

Medical Model of Caries &  
Silver Ion Antimicrobials



## disclosures

My research is now funded by gifts from:

Chan-Zuckerburg BioHub

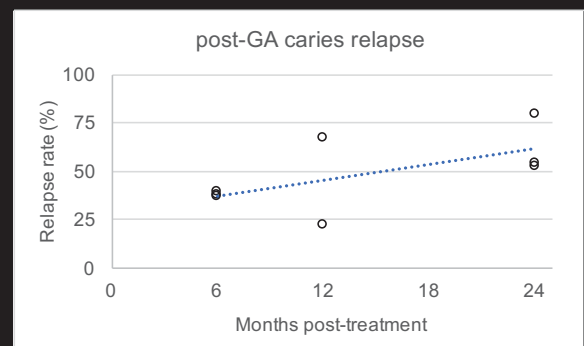
Advantage Silver Arrest

Howard Hughes Medical Institute

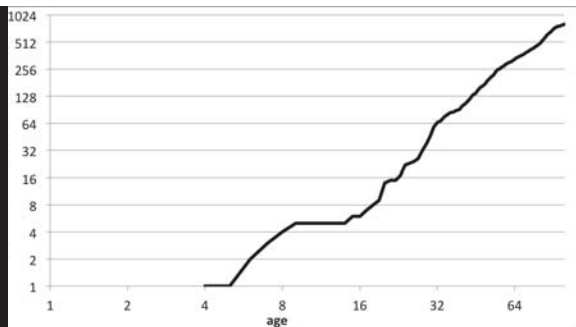
*Jeremy Horst*



We are not going to drill our way  
out of this problem.



Twetman & Dhar, 2015



Dental caries (K02), pulp / periapical abscess (K04), cellulitis (K12.2).

It seems that kids *do not die* from caries in primary teeth.

data from wonder.cdc.gov 1999-2015

## General Anesthetic and Sedation Drugs: Drug Safety Communication - New Warnings for Young Children and Pregnant Women

SHARE TWITTER LINKEDIN PINTEREST EMAIL PRINT

[Posted 12/14/2016]

**AUDIENCE:** Consumer, Surgery, Anesthesiology

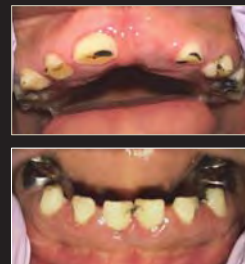
**ISSUE:** FDA is warning that repeated or lengthy use of general anesthetic and sedation drugs during surgeries or procedures in children younger than 3 years or in pregnant women during their third trimester may affect the development of children's brains.

**RECOMMENDATION:** Health care professionals should balance the benefits of appropriate anesthesia in young children and pregnant women against the potential risks, especially for procedures that may last longer than 3 hours or if multiple procedures are required in children under 3 years. Discuss with parents, caregivers, and pregnant women the benefits, risks, and appropriate timing of surgery or procedures requiring anesthetic and sedation drugs.

Parents and caregivers should discuss with their child's health care professional the potential adverse effects of anesthesia on brain development, as well as the appropriate timing of procedures that can be delayed without jeopardizing their child's health. Pregnant women should have similar conversations with their health care professionals. Also talk with them about any questions or concerns.

*No, really.*  
 We are not going to drill our way  
 out of this problem.

3 year outcome – severely fragile 3 to 7 year old



1 year



3 years



No excavation SDF + GIC

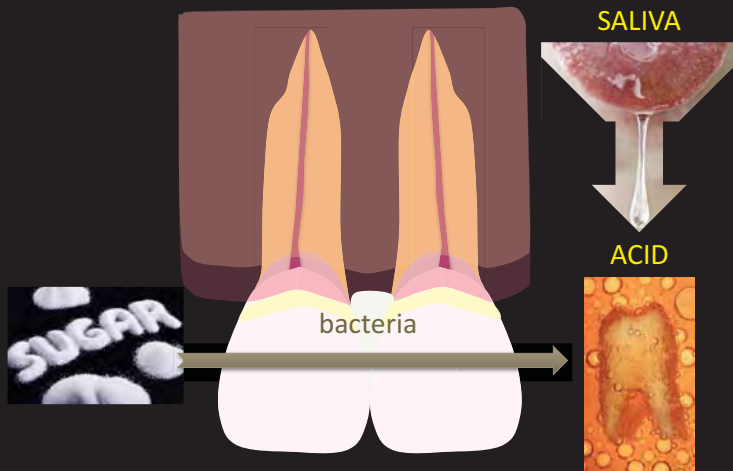


2 years

### Outline

1. Cariology basics
2. Silver Diamine Fluoride
3. Glass Ionomer, Sealants, ART
4. SMART
5. Hall Crown Technique
6. Other important Topicals
7. Systematic model against caries

### dental caries basics



sugar + caries =  
pouring fuel on the fire

SUPPORT  
SUGAR  
TAXES



SUPPORT  
SUGAR  
TAXES



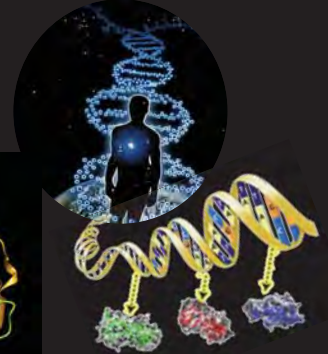
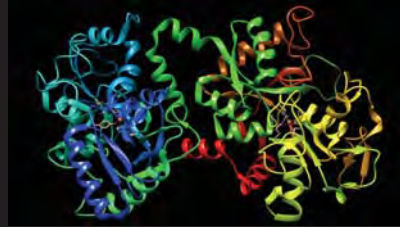
Too much **added sugar** doesn't just make us fat. It can also make us **SICK.**

Growing scientific evidence shows that eating too much added sugar over time is linked to health problems, including chronic diseases such as **heart disease, diabetes and liver disease.**

SugarScience is the authoritative source for evidence-based, scientific information about sugar and its impact on health. [www.sugarscience.org](http://www.sugarscience.org)

## Human component?

- only in dysfunction
- ~no human genetics
- *Lactotransferrin*

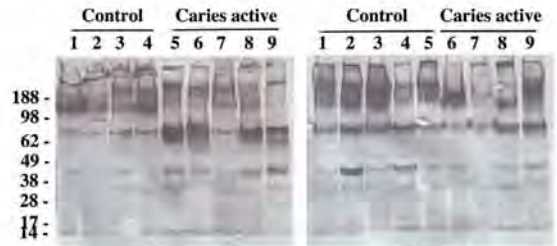


## Weak teeth?



No: weak spit.

Lotus Tetragonolobus (LTL) staining of blots containing whole saliva from control (caries inactive) versus caries active female donors (panel A) and male donors (panel B).



**A**

**B**

Panel A Female donors

Lane 1-4 are caries inactive donors

Lane 5-9 are caries active donors.

Panel B Male donors

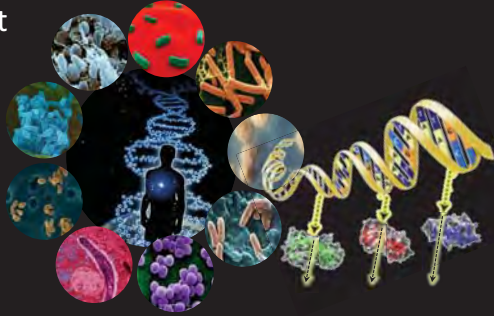
Lane 1-5 are caries inactive donors

Lane 6-9 are caries active donors.

With Susan Fisher Lab

## Bacterial component?

Definitely, but  
it's complex.



## Window of infectivity



Caufield, *Pediatr Dent* 1997

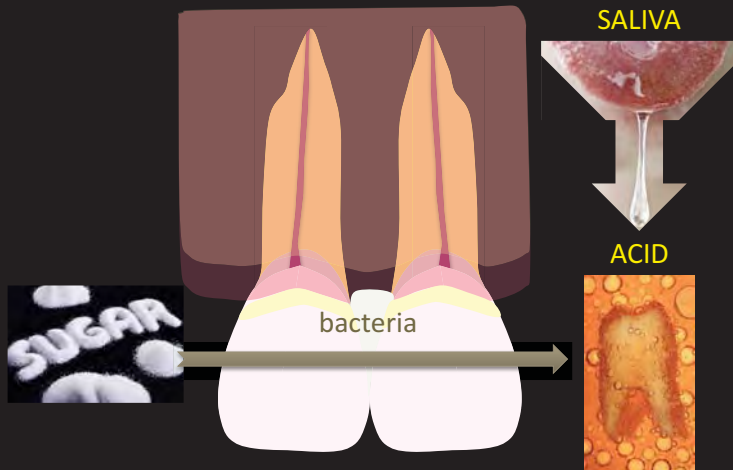
## dental caries passes through families



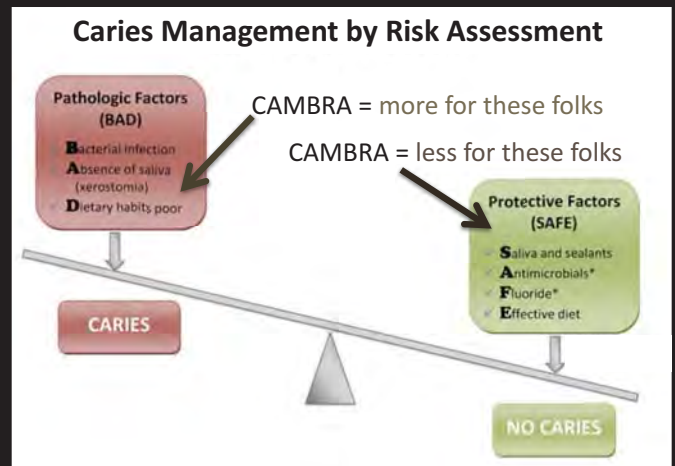
## Life cycle transmission



## dental caries battle map



## Caries Management by Risk Assessment



Featherstone, 2000

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## SDF - what is it?

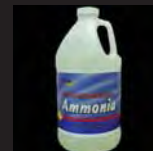


Colorless liquid

25% silver: antimicrobial

8% ammonia: solvent

5% fluoride: remineralization



## SDF vs SN + FV



### SDF

25% silver  
8% ammonia  
5% fluoride  
> effect data

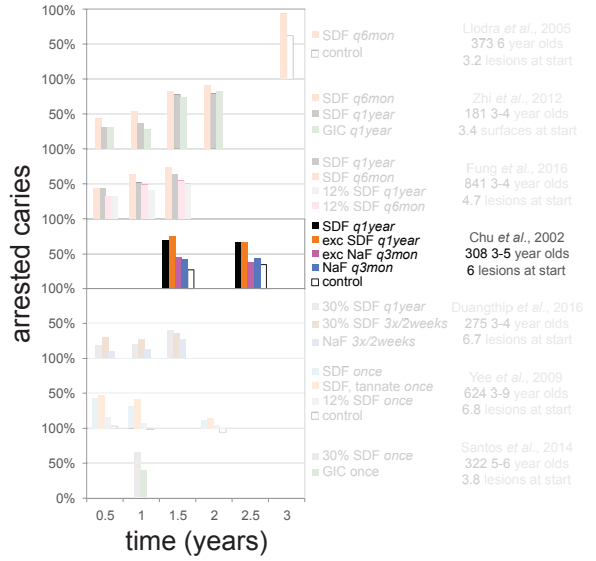
### SN + FV

16% silver  
9% nitrate  
2.5% fluoride  
> safety data

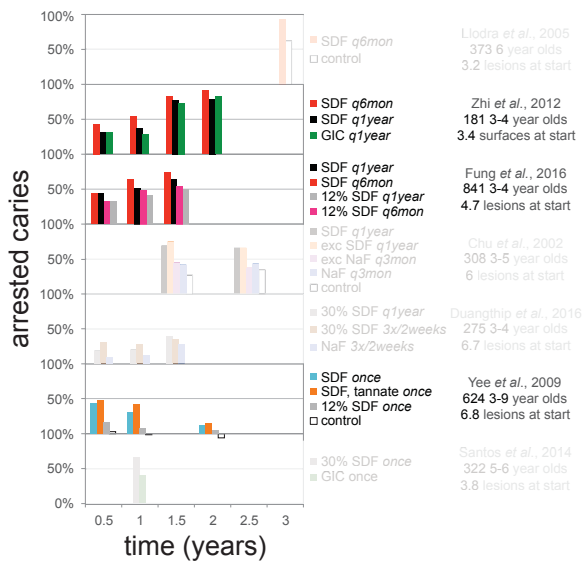


BOTH are safe & effective.

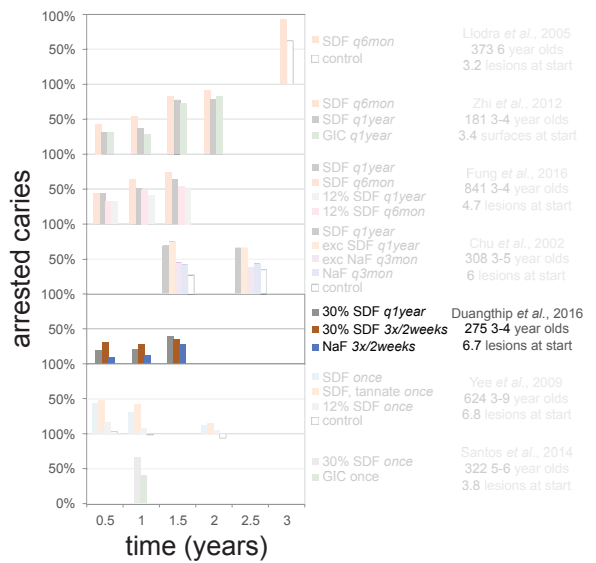
## Caries Arrest in kids



## Caries Arrest in kids

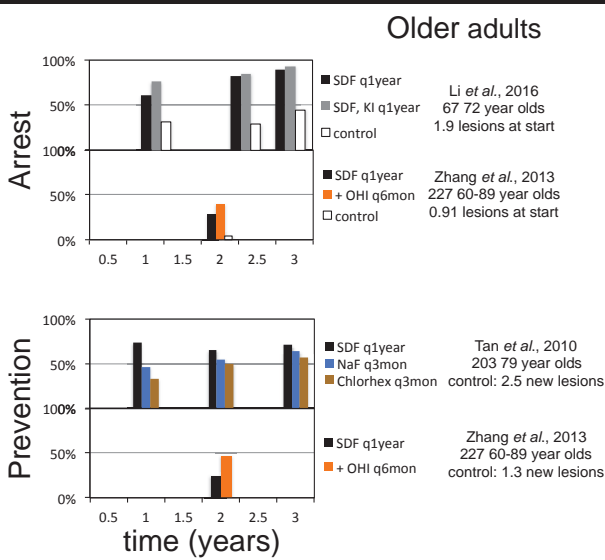
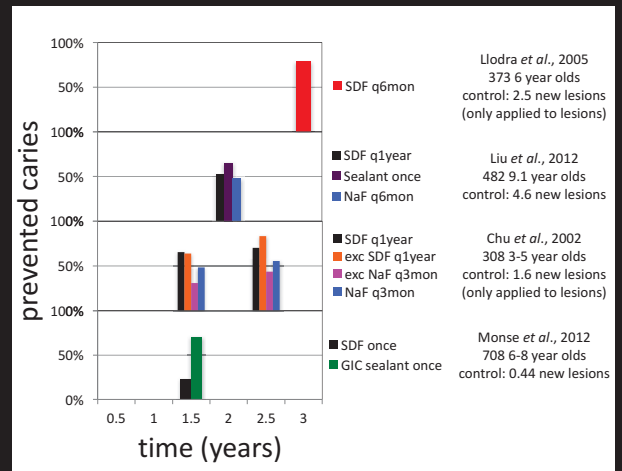
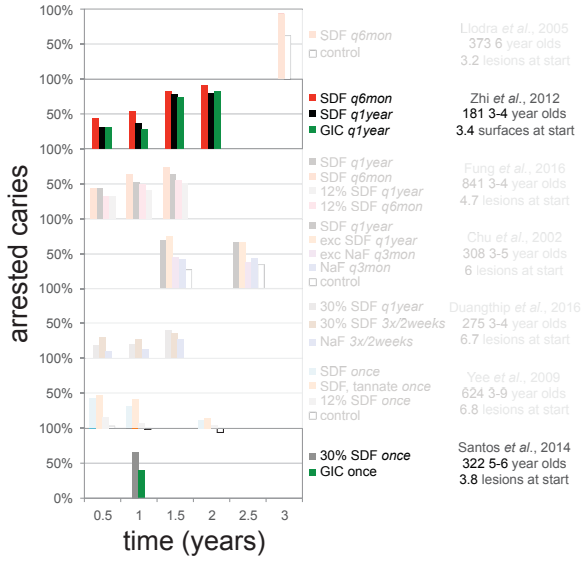


## Caries Arrest in kids





# Caries Arrest in kids



## Learned from clinical trials?

- 12 RCTs with 1,816 patients tx SDF = safe.
- 9 on caries arrest.
  - ~90% arrest with 2/year application.
  - 40-80% arrest with 1/year application.
- 6 on caries prevention (3 overlap).
  - 70-80% prevention in kids by application *only* to lesions.
  - 25-70% prevention, *outperforms everything* by far.

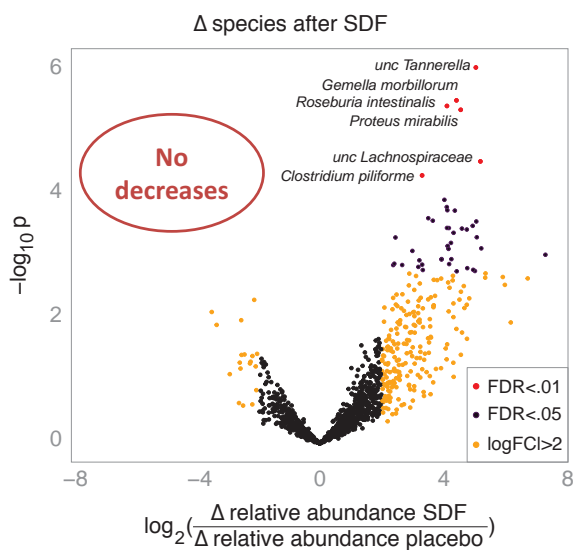
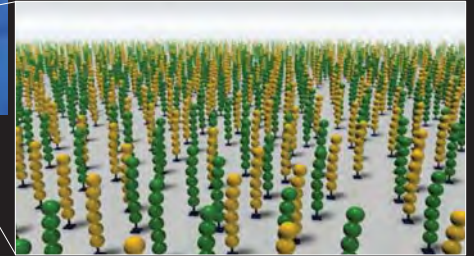
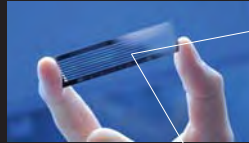
## Stopping Cavities Trial purpose: Safety & Arrest Effectiveness

	n	arrested (SD)	95% CI	adverse events
SDF	30	.72 (.38)	.55 to .85	flu, nausea, redness, spot
placebo	36	.05 (.18)	.00 to .16	diarrhea x 2, tummy ache, toothache + diarrhea

Advantage, UW, UCSF



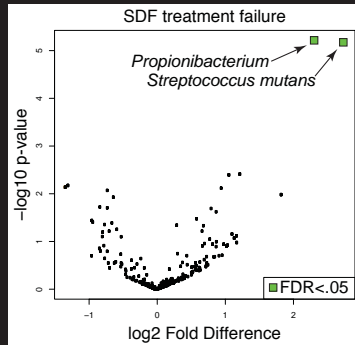
Microbiology  
by  
"sequencing"



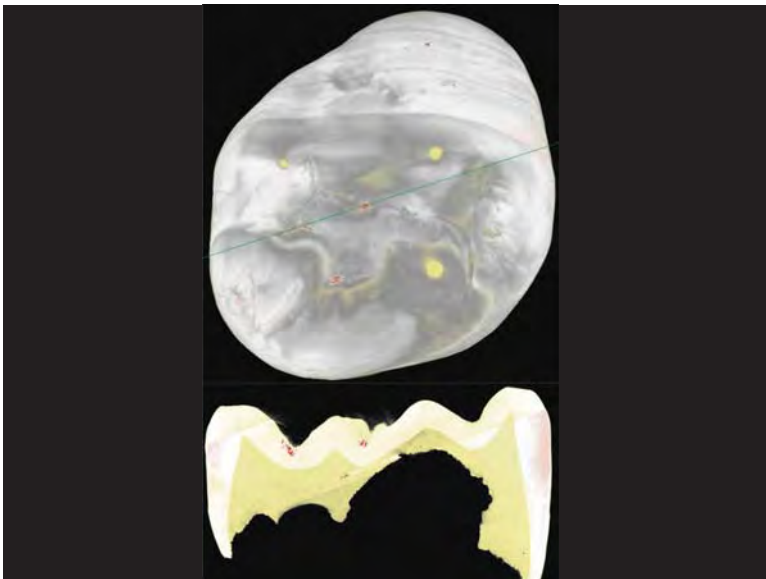
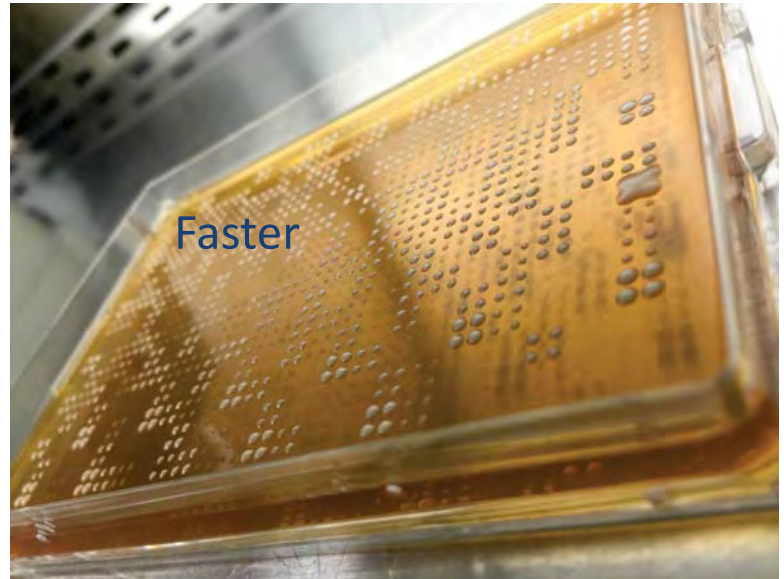
## IHS Pilot

- "If I had anything that worked, do you think I would be introducing an unknown drug that is not standard of care into my community?"
- 5x Silver nitrate + Fluoride varnish
- 3 years: 85% arrest, 75% no new lesions.
- 2 years: 93% arrest.
- After 1 year: "Finally, after 30+ years of clinical experience, I have something that works."

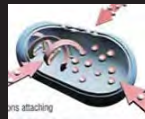
## Ghana Ag+F pilot



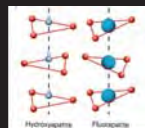
SDF treatment FAILURE



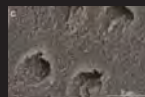
## SDF: how does it work?



- Bactericidal
- Prevents bacterial growth
- Deactivates enzymes



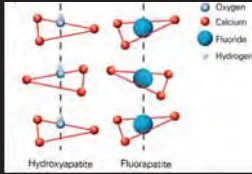
- Remineralizes to fluoroapatite
- Increases lesion hardness
- Prevents demineralization



- Occludes dentinal tubules
- Penetrates far into dentin

## Fluoride: how does it work?

- promotes remineralization
- inhibits demineralization
- can inhibit plaque bacteria



## silver ion = wrecking ball

### Antimicrobial:

- denatures *all* proteins.
- breaks cell walls.
- inhibits DNA replication.



### Coagulant

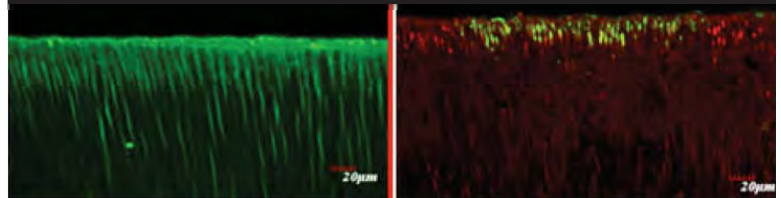
- denatures exposed dentin proteins.

## SDF: sustained antimicrobial effects

- Treated dentin resists plaque formation.
  - *demineralized* dentin resists *more*.
- **Zombie Effect:** Silver-killed bugs kill active bugs.
  - **Ideal substantivity.**



## Silver chases bugs down into tubules



## SDF penetration testing

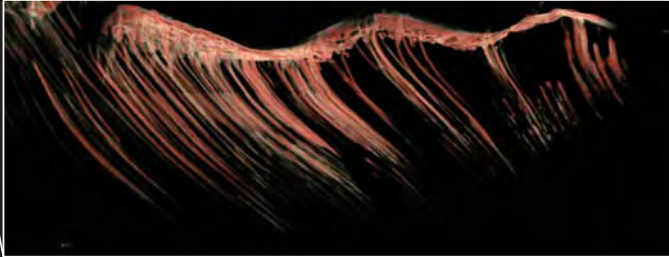
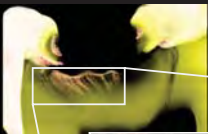


## SDF penetration testing

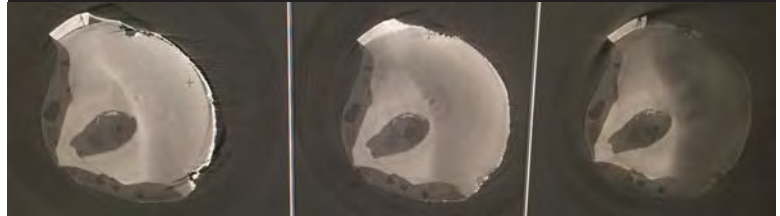


## SDF: penetration

SDF casts silver rebar millimeters into dentin, reinforcing the lesion and sustaining kill.



## kinetics of SDF penetration



1 hour

10 minutes

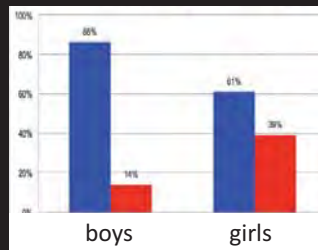
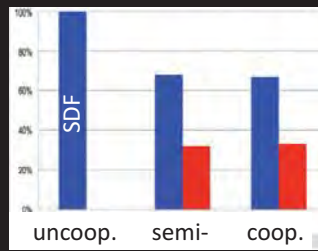
Before



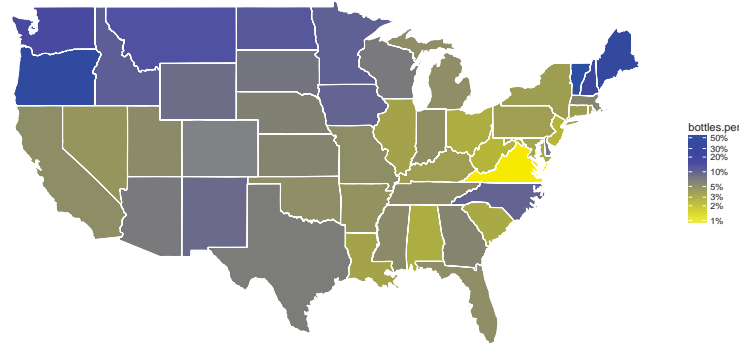
## What do parents think about SDF?



n=33  
Tesoriero & Lee 2016



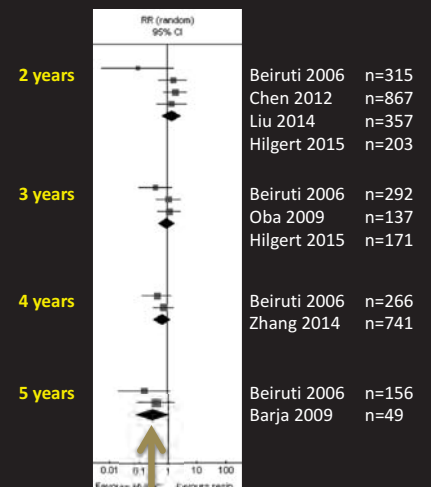
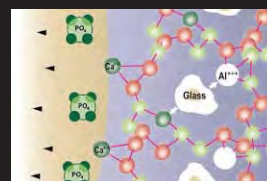
## sales of SDF bottles per dentist



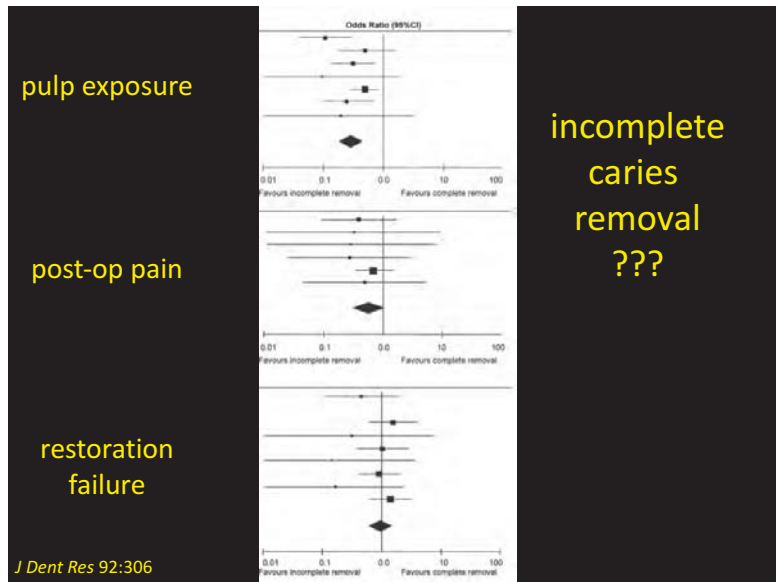
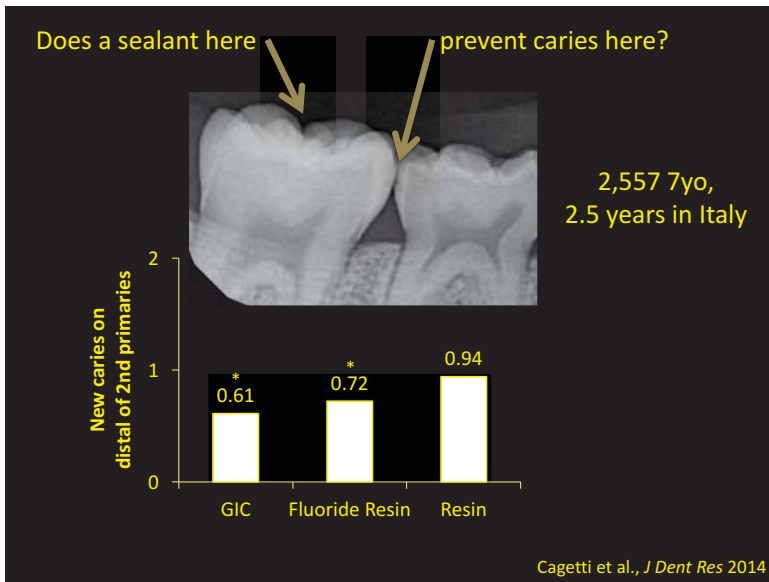
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## GIC sealants vs Resin sealants???



Mickelautsch and Yengopal PLoS One 2016



## Seal over initial caries with GIC

“sealants can prevent the progression of early noncavitated carious lesions.”

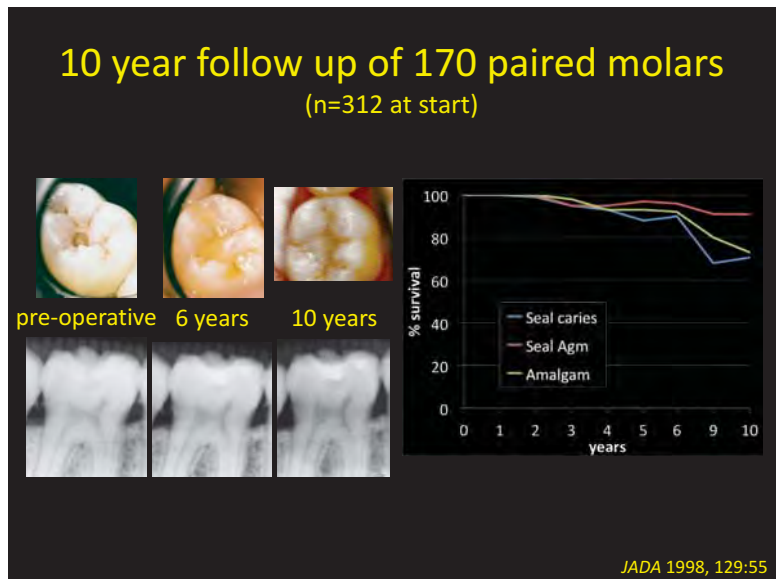
“These clinical recommendations... include use of a glass ionomer cement material”

**COVER STORY** Executive summary follows page 356

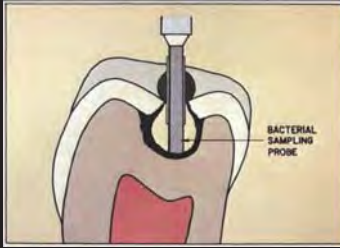
### Evidence-based clinical recommendations for the use of pit-and-fissure sealants

A report of the American Dental Association Council on Scientific Affairs

Jean Beauchamp, DDS; Page W. Caufield, DDS, PhD; James J. Crall, DDS, ScD; Kevin Donly, DDS, MS; Robert Feigal, DDS, PhD; Barbara Gooch, DMD, MPH; Amid Ismail, BDS, MPH, MBA, DrPH; William Kohn, DDS; Mark Siegal, DDS, MPH; Richard Simonsen, DDS, MS



## No vital bacteria under sealant



10<sup>5</sup> mutans streps  
vs  
zero under sealant  
@1-17 months

JADA 1986, 112:194

## Atraumatic Restorative Technique (ART)



multiple surface ART

Table 3. Overview of survival results (in percent) SE and 95% CI of multiple-surface ART restorations using high-strength glass ionomer primary permanent teeth by location and year of survival.

Location	Year of survival		
	1	2	3
	Survival	SE	CI
Bohner et al. (20)	81	4.3	76
Van't Hof-Grootenboer et al. (17)	77	5.0	69
Bohner et al. (21)	80	4.0	73
Takhar et al. (24)	77	5.0	69
Pip et al. (21) and Yu et al. (26)	40	10.2	33
Lu et al. (21)	71	5.8	63
Lu et al. (21) and Lu et al. (27)	59	10.0	49
Muhammad et al. (28)	33	10.0	23
Weighted mean score	71%		

year 1 71%  
year 2 62%  
year 3 31%

single surface ART

Table 3. Overview of survival results (in percent) SE and 95% CI of single-surface ART restorations using high-strength glass ionomer in primary permanent teeth by location and year of survival.

Location	Year of survival		
	1	2	3
	Survival	SE	CI
Bohner et al. (21)	89	2.0	85
Takhar et al. (24)	89	1.8	85
Pip et al. (21) and Yu et al. (26)	91	1.8	88
Pip et al. (21) and Yu et al. (26)	88	4.2	80
Lu et al. (21)	90	2.3	85
Lu et al. (21) and Lu et al. (27)	82	3.4	76
Van't Hof-Grootenboer et al. (17)	100	0.0	100
Bohner et al. (20)	82	2.9	76
Yoshida (21)	70	5.2	62
Weighted mean score	93%		

year 1 95%  
year 2 93%  
year 3 66%



DeAmorim et al., Clin Oral Invest, 2012

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## SDF + GIC: silver modified ART SMART

- Glass Ionomer Cements (GICs) add the benefit of sustained fluoride release and a seal!
- Protocol: SDF, then standard GIC protocol.



(they darken over time)

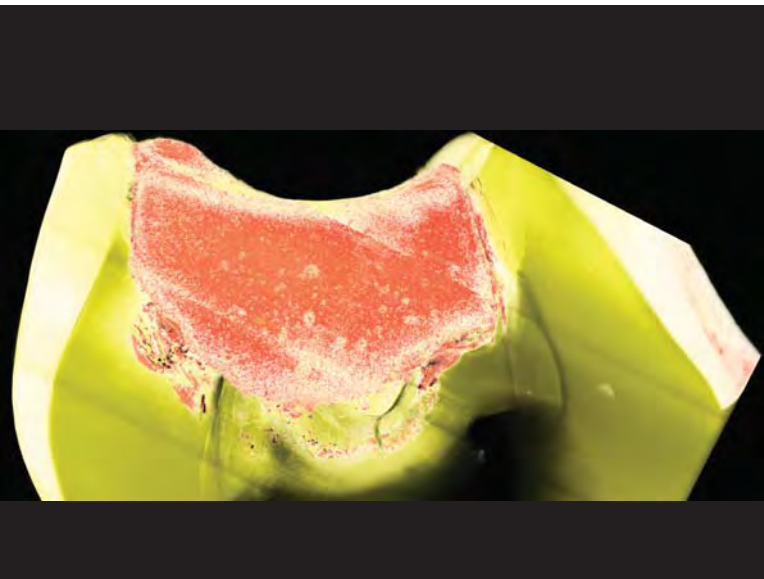
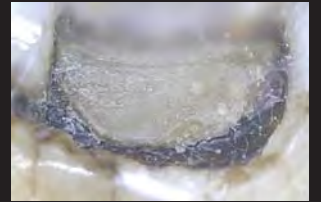
Drs. John Frachella & Cate Quas

No excavation SDF + GIC



2 years

SMART retention



## Kitchen SMARTs



## The paradox of covering

### Lesion (GIC)

- seal stops progression
- seal may seal in SDF
- GIC prevents lesions nearby
- GIC needs less frequent reapplication
- Small lesions may not retain GIC

### Mouth (SDF)

- SDF prevents lesions throughout
- SDF needs more applications
- SDF is cheaper
- SDF is less technique sensitive
- Deep lesions may progress

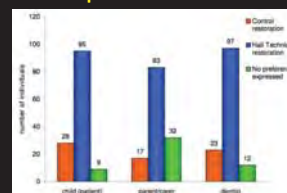
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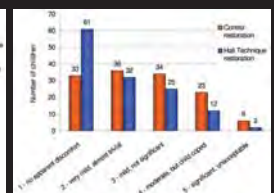
## Hall technique no preparation SSCs



### preference

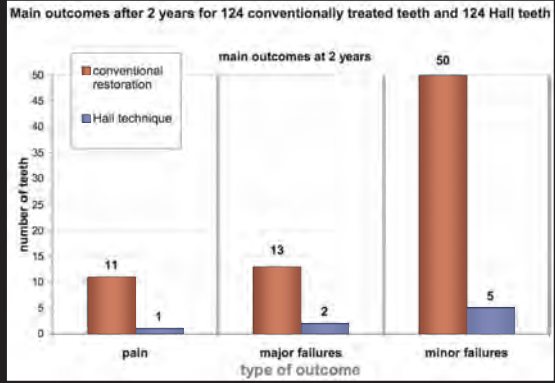


### behavior





## Hall crowns



## Indicators of success

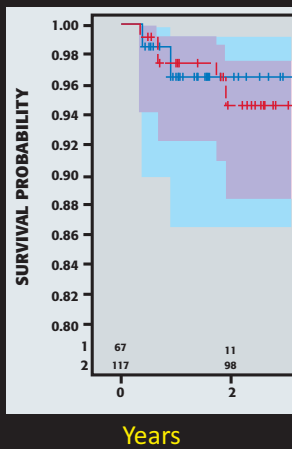


success



failure

## Halls in the USA



JADA 2014

## Occlusion self-adjusts



6 Hall crowns, 1 kiddo.

## Hall technique



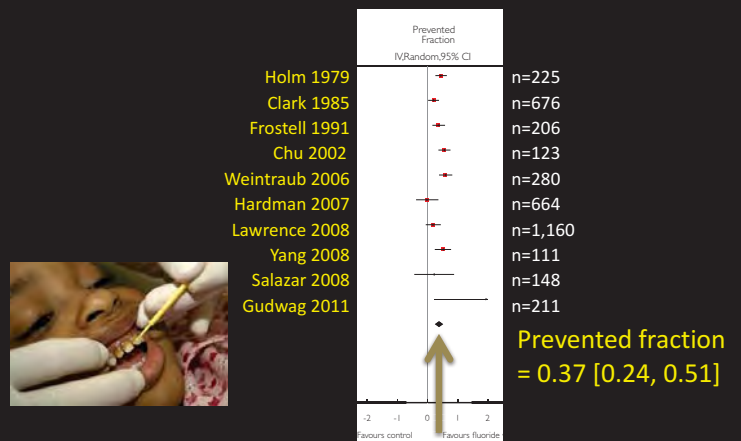
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## ??? best 4 & worst 1 preventive ???

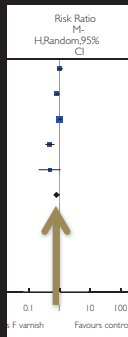
- F varnish + Iodine 80%
- Xylitol in Moms of 3-15month olds
- Xylitol in infants/toddlers
- Daily Self-Flossing
- High F toothpaste
- F toothpaste
- Daily Pro-Flossing
- Vitamin D / UV
- SDF
- F varnish 00%

## F varnish decreases caries severity



## F varnish does not change incidence

Hardman 2007  
Holm 1979  
Lawrence 2008  
Weintraub 2006  
Yang 2008



n=282  
n=225  
n=357  
n=253  
n=111

**Risk Ratio**  
= 0.81 [0.62, 1.06]



## Unfortunately, F varnish does not seem to work <3 years old.

### PubMed ID

25448437 n= 450 No difference.  
25123352 n= 424 No difference.  
21999806 n= 361 No difference.  
24481085 n= 200 No difference.  
25895964 n= 140 No difference.  
26795957 n=3,403 No difference.  
18422711 n=1,275 25% prevented.  
27685609 n=1,248 25% prevented, in combo w/ 1450ppmF toothpaste.  
20707872 n= 666 31% prevented, in combo w/ behavioral intensive.



**NNTs for those showing effect: ~12.**

Meaning: treat 12 kids 2/year to prevent 1 lesion

## Caries prevention with Betadine + F varnish

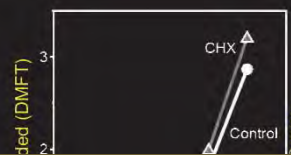
### vs varnish

foam	once	no Δ	Zhan et al., 2006
liquid	once	no Δ	Berkowitz et al., 2011
foam	once	no Δ	Xu et al., 2009
liquid	q3mon	11% less	Tut & Milgrom, 2010
liquid	q3mon	24% less	Milgrom et al., 2011
liquid	q3mon	100% less	Simratvir et al., 2010
liquid	q2mon	80% less	Lopez et al., 2002

∴ liquid q3months  
start by 12 months of age

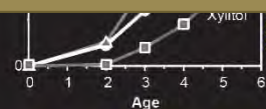


## xylitol gum for new Moms!



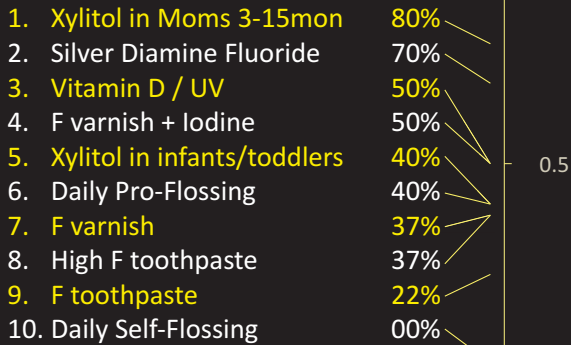
$$\frac{365 \frac{\text{days}}{\text{year}} * 8 \frac{\text{g}}{\text{day}} * \$3.89}{2 \frac{\text{g}}{\text{tab}} * 57 \text{ tabs}} = \$99.64/\text{year}$$

	prevent	start	freq	duration	eval	control	pubmed
n=195	71%	3mon	4/day	21mon	5yo	vs NaF 2/year	11145360
n=60	78%	10-36m	3/day	3mon	2y	vs NaF 2/year	24888659
n=173	71%	6mon	3/day	1year	4yo	vs NaF/xylitol/sorbitol	17164069



**less need for treatment**  
by treating mothers

## Summary of preventives



## Outline

1. Cariology basics
2. Silver Diamine Fluoride
3. Glass Ionomer, Sealants, ART
4. SMART
5. Hall Crown Technique
6. Other important Topicals
7. Systematic model against caries

## systematic model

- Perinatal: Prevent via family & caregivers.
  - Xylitol gum 3/day.
- Age 1-3: Primary prevention.
  - fluoride toothpaste (rice) 2/day @home
  - treat caries by 2-4/year SDF
  - else 2+/year Betadine + F varnish.
- Age 3-5: Arrest decay
  - fluoride toothpaste (pea) 2/day @home
  - Hall crowns if necessary
  - No benefit to cleanings.
- Age 6-10: Prevent spread to erupting permanent teeth
  - sealants (flowable composite or GI), amalgam fillings
  - 2/day supervised brushing @school

## systematic model

- “Adult”: Stop disease before restoration.
  - treat treat caries by SDF at 1<sup>st</sup> visit / recall
- “Family”: Stop the cycle of contagion.
  - Recall visits together.
  - Messaging: “baby teeth are important”
  - Messaging: “sugar is poison” (stop the floss message)
  - Fluoride toothpaste & toothbrush for everyone.
  - Xylitol for recent caries, EVEN IF “treated”!

what will you do?



2 min each

what will you do?



2 min each

THANK YOU

