms in cariology. The aims were to identify and to select the most commonly used terms of dental caries and dental caries management and to define them based on current concepts. Terms related to definition, diagnosis, risk assessment, and monitoring of dental caries were included. The Delphi process was used to establish terms to be considered using the nominal group method favored by consensus. Of 222 terms originally suggested by six cariologists from different countries, a total of 59 terms were reviewed after removing duplicates and unnecessary words. Sixteen experts in cariology took part in the process of reaching consensus about the definitions of the selected caries terms. Decisions were made following thorough "round table" discussions of each term and confirmed by secret electronic voting. Full agreement (100%) was reached on 17 terms, while the definitions of 6 terms were below the agreed 80% threshold of consensus. The suggested terminology is recommended for use in research, in public health, as well as in clinical practice.

Caries Management

Comparative Study > Br Dent J. 2002 Feb 23;192(4):219-23. doi: 10.1038/sj.bdj.4801338.

The fate of the carious primary teeth of children who regularly attend the general dental service

M Tickle [1], K Milsom, D King, P Kearney-Mitchell, A Blinkhorn

- Children's perception of pain
  - 'normalisation' of dental pain

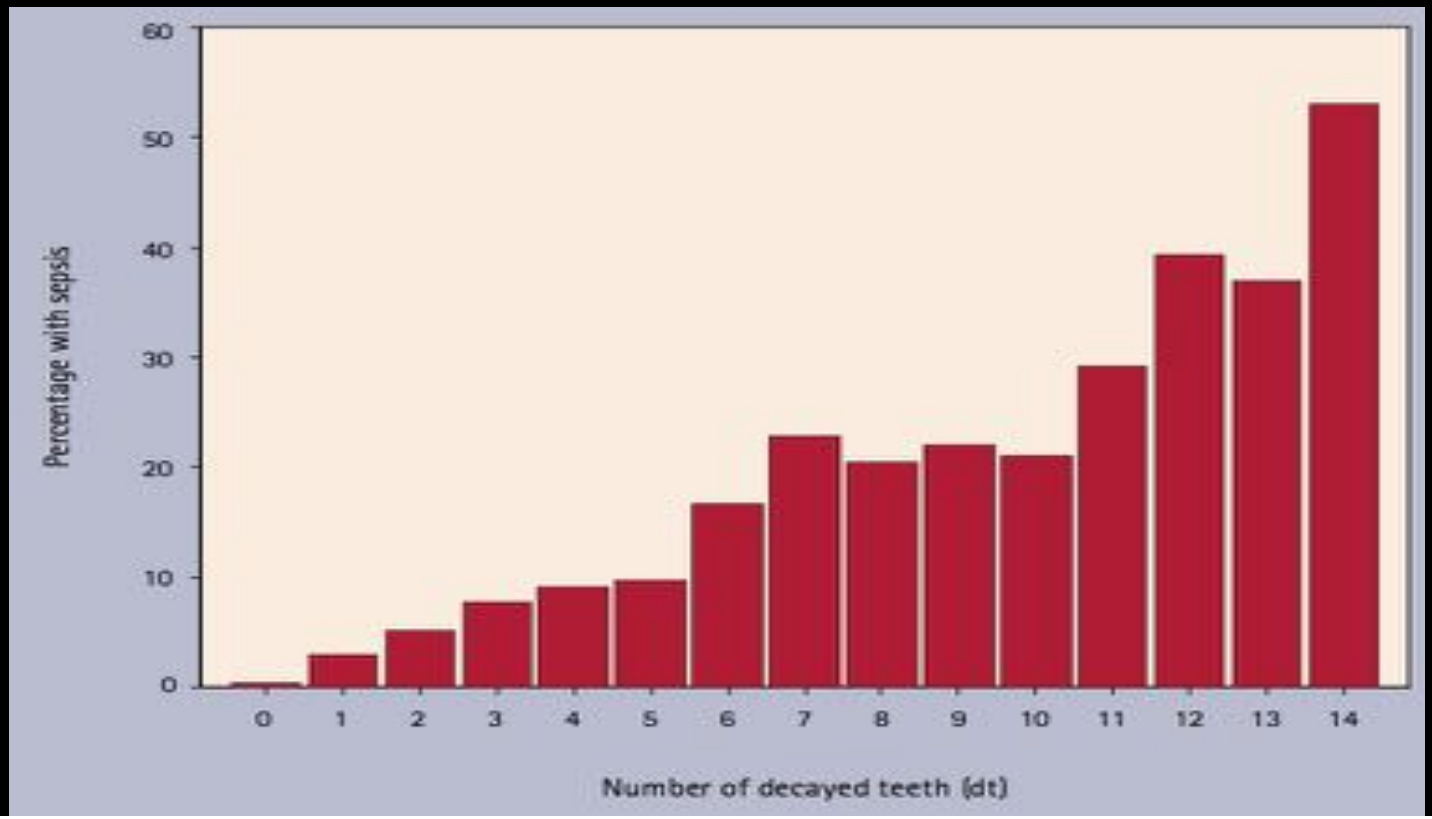
Caries Management

Comparative Study > Br Dent J. 2002 Feb 23;192(4):219-23. doi: 10.1038/sj.bdj.4801338.

The fate of the carious primary teeth of children who regularly attend the general dental service

M Tickle [1], K Milsom, D King, P Kearney-Mitchell, A Blinkhorn

- Untreated caries and sepsis



Pine et al. 2006

Caries Management

Comparative Study > Br Dent J. 2002 Feb 23;192(4):219-23. doi: 10.1038/sj.bdj.4801338.

The fate of the carious primary teeth of children who regularly attend the general dental service

M Tickle [1], K Milsom, D King, P Kearney-Mitchell, A Blinkhorn

- Quality of restorative care?

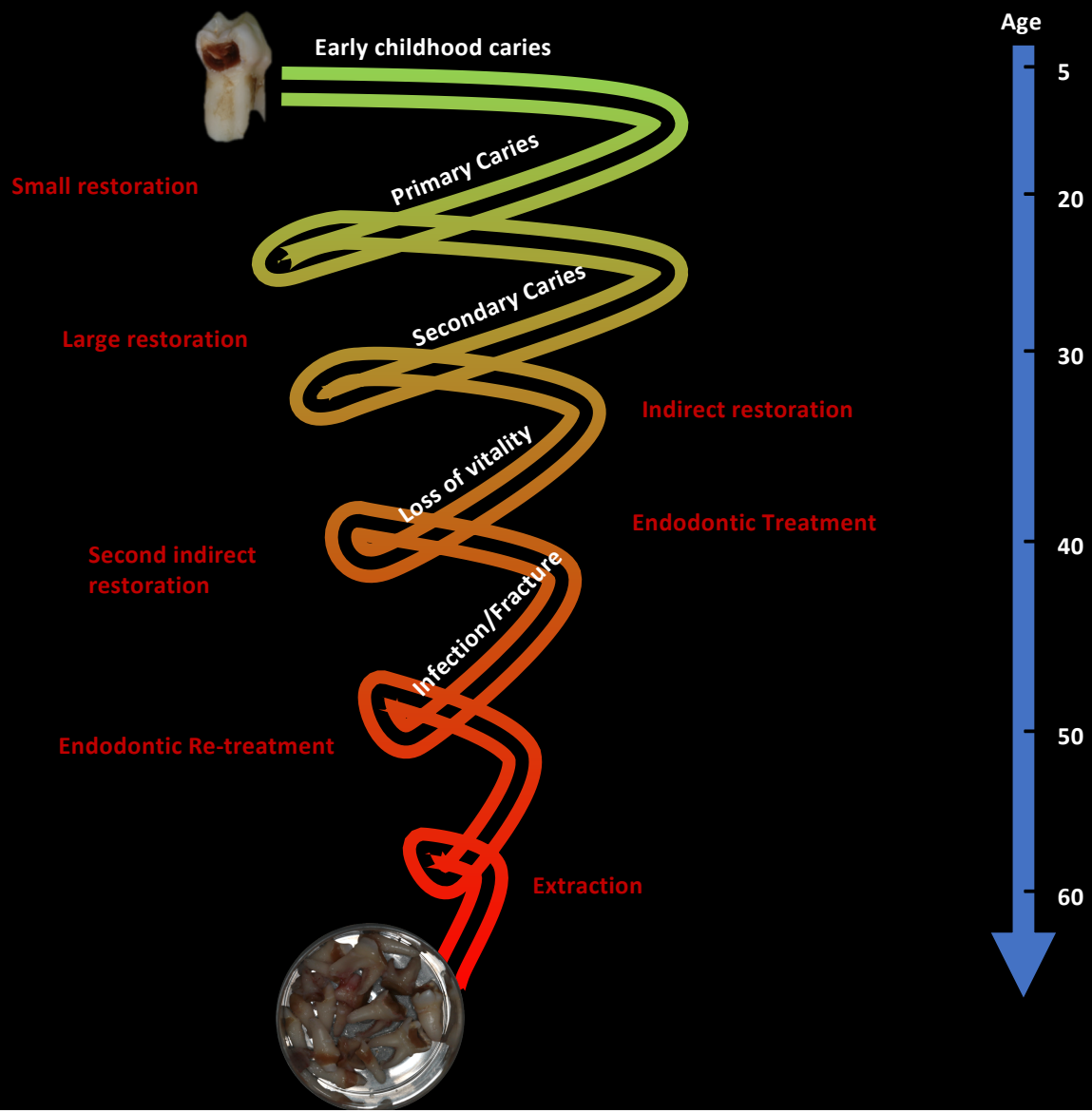


#ART Abuse

Caries Management

The "restorative death spiral"

Fejerskov and Kidd 2008



Caries Management



“is restorative care useful while the poor dental behaviour that caused the need for the fillings persists?”

Kidd 2012

Non-restorative Caries Control





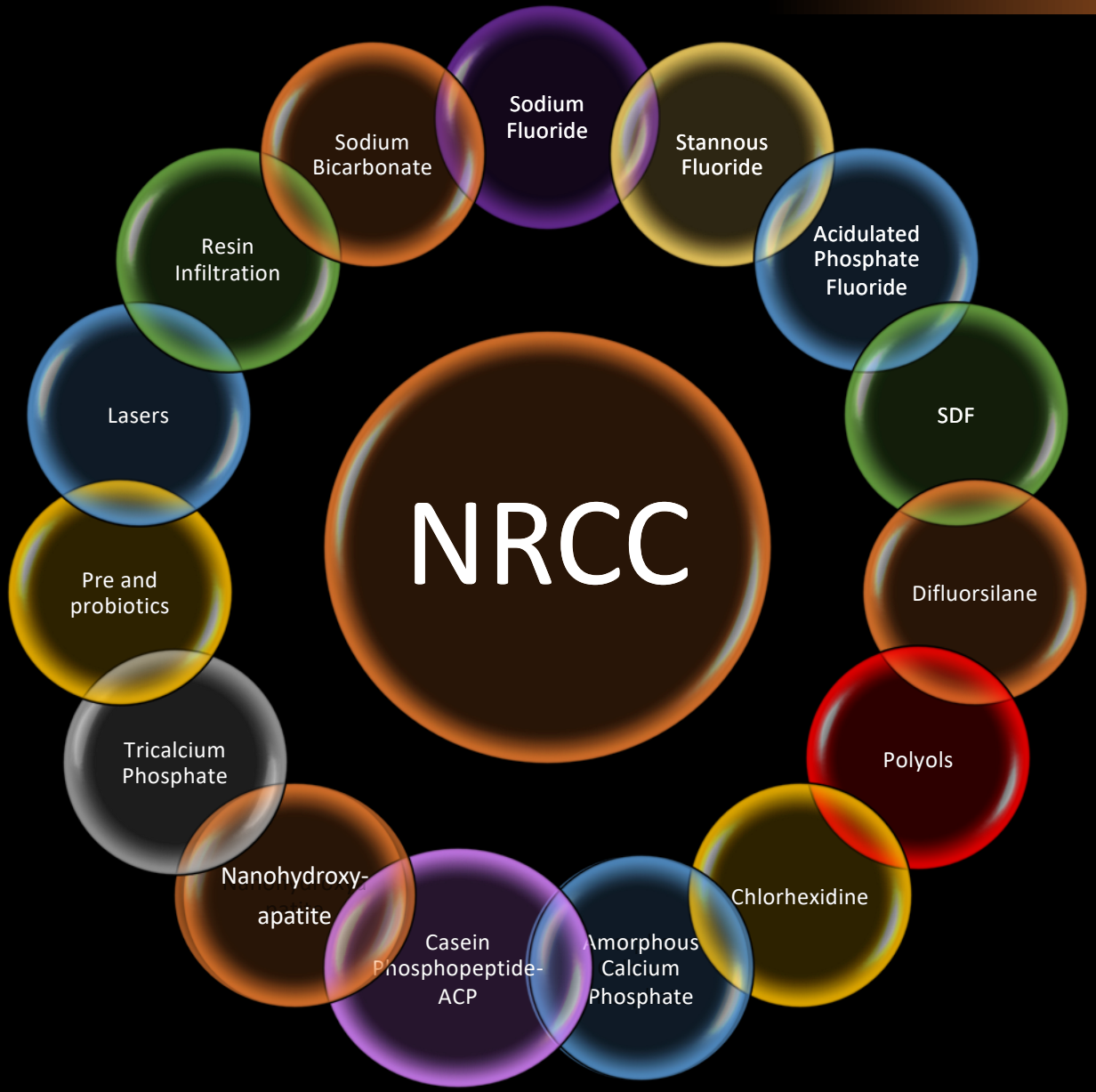








Non-restorative Caries Control



Non-restorative Caries Control

Pre and probiotics

Randomized Controlled Trial > BMC Oral Health. 2015 Sep 24;15(1):112.
doi: 10.1186/s12903-015-0096-5.

Effect of probiotic chewing tablets on early childhood caries--a randomized controlled trial

Trifa Hedayati-Hajikand [1 2], Ulrika Lundberg [3], Catarina Eldh [4], Svante Twetman [5]

Affiliations + expand

PMID: 26403472 PMCID: PMC4583156 DOI: 10.1186/s12903-015-0096-5
Free PMC article

Abstract

Background: To evaluate the effect of probiotic chewing tablets on early childhood caries development in preschool children living in a low socioeconomic multicultural area.

Methods: The investigation employed a randomized double-blind placebo-controlled design. The study group consisted of 138 healthy 2-3-year-old children that were consecutively recruited after informed parental consent. After enrollment, they were randomized to a test or a placebo group. The parents of the test group were instructed to give their child one chewing tablet per day containing three strains of live probiotic bacteria (ProBiora3) and the placebo group got identical tablets without bacteria. The duration was one year and the prevalence and increment of initial and manifest caries lesions was examined at baseline and follow-up. All parents were thoroughly instructed to brush the teeth of their off-springs twice daily with fluoride toothpaste.

Results: The groups were balanced at baseline and the attrition rate was 20%. Around 2/3 of the children in both groups reported an acceptable compliance. The caries increment (Δds) was significantly lower in the test group when compared with the placebo group, 0.2 vs. 0.8 ($p < 0.05$). The risk reduction was 0.47 (95% CI 0.24-0.98) and the number needed to treat close to five. No differences were displayed between the groups concerning presence of visible plaque or bleeding-on-brushing. No side effects were reported.

Conclusions: The results suggested that early childhood caries development could be reduced through administration of these probiotic chewing tablets as adjunct to daily use of fluoride toothpaste in preschool children. Further studies on a possible dose-response relationship seem justified

Non-restorative Caries Control

Polyols

Clinical Trial > Int Dent J. 1995 Feb;45(1 Suppl 1):93-107.

Stabilisation of rampant caries: polyol gums and arrest of dentine caries in two long-term cohort studies in young subjects

K K Mäkinen [1], P L Mäkinen, H R Pape Jr, P Allen, C A Bennett, P J Isokangas, K P Isotupa

Affiliations + expand

PMID: 7607749

Abstract

The purpose of this paper is to report clinical observations on the stabilisation of dentine caries in two chewing gum studies carried out in young subjects. One study focused on the permanent dentition of 1,277 initially 10-year old subjects, while the other study was carried out on 510 initially 6-year old subjects and focused on the primary dentition. In both trials, several chewing gum formulas containing dietary polyols (xylitol and sorbitol, or their combinations) were used for up to 40 months (10-year olds) or up to 24 months (6-year olds). The daily consumption level of both polyols was up to 10.7 g per subject, used normally in 5-minute chewing episodes 3 to 5 times per day. Supervised chewing in schools lasted 5 min per episode, and for variable times during non-school days. Rehardening of dentine caries lesions was observed clinically by experienced, blinded examiners using sharp dental explorers and fibre optic light. After 40 months (permanent dentition) or after 18 months (primary dentition), rehardening (caries arrest) generally occurred more frequently in subjects who used polyol gums than in subjects who did not receive gum as part of the programmes, or who received sucrose gum. Arrest or non-progression of dentine caries was most frequently observed in subjects who used 100 per cent xylitol gums or mixtures of xylitol and sorbitol, but the differences between gums were not consistently significant. However, the usage of 100 per cent xylitol pellet-shaped gum was more frequently associated with arrest of dentine caries than other treatments. These results and previous studies suggest that high-xylitol chewing gum usage can retard or arrest even rampant dentine caries in conditions where effective restoration and prevention programmes have not been instituted, and can also provide additional protection against further caries development during full implementation of restorative procedures by holding the lesion in a non-progressive condition.

Non-restorative Caries Control



Randomized Controlled Trial > J Clin Dent. 2011;22(5):139-43.

Remineralization of early caries by a nano-hydroxyapatite dentifrice

K Najibfard [1], K Ramalingam, I Chedjieu, B T Amaechi

Affiliations + expand

PMID: 22403978

Abstract

Objective: The purpose of this randomized, double-blind, crossover, in situ study was to evaluate the efficacy of nano-hydroxyapatite (nHAP) dentifrices on caries remineralization and demineralization inhibition.

Methods: Three demineralized enamel blocks (A,B,C) and one healthy block (D), cut from each of 30 molars, were exposed respectively to dentifrices of A) 5% nHAP, B) 10% nHAP, C) 1100 ppm fluoride, and D) 10% nHAP via an intra-oral appliance worn by 30 adults in this four-phase study lasting 28 days per phase. Baseline and post-test mineral loss (delta Z) and lesion depth (LD) were quantified using microradiography.

Results: Pair-wise comparison (baseline versus test) demonstrated significant ($p < 0.001$) reductions in delta Z and LD in A, B, and C. ANOVA showed no significant differences among the three products in percent mineral gain. No demineralization occurred in the sound enamel specimens exposed intra-orally while using 10% nHAP.

Conclusion: nHAP dentifrice caused remineralization comparable to a fluoride dentifrice, and inhibited caries development, thus suggesting that an nHAP dentifrice can be an effective alternative to fluoride toothpaste.

Non-restorative Caries Control

- preventing new carious lesions from occurring
    - incidence studies, dmft
    - effectiveness of NaF/sealants etc
- arresting/reversing existing carious lesions

Non-cavitated Lesions



- Occlusal surfaces
  - 0.2% NaF mouthwash + supervised toothbrushing
  - 1.23% APF gel
  - 5% NaF varnish
  - resin infiltration + 5% NaF varnish
  - sealants + 5% NaF varnish → most effective
  - sealants alone
- 2 – 3x greater chance of caries arrest than no treatment
  - 1,575 lesions in primary and permanent teeth
  - 8 to 12 months

Agrawal et al. 2011; Autio-Gold et al. 2001; Bakhshandeh et al. 2015; Borges et al. 2010; da Silveira et al. 2012; Florio et al. 2001; Honkala et al. 2015

Non-cavitated Lesions



- Proximal surfaces
- radiolucencies (lesions in enamel to outer third of the dentin)
    - resin infiltration
    - sealants after tooth separation
    - 5% NaF varnish alone
        - 2x greater chance of caries arrest (low certainty)
    - resin infiltration + 5% NaF varnish → most effective
        - 5 x greater chance of caries arrest (low certainty)

Martignon et al. 2006; Ekstrand et al. 2010; Martignon et al. 2010; Paris et al. 2010; Martignon et al. 2012; Meyer-Lueckel et al. 2012; Gomez et al. 2015

Non-cavitated Lesions



- Buccal/lingual surfaces
  - 5% NaF varnish alone → most effective
  - 1.23% APF + Oral Health Education
    - 2-3x greater chance of caries arrest (low-moderate certainty)
  - 10% CPP-ACP + toothbrushing with 1000ppm toothpaste
    - 2x greater chance of caries arrest (low certainty)

Autio-Gold et al. 2001; Bailey et al. 2009; Agrawal et al. 2011; Bonow et al. 2013; Turska-Szybka et al. 2016

Cavitated Lesions



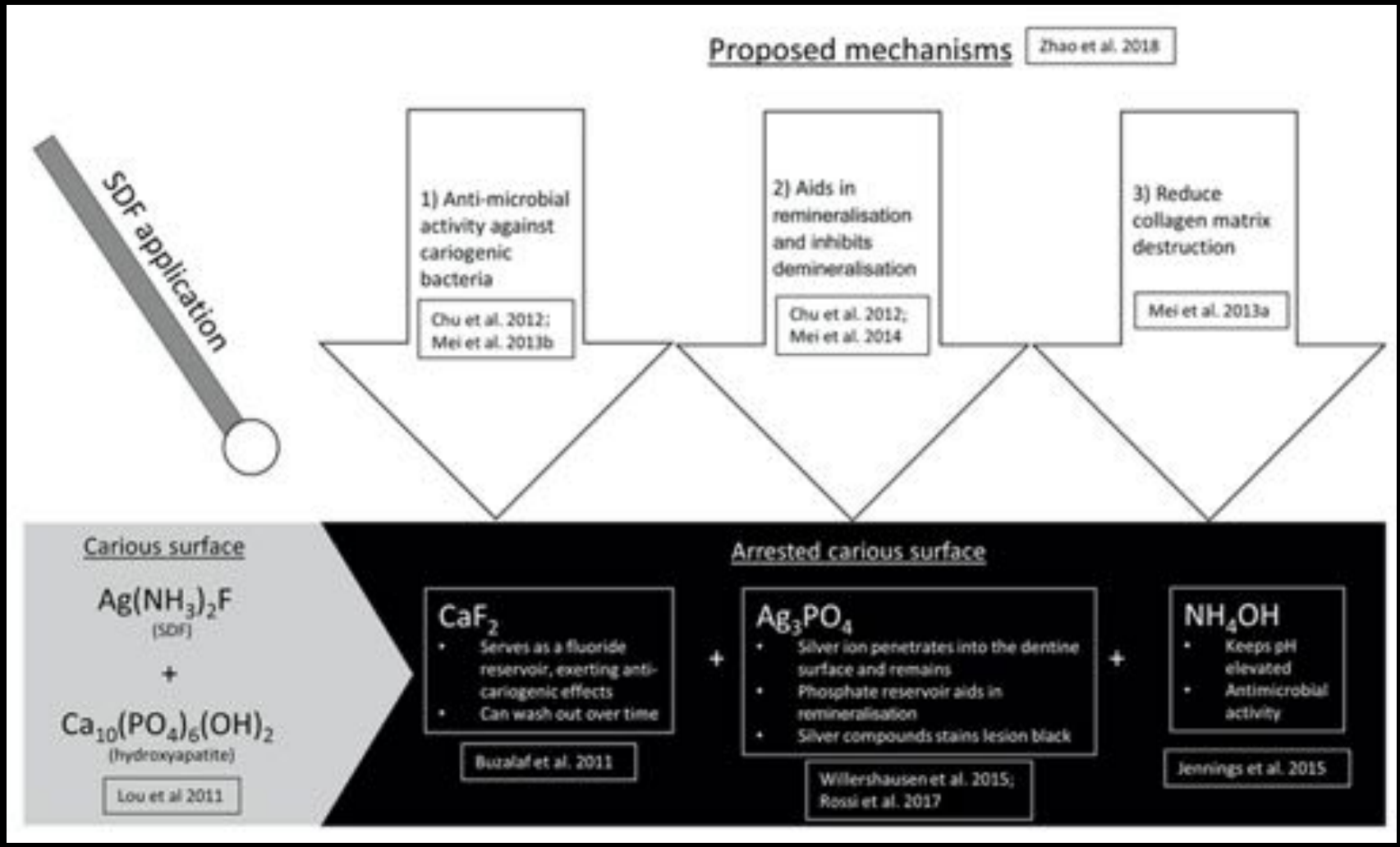
- Coronal surfaces
    - 30% SDF solution annually is superior to 5% NaF applied 1/wk for 3wks
        - high certainty
    - 38% SDF solution biannually is superior to 12% biannually or 38% annually
        - high certainty

Duangthip et al. 2016; Fung, et al. 2018; Duangthip, et al. 2018; Fung et al. 2016; Llodra et al. 2005; Yee et al. 2009

Cavitated Lesions



- Silver Diamine Fluoride



Zhao et al; Hu et al. 2018

Cavitated Lesions



- Silver Diamine Fluoride
- **2014:** US FDA approves SDF as a treatment for dentinal sensitivity
    - prior to this SDF had been used off-label for caries arrest
- **2016:** FDA awarded ‘Breakthrough Therapy status’ for approval of SDF as a drug to treat severe early childhood caries
    - allows for SDF to be evaluated in clinical trials in the treatment of dental caries
- **2016:** “Interim Caries Arresting Medicament Application”

Cavitated Lesions



- Silver Diamine Fluoride

Product name	SDF%	Manufacturer	Country of manufacture
Advantage Arrest	38%	Elevate Oral Care	USA
Bioride	38%	Dentsply Industria e Comercio Ltda	Brazil
Cariostatic	10%	Inodon Laboratorio	Brazil
Cariestop	30%	Biodinamica Quimica e Farmaceutica Ltda	Brazil
Cariestop	12%	Biodinamica Quimica e Farmaceutica Ltda	Brazil
e-SDF	38%	Kids-e-dental Llp	India
Fagamin	38%	Tedequim SRL	Argentina
Fluoroplat	38%	NAF Laboratorios	Argentina
Saforide	38%	Toyo Seiyaku Kasei Co Ltd	Japan
Topamine	38%	PharmaDesign corporation	Thailand
Riva Star	38%	SDI Dental Limited	Australia

Patel et al. 2021











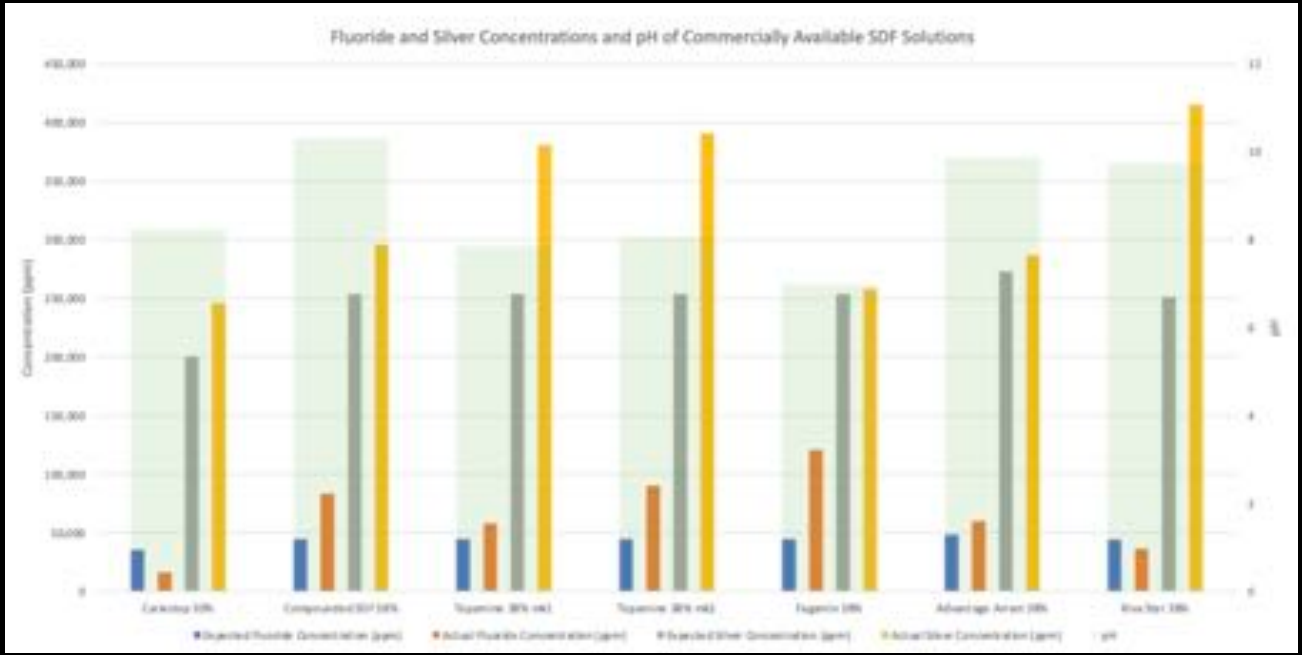
Cavitated Lesions



- Silver Diamine Fluoride

Table 1. Differences between expected and measured values for fluoride concentration, silver concentration and pH of various silver diamine fluoride (SDF) solutions

	Cariestop 30%	Compounded SDF 38%	Topamine 38% mk1	Topamine 38% mk2	Fagamin 38%	Advantage Arrest 38%	Riva Star 38%
Expected Fluoride Concentration (ppm)	35 400	44 800	44 800	44 800	44 800	48 107	44 260
Actual Fluoride Concentration (ppm)	16 343	83 354	58 101	90 117	120 760	60 022	36 457
Expected Silver Concentration (ppm)	200 400	253 870	253 870	253 870	253 870	273 143	251 250
Actual Silver Concentration (ppm)	246 000	296 000	381 000	391 000	258 000	287 000	415 433
pH	8.23	10.3	7.86	8.07	6.99	9.87	9.74



Patel et al. 2021

Cavitated Lesions



- Silver Diamine Fluoride
- **Contraindications**
  - teeth with evidence of pulpitis
  - deep dentine lesions encroaching the pulp
  - silver allergy
  - aesthetic demand



Baseline & DF Coke at 24 min

Case 2 at 24:36

Antcms :24:45

Patel et al. 2019

Cavitated Lesions



- Coronal surfaces

Randomized Controlled Trial > Caries Res. 2018 Jan;51(6):605-614. doi: 10.1159/000477855. Epub 2017 Dec 20.

Alternative Caries Management Options for Primary Molars: 2.5-Year Outcomes of a Randomised Clinical Trial

Ruth M Santamaria [1], N P T Innes, Vita Machiulskiene, Julian Schmoeckel, Mohammad Alkilzy, Christian H Splieth

- Hall Technique (HT)
- Non-restorative caries treatment (NRCT)
- Conventional restorations (CR)

Santamaria et al. 2018

Cavitated Lesions



- Hall Technique (HT)
  - No caries removal or tooth preparation
  - No local anaesthesia
  - Ortho separators
  - Cementation of stainless steel crown
- Non-restorative caries treatment (NRCT)
  - Lesions were opened with a high-speed bur
  - Cavity made cleansable
  - Application of 5% NaF
- Conventional restorations (CR)
  - Complete caries removal under local anaesthesia
  - Matrix band
  - Restored using a compomer

Santamaria et al. 2018

Cavitated Lesions



- Non-restorative caries treatment (NRCT)





Example of NRT at 26 mo

Kidd et al. 2012

Cavitated Lesions



Table 2. Treatment success rates and reasons for failures after the 2.5-year follow-up by arm

Outcomes (cumulative)		HT, *n* (%)	NRCT, *n* (%)	CR, *n* (%)	Total, *n* (%)
Successful	Crown/restoration appears satisfactory or caries arrested	37 (92.5)	31 (70)	39 (67)	107 (75)
Minor failure[a]	Caries progression/secondary caries	1 (2.5)	7 (16)	9 (15)	25 (18)
	Restoration loss/fracture	1 (2.5)	0	5 (9)	
	Pulpitis (pulpotomy not required)	0	2 (5)	0	
Major failure	Reversible pulpitis	0	0	2 (3)	10 (7)
	Irreversible pulpitis	0	1 (2)	0	
	Abscess	1 (2.5)	3 (7)	3 (5)	
Total		40	44	58	142

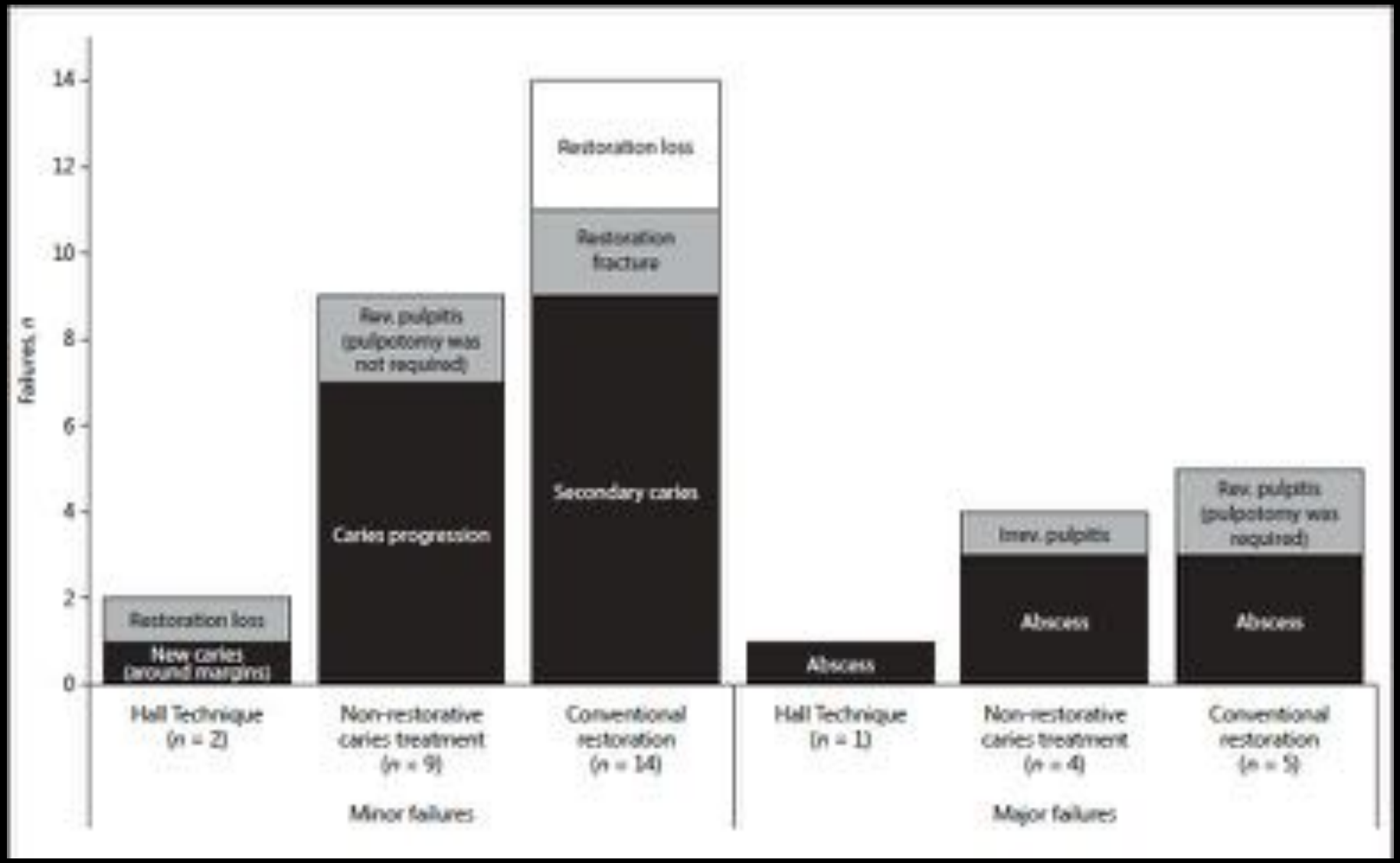
- No statistically significant difference between NRCT and CR

↳ hall technique has a better seal!
↳ need to ensure dentin between lesion & pulp

Santamaria et al. 2018

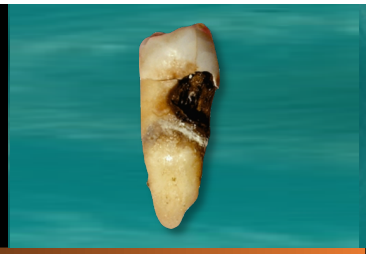
Cavitated Lesions





Santamaria et al. 2018

Root Surfaces



- Root surfaces
  - 5000ppm F toothpaste → best outcome
    - 3 x greater chance of caries arrest (low certainty)
  - 1% Chx + 1% thymol varnish
  - 38% SDF annually
  - 38% SDF + KI annually
  - 5% NaF varnish
    - 2-3x greater chance of caries arrest (v low – low certainty)

Schaeken et al. 1991; Wallace et al. 1993; Lynch et al. 2000; Baysan et al. 2001; Brailsford et al. 2002; Wyatt et al. 2004; Ekstrand et al. 2008; Baca et al. 2009; Ekstrand et al. 2013; Zhang et al. 2013; Li et al. 2016

Non-restorative Caries Control

- Summary of Systematic Reviews
  - Non-cavitated proximal surfaces
    - Sealants and resin infiltration more effective than other non-invasive treatments

Dorri et al. 2015

  - Non-cavitated buccal/facial surfaces
    - 5% NaF is more effective than 1.23% APF or no treatment

Lenzi et al. 2016

  - Non-cavitated occlusal surfaces
    - Sealants are more effective than other non-invasive treatments

Wright et al. 2016

  - Cavitated dentine caries
    - 38% SDF solution is more effective than other non-invasive treatments

Contreras et al. 2017

Non-restorative Caries Control

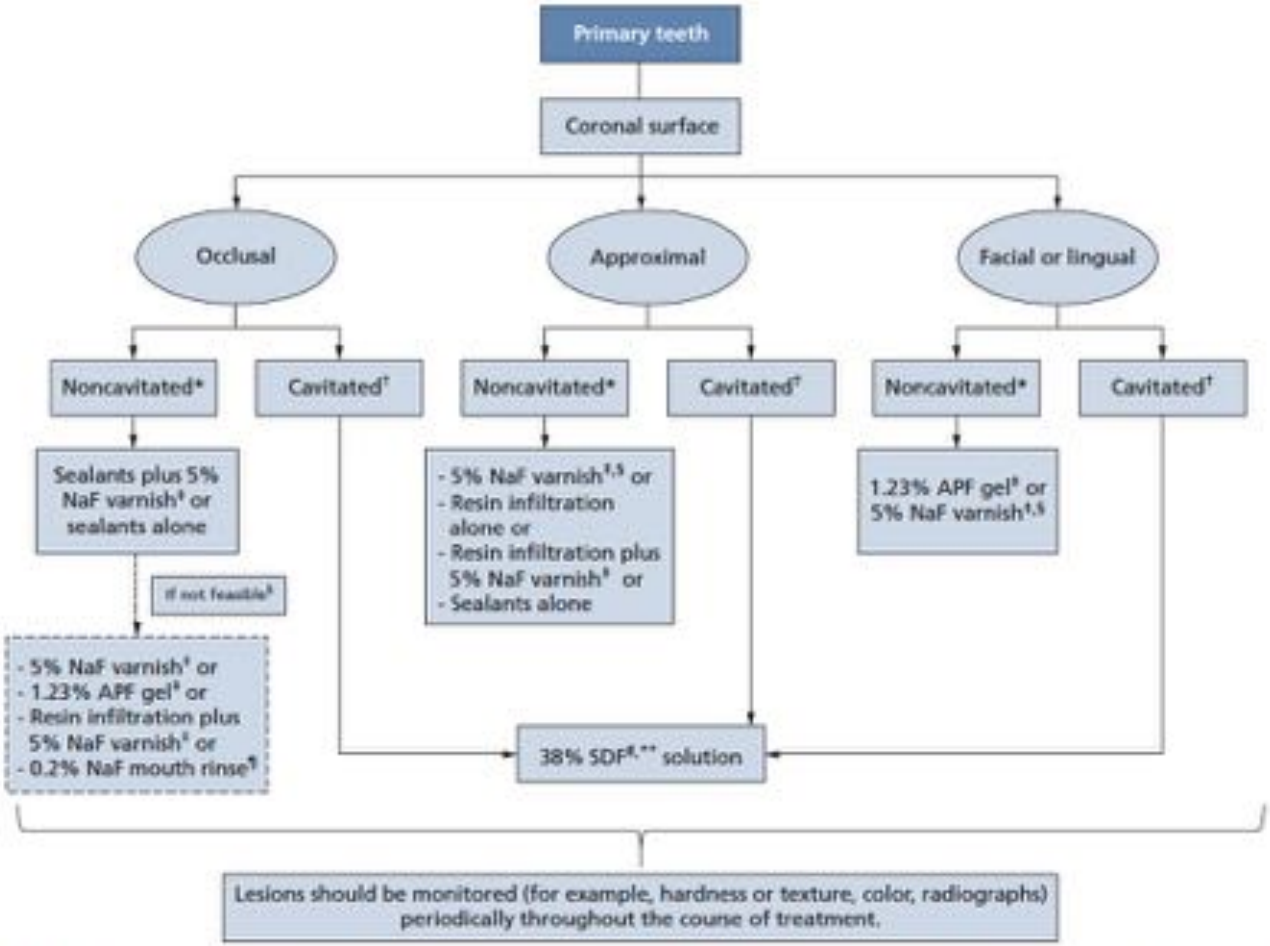


Figure 1. Clinical pathway for the nonrestorative treatment of noncavitated and cavitated carious lesions on primary teeth. APF: Acidulated phosphate fluoride. NaF: Sodium fluoride. SDF: Silver diamine fluoride. * Defined as ICDAS 1-2. † Defined as ICDAS 5-6. ‡ Application every 3 through 6 months. § The order of treatments included in this recommendation represents a ranking of priority defined by the panel when accounting for treatment effectiveness, feasibility, patients' values and preferences, and resource utilization. Considerations such as a particular patient's values and preferences, special needs, or insurance status should inform clinical decision making. ¶ At-home use once per week. # Biannual application. ** In keeping with the concept of informed consent, all nonsurgical and restorative treatment options and their potential side effects (such as blackened tooth surfaces treated with SDF) should be offered and explained to all patients.

Slayton et al. 2018

Non-restorative Caries Control

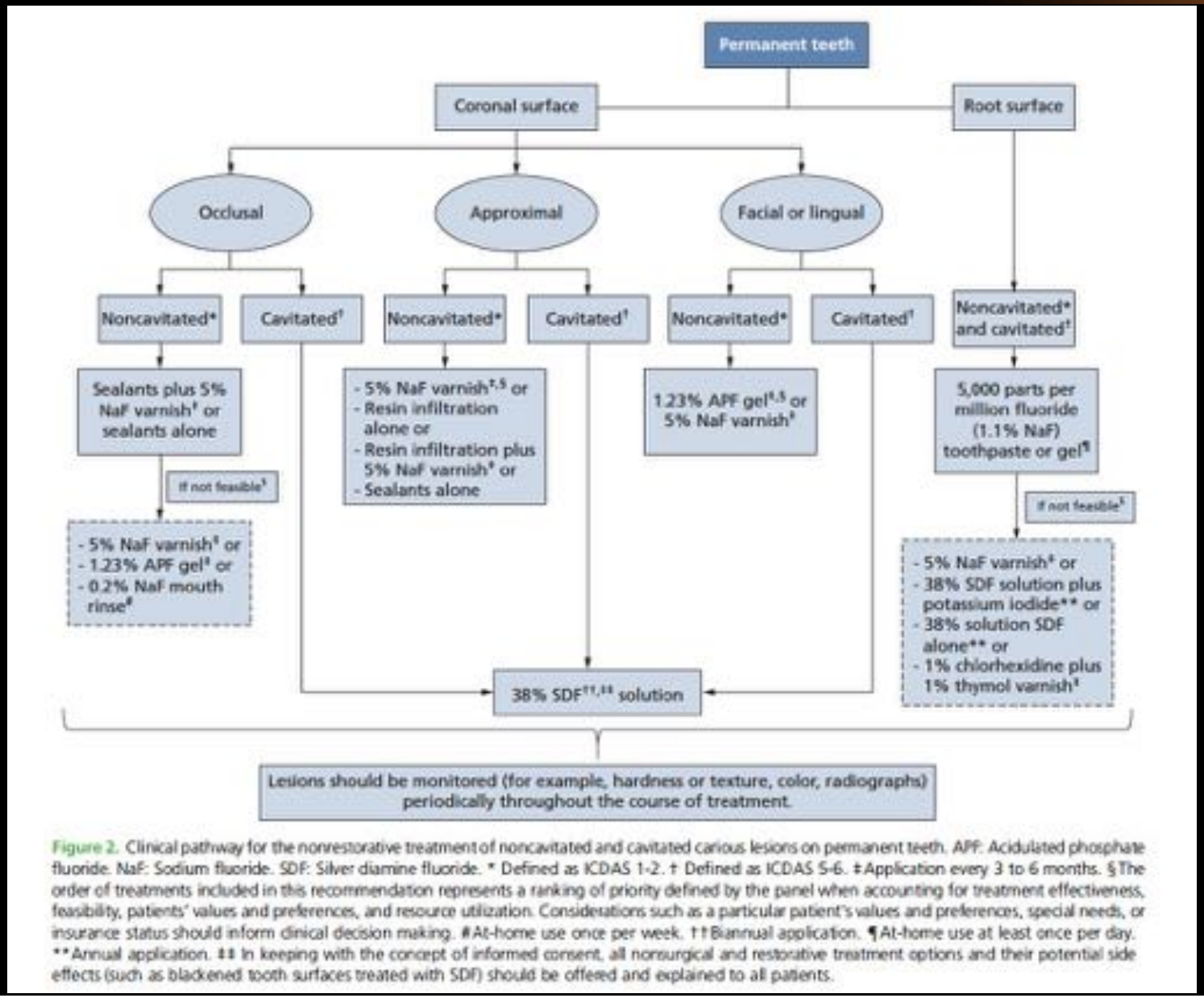


Figure 2. Clinical pathway for the nonrestorative treatment of noncavitated and cavitated carious lesions on permanent teeth. APF: Acidulated phosphate fluoride. NaF: Sodium fluoride. SDF: Silver diamine fluoride. * Defined as ICDAS 1-2. † Defined as ICDAS 5-6. ‡Application every 3 to 6 months. §The order of treatments included in this recommendation represents a ranking of priority defined by the panel when accounting for treatment effectiveness, feasibility, patients' values and preferences, and resource utilization. Considerations such as a particular patient's values and preferences, special needs, or insurance status should inform clinical decision making. #At-home use once per week. ††Biannual application. ¶At-home use at least once per day. **Annual application. ‡‡ In keeping with the concept of informed consent, all nonsurgical and restorative treatment options and their potential side effects (such as blackened tooth surfaces treated with SDF) should be offered and explained to all patients.

Slayton et al. 2018