Health Evidence Review Commission's Oral Health Advisory Panel

June 26, 2017

9:00 AM - 12:00 PM

Clackamas Community College
Wilsonville Training Center, Room 211
29373 SW Town Center Loop E, Wilsonville, Oregon, 97070

Section 1.0

Call to Order

AGENDA
ORAL HEALTH ADVISORY PANEL (OHAP)
June 26, 2017
9:00 am-12:00 pm
Wilsonville Training Center, Room 211
(All agenda items are subject to change and times listed are approximate)

#	Time	Item	Presenter
1	9:00	Call to Order, Review of Minutes	Gary Allen
2	9:10	New discussion items: 1) Orthodontics for non-cleft lip craniofacial anomalies 2) GUIDELINE NOTE 48, FRENULECTOMY/FRENULOTOMY	Ariel Smits
3	9:45	Multisector intervention: early childhood caries prevention	Cat Livingston
4	11:45	Other Business	Gary Allen/staff
5	11:55	Public Comment	
6	12:00	Adjournment	Gary Allen

MINUTES

Health Evidence Review Commission's
Oral Health Advisory Panel (OHAP)

Clackamas Community College
Wilsonville Training Center, Room 210
November 28, 2016
10:00 AM – 1:00 PM

Members Present: Gary Allen, DMD, Chair; Bruce Austin, DMD (via phone); Deborah Loy; Mike Shirtcliff, DMD; Gary Allen, DMD; Lori Lambright (via phone); Patricia Parker, DMD (via phone); Karen Nolan; Eli Schwarz, DDS, MPH, PhD; Len Barozzini, DDS; Lynn Ironside

Members Absent: Mike Plunkett, DMD

Staff Present: Darren Coffman; Ariel Smits, MD, MPH; Cat Livingston, MD, MPH

Also Attending: Kellie Skenandore, OHA; Kathleen Olesitse, CareOregon Dental (via phone); Lori McKeane, AllCare; Heather Simmons, Pacificsource (via phone), Dayna Steringer, DK Stat/ Advantage Dental.

- **Roll Call/Minutes Approval/Staff Report**

The meeting was called to order at 10:02 am and roll was called. The minutes from the September, 2016 meeting were reviewed and minor corrections made. Coffman reviewed the purpose of the meeting.

- **Topic: Multisector intervention: Early Childhood Caries Prevention**

Cat Livingston introduced the concept of multisector interventions and reviewed the draft scope statement for the multisector intervention statement for *Early Childhood Caries Prevention*. Schwarz recommended looking at motivational interviewing/anticipatory guidance. Loy wondered whether the question should include children up to age 6; she felt that it should be limited to younger children (pre-school and younger). It was clarified that children under age 6 means children 5 and younger. Schwarz pointed out that much of the literature on early childhood caries examines children age 3 and younger. The group was generally okay with children up to their 6th birthday; the term used should be consistent in the report.

The group discussed breaking out pregnant women as a separate report, looking at all interventions to improve dental health in pregnant women. Livingston discussed that

multisector interventions can include interventions outside of typical (child-targeted, clinical) interventions and thus xylitol in pregnancy would be appropriate to include as well as other types of interventions such as community-oriented ones. Allen suggested clarifying that the counseling would also include counseling of pregnant women as well as parents of small children. Schwarz recommended looking at extending coverage of dental care beyond the immediate postpartum period as another intervention. Loy mentioned that there is an oral health in pregnancy consensus statement that has already been prepared by the National Maternal and Child Oral Health Policy Center. It was noted to be available on the Oregon Oral Health Coalition website. Shirtcliff noted that the consensus statement is evidence based and has references to all of the literature reviewed.

The panel discussed that the dental group has done an extensive evidence review of early childhood caries several years ago. Livingston reviewed that a multisector intervention would become part of the Prioritized List and would be available to the CCOs and other audiences larger than the dental community. It could result in interventions outside of the typical ICD-10/CPT code pairings or CDT codes. Schwarz expressed reservations about the actual strength of evidence behind many dental interventions.

Livingston discussed creating a report that lists interventions with good evidence to support them. There was some discussion about those interventions, like fluoride toothpaste, which may not be studied because they are so obviously helpful. Livingston noted this and will consider how to present this type of intervention in the report.

Simmons wondered about having codes to implement the multisector interventions. Livingston clarified that many of the multisector interventions are unlikely to have codes, and CCOs and others would choose whether or not to invest discretionary spending in these types of interventions. The tobacco multisector intervention was discussed again as a menu of evidence-based options for CCOs to help achieve their performance metric.

Schwarz talked about addressing early childhood caries through a multisector intervention statement as having value for Oregon. Five to seven other states have their own guidelines (e.g. California, Michigan, and New York). Also, a multisector intervention statement is a key linkage to the public health world. The group agreed it was worth proceeding.

Livingston clarified that toothbrushing and flossing are not in the scope of this statement; in contrast, toothbrushing programs (with or without fluoridated toothpaste) would be included within the scope. Len asked whether including unfluoridated toothpaste within toothbrushing programs was appropriate, and others clarified that programs showing differential effectiveness based on the use of fluoridated versus unfluoridated toothpaste could be helpful, and could potentially result in a recommendation against unfluoridated toothpaste campaigns. Livingston asked whether she should look at prescription strength fluoridated toothpaste and the group did not think this would be useful.

The group reviewed the proposed outcomes. They felt that caries as an outcome was insufficient, and identified more important outcomes of being "cavity-free" and reducing the rate of cavities. They also clarified that dmfs should be used instead of DMFS.

The group turned to a discussion of "overall visits" as an outcome measure. The goal is to prevent certain types of preventable visits (e.g., hospitalization, dental surgery under anesthesia). Barozzini discussed that dental visits should go up and Shirtcliff discussed that there should be a general increase in visits that result in prevention, regardless of where the patient shows up. The group decided to eliminate the outcome of dental visits and focus on the undesirable visits (i.e., ED visits, dental hospitalizations, and oral surgeries).

Loy raised the issue of targeting siblings at the time of oral surgery or hospitalization. Many siblings of kids with cavities will also be at high risk, and studies show intervening can help.

The group discussed whether or not to add the use of antibiotics and opioids to the outcomes. Schwarz said that the studies are going to be older and there will be no evidence about opioids. The group directed staff to look at these only if they were to show up in the harms.

Schwarz raised that Key Question 2e did not accurately capture the intent, and they struck the bullet.

Barozzini raised the issue of making sure that breastfeeding was not discouraged as part of early childhood caries prevention. The group talked about the importance of baby bottle tooth decay and not having constant sugary drink consumption in bottles. Barozzini discussed that breastfeeding helps to prevent this, and the group decided to amend the scope statement to include this.

Contextual question 2 discusses risk assessment tools, and the group clarified the mostly useful one of these would be for risk assessment outside of the dental office.

The age range was again discussed and the group chose to stay with under 6 because it mirrors what is in the OARs, but given the ongoing concern about the language, Livingston offered to add 5 and under parenthetically for greater clarity.

Livingston said she would revise the scoping statement and send it out to the group. The evidence review will be completed internally by HERC staff. The review will not be ready for the February 2017 OHAP meeting and will be reviewed at a future OHAP meeting in 2017.

Recommended Actions:

1) Livingston will send out the revised PICO and key questions via email to the group for review
2) Livingston to work on the multisector intervention evidence review and bring it back to a 2017 OHAP meeting for further review and discussion

➢ **Topic: Guideline Note 17: Preventive Dental Care**

Smits reviewed the request to clarify "high risk" in GN17. The OHAP members had received several documents with information about dental risk. Shirtcliff brought up the new CDT risk codes (D0601-D0603), which were introduced to assist in identifying high risk patients. The group felt that high risk should be defined as CDT D0603 (Caries risk assessment and documentation with a finding of high risk) in a billing statement. If D0603 appears on a bill for fluoride or prophylactic care, then a higher frequency of claims for that patient should be allowed. Kellie Skenandore will look into whether D0603 can be used as a secondary code for billing. Shirtcliff noted that DCOs would still need to do chart audits to determine whether they were coded correctly as high risk. This was acknowledged. Allen felt this change would be helpful, and that the use of D0603 should be encouraged.

Recommended Actions:

1) No change to GN17
2) Skenandore will look into operationalizing the use of D0603 as a secondary code to allow identification of high risk patients

➢ **Topic: Guideline Note 34: Oral Surgery**

Smits reviewed the topic summary. The OHAP members felt the revised guideline was much improved. Loy suggested that OHAP might look at old HSD rules that defined severe dental pain. She believed the old rules included such items as: not responsive to OTC meds, keeps you up at night, etc. An "or" was added to clause #2 to clarify that a patient only needed one of the three entries to qualify for impacted third wisdom tooth removal. It was noted that non-impacted wisdom teeth could be removed if they met criteria for extraction of any other tooth (i.e. multiple caries, infection, etc.).

Recommended Actions:

1) GN34 was modified as shown below:

GUIDELINE NOTE 34, ~~ORAL SURGERY~~ EXTRACTION OF IMPACTED WISDOM TEETH

Line 349

~~Treatment only for symptomatic dental pain, infection, bleeding or swelling (D7220, D7230, D7240, D7241, D7250).~~

Extraction of impacted wisdom teeth (D7220, D7230, D7240, D7241, D7250) is only included on this line when there is:

1) evidence of pathology. Such pathology includes unrestorable caries, non-treatable pulpal and/or periapical pathology, cellulitis, abscess and osteomyelitis, internal/external resorption of the tooth or adjacent teeth, fracture of tooth, disease of follicle including cyst/tumor, tooth/teeth impeding surgery or reconstructive jaw surgery, and when a tooth is involved in or within the field of tumor resection OR

2) two or more episodes of pericoronitis OR
3) severe pain directly related to the impacted tooth that does not respond to conservative treatment.
    a. extraction for pain or discomfort related to normal tooth eruption or for non-specific symptoms such as "headaches" or "jaw pain" is not considered medically or dentally necessary for treatment.

- **Topic: 2018 Biennial Review: Dental Implant Removal**

Smits reviewed the summary document regarding possible addition of coverage for some or all dental implant CDT codes. Shirtcliff and Parker both supported coverage for the removal of infected implants. Allen pointed out that the CDT code for implant removal (CDT D6100 IMPLANT REMOVAL, BY REPORT) is currently on an uncovered line. Parker and Allen reported that their DCOs are covering implant removal as a needed services, even if they are not reimbursed for it. Loy cautioned that adding coverage for removal of an implant is a slippery slope that might add costs to the DCOs that are more appropriately borne by the medical plans. Nolan suggested that if implant removal is covered, then the DCO rates should be reassessed. Shirtcliff reflected that OHAP should consider coverage for implant placement as well, as current OHP policy results in patients being made edentulous to allow dentures when some teeth could have been saved if implants were covered. Other OHAP members felt that implant placement should be covered only after crowns are covered, as crowns are a more important service. There was general agreement that implant removal should be covered, but not placement. Debridement of implants was discussed, but this was felt to be covered with general scaling of the other teeth. Specific treatment of implants is problematic in terms of what dental professional is responsible (the placing oral surgeon, the treating dentist, etc.). There was concensus that the addition of implant removal should be a biennial review change, to allow the normal rate review process to occur. Implementation of this benefit would then be January 1, 2018. There was also consensus that a guideline for when implant removal would be covered should be drafted, to follow similar situations to the newly adopted guideline for removal of impacted third molars.

Recommended Actions:

1) 2018 Biennial review change:
    a. Add CDT D6100 (IMPLANT REMOVAL, BY REPORT) to line 349 DENTAL CONDITIONS (EG. SEVERE CARIES, INFECTION) Treatment: ORAL SURGERY (I.E. EXTRACTIONS AND OTHER INTRAORAL SURGICAL PROCEDURES)
    b. Smits and Allen to draft a guideline for when implant removal is included on that line and send to OHAP members for review
    c. Further discussion of the guideline will occur at the February, 2017 OHAP meeting

- **Topic: 2018 Biennial Review: Oral Health**

HERC staff reviewed that the 2018 biennial review was currently underway. The dental lines with all codes had been included in the meeting packet for members to review. Staff asked if there was any suggestions for oral health biennial review topics to take up, other than the addition of implant removal.

There was some discussion regarding the counseling CDT codes (D9311, D9991-D9994) that were discussed at the last meeting and added to the HSD Ancillary File. There was a question about adding these to lines to allow more visibility and utilization. The discussion about this centered around lack of clarity in what these codes will be used for, the provider types that can use these codes, etc. The decision was to wait and re-evaluate these codes at a later date once these questions are answered.

Allen brought up possibly adding coverage for immediate partial dentures (CDT D5221-D5222), based on provider request for the addition of this service. Currently, standard and interim partial dentures are covered on line 457. The discussion centered on how to define immediate. The members questioned whether there were any issues with immediate dentures, such as less durability than an interim denture which can last 5 years. Allen thought that an immediate partial denture would be a longer term solution than an interim denture. One of the issues is that dentists feel it is unethical to code for a standard partial denture (not immediate) when an immediate partial denture was actually provided. There were concerns about lack of allowed healing if immediate partial dentures were fitted very soon after an anterior tooth extraction. Some DCO plans are paying for an interim partial denture and then a standard partial denture, while others are only covering one or the other every 5 years. Cost are about the same for immediate and interim partial dentures.

The consensus was that immediate partial dentures should be added to line 457, where interim and standard partial dentures CDT codes already are placed. The DCOs and/or HSD could make rules about whether an immediate partial denture could be followed by a standard partial denture placement, and other utilization rules.

There was discussion that adding immediate partial dentures may add significant cost, and this change was best done as a biennial review change, effective January 1, 2018.

One last biennial review topic was brought up by Barozzini. He would like to clarify coverage of D9110 PALLIATIVE (EMERGENCY) TREATMENT OF DENTAL PAIN-MINOR PROCEDURES. There was some discussion about whether palliative emergency treatment would include prescribing antibiotics. It was unclear what services were allowed with this code. This code will be considered at a later time if there are continued questions or issues.

HERC staff let the members know that biennial review topics can be nominated for consideration at the planned February OHAP meeting. All topics to be nominated must be to HERC staff by 12/30/16.

Recommended Actions:

1) 2018 Biennial review: add D5221-D5222 (Immediate partial denture – resin base) to line 457 DENTAL CONDITIONS (EG. MISSING TEETH, PROSTHESIS FAILURE) Treatment: REMOVABLE PROSTHODONTICS (E.G. FULL AND PARTIAL DENTURES, RELINES) and removed from line 594 DENTAL CONDITIONS (EG. CARIES, FRACTURED TOOTH) Treatment: ADVANCED RESTORATIVE-ELECTIVE (INLAYS,ONLAYS, GOLD FOIL AND HIGH NOBLE METAL RESTORATIONS).
2) HSD to determine rules about how often any type of partial denture can be covered and in what situations immediate partial dentures would be covered (i.e. anterior tooth extraction).

- **Topic: Tooth Extraction for Severe Caries**

Approved with minimal discussion.

Recommended Actions:

1) Add K02 series (Dental caries) to line 349 DENTAL CONDITIONS (EG. SEVERE CARIES, INFECTION) Treatment: ORAL SURGERY (I.E. EXTRACTIONS AND OTHER INTRAORAL SURGICAL PROCEDURES)
2) Add D7210 (SURGICAL REMOVAL OF ERUPTED TOOTH REQUIRING REMOVAL OF BONE AND/OR SECTIONING OF TOOTH, AND INCLUDING ELEVATION OF MUCOPERIOSTEAL FLAP IF INDICATED) to line 349

- **Public Comment:**

No additional public comment was received.

- **Issues for Next Meeting:**

- Guideline for implant removal
- Any other oral health biennial review topics
- Multisector intervention for early childhood caries prevention (post-February meeting)

- **Next Meeting:**
  - TBD

Meeting was adjourned at 12:45 PM.

Section 3.0

New Discussion Items

Orthodontics for Craniofacial Anomalies

Question: Should orthodontics be covered for treatment of craniofacial anomalies other than cleft lip/palate?

Question sources: Dr. Bruce Austin from HSD; Dr. Gary Allen from VBBS/HERC; Dr. Garfinkle, a Portland orthodontist; the Oregon Dental Association; Ms. Olivia Brandon, the mother of two children with cleidocranial dysostosis, and their orthodontist, Dr. Juliana Panchura.

Issue: A new Oregon law was passed a few years ago to require medical insurance carriers to include orthodontia coverage for craniofacial disorders; however, this legislation did not apply to OHP. Multiple stakeholders are requesting consideration of coverage of orthodontics for conditions involving craniofacial deformities. Currently, only cleft lip/palate diagnoses are paired with orthodontia CDT codes.

Most non-cleft lip facial deformities are on line 261 DEFORMITIES OF HEAD Treatment: CRANIOTOMY/CRANIECTOMY. Orthodontics CDT codes are on the two cleft lip/cleft palate lines and an uncovered line for dental malocclusion.

The legislation requiring private insurance coverage of orthodontia for craniofacial anomaly is shown below:

> 76th OREGON LEGISLATIVE ASSEMBLY--2012 Regular Session
> House Bill 4128
> SECTION 2. (1) As used in this section, "craniofacial anomaly" includes any congenital anomaly affecting the face or head, including but not limited to cleft palate, cleft lip, craniosynostosis, craniofacial microsomia and Treacher Collins syndrome.
> (2) All health benefit plans, as defined in ORS 743.730, providing coverage of hospital, surgical or dental services, shall provide coverage for dental and orthodontic services for the treatment of craniofacial anomalies if the services are medically necessary to improve or restore function.

From Dr. Allen:
Below is a definition for medical necessity developed for one health plan.

> Orthodontic services may be considered medically necessary for the treatment of craniofacial anomalies when a physical functional impairment exists. The impairment caused by the congenital craniofacial anomaly must be at a severity level that impairs the member's ability to eat normally, breath and/or speak normally.

See tables below for proposed ICD-10 codes for coverage as well as CDT codes proposed for pairing.

Orthodontics for Craniofacial Anomalies

HERC staff recommendations:

1) Add ICD-10 Q67.4 (Other congenital deformities of skull, face and jaw) to line 261 DEFORMITIES OF HEAD
2) Add orthodontic CDT codes (D8010-D8694) to line 261 DEFORMITIES OF HEAD
3) Add craniofacial surgery CDT codes (CDT D7283-D7955) to line 261 DEFORMITIES OF HEAD
4) Add craniofacial surgery CPT codes (21120-21123, 21193-21199, 21206, 21210, 21215) to line 261 DEFORMITIES OF HEAD
    a. Similar codes CPT 21141-21188 (midface reconstruction) are already on line 261
5) Adopt a new guideline note for line 261 as shown below

GUIDELINE NOTE XXX ORTHODONTICS AND CRANIOFACIAL SURGERY FOR CRANIOFACIAL ANOMALIES
Line 261
Orthodontics (CDT D8010-D8694) and craniofacial surgery (CDT D7283-D7955; CPT 21120-21123, 21193-21199, 21206, 21210, 21215) are included on this line only for pairing with craniofacial anomaly diagnoses when there is significant malocclusion expected to result in difficulty with mastication, speech, or other oral function.

Orthodontics for Craniofacial Anomalies

Proposed conditions to pair with orthodontics:

ICD-10 code	Code description	Current line(s)
Q67.4	Other congenital deformities of skull, face and jaw [used for craniofacial macrosomia and hemifacial macrosomia]	665 MISCELLANEOUS CONDITIONS WITH NO OR MINIMALLY EFFECTIVE TREATMENTS OR NO TREATMENT NECESSARY
Q75.0	Craniosynostosis	261 DEFORMITIES OF HEAD
Q75.1	Craniofacial dysostosis	261 DEFORMITIES OF HEAD
Q75.4	Mandibulofacial dysostosis [Treacher-Collins syndrome)	261 DEFORMITIES OF HEAD
Q87.0	Congenital malformation syndromes predominantly affecting facial appearance [used for Aperts syndrome]	261 DEFORMITIES OF HEAD

Orthodontic and craniofacial repair CDT codes

CDT code	Code description	Current line(s)
D7283	PLACEMENT OF DEVICE TO FACILITATE ERUPTION OF IMPACTED TOOTH	621 DENTAL CONDITIONS (EG. MALOCCLUSION)
D7940	OSTEOPLASTY-FOR ORTHOGNATHIC DEFORMITIES	620 ANOMALIES OF RELATIONSHIP OF JAW TO CRANIAL BASE, MAJOR ANOMALIES OF JAW SIZE, OTHER SPECIFIED AND UNSPECIFIED DENTOFACIAL ANOMALIES
D7941	OSTEOTOMY - MANDIBULAR RAMI	620
D7943	OSTEOTOMY - MANDIBULAR RAMI WITH BONE GRAFT; INCLUDES OBTAINING THE GRAFT	620
D7944	OSTEOTOMY-SEGMENTED OR SUBAPICAL	620
D7945	OSTEOTOMY-BODY OF MANDIBLE	620
D7946	LEFORT I (MAXILLA-TOTAL)	620
D7947	LEFORT I (MAXILLA-SEGMENTED)	620
D7948	LEFORT II OR LEFORT III (OSTEOPLASTY OF FACIAL BONES FOR MIDFACE HYPOPLASIA OR RETRUSION)-WITHOUT BONE GRAFT	620
D7949	LEFORT II OR LEFORT III-WITH BONE GRAFT	620
D7950	OSSEOUS, OSTEOPERIOSTEAL, OR CARTILAGE GRAFT OF THE MANDIBLE OR MAXILLA - AUTOGENOUS OR NONAUTOGENOUS, BY REPORT	650 DENTAL CONDITIONS WHERE TREATMENT RESULTS IN MARGINAL IMPROVEMENT
D7951	Sinus augmentation with bone or bone substitutes via a lateral open approach	622 DENTAL CONDITIONS (EG. MISSING TEETH)
D7952	Sinus augmentation via a vertical approach	622
D7953	BONE REPLACEMENT GRAFT FOR RIDGE PRESERVATION - PER SITE	650 DENTAL CONDITIONS WHERE TREATMENT RESULTS IN MARGINAL IMPROVEMENT
D7955	REPAIR OF MAXILLOFACIAL SOFT AND/OR HARD TISSUE DEFECT	647 TMJ DISORDERS

D8010	LIMITED ORTHODONTIC TREATMENT OF THE PRIMARY DENTITION	47 CLEFT PALATE WITH AIRWAY OBSTRUCTION 305 CLEFT PALATE AND/OR CLEFT LIP 621
D8020	LIMITED ORTHODONTIC TREATMENT OF THE TRANSITIONAL DENTITION	47,305,621
D8030	LIMITED ORTHODONTIC TREATMENT OF THE ADOLESCENT DENTITION	47,305,621
D8040	LIMITED ORTHODONTIC TREATMENT OF THE ADULT DENTITION	47,305,621
D8050	INTERCEPTIVE ORTHODONTIC TREATMENT OF THE PRIMARY DENTITION	305,621
D8060	INTERCEPTIVE ORTHODONTIC TREATMENT OF THE TRANSITIONAL DENTITION	47,305,621
D8070	COMPREHENSIVE ORTHODONTIC TREATMENT OF THE TRANSITIONAL DENTITION	47,305,621
D8080	COMPREHENSIVE ORTHODONTIC TREATMENT OF THE ADOLESCENT DENTITION	47,305,621
D8090	COMPREHENSIVE ORTHODONTIC TREATMENT OF THE ADULT DENTITION	47,305,621
D8210	REMOVABLE APPLIANCE THERAPY	47,305,621
D8220	FIXED APPLIANCE THERAPY	47,305,621
D8660	PRE-ORTHODONTIC EXAMINATION TO MONITOR GROWTH AND DEVELOPMENT	47,305,621
D8670	PERIODIC ORTHODONTIC TREATMENT VISIT	47,305,621
D8680	ORTHODONTIC RETENTION (REMOVAL OF APPLIANCES, CONSTRUCTION AND PLACEMENT OF RETAINER(S))	47,305,621
D8681	Removable orthodontic retainer adjustment	47,305,621
D8690	ORTHODONTIC TREATMENT (ALTERNATIVE BILLING TO A CONTRACT FEE)	47,305,621
D8691	REPAIR OF ORTHODONTIC APPLIANCE	47,305,621
D8692	REPLACEMENT OF LOST OR BROKEN RETAINER	47,305,621
D8693	RE-CEMENT OR RE-BOND FIXED RETAINERS	47,305,621
D8694	Repair of fixed retainers, includes reattachment	47,305,621

Orthodontic and craniofacial repair CPT codes

CPT code	**Code description**	**Current line(s)**
21120	Genioplasty; augmentation (autograft, allograft, prosthetic material)	290 COMPLICATIONS OF A PROCEDURE ALWAYS REQUIRING TREATMENT 428 COMPLICATIONS OF A PROCEDURE USUALLY REQUIRING TREATMENT

		620 ANOMALIES OF RELATIONSHIP OF JAW TO CRANIAL BASE, MAJOR ANOMALIES OF JAW SIZE, OTHER SPECIFIED AND UNSPECIFIED DENTOFACIAL ANOMALIES
21121	Genioplasty; sliding osteotomy, single piece	204 CANCER OF SOFT TISSUE 620
21122	Genioplasty; sliding osteotomies, 2 or more osteotomies	620
21123	Genioplasty; sliding, augmentation with interpositional bone grafts (includes obtaining autografts)	620
21193	Reconstruction of mandibular rami, horizontal, vertical, C, or L osteotomy; without bone graft	207 SLEEP APNEA, NARCOLEPSY AND REM BEHAVIORAL DISORDER 620
21194	Reconstruction of mandibular rami, horizontal, vertical, C, or L osteotomy; with bone graft (includes obtaining graft)	207,620
21195	Reconstruction of mandibular rami and/or body, sagittal split; without internal rigid fixation	207,620
21196	with internal rigid fixation	207,620
21198	Osteotomy, mandible, segmental;	207,620
21199	Osteotomy, mandible, segmental; with genioglossus advancement	207,620
21206	Osteotomy, maxilla, segmental (eg, Wassmund or Schuchard)	207,620
21210	Graft, bone; nasal, maxillary or malar areas (includes obtaining graft)	207 233 FRACTURE OF FACE BONES; INJURY TO OPTIC AND OTHER CRANIAL NERVES 587 ATROPHY OF EDENTULOUS ALVEOLAR RIDGE 647
21215	Graft, bone; mandible (includes obtaining graft)	207,233,587,647

Frenulectomy

Question: Should the breastfeeding difficulties in infants be added as a covered condition for frenulectomy?

Question source: Gary Allen, DMD

Issue: Dr. Allen has requested reconsideration of the guideline for frenulectomy, which currently limits this procedure to persons over age 12. Specifically, he is requesting consideration of coverage of maxillary labial frenulectomy in infants with difficulties with breastfeeding due to lip tie. The guideline for frenulectomy was adopted as part of the 2012 Biennial Review.

Coverage was added for frenotomy for tongue-tie in infants with the ICD-10 Biennial Review, with a guideline limiting use to interference with breastfeeding.

There is no specific ICD-10 code for lip tie. The most used ICD-10 code for this condition is Q 18.9 (Congenital malformation of face and neck, unspecified) which is on line 665 MISCELLANEOUS CONDITIONS WITH NO OR MINIMALLY EFFECTIVE TREATMENTS OR NO TREATMENT NECESSARY.

D7960 (FRENULECTOMY - ALSO KNOWN AS FRENECTOMY OR FRENOTOMY - SEPARATE PROCEDURE NOT INCIDENTAL TO ANOTHER PROCEDURE) is on line 349 DENTAL CONDITIONS (EG. SEVERE CARIES, INFECTION) with GN48 governing coverage.

CPT 40806 (Incision of labial frenum (frenotomy)) is on line 599 TONGUE TIE AND OTHER ANOMALIES OF TONGUE.

GUIDELINE NOTE 48, FRENULECTOMY/FRENULOTOMY

Line 349

Frenulectomy/frenulotomy (D7960) is included on this line for the following situations:

A) When deemed to cause gingival recession
B) When deemed to cause movement of the gingival margin when frenum is placed under tension.

Maxillary labial frenulectomy not covered until age 12 and above

GUIDELINE NOTE 139, FRENOTOMY FOR TONGUE-TIE IN NEWBORNS

Lines 19,599

ICD-10-CM Q38.1 (Ankyloglossia) is included on Line 19 for pairing with CPT 41010 (Frenotomy) only when the ankyloglossia interferes with breastfeeding. Otherwise, Q38.1 and CPT 41010 are included on Line 599.

Evidence

1) **Pransky 2015**, effect of surgical intervention on lip tie and tongue tie on breastfeeding
    a. N=14 with upper-lip tie alone, N=34 with anterior anklyogossia and upper-lip tie, N=33 with posterior ankyloglossia and upper-lip tie.

   b. Upper lip tie alone with release: 0% significant improvement in breastfeeding, 50% moderate improvement, 29% mild improvement, 21% no improvement
   c. Anterior tongue and upper-lip tie with release: 76% significant improvement in breastfeeding, 9% moderate improvement, 6% mild improvement, 6% no improvement, 3% converted to bottle feeding
   d. Posterior tongue and upper-lip tie with release: 61% significant improvement in breastfeeding, 18% moderate improvement, 6% mild improvement, 15% no improvement
   e. Conclusions: Anterior and posterior ankyloglossia and upper-lip tie, or combinations thereof, were commonly recognized in our study population. Although causation cannot be implied, these oral cavity anomalies may contribute to breastfeeding difficulties in some cases.
2) **Francis 2015**, AHRQ review of impact of frenotomy on breast feeding
   a. Included infants with lip tie concomitant with tongue tie; however, unable to determine outcomes for lip tie based on presented data

Other policies:

1) Aetna 2017, does not cover labial frenotomy; does cover ligual frenotomy for breastfeeding difficulties
2) Other private insurers appear to cover with dental policies

HERC staff summary:

There is very limited evidence for the effectiveness of maxillary labial frenulectomy for breastfeeding difficulties. Tongue-tie also has limited evidence, although there is a more robust literature base. Tongue tie frenotomy is a covered service for breast feeding difficulties.

Frenulectomy

HERC staff recommendations:

1) Housekeeping changes required due to inaccurate code placement
    a. Remove CPT 40806 (Incision of labial frenum (frenotomy)) from line 599 TONGUE TIE AND OTHER ANOMALIES OF TONGUE and add to line 665 MISCELLANEOUS CONDITIONS WITH NO OR MINIMALLY EFFECTIVE TREATMENTS OR NO TREATMENT NECESSARY.
        i. Lip-Tie diagnosis is on line 665 not 599
    b. Add D7960 (FRENULECTOMY - ALSO KNOWN AS FRENECTOMY OR FRENOTOMY - SEPARATE PROCEDURE NOT INCIDENTAL TO ANOTHER PROCEDURE) to line 19 and modify GN139 as shown below

GUIDELINE NOTE 139, FRENOTOMY FOR TONGUE-TIE IN NEWBORNS

Lines 19,599

ICD-10-CM Q38.1 (Ankyloglossia) is included on Line 19 for pairing with CPT 41010 (Frenotomy) and CDT D7960 only when the ankyloglossia interferes with breastfeeding. Otherwise, Q38.1 and CPT 41010 are included on Line 599.

2) Discuss adding coverage for maxillary labial frenulectomy for infants with breast feeding difficulties
    a. If no, no changes required
    b. If yes, then
        i. add ICD-10 Q18.9 (Congenital malformation of face and neck, unspecified) to line 19 FEEDING PROBLEMS IN NEWBORNS and keep on line 665 MISCELLANEOUS CONDITIONS WITH NO OR MINIMALLY EFFECTIVE TREATMENTS OR NO TREATMENT NECESSARY
        ii. Add CPT 40806 (Incision of labial frenum (frenotomy)) to line 19
        iii. Modify GN 48 as shown below

GUIDELINE NOTE 48, FRENULECTOMY/FRENULOTOMY

Lines 19, 349, 665

Frenulectomy/frenulotomy (D7960) is included on ~~this~~ line 349 for the following situations:

A) When deemed to cause gingival recession

B) When deemed to cause movement of the gingival margin when frenum is placed under tension.

Maxillary labial frenulectomy not covered until age 12 and above on line 349.

Q18.9 (Congenital malformation of face and neck, unspecified) is included on line 19 only for pairing with Frenulectomy/frenulotomy (CDT D7960/CPT 40806) for upper lip tie which interferes with breastfeeding. Otherwise, G18.9 and CPT 40806 are included on line 665.

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Breastfeeding difficulties and oral cavity anomalies: The influence of posterior ankyloglossia and upper-lip ties

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ABSTRACT

Objective: Oral cavity anomalies may contribute to breastfeeding problems. The objective of this study was to describe our experience in a high-volume breastfeeding difficulty clinic with a focus on posterior ankyloglossia and upper-lip ties.
Methods: A retrospective review of patients from a dedicated breastfeeding difficulty clinic from January 2014 to December 2014 was performed. Those identified to have ankyloglossia and/or upper-lip ties underwent release procedures. Subjective breastfeeding changes were documented afterwards.
Results: Of the 618 total patients, 290 (47%) had anterior ankyloglossia, 120 (19%) had posterior ankyloglossia, and 14 (2%) had upper-lip tie. Some patients had both anterior ankyloglossia and upper lip-tie (6%), or posterior ankyloglossia and upper-lip tie (5%). For those with anterior ankyloglossia, 78% reported some degree of improvement in breastfeeding after frenotomy. For those with posterior ankyloglossia, 91% reported some degree of improvement in breastfeeding after frenotomy. Upper lip-tie release also led to improved breastfeeding (100%).
Conclusions: Anterior and posterior ankyloglossia and upper-lip tie, or combinations thereof, were commonly recognized in our study population. Many newborns, however, also had no oral cavity anomalies. Although causation cannot be implied, these oral cavity anomalies may contribute to breastfeeding difficulties in some cases.

1. Introduction

Ankyloglossia, or tongue-tie, describes a congenital anomaly characterized by an abnormal lingual frenulum, which can limit tongue movement. In the recent past, some clinicians have suggested that infantile ankyloglossia does not contribute to breastfeeding problems [1]. There are, however, a host of contemporary studies suggesting a strong association between ankyloglossia and breastfeeding difficulties [2–5], and resolution of these difficulties with a tongue-tie release procedure [6–9]. A recent systematic review verified the efficacy of frenotomy in alleviating breastfeeding problems [10]. Many physicians and lactation consultants now believe that ankyloglossia can lead to breastfeeding difficulties with poor latch, maternal nipple pain, mastitis and in some infants, poor weight gain and early unnecessary weaning [6,11,12].

With more mothers now wanting and expecting to breastfeed, most clinicians who currently manage newborns are well aware of the overt cases of ankyloglossia. That is, when there is an obvious anteriorly positioned lingual frenulum causing restricted tongue movement, most clinicians will recommend a frenotomy to help with breastfeeding. However, not infrequently, there are cases of posterior ankyloglossia and/or upper-lip ties that may not be readily recognized as their contribution to breastfeeding difficulties remain controversial.

Posterior ankyloglossia does not have the usual appearance as the traditional 'anterior' ankyloglossia. It is a relatively newly recognized clinical entity most commonly identified by lactation consultants; however, it is still a widely unknown and under-recognized entity among most healthcare providers. In fact, there are a limited number of publications in the literature that discuss posterior ankyloglossia to date [13,14]. These studies showed that

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breastfeeding problems resolved post-frenotomy and thus the authors concluded that posterior ankyloglossia may be a contributor to breastfeeding difficulties.

Upper lip-ties are also now being recognized as a possible contributor to breastfeeding problems by some clinicians [15]. It is characterized by a tight maxillary or labial frenum, which may limit upper-lip movement. It is a benign condition that tends to improve with normal facial growth [16]. Currently, there is only anecdotal evidence that upper-lip ties can cause breastfeeding problems. Restricted movement or the inability to flange the upper-lip has been purported to interfere with proper attachment during breastfeeding, which may lead to maternal nipple pain, poor latch and fussiness for the infant at the breast [15].

With the recent increase in referrals for breastfeeding difficulties due to ankyloglossia and other oral cavity anomalies, a dedicated clinic was created at our institution to help improve access for the evaluation and treatment of infants and mothers in the newborn period who are experiencing breastfeeding problems. The objective of this study was to describe our experience in a high-volume breastfeeding difficulty clinic with a focus on posterior ankyloglossia and upper-lip ties.

2. Methods

Local Institutional Review Board approval was obtained for this study.

A retrospective review of patient records from a dedicated ankyloglossia clinic from January 2014 to December 2014 was performed. This biweekly half-day outpatient clinic is run by a physician assistant (DL), who is an Otolaryngology-Physician Assistant trained in assessing and managing various oral cavity anomalies that may contribute to breastfeeding problems. The ankyloglossia clinic is supervised by an attending pediatric otolaryngologist (SMP), who is available to review any cases with the physician assistant. Patient and caregiver demographics, presenting complaints, and clinical outcomes were retrieved. The study population was composed of healthy infants with no other significant medical issues. Infants with other medical problems were seen in clinics run by attending pediatric otolaryngologists.

All infants underwent a full head and neck examination, which included palpation of the floor of mouth and lingual frenulum. Ankyloglossia, if present, was then classified as either anterior (types I and II) or posterior (types III and IV) subtypes [17]. This grading was subjectively determined by the examiner based on the physical prominence, tightness and location of the lingual frenulum on inspection and palpation, as well as on the apparent limitation of tongue movement and notching of the tongue tip. The mothers were then asked if the upper-lip was able to fully flange when breastfeeding, or if they had difficulty in manually flanging the upper-lip of their newborn. If they reported that the upper-lip did not flange, or if the upper-lip curled under during breastfeeding, inspection of this occurrence during an actual breastfeeding episode was carried out during the visit. Visualization and palpation of the maxillary frenum was then performed to confirm the presence of upper-lip tie on examination.

The option for tongue-tie release and/or upper-lip tie release was given to the parents after examination. If agreeable, consent was obtained and the release procedure was performed in the clinic. For ankyloglossia, the grooved director was used to isolate the lingual frenulum. A straight hemostat clamp was then placed on the frenulum; after waiting a few seconds, the clamp was released and the lingual frenulum was incised using an iris scissor. The release maneuver was performed far posteriorly to open up the mucosal reflection to ensure that the chances of recurrence were low. Care was taken not to injure the Wharton's ducts. Any bleeding was controlled with direct pressure with gauze moistened with oxymetazoline. A similar technique was used if a labial frenotomy (upper-lip tie release) was required. All mothers were given a chance to breastfeed immediately afterwards and asked to rate whether improvements were noted. Specifically, they were asked to rate the post-procedure breastfeeding as follows: no change, mild improvement, moderate improvement, or significant improvement. The patients were sent home with saline packets and gauze, and instructed to perform stretching and massaging exercises under the tongue before each feeding for the next five days to help decrease the chance of scar band formation. They were also encouraged to see lactation consultants or nurses that specialized in breastfeeding, if problems persisted. Finally, all parents were asked to call the clinic for any complications (e.g., persistent bleeding, scarring), or if breastfeeding worsened at home.

3. Results

A total of 618 infants and their mothers were seen in the ankyloglossia clinic during the study period. All patient–mother dyads presented with breastfeeding difficulties and were being referred for infants to be examined to rule out any structural oral cavity anomalies. There were 362 (59%) male and 256 (41%) female infants. Regarding ethnicity, there were 338 (55%) Caucasians, 157 (25%) Hispanics, 7 (1%) African Americans, and 11 (2%) Asian Americans; 105 (17%) did not specify their ethnicity. Two-hundred and seven (33%) reported a positive family history of ankyloglossia and 410 (66%) did not report a family history. There was one child who presented with their foster parent and therefore the family history was unknown. This child initially had some issues with breastfeeding with the biological mother and also some bottle-feeding concerns.

Overall, 127 of 618 (21%) had no oral cavity anomalies noted on physical examination and therefore had no intervention. Of those who had breastfeeding difficulties *and* oral cavity anomalies, the majority (n = 290, 47%) had anterior ankyloglossia. There were 120 (19%) infants that were deemed to have posterior ankyloglossia and 14 (2%) were found to have upper-lip tie. Thirty-four (6%) infants had both anterior ankyloglossia and upper-lip tie, while 33 (5%) presented with posterior ankyloglossia and upper-lip tie. All mothers were offered tongue-tie release and/or upper lip-tie release procedures depending on their findings and all agreed to proceed. Consent was then obtained and the release procedures were performed as described above.

All patients who underwent tongue-tie and/or upper-lip tie release procedures had no complications. All mothers (except the foster parent) were given a chance to breastfeed immediately afterwards and asked to rate whether improvements were noted. There were six infants who were sound asleep after the procedure, and they were not breastfed afterwards. Similarly, there were eight mothers who wanted to try breastfeeding at home and only tried bottle-feeding after the procedure.

For those that had anterior ankyloglossia, most (78%) reported some degree of immediate improvement in breastfeeding post-frenotomy, with majority (61%) reporting a significant improvement (Table 1). For those with posterior ankyloglossia, 91% reported some degree of immediate improvement post-frenotomy, with majority (55%) reporting a moderate improvement in breastfeeding. Similar favorable findings were observed for participants with upper-lip tie (100% improved), anterior ankyloglossia and upper-lip tie (91% improved), and posterior ankyloglossia and upper-lip tie (85% improved) (Table 1).

Table 1
Summary of oral cavity anomalies and changes reported after release procedures.

	Anterior	Posterior	Upper-lip	Anterior & upper-lip	Posterior & upper-lip
Significant improvement	178/290 (61%)	27/120 (23%)	0	26/34 (76%)	20/33 (61%)
Moderate improvement	38/290 (13%)	66/120 (55%)	7/14 (50%)	3/34 (9%)	6/33 (18%)
Mild improvement	9/290 (3%)	15/120 (13%)	4/14 (29%)	2/34 (6%)	2/33 (6%)
No change	54/290 (19%)	10/120 (7%)	3/14 (21%)	2/34 (6%)	5/33 (15%)
Bottle feeding	5/290 (2%)	2/120 (2%)	0	1/34 (3%)	0
Asleep	6/290 (2%)	0	0	0	0

4. Discussion

During the study period, there were 120 infants with posterior ankyloglossia and 14 with upper-lip tie, which represents a relatively high prevalence rate compared to other reported series in the literature [12]. Furthermore, these rates are higher when considering the infants with multiple oral cavity anomalies. In total, 81 (13%) infants had an upper-lip tie release procedure and 153 (25%) infants had posterior ankyloglossia frenotomy performed in our study population. The high prevalence rates in this study are likely due to the selection bias of a highly sub-specialized clinic and the associated referral patterns. We work very closely with our referring physicians and lactation consultant colleagues to assess these infants for evaluation in an expedited manner. Also with more reported success, higher volume of referrals was received over time for breastfeeding difficulties. With greater recognition of anomalies such as upper-lip tie and posterior ankyloglossia, the true incidence rate will be known, which may be higher than currently thought or reported.

Interestingly, many newborns ($n = 127$, 21%) who presented with breastfeeding difficulties were deemed not to have any oral cavity anomalies. This is an important finding since these children were referred with a suspicion of oral cavity anomalies, which indicates that there are multiple reasons why a newborn may have breastfeeding difficulties.

Whether an upper lip-tie alone can cause breastfeeding difficulty remains controversial. This is mainly due to the lack of evidence supporting or refuting this relationship. Severe cases of upper lip-tie have been associated with maxillary diastema, or gap between upper two central teeth [18], but the relationship to breastfeeding problems has not been clearly documented. The proposed mechanism of functional problems caused by tight maxillary frenum involves the inability to normally move the upper-lip [15]. Yet, due to the limited amount of upper-lip movement required for breastfeeding and speech production, as well as the possibility of physical adaptation, significant functional problems may not occur. However, in some rare cases there may be breastfeeding difficulties attributed to severe upper-lip ties as demonstrated by the current study. Although our sample of infants with upper-lip tie alone was very small ($n = 14$) and therefore causative relationship cannot be proven, most mothers (79%) reported improved breastfeeding post upper-lip tie release. Thus, upper lip-tie may be a contributing factor to breastfeeding difficulties that clinicians should at least be more aware of.

There are many studies demonstrating that breastfeeding difficulties due to traditional or anterior ankyloglossia can be alleviated by simple division of the lingual frenulum [10,13]. Several studies have also shown that frenotomy is a well-tolerated and safe procedure [10]. However, posterior ankyloglossia remain an under-recognized clinical entity and many clinicians do not believe that it can cause breastfeeding problems. This may be explained by the subtle and not easily visualized posterior nature of the lingual frenulum, but our series contained 153 (25%) infants, of which 136 (89%) had improved breastfeeding after the release was performed. Therefore, clinicians should be aware that posterior ankyloglossia can be another factor that may contribute to breastfeeding problems in some cases. Furthermore, it should be noted that visualization alone is not always adequate to detect posterior ankyloglossia. Visualization with the aid of a grooved director with the tongue elevated and/or the palpation of the floor of mouth should be carried out assess for the presence of a thick band of tissue that represents the posterior ankyloglossia [13].

Our ankyloglossia clinic was created to support the demand for nursing mothers who were having difficulty with breastfeeding. All mothers who were offered a release procedure consented to proceed even though it was made clear that improvements in breastfeeding were not guaranteed. It is likely that these mothers were very motivated to try any measures that may potentially improve breastfeeding.

During the study year, we noted that the referring physicians in our community expressed interest in learning how to perform frenotomies and we also developed increased interaction with our local lactation consultants. Another trend noted was the increased recognition of upper-lip tie as a potential factor influencing breastfeeding. More research, including prospective trials, needs to be done to better understand the influence of this rare clinical entity on breastfeeding.

There are several limitations to the current study. First, the study sample was generated from a highly sub-specialized clinic and therefore selection bias is undoubtedly present. Second, the number of infants in the upper-lip tie alone group was very small. Third, the data was gathered in a retrospective manner and the specific presenting issues pertaining to breastfeeding (e.g., latch difficulties, nipple pain, prolonged feeds) were not consistently documented. Fourth, the long-term follow-up data is lacking and therefore it is unknown whether the breastfeeding problems recurred at home. However, no parents called the clinic to report that breastfeeding worsened at home. Fifth, there were some mothers who did not report improved breastfeeding after the tongue-tie and/or upper-lip tie release procedures. Clearly, there are other factors that can contribute to breastfeeding problems that require further assessments. For instance we were not able to assess maternal anatomy or milk supply related issues. Sixth, the method of diagnosis of various oral cavity anomalies has not been standardized and therefore the generalizability of the current results is unclear. Finally, the post-release improvements in breastfeeding were not measured with validated outcome measures and no control group existed. Therefore, future studies should involve multiple providers in diagnosing the oral cavity anomalies to assess for inter-rater variability and validated measures, such as the Infant Breastfeeding Assessment Tool, should be used to document the changes in breastfeeding after release procedures. As well, prospective studies with long-term follow-up should be conducted to determine if breastfeeding improvements are maintained and whether early weaning was avoided.

5. Conclusion

Anterior and posterior ankyloglossia, upper-lip tie, and combinations thereof, were commonly recognized in our clinic.

Many newborns, however, also had no oral cavity anomalies. Frenotomy continued to be a simple, safe, and effective intervention for many infants and mothers. Although anterior ankyloglossia may be promptly recognized and treated, posterior ankyloglossia and upper-lip tie may also contribute to breastfeeding difficulties in some instances. These clinical entities may often be missed due to its subtle nature and it may require palpation and exposure with a grooved director for identification. As causation cannot be implied from the current study, more research needs to be done to better understand the influence of upper-lip tie and posterior ankyloglossia on breastfeeding.

Conflict of interest statement

None.

References

[1] A.F. Wallace, Tongue tie, Lancet 13 (1963) 377–388.
[2] A.H. Messner, M.L. Lalakea, J. Aby, J. Macmahon, E. Bair, Ankyloglossia: incidence and associated feeding difficulties, Arch. Otolaryngol. Head Neck Surg. 126 (2000) 35–39.
[3] C.E. Horton, H.H. Crawford, J.E. Adamson, T.S. Ashbell, Tongue-tie, Cleft Palate J. 6 (1969) 8–23.
[4] J.E. Wright, Tongue-tie, J. Pediatr. Child Health 31 (1995) 276–278.
[5] L.A. Ricke, N.J. Baker, D.J. Maldon-Kay, T.A. DeFor., Newborn tongue-tie: prevalence and effect on breastfeeding, J. Am. Board Fam. Pract. 18 (2005) 1–7.
[6] D.M. Griffiths, Do tongue ties affect breast feeding? J. Hum. Lact. 20 (2004) 409–414.
[7] H. Wallace, S. Clarke, Tongue tie division in infants with breast feeding difficulties, Int. J. Pediatr. Otorhinolaryngol. 70 (2006) 1257–1261.
[8] N.S. Masaitis, J.W. Kaempf, Developing a frenotomy policy at one medical center: a case study approach, J. Hum. Lact. 12 (1996) 229–232.
[9] J.L. Ballard, C.E. Auer, J.C. Khoury, Ankyloglossia: assessment, incidence and effect of frenuloplasty on the breastfeeding dyad, Pediatrics 110 (2002) e63.
[10] A.N. Webb, W. Hao, P. Hong, The effect of tongue-tie division on breastfeeding and speech articulation: a systematic review, Int. J. Pediatr. Otorhinolaryngol. 77 (2013) 635–646.
[11] C. Marmet, E. Shell, R. Marmet, Neonatal frenotomy may be necessary to correct breastfeeding problems, J. Hum. Lact. 6 (1990) 117–121.
[12] G.E. Notestine, The importance of the identification of ankyloglossia (short lingual frenulum) as a cause of breastfeeding problems, J. Hum. Lact. 6 (1990) 113–115.
[13] P. Hong, D. Lago, J. Seargeant, L. Pellman, A.E. Magit, S.M. Pransky, Defining ankyloglossia: a case series of anterior and posterior tongue ties, Int. J. Pediatr. Otorhinolaryngol. 74 (2010) 1003–1006.
[14] C. O'Callahan, S. Macary, S. Clemente, The effect of office-based frenotomy for anterior and posterior ankyloglossia on breastfeeding, Int. J. Pediatr. Otorhinolaryngol. 77 (2013) 827–832.
[15] L.A. Kotlow, Diagnosing and understanding the maxillary lip-tie (superior labial, the maxillary labial frenum) as it relates to breastfeeding, J. Hum. Lact. 29 (2013) 458–464.
[16] B.F. Dewel, The labial frenum, midline diastema, and palatine papilla: a clinical analysis, Dent. Clin. North Am. 35 (1966) 175–184.
[17] L.A. Kotlow, Ankyloglossia (tongue-tie): a diagnostic and treatment quandary, Quintessence Int. 30 (1999) 259–262.
[18] K. Delli, C. Livas, A. Sculean, C. Katsaros, M.M. Bornstein, Facts and myths regarding the maxillary midline frenum and its treatment: a systematic review of the literature, Quintessence Int. 44 (2013) 177–187.

Section 4.0

New Discussion Items

MULTISECTOR INTERVENTIONS FOR THE PREVENTION OF EARLY CHILDHOOD CARIES

Evidence supports

- Community water fluoridation
- Fluoride varnish, including applied in a primary care setting
- Fluoride gel
- Oral fluoride supplementation
- Community-based programs that combine oral health education with supervised toothbrushing

Limited evidence supports

- Motivational interviewing towards caregivers

Insufficient or conflicting evidence on:

- Anticipatory guidance/oral health education alone
- Encouragement of preventive dental visits
- Risk assessment
- Xylitol products
- Chlorhexidine
- Silver diamine fluoride
- School-based behavioral interventions
- Breastfeeding interventions

Evidence Summary Table

Intervention	Outcomes	Strength of evidence	References	HERC Staff Assessment
Anticipatory guidance/ encourage-ment of preventive dental visits	Preventive dental visits associated with higher need for restorative care, emergency visits Oral health education alone appears ineffective	Very low Low	Sen, 2016 USPSTF, 2014 (document not included due to length) Douglass, 2015 De Silva, 2016	Mixed evidence. Widely endorsed by professional bodies.

	Multicomponent strategies can increase dental visits			
Risk assessment	No specific tool. A variety or risk factors have been identified. Impact of risk assessment on improved outcomes unknown	Very low	USPSTF, 2014 Fontana, 2015	Insufficient evidence
Water fluoridation	Median decrease of 15.2 percentage points in caries. Children having 35% fewer decayed, missing and filled baby teeth and 26% fewer decayed, missing and filled permanent teeth. Fluoridation led to a 15% increase in children with no decay in their baby teeth and a 14% increase in children with no decay in their permanent teeth. Cost-saving	Strong according to Community Preventive Services Task Force	Community Preventive Services Task Force, 2013 Cochrane systematic review, 2015	Highly effective and cost-saving. Possible harm of cosmetic fluorosis.
Topical fluoride	Varnish Primary teeth - 37% reduction in decayed, missing and filled tooth surfaces (dmfs). Percent reduction in caries increment, 18 to 59% Gel – 20% reduction in decayed, missing and filled tooth surfaces (dmfs)	Moderate for varnish Low for gel	Cochrane systematic review, 2013; USPSTF, 2014 Cochrane systematic review, 2015	Highly effective without harms.
Fluoride supplement-ation	32% to 72% reduction in decayed, missing, and filled teeth and from 38% to 81% for decayed, missing, and filled tooth surfaces	Adequate evidence of at least moderate benefit	USPSTF, 2014	Effective. Small risk of enamel fluorosis

Xylitol products	Caries prevention	Insufficient evidence	Cochrane systematic review, 2015	Insufficient evidence
Chlorhexidine	Caries prevention	Insufficient evidence	Cochrane systematic review	Insufficient evidence
Silver diamine fluoride	Caries prevention	Insufficient evidence	MED, 2015	Insufficient evidence and known cosmetic harms
School-based behavioral interventions	Prevented fraction (PF) = 0.65 (95% CI 0.12 to 1.18)	Insufficient evidence	Cochrane systematic review, 2013	Insufficient evidence
Maternal interventions	Motivational interviewing (MI) toward caregivers has mixed but somewhat positive evidence to support its use Conflicting evidence on breastfeeding and caries (protective association for less than 12 months of breastfeeding, increased association beyond 12 months). No direct evidence about breastfeeding interventions and caries outcomes was identified	Very low	Gao, 2014 Borrelli, 2015 Tham, 2015 Document not included due to length	For MI, Mixed but favors benefit
Community targeted programs	Decline in decayed teeth but not reaching clinical significance Improved access to multiple preventive services	Very low	Ricks, 2015	Insufficient
Toothbrushing programs & oral health education	Decrease dmfs caries index (three studies, MD -1.59, 95% CI -2.67 to -0.52, low-quality evidence) and dmft (two studies, MD -0.97, 95% CI	Low quality	De Silva, 2016	Low quality

	-1.06 to -0.89, low-quality evidence)			

Abbreviations:

dfms: An index of decayed, missing or filled surfaces in primary teeth. Each tooth surface is examined separately. dfmt: An index of decayed, missing or filled teeth in primary teeth.

Note: Lower case is used for primary teeth. All capital letters (e.g. DMFS, DMFT) is used for permanent teeth.

Background

Dental caries are largely preventable yet they continue to pose a significant burden on young children. Early childhood caries are defined as the presence of 1 or more decayed (noncavitated or cavitated lesions), missing (due to caries), or filled tooth surfaces in any primary tooth in a child 71 months of age or younger (AAPD, 2008). Caries disproportionately affect low-income children. A recent study found that 0.5% of children age 1-20 enrolled in Medicaid required dental surgeries in operating rooms or ambulatory surgical centers, and 71% of these were children ages 1-5 (Bruen, 2016).

Evidence Review

Anticipatory guidance

USPSTF, 2014
https://www.uspreventiveservicestaskforce.org/Page/Document/UpdateSummaryFinal/dental-caries-in-children-from-birth-through-age-5-years-screening?ds=1&s=dental

- Evidence on the effectiveness of primary care educational or counseling interventions to reduce dental caries remains sparse or unavailable

Blackburn, 2017 doi:10.1001/jamapediatrics.2016.4514

- Retrospective cohort study using claims data for 19,658 Alabama Medicaid children
- Used high-dimensional-propensity scores to reduce selection bias
- Results: 25.8% (n = 3658) received early preventive dental care, of whom 44%were black, 37.6%were white, and 16.3%were Hispanic. Compared matched children without early preventive dental care, children with dentist-delivered preventive dental care more frequently had a subsequent caries-related treatment (20.6%vs 11.3%, $P < .001$), higher rate of visits (0.29 vs 0.15 per child-year, $P < .001$), and greater dental expenditures ($168 vs $87 per year, $P < .001$). Dentist-delivered preventive dental care

was with an increase in the expected number of caries-related treatment visits by 0.14 per child per year (95%CI, 0.11-0.16) and caries-related treatment expenditures by $40.77 child per year (95%CI, $30.48-$51.07). Primary care provider–delivered preventive dental care did not significantly affect caries-related treatment use or expenditures.

- Author conclusions: Children with early preventive care visits from dentists were more likely to have subsequent dental care, including caries-related treatment, and greater expenditures than children without preventive dental care. There was no association with subsequent caries-related treatment and preventive dental care from PCPs.We observed no evidence of a benefit of early preventive dental care, regardless of the provider.

Sen, 2016

- Retrospective cohort study using claims data for all Alabama Medicaid children
- N=4,774 continuously enrolled children
- Evaluating effectiveness of preventive dental visits and 4 year outcomes
- Analyses are conducted separately for children 0–4 years, 4–9 years, and >9 years. For 0–4 years, the intervention of interest is whether they have at least one preventive dental visit before age 3. For the other two age groups, interventions of interest are if they have regular preventive dental visits during each of the first 3 years, and if they have claims for a sealant in the first 3 years.
- Only sealants are associated with a reduced likelihood of using restorative and emergency services and costs.
- Consistent utilization of preventive dental visits is associated with higher probability of restorative visits and higher emergency visits in year 4

<u>Risk assessment</u>

USPSTF, 2014

- Systematic review of prevention of early childhood caries
- No study evaluated the accuracy of risk-assessment tools applied by primary care clinicians to identify children younger than age 5 years at increased risk for future dental caries.
- No randomized trial or observational study compared clinical outcomes between children younger than age 5 years screened and not screened by primary care clinicians for dental caries. One good-quality cohort study found primary care pediatrician examination following 2 hours of training associated with a sensitivity of 0.76 for identifying a child with one or more cavities and 0.63 for identifying children age <36 months in need of a dental referral compared with a pediatric dentist evaluation.

Fontana, 2015

- Included systematic reviews and recommendations on caries risk assessment
- 12 publications
- Many not validated in US populations
- Strongest risk predictors: previous caries experience, multivariate prediction models, low socioeconomic status, high levels of Strep mutans
- The evidence offers no consensus as to the best caries risk assessment tool
- Author Conclusions: Moderate to weak evidence supports the following recommendations:
  (1) Children should have a caries risk assessment done in their first year (or as soon as their first tooth erupts) as part of their overall health assessment, and this should be reassessed periodically over time.
  (2) Multiple clinical, environmental, and behavioral factors should be considered when assessing caries risk in young children, including factors associated with the primary caregiver.
  (3) The use of structured forms, although most may not yet be validated, may aid in systematic assessment of multiple caries risk factors and in objective record-keeping.
  (4) Children from low socioeconomic status groups should be considered at increased risk when developing community preventive programs.

SIGN, 2014 http://www.sign.ac.uk/assets/qrg138.pdf

- Scottish Intercollegiate Guidelines Network guideline on dental interventions to prevent caries in children
  - Obtain a social history. GRADE OF RECOMMENDATION C
  - The following factors should be considered when assessing caries risk: GRADE OF RECOMMENDATION C
    - clinical evidence of previous disease
    - dietary habits, especially frequency of sugary food and drink consumption
    - social history, especially socioeconomic status
    - use of fluoride
    - plaque control
    - saliva
    - medical history
  - Specialist child healthcare professionals should consider carrying out a caries risk assessment of children in their first year as part of the child's overall health assessment. GRADE OF RECOMMENDATION D

- Children whose families live in a deprived area should be considered as at increased risk of early childhood caries when developing preventive programmes. GRADE OF RECOMMENDATION D

Douglass, 2015

- Nonsystematic review of 69 articles examining integration of oral health into primary care settings
- Screening and risk assessment – no studies evaluate impact on caries outcomes, but they are adoptable by PCPs and increase referral
- Oral health counseling - No studies evaluating PCP counseling on oral health outcomes. Studies in dental health providers doing counseling improves oral hygiene but has no impact on caries increment.
- Motivational interviewing - One study specifically examined the use of MI by PCPs in the absence of fluoride varnish. At the one-year follow-up, the ECC prevalence at the intervention site was 17.7 percent versus 31.7 percent at the control site (*P*=0.086).
- Access to Baby and Child Dentistry (ABCD) program for Washington Medicaid, involved 4144 children. 37% had a visit with a dentist compared to 12% of Medicaid non-ABCD children. Program components involve enrolling Medicaid-eligible children by age 1, educating their families and caregivers about dental hygiene and eating habits; providing outreach and case management to connect families with dental offices; training dentists in the best care practices for young children; and creating referral networks of pediatric dentists for children with more difficult treatment needs.

Table 1. EXISTING POLICIES ON ORAL HEALTH SCREENING, RISK ASSESSMENT, AND ESTABLISHMENT OF A DENTAL HOME

American Academy of Pediatrics policy on risk assessment, timing, and establishment of the dental home[36]

- Administer an oral health risk assessment periodically to all children.
- Include anticipatory guidance for oral health as an integral part of comprehensive patient counseling.
- Recommend that every child has a dental home by 1 year of age.

American Academy of Pediatric Dentistry policy on the dental home[68]

- The AAPD encourages parents and other care providers to help every child establish a dental home by 12 months old.

Bright Futures[69]

- The first oral examination should occur within six months of the eruption of the first primary tooth, and no later than age 12 months. Thereafter, the child or adolescent should be seen according to a schedule recommended by the dentist, based on the individual needs and susceptibility to disease.

Table 2. RECOMMENDED AGE OF FIRST DENTAL VISIT BASED ON PERIODICITY RECOMMENDATIONS OR STATE MEDICAID PROGRAM RECOMMENDATIONS

Category	Recommended age of first dental visit based on periodicity schedule or state Medicaid recommendations	No. of states
AAPD dental periodicity schedule	By 12 mos old	25
State-specific dental periodicity schedule	By 12 mos old	8
	By 12-18 mos old	1
	6-24 mos for those at risk; age 3 ys otherwise	1
	≤3 ys	1
	3 ys	1
No dental periodicity schedule available (state Medicaid program defines age of first dental visit)	By 12 mos old	5
	3 ys	4
	2 ys	2
	Unknown/information not available	2

Bottom line

Both risk assessment and early establishment with a dental home has insufficient evidence but are widely recommended.

Water fluoridation

Community Preventive Services Task Force, 2013
https://www.thecommunityguide.org/findings/dental-caries-cavities-community-water-fluoridation

- Systematic review and meta-analysis of community water fluoridation (CWF)

- 28 studies about the effect of CWF on caries; 16 about oral health disparities, and 117 about dental fluorosis
- Combined evidence showed a median decrease of 15.2 percentage points in caries after CWF began (12 studies).
- The only harm is dental fluorosis, which is usually mild and not clinically significant. There is no evidence CWF is associated with severe fluorosis.
- CWF is cost-saving: Benefit–cost ratios ranged from 1.1:1 to 135.0:1 (6 studies); Studies that provided benefit and cost information reported a per capita annual benefit of CWF that ranged from $5.49 to $93.19 (6 studies).
- Conclusions: strong evidence that community water fluoridation results in decreased dental caries across populations.

Iheozor-Ejiofor, 2015

- Cochrane systematic review
- Evaluated caries data and fluorosis
- For caries, they included prospective controlled studies; for fluorosis, any type of controlled study design.
- 155 studies met inclusion criteria, 107 included in quantitative synthesis
- Results: initiation of water fluoridation results in reductions in dmft of 1.81 (95% CI 1.31 to 2.31; 9 studies at high risk of bias, 44,268 participants). This translates to a 35% reduction in dmft compared to the median control group mean values.
- Initiation of water fluoridation results in an increase in the percentage of caries free children of 15% (95% CI 11% to 19%; 10 studies, 39,966 participants) in deciduous dentition.
- Limitations: The majority of studies (71%) were conducted prior to 1975 and the widespread introduction of the use of fluoride toothpaste.
- There is insufficient information to determine whether initiation of a water fluoridation program results in a change in disparities in caries across socioeconomic status (SES) levels.
- With regard to dental fluorosis, we estimated that for a fluoride level of 0.7 ppm the percentage of participants with fluorosis of aesthetic concern was approximately 12% (95% CI 8% to 17%; 40 studies, 59,630 participants). This increases to 40% (95% CI 35% to 44%) when considering fluorosis of any level (detected under highly controlled, clinical conditions; 90 studies, 180,530 participants). Over 97% of the studies were at high risk of bias and there was substantial between-study variation.
- **Author's conclusions:** The available data come predominantly from studies conducted prior to 1975, and indicate that water fluoridation is effective at reducing caries levels in both deciduous and permanent dentition in children. Our confidence in the size of

the effect estimates is limited by the observational nature of the study designs, the high risk of bias within the studies and, importantly, the applicability of the evidence to current lifestyles. There is a significant association between dental fluorosis (of aesthetic concern or all levels of dental fluorosis) and fluoride level. The evidence is limited due to high risk of bias within the studies and substantial between-study variation.

Bottom line: Community water fluoridation is effective at caries prevention and is cost-saving.

Topical fluoride (e.g. varnish, rinses)

Marinho, 2013 *http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD002280.pub2/epdf*

- Cochrane systematic review of randomized trials of fluoride varnish
- 22 trials with 12,455 participants (9595 used in analyses)
- For primary teeth (10 trials) The pooled d(e/m)fs prevented fraction estimate was 37% (95% CI 24% to 51%; P < 0.0001).
- No significant association between estimates d(e/m)fs prevented fractions and the pre-specified factors of baseline caries severity, background exposure to fluorides, application features such as prior prophylaxis, concentration of fluoride, or frequency of application were found.
- Limitations: there was substantial heterogeneity, confirmed statistically; however, this body of evidence was assessed as of moderate quality.

USPSTF, 2014
https://www.uspreventiveservicestaskforce.org/Page/Document/UpdateSummaryFinal/dental-caries-in-children-from-birth-through-age-5-years-screening?ds=1&s=dental

- Three randomized trials published since the prior USPSTF review were consistent with three previous trials in finding fluoride varnish more effective than no fluoride varnish in reducing caries incidence in higher risk children younger than age 5 years (percent reduction in caries increment, 18 to 59%), although in all trials, fluoride varnish was applied by dental personnel.
- The USPSTF recommends that primary care clinicians apply fluoride varnish to the primary teeth of all infants and children starting at the age of primary tooth eruption. GRADE B

SIGN, 2014

- Fluoride varnish should be applied at least twice yearly in all children. LEVEL A

Douglass, 2015

- Fluoride varnish delivered by PCPs in the North Carolina Into the Mouths of Babes (IMB) program
- Children enrolled in the IMB program with at least four visits experienced, on average, a 17 percent reduction in dental-caries-related treatments up to six years of age compared to children with no IMB visits. When data were simulated for initial IMB visits at 12 and 15 months old, there was a cumulative 49 percent reduction in caries-related treatments at 17 months of age. Data analysis revealed that a one-unit increase in IMB visits resulted in a 0.25 dmft decrease per student.
- An observational study involving American Indian Head Start children demonstrated that four or more fluoride varnish visits at well-child visits between nine and 30 months old significantly decreased caries by 35 percent, from a dmfs of 23.66 to 15.5 among those with fluoride varnish treatments. Less than four fluoride varnish treatments did not have a significant effect on caries rates.
- Parents are satisfied with PCP offered varnish care.
- Oral health services provided in the PCP setting does not decrease dental visits.
- Referrals to dentists are only made in high risk children 70-77% of the time
- Reimbursement for primary care providers for oral health risk assessment and fluoride varnish varies from $4 to $85. The plurality of states reimburse between $10 and $30. It may be considered a barrier when too low ($26 in Massachusetts) compared to $45 in Connecticut where it is infrequently perceived as a barrier).
- PCPs provide more fluoride varnish to 1-2 year olds than dentists. Provider training and increased access to dental care important.
- Fluoride varnish in PCP offices is certainly cost-effective and likely to be cost-saving over a 3 year horizon
- Cost-savings/effectiveness of early dental visits are mixed
- Tailored facilitation of fluoride varnish uptake in PCP practices is the most effective strategy. One-hour trainings are insufficient to encourage widespread adoption. A fluoride varnish office champion and EHR-based reminders are key promoters for success.

Bottom line: Fluoride varnish is effective at reduction of caries in primary teeth, including by primary care providers.

<u>Fluoride gel</u>

Marinho, 2015

- Cochrane systematic review of fluoride gels for prevention of caries in children and adolescents.
- Randomized or quasi-randomized controlled trials of at least 1 year duration.
- 28 trials involving 9140 children and adolescents.
- Most school recruitment-based.
- 20 at high risk of bias.
- The d(e/m)fs pooled prevented fraction estimate for the three trials (1254 participants) that contributed data for the meta-analysis on primary teeth surfaces was 20% (95% CI 1% to 38%; P = 0.04; with no heterogeneity (P = 0.54; I2 = 0%); low quality evidence).

Bottom Line: Fluoride gel is likely effective at decreasing caries on primary teeth by around 20%.

Fluoride supplementation

USPSTF, 2014

- Oral fluoride supplementation is effective at reducing caries incidence by 32% to 72% for decayed, missing, and filled teeth and from 38% to 81% for decayed, missing, and filled tooth surfaces in children younger than age 5 years but associated with risk of enamel fluorosis.
- The USPSTF recommends that primary care clinicians prescribe oral fluoride supplementation starting at age 6 months for children whose water supply is deficient in fluoride. GRADE B

Silver diamine fluoride.

MED, 2015

- Evidence review on silver diamine fluoride (SDF) for the effectiveness and adverse effects of SDF solution to prevent and arrest caries.
- Results: Two RCTs examined the effectiveness of SDF to prevent dental caries. One cluster RCT in the Philippines of 704 6-8 year old children found comparable increases in caries in both SDF treatment and non-treatment of six to eight year old children and concluded that a onetime application of 38% SDF is not an effective method to prevent dentinal caries lesions. The other RCT, which took place among 501 2nd and 3rd grade children in China, found an annual application of SDF solution (similar to resin sealant

placement and semi-annual application of fluoride varnish) to be an effective preventive measure against pit and fissure caries in permanent molars.
- *Adverse Effects:* black discoloration is near universal in treated caries

Bottom line: There is insufficient evidence about the utility of silver diamine fluoride as a caries prevention tool in young children. No RCTs were identified for the 0-5 age group and the two studies found in older children had opposing results and are not applicable to US populations. There are cosmetic harms associated with use of silver diamine fluoride if decay is present.

Maternal interventions (pregnant and postpartum, xylitol, counseling, breastfeeding)

Vamos, 2015

- Systematic review of oral health promotion programs during pregnancy
- All interventions (n = 7) were delivered in prenatal care settings and focused on education.
- Modalities varied, including the use of oral instruction and audiovisual presentations, in both individual and group formats; however, content was directed toward infant oral health.
- Primary outcomes measured included knowledge, beliefs, attitudes, self-efficacy and oral hygiene, and health-seeking behaviors.
- All but one study showed significant improvement in one of these outcomes postintervention.
- Staff conclusions: none evaluated infant or child outcomes

Gao, 2014

- Systematic review of motivational interviewing to improve oral health
- 4 studies included targeted to mothers or caregivers
- Behaviors addressed were infant feeding practice and diet, oral hygiene measures and dental visit.
- Results: in one study combining MI with conventional health education significantly reduced the number of new caries lesions in 1 year (0.71 versus 1.91; P <0.01) and the chance of new caries in 2 years (odds ratio = 0.35, 95% confidence interval [CI] = 0.15 to 0.83; hazard ratio = 0.54, 95% CI = 0.35 to 0.84). However, in additional trials performed by other researchers, significant between-group difference was absent in children's caries increment, although MI seemed to reduce the caries severity (fewer decayed teeth at or beyond the dentin level). Behavior-wise, some positive changes were associated with MI, such as less use of shared utensils, more frequent cleaning of child's teeth, brushing at bedtime, and checking the child for ''precavities.'' But no changes were found in children's use of nursing bottle and snacking habits.

- Author conclusions: Although the effect of MI on preventing caries in infants appears to be encouraging, positive changes in clinical outcomes only existed in some studies.

Borrelli, 2015

- Systematic review and meta-analysis of motivational interviewing on multiple parent-child interactions
- 3 studies were identified for early childhood caries. One had no effect and authors computed a meta-analytic estimate with that study excluded and found an overall weighted mean effect size for dental caries: *d+*=0.36 (95% CI=0.18, 0.55).
- Author conclusions: these results, while promising, should be interpreted with caution

Tham, 2015

- Systematic review of observational and experimental studies
- More versus less breastfeeding (up to 12 months) had a reduced risk of caries (OR 0.50; 95%CI 0.25, 0.99).
- Children breastfed >12 months had an increased risk of caries when compared with children breastfed < 12 months (seven studies (OR 1.99; 1.35, 2.95)
- Amongst children breastfed >12 months, those fed nocturnally or more frequently had a further increased caries risk (five studies, OR 7.14; 3.14-16.23)
- There was a lack of studies on children aged >12 months that evaluated confounders
- Breastfeeding in infancy is associated with a lower caries risk up to 12 months [and a higher risk of caries after 12 months]
- Author conclusions: Breastfeeding in infancy may protect against dental caries. Further research to understand the increased risk of caries in children breastfed after 12 months.

Bottom line

Breastfeeding up to 12 months is associated with a decrease in caries, and beyond 12 months is associated with an increase in caries. There is no direct evidence found connecting advice about breastfeeding and caries risk.

<u>Xylitol</u>

Riley, 2015

- Cochrane systematic review of randomized controlled trials
- 10 studies with 5903 participants

- Over 2.5 to 3 years of use, a fluoride toothpaste containing 10% xylitol may reduce caries by 13% when compared to a fluoride-only toothpaste (PF -0.13, 95% CI -0.18 to -0.08, 4216 children analysed, low-quality evidence). However, the 3 studies that contributed to this were in children 8-13 years of age.
- One study reported that xylitol syrup (8 g per day) reduced caries by 58% (95% CI 33% to 83%, 94 infants analysed, low quality evidence) when compared to a low-dose xylitol syrup (2.67 g per day) consumed for 1 year.
- The following results had 95% CIs that were compatible with both a reduction and an increase in caries associated with xylitol: xylitol lozenges versus no treatment in children (very low quality body of evidence); xylitol sucking tablets versus no treatment in infants (very low quality body of evidence); xylitol tablets versus control (sorbitol) tablets in infants (very low quality body of evidence); xylitol wipes versus control wipes in infants (low quality body of evidence).
- Limitations: most studies at high risk of bias
- Author conclusions: We found some low quality evidence to suggest that fluoride toothpaste containing xylitol may be more effective than fluoride-only toothpaste for preventing caries in the permanent teeth of children, and that there are no associated adverse-effects from such toothpastes. The effect estimate should be interpreted with caution due to high risk of bias and the fact that it results from two studies that were carried out by the same authors in the same population. The remaining evidence we found is of low to very low quality and is insufficient to determine whether any other xylitol-containing products can prevent caries in infants, older children, or adults.

USPSTF, 2014

- Three trials reported no clear effects of xylitol versus no xylitol on caries incidence in children younger than 5 years.

Bottom line: For the population of 0-5 year olds, there is insufficient evidence of benefit using xylitol products for the prevention of caries.

Antimicrobials

Chlorhexidine

Walsh, 2015

- Cochrane systematic review
- Parallel-group, RCTs that compared the caries preventive effects of chlorhexidine gels, toothpastes, varnishes, mouth rinses, chewing gums or sprays with each other, placebo or no intervention in children and adolescents.
- Two trials compared chlorhexidine gel (0.12% concentration) with no treatment in the primary dentition. The presence of new caries gave rise to a 95% confidence interval that was compatible with either an increase or a decrease in caries incidence (RR 1.00, 95% CI 0.36 to 2.77; 487 participants; very low quality evidence). Similarly, data for the effects of chlorhexidine gel on the prevalence of Strep mutans were inconclusive (RR 1.26, 95% CI 0.95 to 1.66; two trials, 490 participants; very low quality evidence).

Bottom line: Insufficient evidence regarding the effects of chlorhexidine on caries prevention.

Interventions aimed at family members e.g. at-risk siblings

Nothing found

Community-based interventions

De Silva, 2016 (withdrawn/being updated to extend the evidence search)
https://www.ncbi.nlm.nih.gov/pubmed/27629283

- Cochrane systematic review
- individual- and cluster-(RCTs, controlled before-and-after studies and quasi-experimental and interrupted time series
- 38 studies (total n = 119,789 children, including one national study of 99,071 children, which contributed 80% of total participants) on community-based oral health promotion interventions delivered in a variety of settings and incorporating a range of health promotion strategies (e.g. policy, educational activities, professional oral health care, supervised toothbrushing programmes, motivational interviewing).
- Studies included dietary interventions (n = 3), oral health education (OHE) alone (n = 17), OHE in combination with supervised toothbrushing with fluoridated toothpaste (n = 8) and OHE in combination with a variety of other interventions (including professional preventive oral health care, n = 10).

- Oral health education alone on caries has no effect on dmft (three studies, MD -0.3, 95% CI -1.11 to 0.52, low-quality evidence)
- Oral health education in combination with supervised toothbrushing with fluoridated toothpaste may show a beneficial effect on dmfs (three studies, MD -1.59, 95% CI -2.67 to -0.52, low-quality evidence) and dmft (two studies, MD -0.97, 95% CI -1.06 to -0.89, low-quality evidence)
- Conclusions: Low certainty that community-based oral health promotion interventions that combine oral health education with supervised toothbrushing are effective at reducing caries in primary teeth

Bottom line: Community based oral health promotion that include oral health education and supervised toothbrushing are effective

School oral health programs

Cooper, 2013 *http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD009378.pub2/full*

- Cochrane systematic review of RCTs in primary school settings
- Included behavioural interventions addressing both toothbrushing and consumption of cariogenic foods or drinks and have a primary school as a focus for delivery of the intervention
- Behaviour change techniques included: information around the consequences of twice daily brushing and controlling sugar snacking; information on consequences
- four studies involving 2302 children; 3 studies at high risk of bias
- Only one included study reported the primary outcome of development of caries. This small study at unclear risk of bias showed a prevented fraction of 0.65 (95% confidence interval (CI) 0.12 to 1.18) in the intervention group of adverse behaviour and instruction and demonstration regarding skill development of relevant oral health behaviours.
- Insufficient evidence for the efficacy of primary school-based behavioural interventions for reducing caries

Ricks, 2015

- Early childhood caries collaborative over 5 years
- Zero- to five-year-old Indian/Alaska Native preschool children
- 4 key targets – increasing access to care, sealants, fluoride varnish, and interim therapeutic restorations (ITRs)
- Methods:

    - A national team was created to promote this initiative in each of the 12 geographic and administrative regions of the IHS, with multiple national, regional, and local presentations given to dental staff and prospective health care collaborators.
    - Educational materials, educational videos, continuing education on caries all on a dedicated website
    - Regular updates on the initiative and progress were reported by the national committee to IHS dentists, dental hygienists, dental assistants, physicians, mid-level providers, community health representatives, nurses, and community health representatives through established HIS electronic mail distribution lists.
- Results:
    - Dental visits increased 7%
    - Dental sealants placed increased 65%
    - Fluoride varnish applications increased 161.2%
    - Between 2010 and 2014, the percentage of one- to two-year-olds with decay experience and untreated decay declined, but the difference was not statistically significant.
- Author conclusions: Early childhood caries prevention strategies, such as early access to dental care, sealants, fluoride varnish, and interim therapeutic restorations, demonstrated some initial improvement in the oral health status of zero- to five-year-old Indian/Alaska Native children.

Policy Landscape

American Academy of Pediatric Dentistry, 2014 Policy on early childhood caries

1. Reducing the parent's/sibling's mutans streptococci (MS) levels to decrease transmission of cariogenic bacteria.
2. Minimizing saliva-sharing activities (eg, sharing utensils) to decrease the transmission of cariogenic bacteria.
3. Implementing oral hygiene measures no later than the time of eruption of the first primary tooth. Toothbrushing should be performed for children by a parent twice daily, using a soft toothbrush of age-appropriate size. In all children under the age of three, a 'smear' or 'rice-size' amount of fluoridated toothpaste should be used. In all children ages three to six, a 'pea-size' amount of fluoridated toothpaste should be used.
4. Providing professionally-applied fluoride varnish treatments for children at risk for ECC.
5. Establishing a dental home within six months of eruption of the first tooth and no later than 12 months of age to conduct a caries risk assessment and provide parental education including anticipatory guidance for prevention of oral diseases.

6. Avoiding high frequency consumption of liquids and/or solid foods containing sugar. In particular:
   - Sugar-containing beverages (eg, juices, soft drinks, sweetened tea, milk with sugar added) in a baby bottle or no-spill training cup should be avoided.
   - Infants should not be put to sleep with a bottle filled with milk or liquids containing sugars.
   - Ad libitum breast-feeding should be avoided after the first primary tooth begins to erupt and other dietary carbohydrates are introduced.
   - Parents should be encouraged to have infants drink from a cup as they approach their first birthday. Infants should be weaned from the bottle between 12 to 18 months of age.
7. Working with medical providers to ensure all infants and toddlers have access to dental screenings, counseling, and preventive procedures.

Oral Health Care During Pregnancy Expert Workgroup, 2012

- Convened by Health Resources and Services Administration – Maternal and Child Health Bureau
- Collaboration with ACOG and ADA
- Guidance for prenatal health care professionals
    - During initial prenatal evaluation, take an oral health history and do an oral exam
    - Reassure about safety of dental evaluation and treatment
    - Refer to a dentist if no visit in the prior 6 months
    - Encourage women to seek oral health care, practice good oral hygiene, eat healthy foods, and attend prenatal classes during pregnancy
    - Counsel women to follow oral health professionals recommendations
    - Establish relationships with oral health care professionals, develop a formal referral process (particularly for acute issues) and coordinate care
    - Provide support (insurance, transportation, WIC, etc)
    - Refer to nutrition if guidance on healthy eating would be beneficial
    - Integrate oral health topics into prenatal classes
    - Provide culturally and linguistically appropriate care
- Guidance for oral health care professionals
    - Obtain an oral health history with tailored questions to pregnancy
    - Review medical and social history
    - Perform comprehensive oral exam, including risk assessment
    - Radiographs when clinically indicated
    - Reassure women that oral health care is safe and appropriate during pregnancy
    - Encourage women to seek oral health care, practice good oral hygiene, eat healthy foods, and attend prenatal classes during pregnancy

    - Establish relationships with oral health care professionals, develop a formal referral process (particularly for acute issues) and coordinate care
    - Consult with prenatal health care professionals about comorbidities that may affect management of oral health problems and anesthesia/analgesia
    - Provide acute and emergent dental care
    - Develop comprehensive plan for prevention, treatment, and maintenance throughout pregnancy
    - Help with support social services (transportation, DV, WIC)
    - If does not have a prenatal care provider, explain importance
    - Accept women on Medicaid as patients
    - Refer to nutrition if it would be helpful
- Both include specific advice about healthy eating, brushing twice daily with fluoridated toothpaste, using xylitol after eating, and a nightly fluoridated mouth rinse

JAMA Pediatrics | Original Investigation

Outcomes Associated With Early Preventive Dental Care Among Medicaid-Enrolled Children in Alabama

Justin Blackburn, PhD; Michael A. Morrisey, PhD; Bisakha Sen, PhD

IMPORTANCE There is a recommendation for children to have a dental home by 6 months of age, but there is limited evidence supporting the effectiveness of early preventive dental care or whether primary care providers (PCPs) can deliver it.

OBJECTIVE To investigate the effectiveness of preventive dental care in reducing caries-related treatment visits among Medicaid enrollees.

DESIGN, SETTING, AND PARTICIPANTS High-dimensional propensity scores were used to address selection bias for a retrospective cohort study of children continuously enrolled in coverage from the Alabama Medicaid Agency from birth between 2008 and 2012, adjusting for demographics, access to care, and general health service use.

EXPOSURES Children receiving preventive dental care prior to age 2 years from PCPs or dentists vs no preventive dental care.

MAIN OUTCOME AND MEASURES Two-part models estimated caries-related treatment and expenditures.

RESULTS Among 19 658 eligible children, 25.8% (n = 3658) received early preventive dental care, of whom 44% were black, 37.6% were white, and 16.3% were Hispanic. Compared with matched children without early preventive dental care, children with dentist-delivered preventive dental care more frequently had a subsequent caries-related treatment (20.6% vs 11.3%, $P < .001$), higher rate of visits (0.29 vs 0.15 per child-year, $P < .001$), and greater dental expenditures ($168 vs $87 per year, $P < .001$). Dentist-delivered preventive dental care was associated with an increase in the expected number of caries-related treatment visits by 0.14 per child per year (95% CI, 0.11-0.16) and caries-related treatment expenditures by $40.77 per child per year (95% CI, $30.48-$51.07). Primary care provider–delivered preventive dental care did not significantly affect caries-related treatment use or expenditures.

CONCLUSIONS AND RELEVANCE Children with early preventive care visits from dentists were more likely to have subsequent dental care, including caries-related treatment, and greater expenditures than children without preventive dental care. There was no association with subsequent caries-related treatment and preventive dental care from PCPs. We observed no evidence of a benefit of early preventive dental care, regardless of the provider. Additional research beyond administrative data may be necessary to elucidate any benefits of early preventive dental care.

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Supplemental content

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Tooth decay, otherwise known as dental caries, is cited as the most common chronic disease among children.[1] It disproportionately affects minority and low-socioeconomic status children[2] and is associated with many poor outcomes including loss of teeth,[1] impaired growth,[3] decreased weight gain,[3] poor school performance,[4] and poor quality of life.[5] Contributing factors include lack of access to dental care,[2] low community water fluoride levels,[6] and a lack of parental knowledge about prevention.[7]

The landmark report[1] by the US Surgeon General in 2000 helped shape oral health policy in the subsequent 15 years.[8] In addition to emphasizing the importance of oral health on general health and well-being, the report called for improved oral health through prevention. A greater emphasis on early preventive dental care resulted, prompting recommendations that children have a dental home "within 6 months of the first tooth eruption and no later than 12 months of age."[9,10]

Pediatricians have been increasingly encouraged to provide oral care.[11] In addition to dental coverage under Early Periodic Screening, Diagnostic, and Treatment, many Medicaid agencies have initiatives for primary care providers (PCPs) to incorporate preventive dental care into well-child visits. For example, Alabama initiated the 1st Look program in January 2009, expanding coverage to allow PCPs reimbursement for an oral examination and 3 fluoride varnishes per year for children at high risk of caries.[12] Before 1st Look, preventive dental services were delivered by health care professionals other than dentists at Federally Qualified Health Centers in Alabama. 1st Look and similar programs in other states are designed to increase access, particularly in locations underserved by dentists.[13-15]

Despite the emphasis on prevention, dental caries among children younger than 5 years has been increasing.[16] To our knowledge, evidence that early preventive dental care reduces caries is lacking, nor is there any convincing evidence supporting PCP oral health screenings, referrals to dentists, or fluoride services reducing caries. A recent review[17] concluded that the evidence for early preventive dental care recommendations reducing caries was "weak." A widely cited study recommended the benefits of early preventive dental care because children with a visit by 1 year of age were "more likely to have subsequent preventive visits but were not more likely to have a subsequent restorative or emergency visits."[18] This finding resulted from data on 23 Medicaid-enrolled children in North Carolina. Much of the existing literature comes from North Carolina's Medicaid program, with mixed results. Examples include reduced caries-related treatment only when children received multiple fluoride applications annually[19,20] or preventive and restorative care simultaneously.[21] Other evaluations observed no difference in subsequent restorative costs,[18,22] while some observed increased caries-related treatment for children with at least 1 preventive visit.[23] Multiple studies have observed that children with early preventive dental care had worse outcomes than children initiating later.[21,24,25] In Alabama, preventive dental care among Children's Health Insurance Program enrollees was associated with small reductions in subsequent restorative care.[26,27]

Our objective was to investigate the effectiveness of early preventive dental care in reducing early childhood caries among Medicaid enrollees. One limitation of previous studies is selection bias—namely that children receiving preventive dental care may differ on unmeasured characteristics from their counterparts, including preventive health behaviors or family histories of dental problems. We used an empirical strategy to minimize the effect of selection bias. Furthermore, we investigated how the effectiveness of early preventive dental care differed by provider type. Finally, we considered an analysis among children receiving early preventive dental care comparing whether the frequency of care was associated with subsequent caries-related treatment.

Key Points

Question Does early preventive dental care reduce caries-related treatment and does the provider matter?

Findings A retrospective cohort study of 19 658 children continuously enrolled in Medicaid from birth estimated the effect of early preventive dental care on caries-related visits and expenditures. Dentist-delivered care was associated with an increase of 0.14 caries-related visits per child-year and a $40.77 increase in expenditures per child-year compared with primary care providers, who had no statistically significant effect.

Meaning There was no evidence that early preventive dental care reduced caries-related visits regardless of provider; however, dentist-delivered care was associated with increased caries-related use and expenditures.

Methods

Sample and Design

This study was approved by Alabama Medicaid and the institutional review board at the University of Alabama at Birmingham, which waived informed consent because of the retrospective nature of the study. We conducted a retrospective cohort study using administrative data of children continuously enrolled in Medicaid from birth for 3 or more years beginning September 2007 through October 2012. We considered enrollment at birth if the child was enrolled by 180 days after birth. We used Medicaid enrollment data to construct annual observation files and medical claims data to identify preventive dental visits and expenditures within the first 2 years of life. We calculated annual caries-related visits and expenditures along with total dental expenditures for children in their third through sixth year of enrollment or when they were no longer enrolled in Medicaid. To ensure that children were actually using Medicaid, we restricted the analysis to enrollees with at least 1 paid claim. We also excluded children in the top 1% of total expenditures (more than $38 682, 203 participants) because they may have had profound health conditions contraindicating or restricting their access to dental care.

Treatment Variable

We identified preventive dental visits through oral examination claims containing any of the following Current Dental Terminology codes as specified by the Alabama Medicaid Agency provider

manual and consistent with prior studies: D0120, D0145, D0150, D1120, D1201, D1203, D1205, and D1208 (on a single date of service).[19,20,23] Given our focus on early care, we formed our treatment variable by assessing claims from birth through age 2 years and only included age-appropriate codes. We used provider specialty indicator codes to differentiate care delivered by oral health providers (ie, dentists) vs all other providers (ie, PCPs). We identified fluoride varnish administrations by the following Current Dental Terminology codes: D1201, D1203, and D1208. We considered high-frequency preventive dental care to be 4 or more visits during the first 2 years of life, which is consistent with other studies reporting effects at this threshold.[19,20,23]

Outcome Measures

The main outcome measure was annual caries-related visits and expenditures beginning in the child's third year of life. Consistent with prior studies, we defined caries-related visits as containing at least 1 Current Dental Terminology code between D2000 and D9999 on a single date of service.[19,20,23] We considered caries-related expenditures as the amount paid by Medicaid for visits providing these procedures. We considered total expenditures as all paid expenditures to dental providers (including subsequent preventive visits after the first 2 years of life). All expenditures were adjusted for inflation to 2012 using the Consumer Price Index.

Covariates

We used high-dimensional propensity score matching to account for biases related to differences between children receiving and not receiving early preventive dental care during their first 2 years of life.[28] This enabled us to derive up to 50 variables on health care use and comorbid conditions from claims data based on the association with the treatment and outcome.[29] Thus, the technique matches children on the predicted likelihood of receiving preventive dental care based on demographics, procedures, medications, and diagnoses to reduce bias introduced by parental preferences for health service use, including the use of preventive services and existing health conditions that influence receiving dental care.

The propensity score included all inpatient primary diagnosis codes, outpatient diagnosis and procedure codes, and pharmacy claims for children from birth through their second birthday. *International Classification of Diseases, Ninth Revision (ICD-9)* diagnosis codes were grouped using the Clinical Classification Software single-level definitions. Pharmacy use was grouped by American Hospital Formulary System therapeutic class. We excluded all dental-related diagnoses and procedures. Furthermore, because we included a specific variable for well-child visits, we excluded these claims as described later.

Previous studies indicate that socioeconomic status is associated with the low use of dental care and tooth decay.[2,7] Socioeconomic status within the Medicaid population is homogenous, but other potential confounders included in propensity scores were sex, race/ethnicity, and birth year. Race/ethnicity was classified as white, black, Hispanic, and all other races based on the available enrollment information. We used 4-level zip code approximation rural-urban commuting area codes as a marker of rural-urban status.

To indicate access to dentists, we estimated dentist supply using all Medicaid dental claims for children, regardless of age and eligibility in the current study, from 2007 through 2012. Using unique National Provider Identifier numbers from dental claims, we aggregated to the county level. Because of county variability, this measure was ranked and divided into octiles, the first having the fewest Medicaid-serving dentists and the eighth the greatest. Sensitivity analyses determined that different specifications of this variable did not change the final model estimation.

We considered the number of well-child visits as a measure of preventive-care seeking behavior. We used procedure and diagnostic codes consistent with the National Committee for Quality Assurance measure of well-child visits in the first 15 months of life.[30] This measure was ranked and divided into quartiles, the first quartile having the fewest and the fourth the greatest. Because of ties, quartiles were not evenly distributed. Sensitivity analyses determined different specifications did not change the final model estimation.

We could not obtain reliable information on water fluoridation for the entire study period. We included county fixed effects to control for variations in dental care-seeking behavior related to community water fluoridation or other unobserved heterogeneities.

We separately estimated propensity scores and matched children who received preventive care from dentists and PCPs. Children who received care from both types of providers within the first 2 years of life were few (n=362) and were excluded. In each analysis, propensity scores matched children who received preventive dental care with children who did not using the nearest neighbor technique with a caliper of 0.05 of the propensity score. Follow-up duration for a pair was determined by the longest common follow-up duration, dropping unmatched years. Among children who received preventive dental care, we estimated and matched unique propensity scores to compare children who received high frequency care (4 or more visits) vs 1 to 3 visits.

Statistical Analysis

Analyses were stratified by the type of provider: dentists or PCPs. We compared matched descriptive characteristics for children receiving preventive dental care compared with those who were not, using standardized differences more than 10 as a measure of imbalance. Dental care use and expenditures were compared using tests of proportions or *t* tests when appropriate. We estimated 2-part models to provide the combined effect of preventive dental care on any caries-related visits, the annual number of caries-related visits, and associated expenditures. We estimated the first part, any caries-related visit, using logit regression. The second part, the annual number of caries-related visits, was estimated by generalized linear models with a log-link negative binomial distribution because of the outcome's skewed nature. Expenditure outcomes were estimated by log-linked γ distribution. Both models included a robust variance estimator to account for longitudinal matched-child correlation. Our main effect measure was the combined marginal effects, which represented the absolute difference in caries-related visits or expenditures if an untreated child had received

Table 1. Comparison of Measurable Characteristics of the Propensity Score Matched Study Population for Children Receiving No Early Preventive Dental Care and Those Receiving Dentist-Delivered or Primary Care Provider–Delivered Early Preventive Dental Care

Characteristic	Dentist-Delivered Care, %			Primary Care Provider-Delivered Care, %		
	No Preventive Care (n=3658)	Received Preventive Care (n=3658)	Std Diff	No Preventive Care (n=846)	Received Preventive Care (n=846)	Std Diff
Male	50.7	50.9	0.5	50.5	51.1	1.2
Race/ethnicity						
Black	43.4	44.0	1.4	46.2	47.6	2.9
White	38.3	37.6	1.3	38.8	37.4	2.8
Hispanic	16.5	16.3	0.5	12.2	12.6	1.4
Other	1.8	2.0	1.4	2.8	2.4	3.0
Rural urban commuting area						
Urban	67.4	67.4	0.0	55.2	57.0	3.6
Large rural	15.3	15.1	0.5	21.0	20.7	0.9
Small rural	10.7	10.4	1.1	15.1	12.2	8.6
Isolated	6.6	7.1	2.1	8.6	10.2	5.3
Well-child visits[a]						
1st quartile (0-5)	20.7	17.9	7.2	13.6	12.5	3.2
2nd quartile (6-7)	37.2	37.6	0.7	41.6	41.3	0.7
3rd quartile (8-8)	23.9	25.2	3.0	23.3	25.9	6.0
4th quartile (9-16)	18.1	19.3	3.1	21.5	20.3	2.9
County total Medicaid-serving dentists[b]						
1st octile (0-2)	10.7	11.1	1.1	11.7	11.5	0.7
2nd octile (3-5)	11.0	10.6	1.4	28.7	28.7	0.0
3rd octile (6-8)	9.0	8.9	0.4	7.1	6.9	0.9
4th octile (9-11)	12.6	12.4	0.8	9.9	9.1	2.8
5th octile (12-13)	13.4	13.1	0.8	18.9	20.0	2.7
6th octile (14-18)	11.9	12.5	1.8	16.8	17.3	1.3
7th octile (19-27)	14.1	13.6	1.4	6.7	6.4	1.4
8th octile (64-74)	17.3	17.9	1.7	0.1	0.2	2.8
Birth year						
2007	19.0	19.1	0.1	17.7	16.4	3.5
2008	56.4	55.3	2.2	52.7	53.1	0.7
2009	24.6	25.6	2.4	29.6	30.5	2.1

Abbreviation: Std Diff, standardized difference.

[a] Binary indicator based on the ranked number of well-child visits from birth to date of second birthday; quartile range of well-child visits indicated in parentheses.

[b] Binary indicator based on the ranked number of dentists in the county treating Medicaid enrollees during the year of the child's second birthday; octile range of dentists per county indicated in parentheses.

early preventive dental care. Data were analyzed using SAS 9.4 (SAS Institute) and Stata version 13.1 (StataCorp).

Results

Among 19 658 eligible children, 5095 (25.9%) received preventive dental care before their second birthday, including 3878 from dentists and 1217 from PCPs. The final analysis considered 7316 matched children in the dental-delivered care analysis with an average follow-up of 3.6 years (median, 4 years, interquartile range, 3-4 years) and 1692 matched children in the PCP-delivered care analysis with an average follow-up of 3.5 years (median, 4 years, interquartile range, 3-4 years).

Characteristics of children receiving preventive care from dentists and PCPs are highlighted in **Table 1**. Matching reduced standardized differences between those receiving preventive care vs not below an absolute value of 10 for all covariates in both analyses (eFigures 1 and 2 in the Supplement).

In the dentist-delivered preventive care analysis, 2190 caries-related visits were observed among 2104 unique children in 9732 child-years of follow-up, a rate of 22.5 visits per 100 child-years. Children receiving preventive dental care from dentists were more likely to have had a caries-related visit (29.5%), more frequent visits (0.3 visits per child per year), and greater expenditures for caries-related visits ($91 per child per year) and overall dental care ($168 per child per year) than children without preventive dental care (**Table 2**). In the PCP-delivered preventive care analysis, 323 caries-related visits were observed among 321 unique children in 2174 child-years of follow-up, a rate of 14.9 visits per 100 child-years. Caries-related visits and expenditures were similar for those receiving preventive dental care from PCPs vs not. At least 1 fluoride varnish was applied on 3085 children (84.3%) with preventive dental care from dentists and 749 (88.5%) from PCPs.

Table 2. Comparison of Dental Health Services Utilization and Expenditures Among Children Not Receiving Early Preventive Dental Care and Those Receiving it, Stratified by Whether Delivered by Dentist or Primary Care Provider[a]

Outcome	Dentist-Delivered Care, Child-Years[b]			Primary Care Provider-Delivered Care, Child-Years[b]		
	No Preventive Care (n=4866)	Received Preventive Care (n=4866)	*P* Value	No Preventive Care (n=1087)	Received Preventive Care (n=1087)	*P* Value
Any caries-related treatment visit, %	11.3	20.6	<.001	10.1	10.7	.67
Mean caries-related visits per member per year (SD), $	0.15 (0.50)	0.29 (0.68)	<.001	0.14 (0.47)	0.16 (0.54)	.37
Mean annual caries-related expenditures (SD), $	50 (222)	91 (281)	<.001	37 (156)	49 (212)	.12
Any annual dental visit, %	42.8	80.1	<.001	39.0	43.6	.03
Mean annual dental expenditures (SD), $	87 (249)	168 (306)	<.001	71 (181)	88 (241)	.06
Received fluoride varnish during the first 2 years of life,[c] %	NA	84.3	NA	NA	88.5	NA
Mean No. of fluoride varnishes received[c] (SD)	NA	1.1 (0.7)	NA	NA	1.3 (0.9)	NA

Abbreviation: NA, not applicable.

[a] Expenditures adjusted to 2012 dollars.

[b] Sample size given as children-years of follow-up.

[c] Sample size for dentist-delivered varnishes was n = 3658 children (3085 received); sample size for primary care provider–delivered varnishes was n = 846 children (749 received).

Table 3. Results From 2-Part Models Estimating Health Service Utilization and Expenditures for Propensity-Score Matched Children Receiving Early Preventive Dental Care From Dentists and Primary Care Providers

Outcome	Expected Value of the Outcome	β (95% CI)		Effect of Early Preventive Dental Care	
		Logit[a]	GLM	Marginal Effect[b] (95% CI)	*P* Value
Preventive dental visits from dentists before age 2 y (n = 9732 child-years among 3658 matched child pairs)					
Annual caries-related visits	0.22	0.71 (0.60-0.83)	0.04 (−0.02 to 0.10)	0.14 (0.11-0.16)	<.001
Annual caries-related expenditures	70.50	0.72 (0.60-0.84)	−0.01 (−0.13 to 0.12)	40.77 (30.48-51.07)	<.001
Annual dental expenditures	127.43	1.68 (1.59-1.78)	0.03 (−0.06 to 0.13)	84.96 (72.76-97.17)	<.001
Preventive dental visits from dentists before age 2 y (n = 2174 child-years among 846 matched child pairs)					
Annual caries-related visits	0.15	0.06 (−0.24 to 0.36)	0.08 (−0.06 to 0.22)	0.02 (−0.03 to 0.06)	.40
Annual caries-related expenditures	42.98	0.06 (−0.23 to 0.37)	0.23 (−0.03 to 0.49)	12.36 (−3.86 to 28.58)	.14
Annual dental expenditures	79.58	0.19 (−0.01 to 0.38)	0.11 (−0.09 to 0.31)	17.41 (−1.22 to 36.05)	.07

Abbreviation: GLM, generalized linear model.

[a] Robust standard errors are used to account for matched pairs.

[b] Combined marginal effect, otherwise known as the absolute difference.

Table 3 lists the 2-part regression test results for caries-related outcomes among children receiving preventive dental care from dentists. The first column represents the unadjusted predicted value for each outcome, interpreted as the proportion of caries-related visits (or expenditures) per child per year. Columns 2 and 3 display coefficients from logit and generalized linear models, respectively. The predicted value of caries-related visits was 0.22 per child per year. Dentist-delivered preventive care increased the predicted number of caries-related visits by 0.14 per child per year (95% CI, 0.11-0.16). Likewise, predicted caries-related expenditures were $70.50 per child per year, with preventive dental care adding $40.77 per child per year (95% CI, $30.48-$51.07). Total dental expenditures increased by $84.96 per child per year (95% CI, $72.76-$97.17) for those with preventive dental care. None of the equivalent models for PCP-delivered preventive dental care shown in Table 3 yielded statistically significant effects at the conventional levels.

Among 3878 children with dentist-delivered preventive dental care, 1061 (27.4%) received 4 or more visits before their second birthday (ie, high frequency). Similarly, 180 of the 1217 children (14.8%) with PCP-delivered preventive dental care were considered high frequency. Suitable matches with 1 to 3 preventive visits were found for all but 10 children with dentist-delivered care (eTables 1 and 2 and eFigures 3 and 4 in the Supplement). Dentist-delivered high-frequency care increased the likelihood of caries-related visits by 0.07 per child per year (95% CI, 0.12-0.14), and increased caries-related expenditures by $17.57 (95% CI, $3.34-$38.47) (see **Table 4**). The effect of high-frequency PCP-delivered care was not statistically significant.

Discussion

Currently, the American Academy of Pediatrics, American Dental Association, and American Academy of Pediatric Dentistry

Table 4. Among Children With Early Preventive Dental Care, Comparison of Caries-Related Visits and Expenditures for Propensity Score Matched Children Receiving 4 or More Preventive Dental Visits Before Age 2 Years vs Children With Between 1 and 3 Visits

Outcome	Expected Value of the Outcome	β (95% CI)		Effect of High Frequency Preventive Dental Care	
		Logit[a]	GLM	Marginal Effect[b] (95% CI)	*P* Value
≥4 Preventive dental visits from dentists before age 2 y vs 1-3 visits (n=2848 child-years among 1051 matched child pairs)					
Annual caries-related visits	0.30	0.21 (0.02-0.40)	0.06 (−0.04 to 0.15)	0.07 (0.01-0.12)	.01
Annual caries-related expenditures	92.27	0.21 (0.02-0.40)	0.02 (−0.15 to 0.19)	17.57 (−3.34 to 38.47)	.10
≥4 Preventive dental visits from PCPs before age 2 y vs 1-3 visits (n=424 child-years among 180 matched child pairs)					
Annual caries-related visits	0.17	0.31 (−0.65 to 0.57)	−0.08 (−0.34 to 0.19)	−0.02 (−0.12 to 0.08)	.71
Annual caries-related expenditures	41.05	0.01 (−0.62 to 0.62)	−0.02 (−0.42 to 0.39)	−0.69 (−28.59 to 27.21)	.96

Abbreviations: GLM, generalized linear model; PCP, primary care provider.

Results include estimates from care delivered by dentists and primary care providers.

[a] Robust standard errors are used to account for matched pairs.

[b] Combined marginal effect, otherwise known as the absolute difference.

recommend having established a dental home for children by age 6 months, but this lacks conclusive evidence of improved outcomes. We evaluated the effectiveness of early preventive dental care in preventing caries-related visits among Medicaid-enrolled children, using high-dimensional-propensity scores to reduce selection bias. We have 3 principal findings. First, children who received early preventive dental care from dentists were more likely to have caries-related visits and greater caries-related expenditures than children without preventive dental care. Second, children receiving preventive dental care from PCPs had similar caries-related visits and expenditures compared with children without preventive dental care. Finally, the frequency of preventive dental care did not modify this effect.

Our observations are consistent with previous findings demonstrating an association between early preventive dental care and increased caries-related treatments.[21,23-25] One explanation is that parents and guardians may recognize signs of tooth decay and are more likely to use dental services. At the population level, this would result in a greater use of preventive dental care by children with existing problems, and would increase subsequent caries-related visits and expenditures compared with untreated counterparts. Under this scenario, our analysis could demonstrate a spurious association. Our empirical strategy attempted to minimize this by accounting for health service use, health status, and access to dentists. Much of the restorative dental paradigm is early detection and treatment to prevent worse future outcomes.[1] This too could explain subsequent increases in caries-related visits and expenditures following preventive dental care. An alternative explanation is that dentists have an incentive to perform restorative procedures, a phenomenon of supplier-induced demand previously observed when the supply of dentists exceeds demand.[31]

Declining numbers of dentists accepting Medicaid or other barriers to dental care have increased the involvement of PCPs in oral health.[1,13] Incorporating preventive dental care into well-child visits and allowing additional reimbursement for these services has been proposed as an efficient way to increase the provision of this care.[13-15] Primary care provider–delivered preventive dental care has been associated with fewer caries-related visits and decayed, missing, and filled teeth.[15,23] We did not observe any association between caries-related visits or expenditures from PCP-delivered preventive dental care. However, caries may be underdiagnosed among this group. For example, Kranz et al[32] observed that PCP-delivered preventive dental care appeared to result in fewer decayed, missing, and filled teeth, but those children were later observed to have more untreated decayed teeth compared with those treated by dentists.[32]

Previous studies have observed the benefits of preventive dental care only when children receive 4 or more visits,[19,20] suggesting that consistency is key. However, randomized clinical trials have observed caries-related reductions from any fluoride application, suggesting that a single application is beneficial.[33] Most of our study population received fluoride applications; therefore. we tested whether high-frequency preventive dental care had an additive effect. Our findings were not sensitive to this threshold and were consistent with the main analysis for both provider types.

Limitations

Our findings must be interpreted with some limitations. First, claims data cannot capture any indirect benefits of preventive dental care, such as reductions in missed school days or an improved quality of life. Nor is it possible to evaluate the clinical need for caries-related visits, the presence of caries and tooth decay, or variations in the quality of care provided. Likewise, we do not have information regarding behaviors related to oral health, such as teeth brushing. Despite our efforts to minimize selection bias through restrictions and the use of high-dimensional propensity scores, residual unmeasured parental or child characteristics may predispose some children to use preventive dental care. We controlled for county effects, but water supplies in Alabama do not conform to county boundaries and there is a noticeable variation over time in Alabama's water fluoridation. This lack of precise data on water fluoridation may result in confounding. Finally, our study population of continuously-enrolled Medicaid enrollees from birth in a single state may not generalize to other populations.

Conclusions

Adding to a limited body of literature on early preventive dental care, we observed little evidence of the benefits of this care, regardless of the provider. In fact, preventive dental care from dentists appears to increase caries-related treatment, which is surprising. Additional research among other populations and beyond administrative data may be necessary to elucidate the true effects of early preventive dental care.

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REFERENCES

1. US Department of Health and Human Services. *Oral Health in America: A Report of the Surgeon General*. Rockville, MD: US Department of Health and Human Services, National Institute of Dental and Craniofacial Research, National Institutes of Health; 2000.

2. Kenney GM, McFeeters JR, Yee JY. Preventive dental care and unmet dental needs among low-income children. *Am J Public Health*. 2005;95(8):1360-1366.

3. Acs G, Shulman R, Ng MW, Chussid S. The effect of dental rehabilitation on the body weight of children with early childhood caries. *Pediatr Dent*. 1999;21(2):109-113.

4. Jackson SL, Vann WF Jr, Kotch JB, Pahel BT, Lee JY. Impact of poor oral health on children's school attendance and performance. *Am J Public Health*. 2011;101(10):1900-1906.

5. Filstrup SL, Briskie D, da Fonseca M, Lawrence L, Wandera A, Inglehart MR. Early childhood caries and quality of life: child and parent perspectives. *Pediatr Dent*. 2003;25(5):431-440.

6. Iheozor-Ejiofor Z, Worthington HV, Walsh T, et al. Water fluoridation for the prevention of dental caries. *Cochrane Database Syst Rev*. 2015;18(6):CD010856.

7. Yu SM, Bellamy HA, Schwalberg RH, Drum MA. Factors associated with use of preventive dental and health services among U.S. adolescents. *J Adolesc Health*. 2001;29(6):395-405.

8. Tinanoff N, Reisine S. Update on early childhood caries since the Surgeon General's Report. *Acad Pediatr*. 2009;9(6):396-403.

9. American Academy of Pediatric Dentistry. Policy on early childhood caries (ECC): classifications, consequences, and preventive strategies. http://www.aapd.org/media/Policies_Guidelines/P_ECCClassifications.pdf. Accessed October 1, 2016.

10. American Dental Association. Statement on early childhood caries. http://www.ada.org/en/about-the-ada/ada-positions-policies-and-statements/statement-on-early-childhood-caries. Accessed October 19, 2016.

11. Section On Oral Health. Maintaining and improving the oral health of young children. *Pediatrics*. 2014;134(6):1224-1229.

12. Alabama Medicaid Agency. 1st Look Program Specifics. https://medicaid.alabama.gov/content/4.0_Programs/4.2_Medical_Services/4.2.2_Dental/4.2.2.4_1st_Look.aspx. Accessed October 19, 2015.

13. Rozier RG, Stearns SC, Pahel BT, Quinonez RB, Park J. How a North Carolina program boosted preventive oral health services for low-income children. *Health Aff (Millwood)*. 2010;29(12):2278-2285.

14. Herndon JB, Tomar SL, Catalanotto FA, Vogel WB, Shenkman EA. The effect of Medicaid primary care provider reimbursement on access to early childhood caries preventive services. *Health Serv Res*. 2015;50(1):136-160.

15. Kranz AM, Lee J, Divaris K, Baker AD, Vann W Jr. North Carolina physician-based preventive oral health services improve access and use among young Medicaid enrollees. *Health Aff (Millwood)*. 2014;33(12):2144-2152.

16. Dye BA, Tan S, Smith V, et al. Trends in oral health status: United States, 1988-1994 and 1999-2004. *Vital Health Stat 11*. 2007;11(248):1-92.

17. Bhaskar V, McGraw KA, Divaris K. The importance of preventive dental visits from a young age: systematic review and current perspectives. *Clin Cosmet Investig Dent*. 2014;6(8):21-27.

18. Savage MF, Lee JY, Kotch JB, Vann WF Jr. Early preventive dental visits: effects on subsequent utilization and costs. *Pediatrics*. 2004;114(4):e418-e423.

19. Pahel BT, Rozier RG, Stearns SC, Quiñonez RB. Effectiveness of preventive dental treatments by physicians for young Medicaid enrollees. *Pediatrics*. 2011;127(3):e682-e689.

20. Stearns SC, Rozier RG, Kranz AM, Pahel BT, Quiñonez RB. Cost-effectiveness of preventive oral health care in medical offices for young Medicaid enrollees. *Arch Pediatr Adolesc Med*. 2012;166(10):945-951.

21. Beil H, Rozier RG, Preisser JS, Stearns SC, Lee JY. Effect of early preventive dental visits on subsequent dental treatment and expenditures. *Med Care*. 2012;50(9):749-756.

22. Lee JY, Bouwens TJ, Savage MF, Vann WF Jr. Examining the cost-effectiveness of early dental visits. *Pediatr Dent*. 2006;28(2):102-105.

23. Kranz AM, Rozier RG, Preisser JS, Stearns SC, Weinberger M, Lee JY. Preventive services by medical and dental providers and treatment outcomes. *J Dent Res*. 2014;93(7):633-638.

24. Beil H, Rozier RG, Preisser JS, Stearns SC, Lee JY. Effects of early dental office visits on dental caries experience. *Am J Public Health*. 2014;104(10):1979-1985.

25. Kranz AM, Rozier RG, Preisser JS, Stearns SC, Weinberger M, Lee JY. Comparing medical and dental providers of oral health services on early dental caries experience. *Am J Public Health*. 2014;104(7):e92-e99.

26. Sen B, Blackburn J, Morrisey MA, et al. Effectiveness of preventive dental visits in reducing nonpreventive dental visits and expenditures. *Pediatrics*. 2013;131(6):1107-1113.

27. Sen B, Blackburn J, Kilgore ML, et al. Preventive dental care and long-term dental outcomes among ALL Kids enrollees. *Health Serv Res*. 2016;51(6):2242-2257

28. Schneeweiss S, Rassen JA, Glynn RJ, Avorn J, Mogun H, Brookhart MA. High-dimensional propensity score adjustment in studies of treatment effects using health care claims data. *Epidemiology*. 2009;20(4):512-522.

29. Patorno E, Glynn RJ, Hernández-Díaz S, Liu J, Schneeweiss S. Studies with many covariates and few outcomes: selecting covariates and implementing propensity-score-based confounding adjustments. *Epidemiology*. 2014;25(2):268-278.

30. National Committee for Quality Assurance. Well-Child Visits in the First 15 Months of Life (W15). http://www.ncqa.org/portals/0/Well-Child%20Visits%20in%20the%20First%2015%20Months%20of%20Life.pdf. Accessed December 16, 2015.

31. Grytten J, Holst D, Laake P. Supplier inducement. Its effect on dental services in Norway. *J Health Econ*. 1990;9(4):483-491.

32. Kranz AM, Preisser JS, Rozier RG. Effects of physician-based preventive oral health services on dental caries. *Pediatrics*. 2015;136(1):107-114.

33. Chou R, Cantor A, Zakher B, Mitchell JP, Pappas M. *Prevention of Dental Caries in Children Younger Than 5 Years Old: Systematic Review to Update the US Preventive Services Task Force Recommendation. Evidence Synthesis No. 104. AHRQ Publication No. 12-05170-EF-1*. Rockville, MD: Agency for Healthcare Research and Quality; 2014.

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RESEARCH ARTICLE

Preventive Dental Care and Long-Term Dental Outcomes among ALL Kids Enrollees

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Objective. To investigate whether early or regular preventive dental visit (PDV) reduces restorative or emergency dental care and costs for low-income children.

Study Setting. Enrollees during 1998–2012 in the Alabama CHIP program, ALL Kids.

Study Design. Retrospective cohort study using claims data for children continuously enrolled in ALL Kids for at least 4 years. Analyses are conducted separately for children 0–4 years, 4–9 years, and >9 years. For 0–4 years, the intervention of interest is whether they have at least one PDV before age 3. For the other two age groups, interventions of interest are if they have regular PDVs during each of the first 3 years, and if they have claims for a sealant in the first 3 years. Outcomes—namely restorative and emergency dental service and costs—are measured in the fourth year. To account for selection into PDV, a high-dimensional propensity scores approach is utilized.

Data Extraction. Claims data were obtained from ALL Kids.

Principal Findings. Only sealants are associated with a reduced likelihood of using restorative and emergency services and costs.

Conclusions. Whether PDVs without sealants actually reduce restorative/emergency pediatric dental services is questionable. Further research into benefits of PDV is needed.

Key Words. Preventive, dental, children, costs

Tooth decay or dental caries is among the most common chronic disease affecting children, and it disproportionately affects low-income children. Dental caries are associated with infectious abscesses, chronic pain, missed school, and an overall reduced quality of life (Gift, Reisine, and Larach 1992; Acs et al. 1999; Peterson, Niessen, and Nana Lopez 1999; Schechter 2000; US Department of Health and Human Services 2000; Jackson et al. 2011). Early and regular preventive dental care is frequently advocated as a means to

Conference Paper

The Clinical, Environmental, and Behavioral Factors That Foster Early Childhood Caries: Evidence for Caries Risk Assessment

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Abstract: *Caries risk assessment, an essential component of targeted health care delivery for young children, is of paramount importance in the current environment of increasing health care costs and resource constraints. The purpose of this manuscript was to review recent best available evidence behind the factors that influence caries risk assessment and the validity of strategies to assess the caries risk of young children. Moderate to weak evidence supports the following recommendations: (1) Children should have a caries risk assessment done in their first year (or as soon as their first tooth erupts) as part of their overall health assessment, and this should be reassessed periodically over time. (2) Multiple clinical, environmental, and behavioral factors should be considered when assessing caries risk in young children, including factors associated with the primary caregiver. (3) The use of structured forms, although most may not yet be validated, may aid in systematic assessment of multiple caries risk factors and in objective record-keeping. (4) Children from low socioeconomic status groups should be considered at increased risk when developing community preventive programs.* *(Pediatr Dent 2015;37(3):217-25) Received January 23, 2015 Last Revision March 26, 2015 | Accepted April 3, 2015*

KEYWORDS: RISK FACTORS, DENTAL CARIES, RISK ASSESSMENT, REVIEW, INFANT AND PRESCHOOL CHILDREN

Targeted health care delivery has become paramount in the current environment of increasing health care costs and resource constraints. The management of dental caries is no exception. Early childhood caries (**ECC**) is relatively inexpensive to prevent, yet dental caries is the most prevalent chronic condition among U.S. children and the most common unmet health care need of poor children across the country. If allowed to progress and if left untreated, the disease often has broad dental, medical, social, and quality of life consequences.[1] In addition, there are profound disparities in the impacts of ECC.[2] As much as 80 percent of caries incidence is experienced by only 20 to 25 percent of the population, with children from the lowest socioeconomic groups experiencing caries at significantly higher rates and younger ages.[3] Reports of caries prevalence rates vary by area of the country, with rates ranging from as low as 12 percent to as high as 90 percent in certain vulnerable populations.[4] There are also clear issues related to access to preventive services. In some areas, as few as 25 percent of children saw a dentist in the past year.[5]

The previous challenges have brought about a greater interest in the early and objective identification of children at high caries risk in order to assist in decision-making to appropriately tailor cost-effective interventions and the periodicity of these services. In fact, risk-based, patient-centered decision-making, supported by best available evidence, is an essential component for the correct prevention and management of dental caries,[6,7] especially in young children.[7-9] Caries risk assessment (**CRA**) is defined as the process of establishing the probability of an individual patient to develop new carious lesions over a certain time period[10] and/or the probability that there will be a change in severity and/or activity of currently present lesions.[7] The term caries risk assessment and acronym CRA is sometimes mixed up with caries prediction, which is the statistical modeling of factors related to caries development in defined groups of people. The validity of caries predictors is determined in prospective studies without any intervention, and the outcome is expressed in continuous values (e.g., sensitivity, specificity, area under receiver operating characteristic [**ROC**] curves).[10]

Because of the multifactorial and chronic nature of the dental caries disease process, studies on risk assessment tend to be complex, with multiple influences at the individual, family, and community level challenging the prediction throughout the life of an individual.[8,11] In addition, risk factors may vary based on race, culture, and ethnicity.[12,13] For a clinician, the concepts of assessment of risk and prognosis are an important part of clinical decision-making. In fact, the dentist's overall subjective impression of the patient might have good predictive power for caries risk.[14] However, for monitoring purposes, it is clear than an objective record of risk must be included in the patient's chart.

The list of variables that may directly or indirectly influence caries risk is long, especially in young children,[15-17] and includes: clinical/biological factors (e.g., caries experience of child and caregiver, plaque/microbiology, gingivitis, saliva, tooth developmental defects, medical factors, genetics); environmental factors (e.g., exposure to fluoride, antibiotic usage, exposure to lead); and behavioral/psychosocial/sociodemographic factors (e.g., diet, oral hygiene habits, age, parenting styles, child temperament, beliefs, caregiver's education level, socioeconomic status, insurance status, access to dental care). These variables are then taken to develop a caries risk profile/category (e.g., low risk, moderate risk, high risk). In addition, some of these risk factors not only influence dental caries but have much broader impacts on general health. For example, diet is one of the common risk factors, playing a role in dental caries, obesity, diabetes, heart disease, stroke, and cancers.[18]

There are numerous strategies and tools available for CRA in daily practice, which include an informal assessment, use of structured paper forms, and use of computer-based programs.[10] An informal risk assessment may be carried out in connection

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with a dental examination and is the most common form of risk assessment performed currently in the United States.[19] However, even when an informal risk assessment is performed, data from U.S. adults suggest that this information does not always translate into individualized preventive plans.[20]

Today, there are multiple CRA structured paper forms for different age groups that are being promoted to act as a framework for risk-based treatment decision-making and determine individual recall intervals. Available CRA paper forms are, for the most part, expert-based tools, as none have been validated longitudinally on U.S. children. Examples include the Caries Risk Tool (**CAT**) of the American Academy of Pediatric Dentistry,[15] the American Dental Association's Caries Risk Tool for children younger than six years old,[21] the Caries Management by Risk Assessment (**CAMBRA**) tool for children younger than six years old,[22] and the Dundee Caries Risk Assessment Model.[23] Finally, regarding use of computer-based programs, the Cariogram, a free download software program popular in many countries, is designed to calculate 'the chance to avoid new caries lesions in the near future.'[24] Although the Cariogram may also be useful without bacterial tests, the resulting combined sensitivity/specificity is reduced.[25]

The purpose of this manuscript was to review best available evidence behind the clinical, environmental, and behavioral factors that influence caries risk assessment and the validity of strategies to assess the caries risk of preschool children in order to provide recommendations for risk assessment in practice.

Methods

The primary search was focused on identifying recent systematic reviews and evidence-based recommendations that focused on CRAs or evaluation of caries risk forms for zero- to five-year-old children (inclusion criteria). Reports in the gray literature (theses, etc.), as well as expert opinion reviews, were excluded from the primary search. Databases that were searched, focusing on the English language between 2005 and October 1, 2014, included the Cochrane Database of Systematic Reviews (Cochrane reviews, other reviews, and technology assessments), National Guideline Clearing House, Ovid MEDLINE, and PubMed. MeSH and free terms used included: child preschool; infant; dental caries; caries risk; risk assessment; prediction; practice guidelines; evidence-based recommendation; recommendation; risk factor; caries risk form.

To support the discussion of the systematic review findings, references included in pertinent systematic reviews (and in previous reviews or systematic reviews on CRAs by the author) were also hand searched and used in the discussion. For systematic reviews, essential data on study conclusions, evidence-based recommendations, and risk assessment outcomes (e.g., sensitivity, specificity, area under ROC-curves) were extracted. No formal quality assessments or grading were performed, but if the systematic review or evidence-based recommendation was graded in an included study, this was reported.

The broad search for systematic reviews and evidence-based recommendations identified 311 publications since 2005. After removing duplicates and studies that did not meet the inclusion

Table 1. EXAMPLES OF CONCLUSIONS FROM SYSTEMATIC REVIEWS AND EVIDENCE-BASED RECOMMENDATIONS FOR CARIES RISK ASSESSMENT IN PRESCHOOL CHILDREN (0-5 YEARS OLD): 2007-2014*

Study (year)	Supports multivariate models for caries prediction	Concludes that Cariogram has limited prediction accuracy	Supports previous caries experience as the strongest single predictor	Concludes that other factors have limited accuracy when used alone to predict caries	Rates the quality of the evidence and accuracy of the findings	Includes evidence-based graded recommendations for practice
Swedish Council on Technology Assessment in Health Care (2007)[28]	X		X	X	X	
Tellez et al. (2013)[81]		X			X	
Scottish Intercollegiate Guidelines Network-SIGN (2014)[18]	X		X	X	X	X
Mejàre at al. (2014)[26]	X	X	X	X	X	
Studies of caries risk assessment performed by medical primary care clinicians						
Chou et al. (2014)[82]		No studies available to review			X	
Moyer (2014)[27]		No studies available to review			X	X (USPSTF recommendations)
Studies on risk assessment focused on mutans streptococci (MS)						
Thenisch et al. (2006)[64]	Concludes that, although MS appears associated with an increase in risk in caries-free children, lack of adjustment for confounders limits the interpretation of the result					
Parisotto et al. (2010)[65]	MS is a strong risk factor for caries risk indicators, but longitudinal studies are needed to confirm its role as a predictive risk factor					

* MS=mutans streptococci; USPSTF=U.S. Preventive Services Task Force.

criteria, 12 publications were finally included (cited in Tables 1 to 4, plus Leong et al.[66] and Chou et al.[47]). Greater weight was given to systematic reviews and recommendations published in 2013 and 2014 following well-described search and evidence-grading methodology (e.g., the Scottish Intercollegiate Guidelines Network [**SIGN**],[18] Mejàre et al.[26])

For example, SIGN recently published evidence-based guidelines for caries management in children.[18] They conducted a systematic review of clinical studies between 2000 and 2011 using databases (Medline, Embase, Cinahl, PsycINFO, and the Cochrane Library) and various websites (e.g., U.S. National Guidelines Clearinghouse), and the main searches were supplemented by material identified by the authors. Selected manuscripts were evaluated using standard SIGN methodological checklists and grading of the evidence (Table 2).

Another example used in this manuscript includes findings from the U.S. Preventive Services Task Force's (**USPSTF**) recently published evidence-based recommendations for caries prevention in zero- to five-year-olds targeted to nondental health care personnel.[27] They searched the Cochrane Register of Controlled Trials and Cochrane Database of Systematic Reviews (through the first quarter of 2013), searched Medline (1999 through March 8, 2013), and manually reviewed reference lists. Only English-language randomized and nonrandomized trials were included.

Results and Discussion

Very few high-quality, longitudinal caries risk studies exist that focus on infants and toddlers.[8,26,28,29] In addition, very few quality systematic reviews have looked at risk assessment and/or provided evidence-based recommendations for young children (Table 1). Existing studies have been conducted primarily in selective populations in Europe[30-36] or Asia,[29-37,38] with a limited number of studies conducted in the United States.[12,39,40] Furthermore, the prediction models have not been validated in independent populations, thereby diminishing the generalizability of their results. According to Mejàre et al.,[26] for schoolchildren and adolescents, only one study was identified where the model had been validated in another population; it showed that the sensitivity differed considerably when applied to another population.[41]

Multivariate variable models. Together, existing studies suggest that: (1) the possibilities to correctly identify preschool children at risk of caries are relatively high; and (2) additional factors related to caries experience are associated with caries progression and may increase the accuracy of prediction when applied to very young children. However, presence of these factors individually is not necessarily predictive of dental caries (evidence grade equals 2++, SIGN[18]; Table 2). The use of multivariate risk models has generally proven more accurate than using few or single factors, which seems particularly true in preschool children.[26] Data obtained using a structured parental interview suggest that caries prediction in young children may be possible without the necessity of an oral examination.[12,42] A risk factor model comprising 10 demographic variables (exposure to water fluoridation, environmental smoke exposure, tobacco use, race, gender, age, urban versus rural local, body mass index, insurance status, and sealant application) was validated for future caries over six years in a public health setting, resulting in a sensitivity and specificity of 79 percent and 81 percent, respectively.[42]

In a prospective study in Singapore, a sensitivity and specificity of 0.9 in 3- to 6-year-olds was achieved when a questionnaire, oral examination, and salivary tests were combined to predict a one-year caries increment.[29] In this study, a sensitivity/specificity of 0.82/0.81 was achieved when using only multivariate data derived from a questionnaire. At one year of age, a combination of sociodemographic factors (immigrant status, measured as language spoken at home; mother's education), dietary habits (consumption of more than one piece of candy per week; consumption of sugared beverages greater than twice a day) and mutans streptococci counts in a low socioeconomic immigrant area in Sweden gave a sensitivity and specificity sum of 170 percent.[31] A follow-up analysis in the same children at 2.5 years old showed, however, that the presence of carious lesions was the single best predictor as the child aged.[32] In another study of Finnish toddlers, the greatest precision in prediction was achieved by a combination of history of caries, dietary habits (candy consumption), and mutans streptococci (sensitivity/specificity of 0.69/0.78).[35]

In a systematic review, Zero et al.[9] concluded that the best predictor for caries in primary teeth was previous caries experience, followed by level of parental education,[30] and socioeconomic status.[43] They concluded that: (1) many models included similar categories of risk indicators but provided different outcomes, depending on the study population; (2) in many instances, the use of a single risk indicator gave equally good results as the use of a combination of indicators; (3) no combination of risk indicators was consistently considered a good predictor when applied to different countries, across different age groups; (4) however, in general, the best indicators of caries risk, especially in young children, were easily obtained from interviewing parents and did not require additional testing.

Previous caries experience. Previous or current caries experience summarizes the cumulative effect of all risk factors and protective factors to which an individual has been exposed over a lifetime. Children with previous caries experience are at increased risk of future caries[26,31,44-46] (evidence grade equals 2++[18]). Use of previous caries experience might also be a useful predictor when used by nondental personnel. For example, a recent systematic review[47] found a good-quality study of primary care pediatricians' examination of children younger than 36 months old was associated with a sensitivity of 0.76 for identifying a child with one or more cavities and 0.98 for identifying children who needed a dental referral.[48] Another study found that pediatrician examinations resulted in a sensitivity/specificity of 1.0/0.87 for identifying caries involving one or more of the primary maxillary central or lateral incisors or the primary molars, but excluding the primary mandibular incisors, in 18- to 36-month-olds.[49]

Microbiological risk factors. Dental caries is a microbial disease in which the etiological agents are normal constituents of the oral biofilm that cause problems only when their pathogenicity and proportions change in response to environmental conditions. The presence of mutans streptococci or lactobacilli in saliva or plaque as a sole predictor for caries in the primary dentition has showed low accuracy.[50] One of the reasons might be that the methods used do not properly best reflect the biolfilm's cariogenic activity, and/or that a high level of mutans streptococci may be partly compensated by other factors, such as good oral hygiene and a noncariogenic diet.[51] However, their presence in saliva contributes to the accuracy of some multivariate prediction models in preschoolers.[26,37] Thus, caries

Table 2. ACCURACY AND STRENGTH OF THE EVIDENCE FOR RISK FACTORS THAT ELEVATE CARIES RISK IN PRESCHOOL CHILDREN (0-5 YEARS OLD), BASED ON 2014 REVIEWS

Risk factor	Accuracy	Quality/strength of evidence	
	Source (study year) and details on how accuracy or evidence was graded		
	Mejàre at al. (2014)[26a*]	Mejàre at al. (2014)[26b†]	Scottish Intercollegiate Guidelines Network-SIGN (2014)[18c‡]
Multivariate prediction models (excluding Cariogram)	Moderate/good (but most not validated in independent population) Best models: Se >0.80; Sp >0.70	Limited	Multiple risk factors involved: 2++ Dentists' subjective judgment of new lesions over time: 2+ No consensus as to which tool is most effective: 3
Cariogram	Limited Se=0.46-0.71; Sp=0.66-0.88	Limited	No consensus as to which tool is most effective: 3
Presence of previous caries experience	Moderate/good Sen=0.29-0.78; spec=0.72-0.97 Odds ratio=2.2-13.5 Relative risk/hazard ratio=2.3-3	Limited	One of the most important risk indicators: 2++
High levels of mutans streptococci	Poor Se=0.13-0.69; Sp=0.78-0.97 Odds ratio=3.2-3.9; hazard ratio=4.1-7.6 (high specificity)	Limited	One of the most important risk indicators: 2++
Low socioeconomic status (SES, including belonging to a minority race/ethnicity)	Limited/poor immigrant background: Se=0.77; Sp=0.59 Odds ratio=3.4 Parents education: Se=0.69; Sp=0.57	Limited	Caries more prevalent in children from low SES: 2++
Presence of developmental tooth defects/low birthweight		Weak	More research is required in this area before conclusions can be drawn: 2++
Salivary problems (buffer capacity, urease)	Salivary buffer capacity of no predictive value Increasing urease: hazard ratio=4.98	Limited	Generally not helpful to assess risk: 4
Problems with oral hygiene/use of fluoride	Poor Se=0.55-0.59; Sp=0.63	Limited	
Diet (frequent sugar exposure), including factors related to inappropriate breast- and bottle-feeding	Poor Candies >1/wk: Se=0.72-0.84; Sp=0.45-0.55 Odds ratio=1.5-2.3 No sugar at night: odds ratio (to avoid caries)=24	Limited	
Maternal and family associated factors (e.g., caries experience, low socioeconomic status, frequent snacking, lack of knowledge about oral health, etc.)			Parental deprivation is a risk indicator for caries in their children: 3 All other maternal factors not proven helpful as predictive indicators yet: 2+
Posteruptive age	Insufficient evidence	Insufficient evidence	

* a: evidence graded according to the sum of sensitivity (Se) and specificity (Sp): moderate/good= >1.5; limited= <1.5 but >1.3; poor= <1.3.
† b: high=based on high/moderate quality studies containing no factors that weaken the overall judgment; moderate=based on high/moderate quality studies containing isolated factors that weaken the overall judgment; limited=based on high/moderate quality studies containing factors that weaken the overall judgment; insufficient=scientific evidence is lacking, quality of available studies is poor, or studies of similar quality are contradictory.
‡ c: 1++, 1+, and 1- =evidence is derived from meta-analyses, systematic reviews, or randomized clinical trials with very low, low, or high risk of bias; 2++ =evidence is derived from high quality systematic reviews of case control/cohort studies, or evidence derived from high quality case control/cohort studies with a very low risk of bias and high probability that the relationship is causal; 2+ =well-conducted case control/cohort studies with a low risk of bias and moderate probability that the relationship is causal; 2- =case control/cohort studies with a high risk of bias and significant risk that the relationship is not causal; 3=nonanalytic studies (e.g., case reports); 4=expert opinion.

in young children is associated with high oral levels of mutans streptococci[52-58] (evidence grade equals 2++[18]); together with caries experience, this is one of the most important risk factors identified in young children.[14,31,35,45,46,59-63]

In a 2006 systematic review, the presence of mutans streptococci in the plaque and saliva of young caries-free children was also associated with a considerable increase in caries risk; however, the lack of adjustment for confounders might limit the extent to which this finding can be extrapolated to practice.[64] A 2010 review also supported the use of mutans streptococci as a strong risk indicator for caries in young children.[65] A recent study found that when mutans streptococci and lactobacilli levels were added into a biopsychosociobehavioral model for ECC, it slightly improved the prediction, regardless of whether past caries experience was (sensitivity/specificity equals 81 percent/85 percent) or was not (85 percent/80 percent) incorporated into the model (Table 3).[37] A recent systematic review concluded that, although multiple maternal factors (e.g., high levels of cariogenic bacteria) were identified to influence bacterial acquisition in young children, and colonization appeared mediated by some oral health behaviors and feeding habits, a relationship between these factors and subsequent caries was still not clear.[66]

Sociodemographic and dietary risk factors. Sociodemographic variables are included in several multivariate models tested to assess caries risk in preschool children, with immigrant status and parents' education/beliefs being significant in several studies.[26,30,31] As reviewed recently by SIGN,[18] children living in low socioeconomic status families and/or high deprivation areas have significantly more caries than those from high socioeconomic areas[38,67] (evidence grade equals 2++). In addition, it was concluded that no relationship has been demonstrated between low birth weight and caries development.[68] One of the studies included in the SIGN review showed that low birth weight could be associated with enamel defects and caries in the primary dentition,[69] but more longitudinal research is required before conclusions can be drawn (evidence grade equals 2++). The very few longitudinal studies that focus on the relationship between enamel defects and caries risk suggest that enamel hypoplasia is a significant risk factor for caries and should be considered in CRAs.[70,71]

Sugar exposure is an important etiologic factor in caries development. Because of the wide use of fluoride and its effect in lowering the incidence and rate of caries, it is difficult today to show a strong positive association between total sugar consumption and caries development. In a recent systematic review, the odds ratio for assessment of dietary habits and attitudes toward diet for prediction of caries in preschoolers was moderate to low (1.5 to 3.6), with poor accuracy.[26] However, in preschool children, dietary habits as a single risk factor were statistically significant in univariate analysis in several studies, probably because exposure to fluoride in this age group tends to be limited; however, the accuracy was still poor.[26]

Saliva. Saliva plays an important role in the health of soft and hard tissues in the oral cavity. Dentists can assess several salivary parameters related to caries risk, but the most common ones include salivary flow rate, buffering capacity, and pH.[72] Although decreased salivary flow rate tends to be a problem more common in adults than children, a small proportion of children may have reduced salivary flow,

Table 3. ROLE OF MICROBIAL FACTORS IN CARIES RISK PREDICTION (BASED ON DATA FROM GAO ET AL., 2013)[37]*

Variable	Sensitivity (%) for Ddmft>0	Specificity (%) for Ddmft>0	Accuracy	AUC
MS (Dentocult score >2)	79	67	72	NA
LB (Dentocult score >2)	51	89	71	NA
MS+LB	66	85	77	0.82
Past caries	70	83	77	NA
Past caries+MS	81	77	79	0.84
MS+LB+past caries	80	80	80	0.85
Multifactorial screening model (sociodemographic; oral habits; oral hygiene; caries)[29]	82	73	77	0.85
Multifactorial screening model without caries	75	76	75	0.80
Multifactorial model+MS+LB	81	85	83	0.90
Multifactorial model+MS+LB without caries	85	80	82	0.89

* A total of 1,576 3-5 year olds in Singapore were followed for 1 year. Microbial data was collected using Dentocult (MS=mutans streptococci; LB=lactobacilli); dmft=decayed, missing, and filled primary teeth.

Table 4. COMPARISON OF CARIES RISK TOOLS IN PREDICTING CARIES IN YOUNG CHILDREN IN HONG KONG (BASED ON GAO ET AL., 2013)[38]*

Caries risk tool (risk threshold)	Sensitivity (%) for Δdmft>0	Specificity (%) for Δdmft>0	Accuracy
CAT screening (> high)	99	5	40
CAT with salivary/microbiological test (> high)	100	4	39
CAMBRA screening (> moderate)	97	21	49
CAMBRA screening (> high)	94	44	62
CAMBRA with salivary/microbiological test (>moderate)	92	40	59
CAMBRA with salivary/microbiological test (> high)	84	63	71
Cariogram screening (algorithms) (> 38.5% change of caries)	63	78	73
Cariogram with microbiological test (algorithms) (> 37.6% change of caries)	65	79	74
NUS-CRA screening (algorithms) (> 32.8% change of caries)	74	85	81
NUS-CRA with microbiological test (algorithms) (> 35.2% change of caries)	78	85	83

* CRA=caries risk assessment; CAT=caries risk tool of the American Academy of Pediatric Dentistry[15]; CAMBRA=Caries Management by Risk Assessment (CAMBRA) tool for children younger than 6 years old[22]; NUS=model proposed by Gao et al. in 2013 (called the National University of Singapore model-NUS)[29]; dmft=decayed, missing, and filled primary teeth.

usually as a consequence of their medical history and related medications. Despite the association between low salivary flow and caries, salivary markers have generally proved unhelpful in the formal assessment of caries risk in the 0-5 year old age group [18,73,74] (evidence grade equals 4[18]).

Influence of parental oral health status. Because of the multiple influences at the individual-family-community level in the development of ECC,[11] parental factors associated with CRAs in young children have been the focus of extensive research. A recent review by SIGN[18] concluded that parental deprivation was a risk indicator for caries development in their children[14,53] (evidence grade equals 3), but the presence of maternal active carious lesions, high levels of oral mutans streptococci, or reported high sucrose consumption has not been proven to be predictive indicators of caries risk in children[75] (evidence grade equals 2+). The SIGN[18] review included articles up to 2011. Since then, there have been several longitudinal or large cohort studies showing an association between material risk factors and caries in their children. For example, a recent study showed that mothers of ECC children had significantly lower prenatal concentrations of vitamin D than mothers of caries-free children.[76] Maternal weight and intake of sugar and fat in pregnancy were associated with caries experience in preschool children.[77] Maternal salivary bacterial challenge not only was associated with oral infection among children but also predicted increased ECC occurrence.[78] Compared to children delivered by Caesarean section, vaginally born children experienced increased ECC prevalence and were more likely to have higher MS scores.[79] Mothers' oral health status was a strong predictor of the oral health status of their children, with a similar relationship observed between mothers' tooth loss and caries experience among their children.[80]

Assessment of caries risk forms/programs/tools. Even when there is evidence that the development of a generalizable CRA tool for preschool children is feasible[18,23] (and there are many CRA tools in existence), the evidence offers no consensus as to which tool is more effective; in addition, their validity is still very limited.[81] SIGN[18] found no evidence that the use of a CRA tool results in enhanced caries prevention for at-risk groups (evidence grade equals 3). Furthermore, the USPSTF concluded there are no validated multivariate screening tools to determine which children are at higher risk for dental caries, especially when used in the primary care setting.[27,82] On the other hand, the Cariogram has been successfully validated in numerous prospective longitudinal studies in schoolchildren[83,84] but has been found less useful in younger preschool children.[10,29,81,85] The sensitivity and specificity for schoolchildren has been reported to be between 73 to 83 percent and 66 to 85 percent, respectively.[28,84]

Yet, it can be argued that, when the well-being of the young child is considered, it is more important to carry out a risk assessment incorporating best available evidence than making no attempt due to lack of consensus and firm evidence on which form to use.[8,10,72] In preschool children, although there is no clearly superior method for predicting future caries, the use of structured protocols combining sociodemographic factors, previous caries experience, and etiologic factors (e.g., diet, oral hygiene routines) resulted in moderate to good accuracy, with sensitivity greater than 80 percent and specificity exceeding 70 percent.[26] Interestingly, although most reviews on CRAs conclude that a CRA is still limited because it is more effective in the selection of low-risk versus high-risk patients,[8,26,28] this limitation might be useful in some population groups to screen out low-risk patients so that resources can be given to those with the greatest need.[10,86] In fact, a recent study of 544 three-year olds followed for one year in Hong Kong compared the accuracy for caries prediction of several risk tools (Table 4),[38] including CAT,[15] CAMBRA,[22] Cariogram,[24] and the National University of Singapore model (**NUS**) proposed by Gao et al.[29] They concluded that the CAT and CAMBRA tools with and without salivary/microbial factors included had low specificities (range equals five to 63) but high sensitivities (range equals 84 to 100), while the Cariogram and NUS model had higher specificities (range equals 78 to 85) and sensitivities (range equals 63 to 78) when used in this population.

Conclusions

Based on this study's findings, the following conclusions and recommendations, slightly modified from those provided by the Scottish Intercollegiate Guidelines Network,[18] can be made:

1. Health care professionals (and certainly dental professionals) should carry out a caries risk assessment of children in their first year (or as soon as their first tooth erupts[15]) as part of the child's overall health assessment (recommendation grade level is D, per SIGN[18]); this should be reassessed periodically over time. A child considered to be at risk for caries should be referred to the appropriate health service provider for follow-up care.
2. Multiple clinical, environmental, and behavioral factors should be considered when assessing caries risk in young children (recommendation grade level is C, per SIGN[18]), and many of these are easily attainable by interviewing parents. Examples include: caries experience; dietary habits, especially frequency of sugary food and drink consumption; social history, particularly socioeconomic status; oral hygiene habits, including use of fluorides; and medical history, with emphasis on conditions that could affect salivary flow rate. Furthermore, when assessing the caries risk of very young children, it is important to consider not only factors associated with the child but also the parent/primary caregiver (e.g., parental oral health status and parental deprivation).
3. The use of structured forms, although with limited validity, may aid in the systematic assessment of multiple caries risk factors in practice and aid in objective record-keeping over time (recommendation grade level is D). More research is needed to validate multivariate models for risk assessment, outcomes of their use by dental and nondental health care providers, and their validity across different population groups.
4. Children from low socioeconomic status groups should be considered at increased risk of early childhood caries when developing community preventive programs (recommendation grade level is D, per SIGN[18]).

References

1. Casamassimo PS, Thikkurissy S, Edelstein BL, Maiorini E. Beyond the dmft: the human and economic cost of early childhood caries. J Am Dent Assoc 2009;140(6):650-7.

2. Dye BA, Thornton-Evans G, Li X, Iafolla TJ. Dental Caries and Sealant Prevalence in Children and Adolescents in the United States, 2011-2012. NCHS data brief, no 191. Hyattsville, Md., USA: National Center for Health Statistics; 2015.
3. Vargas CM, Crall JJ, Schneider DA. Sociodemographic distribution of pediatric dental caries: NHANES III, 1988-1994. J Am Dent Assoc 1998;129(9):1229-38.
4. Savage M, Lee J, Kotch J, Vann W. Early preventive dental visits: effects on subsequent utilization and costs. Pediatrics 2004;114(4):e418-e423.
5. U.S. Department of Health and Human Services. Annual report on the quality of care for children in Medicaid and CHIP; 2012. Available at: "http://www.medicaid.gov/Medicaid-CHIP-Program-Information/By-Topics/Quality-of-Care/Downloads/2012-Ann-Sec-Rept.pdf". Accessed April 27, 2015. Archived by WebCite® at: "http://www.webcitation.org/6Y6WCvZD1". Accessed April 27, 2015.
6. Featherstone JDB. The caries balance: contributing factors and early detection. J Cal Dent Assoc 2003;31(2):129-33.
7. Fontana, M, Zero D. Assessing patients' caries risk. J Am Dent Assoc 2006;137:1231-40.
8. Twetman S, Fontana M. Patient caries risk assessment. Monogr Oral Sci 2009;21:91-101.
9. Zero D, Fontana M, Lennon AM. Clinical applications and outcomes of using indicators of risk in caries management. J Dent Educ 2001;65(10):1126-32.
10. Twetman S, Fontana M, Featherstone JDB. Risk assessment: can we achieve consensus? Community Dent Oral Epidemiol 2013;41:64-70.
11. Fisher-Owens SA, Gansky SA, Platt LJ, et al. Influences on children's oral health: a conceptual model. Pediatrics 2007;120:e510-e520.
12. Fontana M, Jackson R, Eckert G, et al. Identification of caries risk factors in toddlers. J Dent Res 2011;90(2):209-14. doi: 10.1177/0022034510385458. Epub 2010 Dec 20.
13. Eckert GE, Jackson R, Fontana M. Sociodemographic variation of caries risk factors in toddlers and caregivers. Int J Dent 2010;2010. pii: 593487. doi: 10.1155/2010/593487. Epub 2010 Sep 23.
14. Disney JA, Graves RC, Stamm JW, Bohannan HM, Abernathy JR, Zack DD. The University of North Carolina Caries Risk Assessment Study: further developments in caries risk prediction. Community Dent Oral Epidemiol 1992;20(2):64-75.
15. American Academy of Pediatric Dentistry. Guideline on caries risk assessment and management for infants, children, and adolescents. Reference Manual 2013-2014. Pediatr Dent 2013;35:13-4. Available at: "http://www.aapd.org/media/Policies_Guidelines/G_CariesRiskAssessment.pdf". Accessed April 27, 2015. Archived by WebCite® at: "http://www.webcitation.org/6Y6WSVfdt". Accessed April 27, 2015.
16. Demers M, Brodeur JM, Simard PL, Mouton C, Veilleux G, Fréchette S. Caries predictors suitable for mass-screenings in children: a literature review. Community Dent Health 1990;7(1):11-21.
17. Harris R, Nicoll AD, Adair PM, Pine CM. Risk factors for dental caries in young children: a systematic review of the literature. Community Dent Health 2004;21(suppl 1):71-85.
18. Scottish Intercollegiate Guidelines Network (SIGN). Dental Interventions to Prevent Caries in Children. SIGN publication no. 138. A national clinical guideline; March 2014. Health Improvement Scotland. Edinburgh, U.K.: SIGN; 2014. Available at: "http://www.sign.ac.uk/pdf/SIGN138.pdf". Accessed April 27, 2015.
19. Riley JL III, Gordan VV, Rindal DB, et al. Preferences for caries prevention agents in adult patients: findings from the dental practice-based research network. Community Dent Oral Epidemiol 2010;38(4):360-70. doi: 10.1111/j.1600-0528.2010.00547.x. Epub 2010 May 18.
20. Riley JL III, Gordan VV, Ajmo CT, et al. Dentists' use of caries risk assessment and individualized preventive for their adult patients: findings for the Dental Practice Based Research Network. Community Dent Oral Epidemiol 2011;39(6):564-73.
21. American Dental Association. Caries form (patients 0-6), updated 2008. Available at: "http://www.ada.org/~/media/ADA/Member%20Center/FIles/topics_caries_under6.ashx". Accessed April 27, 2015. Archived by WebCite® at: "http://www.webcitation.org/6Y6Y0r6v6". Accessed April 27, 2015.
22. Ramos-Gomez FJ, Crall J, Gansky SA, Slayton RL, Featherstone JDB. Caries risk assessment appropriate for the age of 1 visit (infants and toddlers). J Calif Dent Assoc 2007;35(10):687-702.
23. MacRitchie HM, Longbottom C, Robertson M, et al. Development of the Dundee Caries Risk Assessment Model (DCRAM): risk model development using a novel application of CHAID analysis. Community Dent Oral Epidemiol 2012;40(1):37-45.
24. Bratthall D, Hänsel Petersson G. Cariogram: a multifactorial risk assessment model for a multifactorial disease. Community Dent Oral Epidemiol 2005;33(4):256-64.
25. Petersson GH, Isberg PE, Twetman S. Caries risk assessment in school children using a reduced Cariogram model without saliva tests. BMC Oral Health 2010;10:5. doi: 10.1186/1472-6831-10-5.
26. Mejàre I, Axelsson S, Dahlén G, et al. Caries risk assessment: a systematic review. Acta Odontol Scand 2014;72(2):81-91.
27. Moyer VA. Prevention of dental caries in children from birth through age 5 years: U.S. Preventive Services Task Force recommendation statement. U.S. Preventive Services Task Force. Pediatrics 2014;133(6):1102-11.
28. Swedish Council on Technology Assessment in Health Care. Caries diagnosis, risk assessment and non-invasive treatment: a systematic review. Summary and conclusions. Report No 188, 2007. ISBN:978-91-85413-21-8. Available at: "http://www.sbu.se/upload/publikationer/content1/1/caries_summary_2008.pdf". Accessed April 27, 2015. Archived by WebCite® at: "http://www.webcitation.org/6Y6Z5A0vo". Accessed April 27, 2015.
29. Gao XL, Hsu CY, Xu Y, Hwarng HB, Loh T, Koh D. Building caries risk assessment models for children. J Dent Res 2010;89(6):637-43. doi: 10.1177/0022034510364489. Epub 2010 Apr 16.
30. Demers M, Brodeur J, Mouton C, Simard P, Trahan L, Veilleux G. A multivariate model to predict caries increment in Montreal children aged 5 years. Comm Dental Health 1992;9(3):273-81.
31. Grindefjord M, Dahllöf G, Nilsson B, Modéer T. Prediction of dental caries development in 1-year-old children. Caries Res 1995;29(5):343-8.

32. Grindefjord M, Dahllöf G, Nilsson B, Modéer T. Stepwise prediction of dental caries in children up to 3.5 years of age. Caries Res 1996;30(4):256-66.
33. Karjalainen S, Söderling E, Sewón L, Lapinleimu H, Simell O. A prospective study on sucrose consumption, visible plaque and caries in children from 3 to 6 years of age. Community Dent Oral Epidemiol 2001;29(2):136-42.
34. Pienihäkkinen K, Jokela J. Clinical outcomes of risk-based caries prevention in preschool-aged children. Community Dent Oral Epidemiol 2002;30(2):143-50.
35. Pienihäkkinen K, Jokela J, Alanen P. Assessment of caries risk in preschool children. Caries Res 2004;38(2):156-62.
36. Wendt LK, Hallonsten AL, Koch G, Birkhed D. Analysis of caries-related factors in infants and toddlers living in Sweden. Acta Odontol Scand 1996;54(2):131-7.
37. Gao X, Stephen Hsu C-Y, Loh T, Hwarng, Koh D. Role of microbiological factors in predicting early childhood caries. Pediatr Dent 2013;36(4):348-54.
38. Gao X, Wu ID, Man Lo EC, Chu CH, Stephen Hsu C-Y, Wong MCM. Validity of caries risk assessment programmes in preschool children. J Dent 2013;41(9):787-95.
39. Ismail AI, Sohn W, Lim S, Willem JM. Predictors of dental caries progression in primary teeth. J Dent Res 2009;88(3):270-5. doi: 10.1177/0022034508331011.
40. Chankanka O, Cavanaugh JE, Levy SM, et al. Longitudinal associations between children's dental caries and risk factors. J Public Health Dent 2011;71(4):289-300.
41. Beck JD, Weintraub JA, Disney JA, et al. University of North Carolina Caries Risk Assessment Study: comparisons of high risk prediction, any risk prediction, and any risk etiologic models. Community Dent Oral Epidemiol 1992;20(6):313-21.
42. Ditmyer MM, Dounis G, Howard KM, Mobley C, Cappelli D. Validation of a multifactorial risk factor model used for predicting future caries risk with Nevada adolescents. BMC Oral Health 2011;11:18.
43. Isokangas P, Alanen P, Tiekso J. The clinician's ability to identify caries risk subjects without saliva tests: a pilot study. Community Dent Oral Epidemiol 1993;21(1):8-10.
44. Saemundsson SR, Slade GD, Spencer AJ, Davies MJ. The basis for clinicians' caries risk grouping in children. Pediatr Dent 1997;19(5):331-8.
45. Wandera A, Bhakta S, Barker T. Caries prediction and indicators using a pediatric risk assessment teaching tool. J Dent Child 2000;67(6):375, 408-12.
46. Wendt LK, Hallonsten AL, Koch G. Oral health in preschool children living in Sweden. Part III: a longitudinal study. Risk analyses based on caries prevalence at 3 years of age and immigrant status. Swed Dent J 1999;23(1):17-25.
47. Chou R, Cantor A, Zakher B, Mitchell J, Pappas M. Prevention of Dental Caries in Children Younger Than Age 5 Years: Systematic Review to Update the U.S. Preventive Services Task Force Recommendation. Evidence Synthesis No. 104. Rockville, Md., USA: Agency for Healthcare Research and Quality; 2014.
48. Pierce KM, Rozier RG, Vann WF Jr. Accuracy of pediatric primary care providers' screening and referral for early childhood caries. Pediatrics 2002;109(5):1-7; E82.
49. Serwint JR, Mungo R, Negrete VF, et al. Child-rearing practices and nursing caries. Pediatrics 1993;92(2):233-7.
50. National Institutes of Health Consensus Development Conference Statement. Diagnosis and management of dental caries throughout life. National Institutes of Health Consensus March 26-28, 2001. J Dent Educ 2001;65(10):1162-8.
51. Gibson S, Williams S. Dental caries in pre-school children: associations with social class, toothbrushing habit and consumption of sugars and sugar-containing foods. Further analysis of data from the National Diet and Nutrition Survey of children aged 1.5-4.5 years. Caries Res 1999;33(2):101-13.
52. Barsamian-Wunsch P, Park JH, Watson MR, Tinanoff N, Minah GE. Microbiological screening for cariogenic bacteria in children 9 to 36 months of age. Pediatr Dent 2004;26(3):231-9.
53. Radford JR, Ballantyne HM, Nugent Z, et al. Caries-associated micro-organisms in infants from different socioeconomic backgrounds in Scotland. J Dent 2000;28(5):307-12.
54. O'Sullivan DM, Thibodeau EA. Caries experience and mutans streptococci as indicators of caries incidence. Pediatr Dent 1996;18(5):371-4.
55. Twetman S, Petersson LG. Interdental caries incidence and progression in relation to mutans streptococci suppression after chlorhexidine-thymol varnish treatments in school-children. Acta Odontol Scand 1999;57(3):144-8.
56. Tenovuo J, Hakkinen P, Paunio P, Emilson CG. Effects of chlorhexidine-fluoride gel treatments in mothers on the establishment of mutans streptococci in primary teeth and the development of dental caries in children. Caries Res 1992;26(4):275-80.
57. Thibodeau EA, O'Sullivan DM. Salivary mutans streptococci and caries development in the primary and mixed dentitions of children. Community Dent Oral Epidemiol 1999;27(6):406-12.
58. Thibodeau EA, O'Sullivan DM. Salivary mutans streptococci and incidence of caries in preschool children. Caries Res 1995;29(2):148-53.
59. Vanobbergen J, Martens L, Lesaffre E, Bogaerts K, Declerck D. Assessing risk indicators for dental caries in the primary dentition. Community Dent Oral Epidemiol 2001;29(6):424-34.
60. Franco E, Saunders CP, Roberts GJ, Suwanprasit A. Dental disease, caries related microflora and salivary IgA of children with severe congenital cardiac disease: an epidemiological and oral microbial survey. Pediatr Dent 1996;18(3):228-35.
61. Holbrook WP, de Soet JJ, de Graaff J. Prediction of dental caries in pre-school children. Caries Res 1993;27(5):424-30.
62. Mohan A, Morse DE, O'Sullivan DM, Tinanoff N. The relationship between bottle usage/content, age, and number of teeth with mutans streptococci colonization in 6-24-month-old children. Community Dent Oral Epidemiol 1998;26(1):12-20.
63. Habibian M, Beighton D, Stevenson R, Lawson M, Roberts G. Relationships between dietary behaviours, oral hygiene and mutans streptococci in dental plaque of a group of infants in Southern England. Arch Oral Biol 2002;47(6):491-8.
64. Thenisch NL, Bachmann LM, Imfeld T, Leisebach Minder T, Steurer J. Are mutans streptococci detected in preschool children a reliable predictive factor for dental caries risk? A systematic review. Caries Res 2006;40(5):366-74.

65. Parisotto TM, Steiner-Oliveira C, Silva CM, Rodrigues LK, Nobre-dos-Santos M. Early childhood caries and mutans streptococci: a systematic review. Oral Health Prev Dent 2010;8(1):59-70.
66. Leong PM, Mark Gussy G, Barrow S-YL, De Silva-Sanigorski A, Waters E. A systematic review of risk factors during first year of life for early childhood caries. Int J Paediatr Dent 2013;23(4):235-50.
67. Prendergast MJ, Beal JF, Williams SA. The relationship between deprivation, ethnicity and dental health in 5-year-old children in Leeds, U.K. Community Dent Health 1997;14(1):18-21.
68. Burt BA, Pai S. Does low birth weight increase the risk of caries? A systematic review. J Dent Educ 2001;65 (10):1024-7.
69. Lai PY, Seow WK, Tudehope DI, Rogers Y. Enamel hypoplasia and dental caries in very low birth weight children: a case-controlled, longitudinal study. Pediatr Dent 1997;19(1):42-9.
70. Oliveira AFB, Chaves AMB, Rosenblatt A. The influence of enamel defects on the development of early childhood caries in a population with low socioeconomic status: a longitudinal study. Caries Res 2006;40(4):296-302.
71. Hong L, Levy SM, Warren JJ, Broffit B. Association between enamel hypoplasia and dental caries in primary secondary molars: a cohort study. Caries Res 2009;43 (5):345-53. doi: 10.1159/000231571. Epub 2009 Aug 1.
72. Fontana M, Gonzalez-Cabezas C. Minimal intervention dentistry: part 2. Caries risk assessment in adults. Br Dent J 2012;213(9):447-51. doi: 10.1038/sj.bdj.2012.1008. Erratum in: Br Dent J 2012;213(10):508.
73. Sanchez-Perez L, Golubov J, Irigoyen-Camacho ME, Moctezuma PA, Acosta-Gio E. Clinical, salivary, and bacterial markers for caries risk assessment in schoolchildren: a 4-year follow-up. Int J Paediatr Dent 2009;19(3):186-92.
74. Cunha-Cruz J, Scott J, Rothen M, et al. Salivary characteristics and dental caries: evidence from general dental practices. J Am Dent Assoc 2013;144(5):e31-e40.
75. Smith RE, Badner VM, Morse DE, Freeman K. Maternal risk indicators for childhood caries in an inner city population. Community Dent Oral Epidemiol 2002;30(3): 176-81.
76. Schroth RJ, Lavelle C, Tate R, Bruce S, Billings RJ, Moffatt MEK. Prenatal vitamin D and dental caries in infants. Pediatrics 2014;133(5):e1277-e1284. doi: 10.1542/peds.2013-2215.
77. Wigen TI, Wang, NJ. Maternal health and lifestyle, and caries experience in preschool children: a longitudinal study from pregnancy to age 5 yr. Eur J Oral Sci 2011; 119(6):463-8. doi: 10.1111/j.1600-0722.2011.00862.x. Epub 2011 Sep 27.
78. Chaffee BW, Gansky SA,Weintraub JA, Featherstone JDB, Ramos-Gomez FJ. Maternal oral bacterial levels predict early childhood caries development. J Dent Res 2014; 93(3):238-44.
79. Pattanaporn K, Saraithong P, Khongkhunthian S, et al. Mode of delivery, mutans streptococci colonization, and early childhood caries in three- to five-year-old Thai children. Community Dent Oral Epidemiol 2013;41(3): 212-23.
80. Dye BA, Vargas CM, Lee JJ, Magder L, Tinanoff N. Assessing the relationship between children's oral health status and that of their mothers. J Am Dent Assoc 2011; 142(2):173-83.
81. Tellez M, Gomez J, Pretty I, Ellwood R, Ismail AI. Evidence on existing caries risk assessment systems: are they predictive of future caries? Community Dent Oral Epidemiol 2013;41(1):67-78.
82. Chou R, Cantor A, Zakher B, Mitchell JP, Pappas M. Preventing dental caries in children 5 years: systematic review updating USPSTF recommendation. Pediatrics 2013;132(2):332-50.
83. Hänsel Petersson G, Twetman S, Bratthall D. Evaluation of a computer program for caries risk assessment in school-children. Caries Res 2002;36(5):327-40.
84. Campus G, Cagetti MG, Sale S, Carta G, Lingström P. Cariogram validity in schoolchildren: a two-year follow-up study. Caries Res 2012;46(1):16-22.
85. Holgerson PL, Twetman S, Stecksèn-Blicks C. Validation of an age-modified caries risk assessment program (Cariogram) in preschool children. Acta Odontol Scand 2009; 67(2):106-12.
86. Brocklehurst PR, Ashley JR, Tickle M. Patient assessment in general dental practice: risk assessment or clinical monitoring? Br Dent J 2011;210(8):351-4.

ASSESSMENT OF CARIES RISK

C **As part of the patient assessment, a social history should be taken which will contribute to dental brief interventions being specific to individuals and tailored to their particular needs and circumstances.**

✓ Dental health professionals should take a common risk factor approach supporting a variety of topic-based brief interventions and when possible provide support to colleagues to expand the delivery of brief interventions across other appropriate settings.

C **The following factors should be considered when assessing caries risk:**

- **clinical evidence of previous disease**
- **dietary habits, especially frequency of sugary food and drink consumption**
- **social history, especially socioeconomic status**
- **use of fluoride**
- **plaque control**
- **saliva**
- **medical history.**

✓ Clinicians should be aware of individuals with a medical or physical disability for whom the consequences of dental caries could be detrimental to their general health. These patients should receive intensive preventive dental care.

D **Specialist child healthcare professionals should consider carrying out a caries risk assessment of children in their first year as part of the child's overall health assessment.**

D **Children whose families live in a deprived area should be considered as at increased risk of early childhood caries when developing preventive programmes.**

✓ A child considered by the healthcare professional to be at high caries risk should be referred to the appropriate health service provider.

ORAL HEALTH PROMOTION IN THE PRACTICE SETTING

B **Oral health promotion interventions should facilitate daily toothbrushing with fluoride toothpaste.**

B **Oral health promotion interventions should be based on recognised health behaviour theory and models such as motivational interviewing.**

PREVENTIVE TREATMENTS

A **Fluoride varnish should be applied at least twice yearly in all children.**

A **Resin-based fissure sealants should be applied to the permanent molars of all children as early after eruption as possible.**

✓ Glass ionomer sealants may be considered if the application of a resin-based sealant is not possible.

TOOTHBRUSHING WITH FLUORIDE TOOTHPASTE

Use of fluoride toothpaste

	Approximate tolerable daily volume of toothpaste ingestion (mls)		
Toothpaste strength (ppmF)	1–3 year old child (13 kg)	4–8 year old child (22 kg)	9–13 year old child (40 kg)
1,000	1.3	2.2	10
1,500	0.86	1.46	6.7
2,800	Not recommended		3.6

✓ To reduce the risk of mild fluorosis and reinforce good oral health the amount of toothpaste used by children up to the age of three years should be supervised.

Smear of toothpaste (approximately 0.1 ml) representing the recommended volume for children under the age of three years

Pea-sized amount of toothpaste (approximately 0.25 ml) representing the recommended volume for children over the age of three years

TOOTHBRUSHING WITH FLUORIDE TOOTHPASTE (contd.)

Age at commencement of brushing

✓ Children should be assisted to brush their teeth as soon as they erupt.

Frequency and duration of brushing

A **Toothbrushing with fluoride toothpaste should take place at least twice daily.**

Supervised toothbrushing

A **Supervision of toothbrushing with fluoride toothpaste is recommended as an effective caries prevention measure.**

✓ Children who are unable to brush their teeth unaided should be assisted to do so.

Toothbrushing practice

A **Children should be encouraged to spit out excess toothpaste and not rinse with water after brushing.**

✓ Children's teeth should be brushed last thing at night before bedtime and on at least one other occasion.

✓ Children's teeth can be brushed with either manual or powered toothbrushes as an effective means of administering fluoride.

Concentration of fluoride toothpaste

A **Following risk assessment, children and young people up to the age of 18 years who are at standard risk of developing dental caries should be advised to use toothpastes in the range 1,000 to 1,500 ppmF.**

✓ Following risk assessment, children up to the age of 10 years who are at increased risk of developing dental caries should be advised to use toothpastes at 1,500 ppmF.

A **Following risk assessment, children aged from 10 to 16 years who are at increased risk of developing dental caries should be advised to use toothpastes at a concentration of 2,800 ppmF.**

This Quick Reference Guide provides a summary of the main recommendations in **SIGN 138 Dental interventions to prevent caries in children.** Recommendations are graded **A B C D** to indicate the strength of the supporting evidence.

Good practice points ✓ are provided where the guideline development group wishes to highlight specific aspects of accepted clinical practice.

Details of the evidence supporting these recommendations can be found in the full guideline, available on the SIGN website: www.sign.ac.uk. This Quick Reference Guide is also available as part of the SIGN Guidelines app.

Available on the App Store

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Healthcare Improvement Scotland

SIGN

SIGN 138 • Dental interventions to prevent caries in children

Quick Reference Guide *March 2014*

Evidence

Conference Paper

Integrating Oral Health Into Overall Health Care to Prevent Early Childhood Caries: Need, Evidence, and Solutions

Joanna M. Douglass, BDS, DDS[1] • Melinda B. Clark, MD[2]

Abstract: *Medicaid data shows that few one- to two-year-olds receive a preventive dental visit, indicating our limited success implementing the existing policy paradigm of dental home establishment by 12 months of age. Few pediatricians refer children for early dental care, few dentists are comfortable seeing children younger than two-years-old, fewer still provide restorative care, and many dentists do not accept Medicaid insurance. These realities mandate new strategies to meet the needs of children and families and effectively tackle early childhood caries (ECC). Primary care medical providers have frequent contact with families, providing opportunities to incorporate oral health promotion and prevention in non-dental settings. Components of such an approach include: screening; risk assessment; oral health counseling; fluoride varnish application; successful referral for children needing intense intervention; policy support; and financial incentives to sustain change. Current research indicates that oral health counseling, particularly motivational interviewing, and fluoride varnish applied in the non-dental setting positively affect patient outcomes. Cost savings may only be realized if ECC prevention programs use: support professionals; integrative disease management; and innovative insurance structures. The purpose of this paper was to examine the evidence for the effectiveness of the provision of oral health preventive services in the primary care setting.* *(Pediatr Dent 2015;37(3):266-74) Received January 23, 2015 Last Revision March 24, 2015 / Accepted March 25, 2015*

KEYWORDS: ORAL HEALTH, DENTAL CARIES, PRESCHOOL CHILD

Early childhood caries (**ECC**), especially in high-risk children, begins prior to tooth eruption with the transfer of cariogenic bacteria from caregiver to child. The clinical manifestation of this disease can be identified soon after primary tooth eruption, but entry into the dental care system often occurs much later. Despite professional guidelines encouraging establishment of a dental home by 12 months old, national Medicaid data from 2008 reveals that only nine percent of one- to two-year-olds receive a preventive dental visit.[1] Caries prevalence among two- to five-year-olds from higher-income families is 18 percent, but among children from low-income families it is 42 percent.[2] The existing paradigm for establishing early dental care has been met with limited success. Few pediatricians refer children for dental care at one year of age,[3] few dentists are comfortable seeing zero- to two-year-old children, fewer still provide restorative care,[4] and many do not accept Medicaid because of low reimbursement.[5] These realities suggest that we must consider new strategies to meet the needs of children and families and effectively tackle the ECC epidemic.

Though they may not be accessing dental care, caregivers and children frequently interact with other health care professionals, including obstetricians, midwives, and primary care providers (**PCPs**). In fact, children average 10 or more visits to their PCP during the first two years of life alone.[6] Given that oral health literacy is often low, especially among children with ECC risk factors, frequent contact with families affords excellent opportunities to incorporate oral health promotion and prevention in settings outside of the dental office.

Non-health professional sources of information, such as the Internet, play an important role in parents' attitudes about oral health. The overwhelming majority of postings to parent blogs recommend age three for the first dental visit, and most credit this information to their dentist.[6,7] In one study of low-income Mexican American mothers, the mean age of the first dental visit was three years old. Half of the initial visits were parent initiated, either due to an identified problem such as pain or to help prevent problems in the future. Only 21 percent of first visits were in response to a recommendation of a medical provider.[7] These findings underscore the need for health professional education about current policy and the value of reaching children where they currently obtain health care, as parents are not being directed to seek early dental care. In fact, given the challenges for families at high caries risk to attend multiple appointments, incorporating oral health into locations where children already attend is a promising strategy to combat the ECC epidemic.

The purposes of this paper were to examine (1) evidence for the effectiveness of the provision of oral health preventive services for each of the following methods promulgated to promote early childhood care prevention in the primary care setting: screening and risk assessment; oral health counseling and behavioral change strategies; fluoride varnish application; successful referral of children requiring more intense intervention; policy support for proven effective strategies; and incentives to help build and sustain systems necessary to effect meaningful change; (2) barriers to establishing oral health prevention programs in the primary care setting and the potential cost savings of the aforementioned interventions; and (3) the reviewed information to determine whether current policy strategies for early oral health care are effective and what recommendations for the future might be made.

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Methods

An electronic search was conducted using PubMed with the following parameters in appropriate combination: (1) terms: caries, physician, medical, primary care, fluoride varnish, and motivational interviewing; and (2) limits applied: within the last 10 years, humans, English, and children zero to five years old. A total of 163 articles were identified; of these, 24 were selected for inclusion. Additionally, the reference sections of papers already selected for inclusion were screened for potentially relevant articles that were then pulled for review. Articles were excluded if they were not original research, did not specifically address the areas of focus of this evidence-based review, or were superseded by an updated publication in the case of national surveys or policy statements. A total of 69 articles were identified for inclusion in the review.

Results

Screening and risk assessment. Without screening and risk assessment, all children receive the same interventions, regardless of need. Given the reality of limited resources, we must target resources where they are most required. Risk assessment and triage are embedded in the current medical care system, so this concept can be applied to oral health disease as well.

Studies demonstrate that PCPs can, with only a couple of hours of training, accurately identify children with cavitated ECC and those who need referral.[8,9] The AAP developed a simplified screening tool (Figure 1). The Quality Improvement Innovation Network pilot of the tool revealed that: (1) over 80 percent of practices found the tool easy to implement and required two minutes during the well child visit; and (2) identification of high-risk patients for oral health referral increased from 11 percent to over 87 percent with tool use.[10]

Unfortunately, no published studies have examined the reliability of PCPs to detect white spots or properly use caries risk assessment tools. Further, there are no studies that examine whether oral screening by PCPs results in decreased caries rates.[11] In fact, the efficacy of caries risk assessment tools themselves has not been well-studied when utilized by PCPs or by dentists. The only study found on the subject suggests that mutans streptococci sampling may be superior in evaluating risk than one of the more popular risk assessment tools.[12]

Despite the paucity of data validating the effectiveness of screening and risk assessment specific to oral health, cost-effective prevention programs for highly prevalent diseases require early assessment of disease risk and triage. This is especially true for conditions where existing treatment modalities are overly focused on expensive surgical approaches, such as dental caries.

Oral health counseling. Programs aimed at engaging PCPs in oral health promotion typically focus on oral health education for families, with the desired outcome of improved oral health behaviors and subsequent improved oral health status. No studies were identified that examined the success of PCP oral health education on patient oral health outcomes. However, a systematic review of educational interventions among dental providers revealed that dental health education temporarily improves a patient's oral hygiene and consistently improves knowledge but has no effect on caries increment.[13] This lack of success of education may be the result of dental providers receiving minimal or ineffective training in counseling and education strategies.[14]

Recently, motivational interviewing (**MI**) has gained attention as a method successful in prompting health behavior change. MI is a brief, patient centered, personalized counseling approach. MI helps raise caregiver and child awareness of the problem in order to identify personal oral health goals and explore if current behaviors are consistent with desired goals. Reflective listening and the use of open-ended questions are the core elements of MI. Clinical literature substantiates the effectiveness of MI as a behavior change promoter and suggests that this is the most effective method for altering health behaviors in the clinical setting.[15]

Oral Health Risk Assessment Tool

The child is at an absolute high risk for caries if any risk factors or clinical findings, marked with a ⚠ sign, are documented yes. In the absence of ⚠ risk factors or clinical findings, the clinician may determine the child is at high risk of caries based on one or more positive responses to other risk factors or clinical findings. Answering yes to protective factors should be taken into account with risk factors/clinical findings in determining low versus high risk.

Patient Name:_____ Date of Birth:_____ Date:_____

Visit: ☐6 month ☐9 month ☐12 month ☐15 month ☐18 month ☐24 month ☐30 month ☐3 year ☐4 year ☐5 year ☐6 year ☐Other_____

RISK FACTORS

⚠ Mother or primary caregiver had active decay in the past 12 months ☐Yes ☐No

● Mother or primary caregiver does not have a dentist ☐Yes ☐No

● Continual bottle/sippy cup use with fluid other than water ☐Yes ☐No

● Frequent snacking ☐Yes ☐No

● Special health care needs ☐Yes ☐No

● Medicaid eligible ☐Yes ☐No

PROTECTIVE FACTORS

● Existing dental home ☐Yes ☐No

● Drinks fluoridated water or takes fluoride supplements ☐Yes ☐No

● Fluoride varnish in the last 6 months ☐Yes ☐No

● Has teeth brushed twice daily ☐Yes ☐No

CLINICAL FINDINGS

⚠ White spots or visible decalcifications in the past 12 months ☐Yes ☐No

⚠ Obvious decay ☐Yes ☐No

⚠ Restorations (fillings) present ☐Yes ☐No

● Visible plaque accumulation ☐Yes ☐No

● Gingivitis (swollen/bleeding gums) ☐Yes ☐No

● Teeth present ☐Yes ☐No

● Healthy teeth ☐Yes ☐No

ASSESSMENT/PLAN

Caries Risk: ☐Low ☐High

Completed: ☐Anticipatory Guidance ☐Fluoride Varnish ☐Dental Referral

Self Management Goals:

☐Regular dental visits ☐Dental treatment for parents ☐Brush twice daily ☐Use fluoride toothpaste

☐Wean off bottle ☐Less/No juice ☐Only water in sippy cup ☐Drink tap water

☐Healthy snacks ☐Less/No junk food or candy ☐No soda ☐Xylitol

Treatment of High Risk Children

If appropriate, high-risk children should receive professionally applied fluoride varnish and have their teeth brushed twice daily with an age-appropriate amount of fluoridated toothpaste. Referral to a pediatric dentist or a dentist comfortable caring for children should be made with follow-up to ensure that the child is being cared for in the dental home.

Adapted from Ramos-Gomez FJ, Crystal YO, Ng MW, Crall JJ, Featherstone JD. Pediatric dental care: prevention and management protocols based on caries risk assessment. *J Calif Dent Assoc.* 2010;38(10):746–761; American Academy of Pediatrics Section on Pediatric Dentistry and Oral Health. Preventive oral health intervention for pediatricians. *Pediatrics.* 2003; 122(6):1387–1394; and American Academy of Pediatrics Section of Pediatric Dentistry. Oral health risk assessment timing and establishment of the dental home. *Pediatrics.* 2003;111(5):1113–1116.

Figure 1. American Academy of Pediatrics Oral Health Risk Assessment Tool. Reprinted with permission from the American Academy of Pediatrics.

Studies of MI effectiveness, when used by non-dentists, on oral health behaviors and ECC have shown variable outcomes. Four studies were identified that utilized MI techniques employed by either trained laypersons or counselors. Of these, one study found no difference in caries prevalence at a two-year follow-up but found significant improvement in brushing behaviors.[16] The other two studies showed decreased caries prevalence of approximately 10 percentage points.[17,18] Of particular interest is the fourth study, which included education and MI regarding fluoride varnish use. At two years, children of parents in the MI group had 4.1 fluoride varnish applications versus 0.3 in the control group and only 35 percent of the MI children had new carious lesions compared to 52 percent in the control group.[19] Overall, the number of decayed, missing and filled primary tooth surfaces (**dmfs**) was reduced by more than 50 percent.[20]

One study specifically examined the use of MI by PCPs in the absence of fluoride varnish. At the one-year follow-up, the ECC prevalence at the intervention site was 17.7 percent versus 31.7 percent at the control site (P=0.086).[21]

Fluoride varnish. Of all the preventive strategies examined, the application of fluoride varnish by non-dental health professionals is the best studied and most widely implemented. Studies examining the use of fluoride varnish in the medical setting typically include oral health education as a component of the intervention, making it difficult to compare the individual effects of these two distinct, but complementary, interventions.

The majority of studies examining the use of fluoride varnish in medical offices have emanated from the Into the Mouth of Babes (**IMB**) program in North Carolina. Children enrolled in the IMB program with at least four visits experienced, on an average, a 17 percent reduction in dental-caries-related treatments up to six years of age compared to children with no IMB visits. When data were simulated for initial IMB visits at 12 and 15 months old, there was a cumulative 49 percent reduction in caries-related treatments at 17 months of age.[22] In a statewide survey, the mean decayed, missing, and filled primary teeth (**dmft**) for kindergarten students increased from 1.53 in 1989 to 1.84 in 2004 and then decreased to 1.59 in 2009. During this time, the mean number of IMB visits per zero- to four-year-old child increased from 0.01 in 2000 to 0.22 in 2009. Data analysis revealed that a one-unit increase in IMB visits resulted in a 0.25 dmft decrease per student.[23] Further, kindergarten children who had preventive services provided either in the primary care office or in the dental office had no difference in dmft scores, indicating that either venue was equally effective in providing preventive dental services.[24]

An observational study involving American Indian Head Start children demonstrated that four or more fluoride varnish visits at well-child visits between nine and 30 months old significantly decreased caries by 35 percent, from a dmfs of 23.66 to 15.5 among those with fluoride varnish treatments. Less than four fluoride varnish treatments did not have a significant effect on caries rates.[25]

The evidence for the efficacy of fluoride varnish application by PCPs is strong enough that the U.S. Preventive Services Task Force now recommends application of fluoride varnish to the primary teeth of all infants and children starting at the age of primary tooth eruption.[11] This received a grade B recommendation, indicating that there is high certainty that the net benefit is moderate or there is moderate certainty that the net benefit is moderate to substantial.[26]

Importantly, parents report being satisfied with oral health care provided by PCPs. Approximately 92 percent of parents who remembered receiving oral health services reported that the provider explained things in a way they could understand, and 84 percent reported that the provider spent enough time with their child.[27] Furthermore, oral health services provided in the primary care setting do not result in decreased dental visits.[28]

Referral and case management. Inherent in any strategy that incorporates oral health screening, risk assessment, and triage by PCPs is the need to effectively refer high-risk children into the dental care system. The referral component is frequently unsuccessful, as those who are most in need of services are often the least likely to have been seen in the dental office.

Even with training, dental referral by PCPs may be challenging to achieve. Data from NC reveal that PCPs identify high-risk individuals but may not actually provide dental referrals.[29] In one survey, 78 percent of PCPs were likely to refer children for dental care if they were high risk or had signs of early decay. Those who felt confident conducting screenings and those who knew dentists who were willing to accept referrals were more likely to refer, and practices comprised mostly of infants and toddlers were less likely to refer. A different study showed that oral health knowledge and opinions alone do not affect whether or not a PCP made referrals for children with signs of dental disease.[30]

In Connecticut, USA, among practices that received oral health training, 77 percent said they referred children for an age one dental visit. More than half of the PCPs reported having difficulties making the referral,[31] despite Connecticut having one of the highest access rates among the country for children with Medicaid. In a study comparing independent, blinded oral screening results and referral recommendations made by PCPs, only 70 percent of children with evidence of untreated dental disease received a dental referral from their PCP.[8]

Case management is a strategy that can be employed to assist families with ECC children to overcome challenges to obtaining care and changing health behaviors. Internal family factors that can adversely affect oral health include parental belief systems and health practices, low levels of oral health literacy, inability to understand educational materials, financial barriers, perceived lack of time for home oral health care

Table 1. EXISTING POLICIES ON ORAL HEALTH SCREENING, RISK ASSESSMENT, AND ESTABLISHMENT OF A DENTAL HOME

American Academy of Pediatrics policy on risk assessment, timing, and establishment of the dental home[36] • Administer an oral health risk assessment periodically to all children. • Include anticipatory guidance for oral health as an integral part of comprehensive patient counseling. • Recommend that every child has a dental home by 1 year of age.
American Academy of Pediatric Dentistry policy on the dental home[68] • The AAPD encourages parents and other care providers to help every child establish a dental home by 12 months old.
Bright Futures[69] • The first oral examination should occur within six months of the eruption of the first primary tooth, and no later than age 12 months. Thereafter, the child or adolescent should be seen according to a schedule recommended by the dentist, based on the individual needs and susceptibility to disease.

measures, and dental anxiety. External factors affecting oral health access include availability of providers, transportation problems, lack of insurance, inadequate time off of work, and the complexity of navigating the health care system.[32] Case management is a collaborative process of assessment, planning, and facilitation to help the family meet their health care needs through communication and linking to appropriate resources.[32]

Case management, and more specifically care coordination, has been used extensively in the medical field. While the range of interventions is broad and the quality of studies variable, results do show improved patient outcomes for several diseases across a spectrum of clinical settings.[33] By contrast, the little research that has been done in the dental setting has involved small numbers of patients. In one study of 136 subjects with Medicaid insurance, dental utilization was 43 percent among those who had support finding a dentist and making and keeping the appointments, compared to 26 percent of those who received regular outreach from their Medicaid vendor.[34] In a significantly larger project, the Access to Baby and Child Dentistry (**ABCD**) program in Washington, USA, 37 percent of the 4,144 ABCD children had at least one visit to the dentist compared to only 12 percent of non-ABCD Medicaid-enrolled children.[35]

Policies. An important driver of health care practice and reimbursement are established policies that outline standards of care. There has been policy creation regarding early oral health screening, risk assessment, and establishment of a dental home. The 2014 American Academy of Pediatrics (**AAP**) policy[36] outlines the need for early screening and risk assessment and recommends establishment of a dental home by 12 months old (Table 1). However, the lack of evidence for this recommendation is articulated and, while the potential benefits are highlighted, there remains significant room for individual interpretation on how closely to follow this recommendation.[36] The current periodicity schedule endorsed by the AAP and Bright Futures also recommends oral health screening and risk assessments starting at age six months but also qualifies that establishment of a dental home is contingent upon risk and availability of a dentist to provide a dental home.[37]

A separate Bright Futures policy varies from its endorsement position of the AAP periodicity schedule by indicating that the dental home should be established no later than 12 months old, with no qualifiers based on risk or provider availability (Table 1). Despite the importance of guidelines, their effectiveness relies on providers to be information seekers and willing to change behavior as well as infrastructure to support the change. Guidelines are necessary, but not sufficient, for performance improvement.[38] Barriers to guideline adoption include lack of awareness, agreement with guidelines, anticipation of good outcomes, and ability to change practice inertia.[39]

State Medicaid programs also help drive practice standards. Utilizing information from the American Academy of Pediatric Dentistry (**AAPD**) Pediatric Oral Health Research and Policy Center,[40] and a brief web search to locate individual state Early and Periodic Screening, Diagnostic, and Treatment periodicity schedules reveals that states have adopted three strategies defining when dental care should occur: states (1) follow the AAPD periodicity schedule; (2) develop their own unique periodicity schedule; or (3) have no published periodicity schedule and simply delineate when the first dental visit should occur. The majority of state Medicaid programs support the concept of the first dental visit by 12 months old (Table 2).

This data should be examined with consideration for the negative implications of certain policy approaches. A study that modeled the effects of referring all children for an age one dental visit versus referring only those at risk of caries found that, under most plausible scenarios, the referral of all children, regardless of risk, will increase the burden of disease in high caries-risk populations, such as children on Medicaid.[41] This is perhaps unsurprising, given that only half of general dentists are willing to care for infants and toddlers.[42-46]

Reimbursement and policies to support reimbursement is another important change driver in health care. PCP reimbursement for fluoride varnish application and oral health assessment has dramatically shifted over the last decade, such that now only four states do not reimburse for fluoride varnish in the primary care setting. Reimbursement for fluoride varnish and oral health risk assessment services varies from $4 to $85. Currently, two states reimburse less than $10, 28 states reimburse $10 to $30, and 15 states reimburse greater than $30 for said primary care services.[47]

Studies on the effect of reimbursement and PCP participation in fluoride varnish application are few. In Wisconsin, a review of Medicaid encounter data showed that fluoride varnish reimbursement claims for one- to three-year-olds increased from 557 at baseline to 9,053 over the two-year period after reimbursement for fluoride varnish was introduced.[48] Of note, PCPs provided the vast majority of fluoride varnish treatments for one- to two-year-olds, with dentists providing the minority.[49] Washington reported similar findings following introduction of reimbursement, an increase from 145 applications in 2000 to 9,098 in 2007. Authors noted the importance of provider training and increasing access to dental care in achieving this success.[50]

Cost effectiveness. The question remains as to whether oral health preventive services in the primary care setting versus early dental referral for those at risk is most cost-effective.

Table 2. RECOMMENDED AGE OF FIRST DENTAL VISIT BASED ON PERIODICITY RECOMMENDATIONS OR STATE MEDICAID PROGRAM RECOMMENDATIONS

Category	Recommended age of first dental visit based on periodicity schedule or state Medicaid recommendations	No. of states
AAPD dental periodicity schedule	By 12 mos old	25
State-specific dental periodicity schedule	By 12 mos old	8
	By 12-18 mos old	1
	6-24 mos for those at risk; age 3 ys otherwise	1
	≤3 ys	1
	3 ys	1
No dental periodicity schedule available (state Medicaid program defines age of first dental visit)	By 12 mos old	5
	3 ys	4
	2 ys	2
	Unknown/information not available	2

Data, based on modeling, on cost effectiveness of fluoride varnish applied by PCPs is ambiguous. Early modeling by Quinonez et al.[51] purported that fluoride varnish applications in the North Carolina IMB program reduced ECC but showed no cost savings in the first 42 months of life. More recent analysis has compared the dental care outcomes of children with four or more IMB visits to those with no visits. Results showed that four IMB visits resulted in less dental restorative care both in dental offices and in the hospital under general anesthesia. Interestingly, if the Medicaid program is prepared to invest $2,331 into the IMB program for each hospital visit averted, or reduce program payments from $55 to $34, the program would be cost effective with certainty.[52] Using Indiana data, another study found that restorative service utilization for children 36 months and older are high enough that fluoride varnish regularly applied by PCPs from nine months through 36 months would save Medicaid funds over a three-year horizon.[53]

Information on the cost-effectiveness of early dental visits, as opposed to fluoride varnish application in medical offices, suggests savings may be limited and based on caries risk. Early reports from North Carolina suggested that early dental visits resulted in reduced restorative costs,[54,55] but a more recent study did not reveal savings or differences in treatment rates at 42 and 72 months old for children with an earlier visit. However, selective savings were evident for a subgroup of children who had both prevention visits and two or more restorative services.[56] Lower dmft scores in kindergarten were not seen among North Carolina children who attended the dentist by 24 months.[57] This unexpected finding was attributed to the possibility that early dental care is still likely driven by perceived need, as defined by the presence of dental decay. Data from Alabama suggest early dental visits do not reduce overall dental or medical expenditures, but those with earlier dental visits may be healthier.[58]

Barriers to establishing oral health prevention services in the medical setting. While oral health screening, risk assessment, and prevention in medical settings can improve outcomes in some studies, implementing these changes broadly has proven challenging. A surveys of pediatricians in 2012 (N equals 402) and 2008 (N equals 698) revealed that 76 percent of pediatricians now had oral health training compared to only 36 percent in 2008, with training usually during or following residency. In both surveys, approximately 90 percent of respondents felt that they should screen for caries but they performed screenings only about half of the time. Philosophy around fluoride varnish application changed between the two surveys. A total of 41 percent of pediatricians in 2012 thought that fluoride varnish should be applied in the medical office compared to only 19 percent in 2008. However, the percentage of pediatricians regularly applying varnish increased from only three to seven percent and the percentage of those reporting feeling comfortable providing these services increased from eight percent to 19 percent.[59]

In Connecticut, only 28 percent of practices that received one hour standard training regarding office oral health service integration routinely applied fluoride varnish.[31] In North Carolina, three different practice interventions were compared: (1) didactic training; (2) didactic training with weekly support conference calls; and (3) didactic training, conference calls, and in-office hands-on advice and support. Overall, 43 percent of offices provided 20 or more fluoride varnishes during the first year, but there was no statistically significant difference among the three training groups.[60]

More intensive interventions, such as practice tailored facilitation with rapid cycle change, may be more likely to effect change than mandates or education alone. This strategy combines practice coaching of plan-do-study-act cycles that enable practices to rapidly try, evaluate, and implement new approaches to help adopt new behaviors. Study utilizing tailored facilitation to introduce fluoride varnish application found that, among those practices in a standard education program, only 4.4 percent of eligible children received fluoride varnish application four months following program initiation compared to 89 percent of children in practices receiving tailored facilitation.[61]

PCPs report a number of barriers to implementing oral health interventions in their practices. Commonly reported barriers include: applying fluoride varnish; integrating procedures into the office routine; support-staff resistance; problems with dental referral; uncertainty about how to order varnish; and not enough time.[62,63]

Encouragingly, in one study, 46 percent of those with a moderate to high number of perceived barriers were able to fully implement a fluoride varnish program.[62] Factors related to success included the presence of clinical providers actively engaged in public health, communication that included all office staff members in planning the provision of oral health services, and careful consideration of methods to overcome the practical logistics of identifying patients and applying the fluoride varnish.[64] The most commonly cited promoters of success were the presence of a fluoride varnish office champion and a reminder system in patient records.[63] Change champions have been examined in other contexts, and success is most consistent if there are change champions specific to the project (in this case, fluoride varnish) and champions focused on creating change within the entire organization.[65]

In Connecticut, only eight percent reported reimbursement as a barrier, possibly because Connecticut physicians are reimbursed well for this service at $45 per oral health assessment and fluoride varnish application. This finding is in contrast to a survey in Massachusetts, where 60 percent reported the reimbursement rate of $26 as too low.[63]

Discussion

ECC, despite a variety of available preventive and treatment strategies, remains a serious and prevalent childhood disease, especially among the most socially disadvantaged. This paper specifically focused on evidence for the effectiveness of the provision of oral health preventive services and the facilitators and barriers to providing these services in medical setting. The narrow focus does not include examination of issues regarding professional oral health education or the role of interprofessional learning to promote integration of oral health into overall health care. Furthermore, literature for the effectiveness of the integration of oral health into the primary care setting originates in a small number of states, and the limited data generated may not be generalizable. Despite the limitations of this review, the data provides a strong framework for decision-making.

Much focus has been placed upon establishing dental visits at a young age, yet the evidence suggests this may be a far from feasible strategy. Few general dentists appear comfortable and willing to see and treat young children, and the cost effectiveness of this strategy has not been proven. There is indication that

this strategy may actually be more costly than other models that incorporate a variety of providers in prevention, such as community health care workers and PCPs.[67] Furthermore, families at greatest risk of having children with ECC may have insurance, financial, and motivational barriers to attending additional health appointments and may lack awareness of the importance of doing so. These facts beckon the need for a new paradigm to tackle the problem of ECC.

Incorporating oral health into the medical home through the work of PCPs is a viable strategy based on existing evidence. PCPs have strong skill sets in many of the required areas, including: regular patient interactions at routine health care and other visits; familiarity with the concept and implementation of risk-based care; expertise in education and counseling; and engagement in the overall health of their child patients, not just one facet of their care.

PCPs are trained in prevention. Shifting ECC prevention into the medical home allows PCPs to perform primary prevention, and reserves the specialists, in this case dentists, to care for those at high risk or those with established disease. This is the model for every other medical condition; therefore, it is reasonable that this should work for dental disease.

Importantly, fluoride varnish application in the medical setting has been proven successful in reducing ECC prevalence and intensity, especially if frequent applications are undertaken early. The U.S. Preventive Services Task Force felt that evidence for the effectiveness of fluoride varnish was strong enough to recommend its application for all children starting at tooth eruption, not based on risk.[66] The rationale discussed in the paper for extending this service to all children, not just those deemed high risk, includes that the prevalence of risk factors is high in the U.S. population, the number needed to treat is low, and the potential harms of the intervention are small.[66] In addition, our current lack of validated risk-assessment makes determination of service based on risk-assessment challenging in the primary care setting.

While fluoride varnish is efficacious, integrating oral health services into primary medical care has significant challenges to surmount. In particular, the most promising method used to implement oral health services into primary care is relatively costly, involving office-tailored facilitation with rapid-cycle change.

While these issues need to be addressed, the greatest challenge we face in addressing the issue of ECC may be our insistence on treating oral health as separate from overall health. The profession discusses integrating approaches and incorporating oral health into primary care medical offices but develops interventions to engage PCPs that only discuss oral health. If we want to increase our success, we may need to holistically examine how PCPs and patients view health. We need to consider interventions that help PCPs address issues common to many chronic diseases. For example, diet change is important for weight, diabetes, and oral health. Compliance with health recommendations is important for many issues, including medication usage, toothbrushing, and exercise. We need to consider conversations that unite management, rather than focusing on interventions that fail to cross-pollinate among chronic disease management and concomitant social and behavioral issues. At present, such approaches to health promotion are limited and typically confined to addressing one or two related diseases. Additional research will be required to determine the feasibility and success of such strategies.

As the patient-centered medical home concept is universally adopted, this will involve increased utilization of case managers, community health workers, and others who coordinate chronic disease care. The goal of such integrated approaches to disease management is improved quality of care at lower cost. At present, as the cost effectiveness of oral health prevention is examined through the lens of this one disease, it's possible to miss the opportunity of capitalizing on the potential synergy of addressing multiple conditions simultaneously. Integrating oral health care into other chronic disease management strategies increases the likelihood that this will be a successful long-term strategy in the primary care medical setting.

By contrast, solely promoting establishment of the dental home by the age of one continues to isolate oral health from the overall health continuum and does not utilize the systems of care already inherent in the primary care setting. One comparative analysis of strategies to integrate medical and oral health care suggests that the most cost efficient way to significantly impact ECC is to employ the use of community health care workers and other helping professionals to provide ongoing risk assessment and counseling as part of an integrated approach to ECC management.[67] To achieve such change, insurance programs would have to directly support the work of health professionals or change reimbursement strategies to include a focus on counseling and encourage a movement away from restorative treatment. Such strategies would require medical and dental insurers to work cooperatively to realize savings.

Conclusions

Based on this study's results, the following conclusions can be made:

1. Singularly focusing on establishing a dental home by age is neither feasible nor well supported by the evidence.
2. Oral health preventive services can be successfully incorporated into primary care settings.
3. Barriers exist to the implementation of oral health services in the primary care setting. There is evidence to support strategies to overcome these barriers.
4. Oral health risk assessment seems to be an important component of care, but models used in the primary care setting need to be validated.
5. Oral health counseling utilizing motivational interviewing shows success in changing selected oral health behaviors when used by non-dentists.
6. Fluoride varnish applied in the primary medical care setting decreases caries experience, especially if applied frequently and close to tooth eruption.
7. Dental referral and case management for young children identified as high-risk is important but often not very successful.
8. Policies are an important driver of health care practice and reimbursement; however, evidence suggests that current policy directions are not reinforcing the most effective interventions.
9. Cost savings with existing models are not readily apparent. New approaches may be required to implement effective prevention strategies, including utilizing support professionals, integrated disease management, and innovative insurance structuring.

10. Reform focused on implementation of chronic disease management within the medical home suggests that primary ECC prevention should be integrated into the primary care setting.

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References

1. Bouchery E. Utilization of dental services among Medicaid-enrolled children. Medicare Medicaid Res Re.003.03.b04.
2. Dye BA, Arevalo O, Vargas CM. Trends in paediatric dental caries by poverty status in the United States, 1988-1994 and 1999-2004. Int J Paediatr Dent 2010;20:132-43.
3. Brickhouse TH, Unkel JH, Kancitis I, Best AM, Davis RD. Infant oral health care: a survey of general dentists, pediatric dentists, and pediatricians in Virginia. Pediatr Dent 2008;30:147-53.
4. Garg S, Rubin T, Jasek J, Weinstein J, Helburn L, Kaye K. How willing are dentists to treat young children? A survey of dentists affiliated with Medicaid managed care in New York City, 2010. J Am Dent Assoc 2013;144:416-25.
5. Borchgrevink A, Snyder A, Gehshan S. The Effects of Medicaid Reimbursement Rates on Access to Dental Care. Washington, D.C., USA: National Academy for State Health Policy; 2008. Available at: "http://nashp.org/sites/default/files/CHCF_dental_rates.pdf?q=Files/CHCF_dental_rates.pdf". Accessed April 16, 2015.
6. American Academy of Pediatrics. Committee on Practice and Ambulatory Medicine Pediatrics. Recommendations for preventive pediatric health care. Pediatrics 2000;105:645-6.
7. Hoeft KS, Barker JC, Masterson EE. Maternal beliefs and motivations for first dental visit by low-income Mexican American children in California. Pediatr Dent 2011;33:392-8.
8. Pierce KM, Rozier RG, Vann WF Jr. Accuracy of pediatric primary care providers' screening and referral for early childhood caries. Pediatrics 2002;109(5):e82-e2.
9. Serwint JR, Mungo R, Negrete VF, et al. Child-rearing practices and nursing caries. Pediatrics 1993;92:233-7.
10. Brightening Oral Health Workgroup and Quality Improvement Innovation Networks, American Academy of Pediatrics. Brightening Oral Health: Teaching and Implementing Oral Health Risk Assessments in Pediatric Care Project. (Unpublished data.) Elk Grove Village, Ill., USA: Brightening Oral Health Workgroup and Quality Improvement Innovation Networks, AAP; 2009.
11. Chou R, Cantor A, Zakher B, Mitchell JP, Pappas M. Prevention of Dental Caries in Children Younger Than 5 Years Old. Systematic Review to Update the U.S. Preventive Services Task Force Recommendation. Evidence Syntheses, No. 104. Rockville, Md., USA: Pacific Northwest Evidence-based Practice Center, Agency for Healthcare Research and Quality (US); 2014.
12. Yoon RK, Smaldone AM, Edelstein BL. Early childhood caries screening tools: a comparison of four approaches. J Am Dent Assoc 2012;143:756-63.
13. Kay EJ, Locker D. Is dental health education effective? A systematic review of current evidence. Community Dent Oral Epidemiol 1996;24:231-5.
14. Edelstein BL. Training new dental health providers in the US. Battle Creek, Mich., USA: W.K. Kellogg Found; 2000.
15. Yevlahova D, Satur J. Models for individual oral health promotion and their effectiveness: a systematic review. Aust Dent J 2009;54:190-7.
16. Ismail AI, Ondersma S, Jedele JM, Little RJ, Lepkowski JM. Evaluation of a brief tailored motivational intervention to prevent early childhood caries. Community Dent Oral Epidemiol 2011;39:433-48.
17. Harrison RLL, Veronneau J, Leroux B. Effectiveness of maternal counseling in reducing caries in Cree children. J Dent Res 2012;91:1032-7.
18. Wagner YL, Greiner S, Heinrich-Weltzien R. Evaluation of an oral health promotion program at the time of birth on dental caries in 5-year-old children in Vorarlberg, Austria. Community Dent Oral Epidemiol 2014;42:160-9.
19. Weinstein P, Harrison R, Benton T. Motivating mothers to prevent caries: confirming the beneficial effect of counseling. J Am Dent Assoc 2006;137:789-93.
20. Harrison R, Benton T, Everson-Stewart S, Weinstein P. Effect of motivational interviewing on rates of early childhood caries: a randomized trial. Pediatr Dent 2007;29:16-22.
21. Kressin NRL, Nunn ME, Singh H, et al. Pediatric clinicians can help reduce rates of early childhood caries: effects of a practice based intervention. Med Care 2009;47:1121-8.
22. Pahel BT, Rozier RG, Stearns SC, Quiñonez RB. Effectiveness of preventive dental treatments by physicians for young Medicaid enrollees. Pediatrics 2011;127:e682-e689.
23. Achembong LN, KranzAM, Rozier RG. Office-based preventive dental program and statewide trends in dental caries. Pediatrics 2014;133:e827-e834.
24. Kranz AM, Rozier RG, Preisser JS, Stearns SC, Weinberger M, Lee JY. Comparing medical and dental providers of oral health services on early dental caries experience. Am J Public Health 2014;104:e92-e99.
25. Holve S. An observational study of the association of fluoride varnish applied during well child visits and the prevention of early childhood caries in American Indian children. Matern Child Health J 2008;12:64-7.
26. U.S. Preventive Services Task Force. Grades definition. Available at: "http://www.uspreventiveservicestaskforce.org/uspstf/grades.htm#brec". Accessed April 23, 2015.
27. Rozier RG, Slade GD, Zeldin LP, Wang H. Parents' satisfaction with preventive dental care for young children provided by nondental primary care providers. Pediatr Dent 2005;27:313-22.
28. Cantrel C. The role of physicians in children's oral health. State Health Policy Monitor, National Academy of State Health Policy. December 2008. Available at: "http://nashp.org/sites/default/files/Fluoride%20Varnish%20Monitor.pdf?q=files/Fluoride%20Varnish%20Monitor.pdf". Accessed April 23, 2015.
29. Long CM, Quinonez RB, Beil HA, et al. Pediatricians' assessments of caries risk and need for a dental evaluation in preschool aged children. BMC Pediatr 2012;12:49.

30. de la Cruz GG, Rozier RG, Slade G. Dental screening and referral of young children by pediatric primary care providers. Pediatrics 2004;114:e642-e652.
31. O'Callaghan AM, Douglass JM. The experience of medical clinicians implementing fluoride varnish in Connecticut. Pediatr Dent 2013;35:435-9.
32. Silverman J, Douglass JM, Graham L. The use of case management to improve dental health in high risk populations. AAPD Pediatric Oral Health Research and Policy Center. June 2013. Available at: "http://www.aapd.org/assets/1/7/POHRPC-TR3-2013-Final.1.pdf". Accessed April 23, 2015.
33. AHRQ. Closing the quality gap: a critical analysis of quality improvement strategies. Publication no. 04(07)-0051-7, volume 7. Care Coordination, June 2007. Available at: "http://www.ahrq.gov/research/findings/evidence-based-reports/caregap.pdf". Accessed April 23, 2015.
34. Binkley CJ, Garrett B, Johnson KW. Increasing dental care utilization by Medicaid-eligible children: a dental care coordinator intervention. J Public Health Dent 2010;70:76-84.
35. Milgrom P, Hujoel P, Grembowski D, Fong R. A community strategy for Medicaid child dental services. Public Health Reports 1999;11:528-32.
36. American Academy of Pediatrics, Section on Oral Health. Maintaining and improving the oral health of young children. Pediatrics 2014;134:1224-9.
37. Bright Futures, AAP. Recommendations for preventive pediatric health care. Available at: "http://www.aap.org/en-us/professional-resources/practice-support/Periodicity/Periodicity%20Schedule_FINAL.pdf". Accessed April 23, 2015.
38. Smith WR. Evidence for the effectiveness of techniques to change physician behavior. Chest 2000;118:8S-17S.
39. Cabana MD, Rand CS, Powe NR, et al. Why don't physicians follow clinical practice guidelines? A framework for improvement. JAMA 1999;282:1458-65.
40. American Academy of Pediatric Dentistry. State dental periodicity schedules. Available at: "http://www.aapd.org/advocacy/state_periodicity_schedules/". Accessed April 23, 2015.
41. Jones K, Tomar SL. Estimated impact of competing policy recommendations for age of first dental visit. Pediatrics 2005;115:906-14.
42. Santos CL, Douglass JM. Practices and opinions of pediatric and general dentists in Connecticut regarding the age 1 dental visit and dental care for children younger than 3 years old. Pediatr Dent 2008;30:348-51.
43. Garg S, Rubin T, Jasek J, Weinstein J, Helburn L, Kaye K. How willing are dentists to treat young children? A survey of dentists affiliated with Medicaid managed care in New York City, 2010. J Am Dent Assoc 2013;144:416-25.
44. Ananaba N, Malcheff S, Briskie D, Inglehart MR. Infant oral health examinations: attitudes and professional behavior of general and pediatric dentists in Michigan and pediatric dentists in the U.S. J Mich Dent Assoc 2010;92:38-43.
45. Brickhouse TH, Unkel JH, Kancitis I, Best AM, Davis RD. Infant oral health care: a survey of general dentists, pediatric dentists, and pediatricians in Virginia. Pediatr Dent 2008;30:147-53.
46. Seale NS, Casamassimo PS. Access to dental care for children in the United States: a survey of general practitioners. J Am Dent Assoc 2003;134:1630-40.
47. AAP. State Medicaid payment for caries prevention services by non-dental professionals. Available at: "http://www2.aap.org/oralhealth/docs/OHReimbursementChart.pdf". Accessed April 23, 2015.
48. Okunseri C, Szabo A, Garcia RI, Jackson S, Pajewski NM. Provision of fluoride varnish treatment by medical and dental care providers: variation by race/ethnicity and levels of urban influence. J Public Health Dent 2010;70:211-9.
49. Okunseri C, Szabo A, Jackson S, Pajewski NM, Garcia RI. Increased children's access to fluoride varnish treatment by involving medical care providers: effect of a Medicaid policy change. Health Serv Res 2009;44:1144-56.
50. Riter D, Maier R, Grossman DC. Delivering preventive oral health services in pediatric primary care: a case study. Health Aff (Millwood) 2008;27:1728-32.
51. Quiñonez RB, Stearns SC, Talekar BS, Rozier RG, Downs SM. Simulating cost-effectiveness of fluoride varnish during well-child visits for Medicaid-enrolled children. Arch Pediatr Adolesc Med 2006;160:164-70.
52. Stearns SC, Rozier RG, Kranz AM, Pahel BT, Quiñonez RB. Cost-effectiveness of preventive oral health care in medical offices for young Medicaid enrollees. Arch Pediatr Adolesc Med 2012;166:945-51.
53. Hendrix KS, Downs SM, Brophy G, Carney Doebbeling C, Swigonski NL. Threshold analysis of reimbursing physicians for the application of fluoride varnish in young children. J Public Health Dent 2013;73:297-303.
54. Savage MF, Lee JY, Kotch JB, Vann WF. Early preventive dental visits: effects on subsequent utilization and costs. Pediatrics 2004;114:e418-e423.
55. Lee JY, Bouwens TJ, Savage MF, Vann WF. Examining the cost-effectiveness of early dental visits. Pediatr Dent 2006;28:102-5.
56. Beil H, Rozier RG, Preisser JS, et al. Effect of early preventive dental visits on subsequent dental treatment and expenditures. Med Care 2012;50:749-56.
57. Beil H, Rozier RG, Preisser JS, Stearns SC, Lee JY. Effects of early dental office visits on dental caries experience. Am J Public Health 2013. Epub ahead of print.
58. Sen B, Blackburn J, Morrisey MA, et al. Effectiveness of preventive dental visits in reducing nonpreventive dental visits and expenditures. Pediatrics 2013;131:1107-13.
59. Quinonez RB, Kranz AM, Lewis CW, et al. Oral health opinions and practices of pediatricians: updated results from a national survey. Acad Pediatr 2014;14:616-23.
60. Slade GD, Rozier RG, Zeldin LP, Margolis PA. Training pediatric health care providers in prevention of dental decay: results from a randomized controlled trial. BMC Health Serv Res 2007;7:176.
61. Meropol SB, Schiltz NK, Sattar A, et al. Practice-tailored facilitation to improve pediatric preventive care delivery: a randomized trial. Pediatrics 2014;133:e1664-e1675.
62. Close K, Rozier RG, Zeldin LP, Gilbert AR. Barriers to the adoption and implementation of preventive dental services in primary medical care. Pediatrics 2010;125:509-17.

63. Isong IA, Silk H, Rao SR, Perrin JM, Savageau JA, Donelan K. Provision of fluoride varnish to Medicaid-enrolled children by physicians: the Massachusetts experience. Health Serv Res 2011;46:1843-62.
64. Lewis C, Lynch H, Richardson L. Fluoride varnish use in primary care: what do providers think? Pediatrics 2005;115:e69-e76.
65. Shaw EK, Howard J, West DR, et al. The role of the champion in primary care change efforts: from the State Networks of Colorado Ambulatory Practices and Partners (SNOCAP). J Am Board Fam Med 2012;25:676-85.
66. Moyer VA. Prevention of dental caries in children from birth through age 5 years: US Preventive Services Task Force Recommendation Statement. Pediatrics 2014;133: 1-10.
67. Edelstein BL, Rubin M. Improving Children's Oral Health by Crossing the Medical Dental Divide. Connecticut Health Foundation. December 2014. Available at: "http://www.cthealth.org/wp-content/uploads/2015/02/Crossing-the-Medical-Dental-Divide-Final.pdf". Accessed April 16, 2015.
68. AAPD. Policy on the dental home. Reference Manual 2014-2015. Pediatr Dent 2014;36:24-5. Available at: "http://www.aapd.org/media/Policies_Guidelines/P_Dental-Home.pdf". Accessed April 23, 2015.
69. Casamassimo P, Holt K, eds. Bright Futures in Practice: Oral Health—Pocket Guide. Washington, D.C., USA: National Maternal and Child Oral Health Resource Center; 2004.

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Water fluoridation for the prevention of dental caries (Review)

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[Intervention Review]

Water fluoridation for the prevention of dental caries

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ABSTRACT

Background

Dental caries is a major public health problem in most industrialised countries, affecting 60% to 90% of school children. Community water fluoridation was initiated in the USA in 1945 and is currently practised in about 25 countries around the world; health authorities consider it to be a key strategy for preventing dental caries. Given the continued interest in this topic from health professionals, policy makers and the public, it is important to update and maintain a systematic review that reflects contemporary evidence.

Objectives

To evaluate the effects of water fluoridation (artificial or natural) on the prevention of dental caries.

To evaluate the effects of water fluoridation (artificial or natural) on dental fluorosis.

Search methods

We searched the following electronic databases: The Cochrane Oral Health Group's Trials Register (to 19 February 2015); The Cochrane Central Register of Controlled Trials (CENTRAL; Issue 1, 2015); MEDLINE via OVID (1946 to 19 February 2015); EMBASE via OVID (1980 to 19 February 2015); Proquest (to 19 February 2015); Web of Science Conference Proceedings (1990 to 19 February 2015); ZETOC Conference Proceedings (1993 to 19 February 2015). We searched the US National Institutes of Health Trials Registry (ClinicalTrials.gov) and the World Health Organization's WHO International Clinical Trials Registry Platform for ongoing trials. There were no restrictions on language of publication or publication status in the searches of the electronic databases.

Selection criteria

For caries data, we included only prospective studies with a concurrent control that compared at least two populations - one receiving fluoridated water and the other non-fluoridated water - with outcome(s) evaluated at at least two points in time. For the assessment of fluorosis, we included any type of study design, with concurrent control, that compared populations exposed to different water fluoride concentrations. We included populations of all ages that received fluoridated water (naturally or artificially fluoridated) or non-fluoridated water.

Data collection and analysis

We used an adaptation of the Cochrane 'Risk of bias' tool to assess risk of bias in the included studies.

We included the following caries indices in the analyses: decayed, missing and filled teeth (dmft (deciduous dentition) and DMFT (permanent dentition)), and proportion caries free in both dentitions. For dmft and DMFT analyses we calculated the difference in mean change scores between the fluoridated and control groups. For the proportion caries free we calculated the difference in the proportion caries free between the fluoridated and control groups.

For fluorosis data we calculated the log odds and presented them as probabilities for interpretation.

Main results

A total of 155 studies met the inclusion criteria; 107 studies provided sufficient data for quantitative synthesis.

The results from the caries severity data indicate that the initiation of water fluoridation results in reductions in dmft of 1.81 (95% CI 1.31 to 2.31; 9 studies at high risk of bias, 44,268 participants) and in DMFT of 1.16 (95% CI 0.72 to 1.61; 10 studies at high risk of bias, 78,764 participants). This translates to a 35% reduction in dmft and a 26% reduction in DMFT compared to the median control group mean values. There were also increases in the percentage of caries free children of 15% (95% CI 11% to 19%; 10 studies, 39,966 participants) in deciduous dentition and 14% (95% CI 5% to 23%; 8 studies, 53,538 participants) in permanent dentition. The majority of studies (71%) were conducted prior to 1975 and the widespread introduction of the use of fluoride toothpaste.

There is insufficient information to determine whether initiation of a water fluoridation programme results in a change in disparities in caries across socioeconomic status (SES) levels.

There is insufficient information to determine the effect of stopping water fluoridation programmes on caries levels.

No studies that aimed to determine the effectiveness of water fluoridation for preventing caries in adults met the review's inclusion criteria.

With regard to dental fluorosis, we estimated that for a fluoride level of 0.7 ppm the percentage of participants with fluorosis of aesthetic concern was approximately 12% (95% CI 8% to 17%; 40 studies, 59,630 participants). This increases to 40% (95% CI 35% to 44%) when considering fluorosis of any level (detected under highly controlled, clinical conditions; 90 studies, 180,530 participants). Over 97% of the studies were at high risk of bias and there was substantial between-study variation.

Authors' conclusions

There is very little contemporary evidence, meeting the review's inclusion criteria, that has evaluated the effectiveness of water fluoridation for the prevention of caries.

The available data come predominantly from studies conducted prior to 1975, and indicate that water fluoridation is effective at reducing caries levels in both deciduous and permanent dentition in children. Our confidence in the size of the effect estimates is limited by the observational nature of the study designs, the high risk of bias within the studies and, importantly, the applicability of the evidence to current lifestyles. The decision to implement a water fluoridation programme relies upon an understanding of the population's oral health behaviour (e.g. use of fluoride toothpaste), the availability and uptake of other caries prevention strategies, their diet and consumption of tap water and the movement/migration of the population. There is insufficient evidence to determine whether water fluoridation results in a change in disparities in caries levels across SES. We did not identify any evidence, meeting the review's inclusion criteria, to determine the effectiveness of water fluoridation for preventing caries in adults.

There is insufficient information to determine the effect on caries levels of stopping water fluoridation programmes.

There is a significant association between dental fluorosis (of aesthetic concern or all levels of dental fluorosis) and fluoride level. The evidence is limited due to high risk of bias within the studies and substantial between-study variation.

PLAIN LANGUAGE SUMMARY

Water fluoridation to prevent tooth decay

Background

Tooth decay is a worldwide problem affecting most adults and children. Untreated decay may cause pain and lead to teeth having to be removed. In many parts of the world, tooth decay is decreasing. Children from poorer backgrounds still tend to have greater levels of decay. Fluoride is a mineral that prevents tooth decay. It occurs naturally in water at varying levels. Fluoride can also be added to the water with the aim of preventing tooth decay. Fluoride is present in most toothpastes and available in mouthrinses, varnishes and gels. If young children swallow too much fluoride while their permanent teeth are forming, there is a risk of marks developing on those teeth. This is called 'dental fluorosis'. Most fluorosis is very mild, with faint white lines or streaks visible only to dentists under good lighting in the clinic. More noticeable fluorosis, which is less common, may cause people concern about how their teeth look.

Review question

We carried out this review to evaluate the effects of fluoride in water (added fluoride or naturally occurring) on the prevention of tooth decay and markings on teeth (dental fluorosis).

Study characteristics

We reviewed 20 studies on the effects of fluoridated water on tooth decay and 135 studies on dental fluorosis. The evidence is up to date at 19 February 2015.

Nineteen studies assessed the effects of starting a water fluoridation scheme. They compared tooth decay in two communities around the time fluoridation started in one of them. After several years, a second survey was done to see what difference it made. Around 70% of these studies were conducted before 1975. Other, more recent studies comparing fluoridated and non-fluoridated communities have been conducted. We excluded them from our review because they did not carry out initial surveys of tooth decay levels around the time fluoridation started so were unable to evaluate changes in those levels since then. We reviewed one study that compared tooth decay in two fluoridated areas before fluoridation was stopped in one area. Again, after several years, a second survey was done to see what difference it made.

Around 73% of dental fluorosis studies were conducted in places with naturally occurring - not added - fluoride in their water. Some had levels of up to 5 parts per million (ppm).

Key results

Our review found that water fluoridation is effective at reducing levels of tooth decay among children. The introduction of water fluoridation resulted in children having 35% fewer decayed, missing and filled baby teeth and 26% fewer decayed, missing and filled permanent teeth. We also found that fluoridation led to a 15% increase in children with no decay in their baby teeth and a 14% increase in children with no decay in their permanent teeth. These results are based predominantly on old studies and may not be applicable today.

Within the 'before and after' studies we were looking for, we did not find any on the benefits of fluoridated water for adults.

We found insufficient information about the effects of stopping water fluoridation.

We found insufficient information to determine whether fluoridation reduces differences in tooth decay levels between children from poorer and more affluent backgrounds.

Overall, the results of the studies reviewed suggest that, where the fluoride level in water is 0.7 ppm, there is a chance of around 12% of people having dental fluorosis that may cause concern about how their teeth look.

Quality of the evidence

We assessed each study for the quality of the methods used and how thoroughly the results were reported. We had concerns about the methods used, or the reporting of the results, in the vast majority (97%) of the studies. For example, many did not take full account of all the factors that could affect children's risk of tooth decay or dental fluorosis. There was also substantial variation between the results of the studies, many of which took place before the introduction of fluoride toothpaste. This makes it difficult to be confident of the size of the effects of water fluoridation on tooth decay or the numbers of people likely to have dental fluorosis at different levels of fluoride in the water.

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Community Dentistry and Oral Epidemiology

Oral health promotion interventions during pregnancy: a systematic review

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Abstract – *Objectives:* Maternal oral disease during pregnancy is a significant public health issue due to its prevalence and lifecourse connections with adverse pregnancy/birth outcomes, early childhood caries, and chronic diseases. Although both medical and dental professional organizations have discipline-specific and co-endorsed guidelines, whether interventions exist that translate oral health evidence into practice remains unknown. Thus, we conducted a systematic review to examine the range, scope and impact of existing oral health promotion interventions during pregnancy. *Methods:* Search terms related to oral health, health promotion, and pregnancy produced 7754 articles published before March 2013 from five search engines. Inclusion criteria: (i) intervention-based; (ii) quasi-experimental, experimental, or pretest/post-test design; (iii) pregnant women participants; (iv) outcomes including oral health knowledge, attitudes, and/or behaviors; (v) ≥5 participants; (vi) peer-review publication; and (vii) English language. *Results:* All interventions (n = 7) were delivered in prenatal care settings and focused on education. Modalities varied, including the use of oral instruction and audiovisual presentations, in both individual and group formats; however, content was directed toward infant oral health. Few studies specifically addressed prenatal oral health guidelines. Primary outcomes measured included knowledge, beliefs, attitudes, self-efficacy and oral hygiene, and health-seeking behaviors. All but one study showed significant improvement in one of these outcomes postintervention. *Conclusions:* Few oral health interventions among pregnant women addressed oral-related symptoms, hygiene behaviors, and potential oral–systemic implications specific to mothers. Subsequently, more theory- and evidence-based interventions addressing current prenatal oral health guidelines using rigorous designs are needed to improve oral and systemic health for both women and their offspring.

Key words: behavioral science; dental health promotion; health promotion; prevention; public health

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Oral health is a critical component of overall health and well-being (1, 2); yet, oral disease remains a silent epidemic (1) in part due to missed prevention opportunities (3). Research demonstrates an association between oral and systemic diseases such as, cardiovascular disease, Alzheimer's disease, respiratory infection, and diabetes (4–10). Pregnancy represents a unique and sensitive period during the oral health lifecourse (2), and due to changes in hormonal levels, pregnant women are more susceptible to oral diseases such as periodontal disease (11, 12). Periodontal diseases are divided into two main conditions: (i) gingivitis and (ii) periodontitis. Gingivitis is defined as the inflammatory process of the soft tissue surrounding the tooth. If left untreated, gingivitis can lead to

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periodontitis, which is characterized by inflammation around the tooth that destroys supporting structures (13).

Approximately 40% of pregnant women demonstrate clinical evidence of periodontal disease (14). Several studies have shown a positive relationship between periodontal disease and adverse pregnancy outcomes, including low birthweight, preterm birth, preeclampsia, and miscarriages (15–17). Moreover, maternal oral disease increases risk for early childhood caries (18). Early childhood caries is the most common chronic disease in childhood and can result in significant health and developmental consequences (e.g., increased emergency room and hospitalization visits, poor nutritional intake, delayed physical growth and development, missed school days) (19, 20). Although the connection between prenatal oral disease and adverse pregnancy and birth outcomes has been established, evidence regarding the effectiveness of dental treatment of periodontal disease during pregnancy on birth outcomes remains inconclusive (4, 21, 22). This may suggest that tertiary treatments may be administered too late, underscoring the need for preventing and addressing poor oral health earlier in the pregnancy or during the preconception period.

Nonetheless, the critical importance of oral health promotion, including education and healthcare services during pregnancy, has been documented and highlighted in numerous medical and dental associations' professional guidelines (11, 23–26). Most recently, a consolidated version of interprofessional practice guidelines, endorsed by the American College of Obstetricians and Gynecologists and the American Dental Association, as well as other organizations, reviewed the evidence, assessed existing guidelines, and synthesized key recommendations for both prenatal and oral health providers (27). These guidelines indicate that both prenatal and oral health providers should: (i) assess pregnant women's oral health status; (ii) advise pregnant women on oral health issues, including counseling on proper oral health hygiene and healthcare-seeking behaviors and reassuring that oral procedures are safe during pregnancy; and (iii) refer and coordinate care to promote oral health for both the woman and the baby (27).

The broad field of health promotion is defined as the 'process of enabling people to increase control over, and to improve, their health. It moves beyond a focus on individual behavior toward a wide range of social and environmental interventions' (28). Thus, health promotion efforts often aim to increase health-related knowledge; however, efforts also include changes in other behavioral determinants such as attitudes, beliefs, norms, and the social and environmental barriers and supports that influence health behaviors. In addition to educational efforts, health promotion activities can also include community development, policy, legislation, and regulation (28).

The importance of health promotion during the prenatal period is endorsed by professional associations (11, 23–26) and other related national priorities (29). Thus, given that rates of periodontal disease during pregnancy are high and the significant health implications of poor oral health for mother and offspring across the lifecourse, there is a critical need to assess what interventions are available and effective that translate the oral health guidelines into practice and improve oral health during pregnancy. There has been some research devoted to assessing and evaluating clinical interventions (e.g., treatment) on outcomes; however, health promotion interventions have not yet been reviewed or critically examined for their impact on a range of short-, intermediate, or long-term outcomes. Although previous and current national guidelines call for oral health promotion during pregnancy, it is unknown what oral health promotion interventions exist during this critical period in the lifecourse. Thus, this systematic review was to examine the range, scope and impact of existing oral health promotion interventions during pregnancy. In addition, this review will serve as an initial step toward establishing evidence-based interventions and identifying potential gaps to guide future efforts that ensure the established prenatal oral health guidelines are effectively integrated into health promotion efforts.

Materials and methods

Articles were abstracted from five databases: CINAHL, Web of Science, PsychInfo, PubMed, and Cochrane Central. The date range was from database inception to March 2013. Although the recent interprofessional guidelines were consolidated and published in 2012, several medical and dental professional associations (11, 24, 30–32) have had established guidelines prior to this date, and thus, we wanted to capture existing interventions that may have responded to any of the associations' recommendations. Search terms were used in three

general categories: (i) dentistry (e.g., oral, denti*, denta*); (ii) health promotion (e.g., health education, preventive health services [MeSH]); and (iii) pregnant women (e.g., pregnan*, prenatal). Boolean terms were used to look within categories ('OR') and combine the three categories ('AND'). Additionally, the 'NOT' Boolean term was used to omit articles related to *contraceptive agents*, which initially appeared due to the combination words similar to *oral* and *pregnant*. Inclusion criteria were as follows: (i) an implemented health promotion intervention; (ii) quasi-experimental, experimental, or pretest/post-test design; (iii) included pregnant women as participants; (iv) outcomes including oral health knowledge, attitudes, and/or behaviors; (v) at least five participants included; (vi) peer-review publication; and (vii) English-language. Exclusion criteria were as follows: (i) case studies; or (ii) published abstracts.

The search strategy was implemented and 7754 records were found. After removing duplicates, 6736 remained. Articles were removed based on titles and abstracts resulting in 68 articles to be examined full text. These full-text articles' references were scanned for additional articles; no additional articles were included. Articles were excluded due to non-English language (n = 3); non-empirically-based (n = 5); nonpregnant participants (n = 12); outcomes not related to oral health knowledge, attitudes, and/or behavior (n = 31); and nonexperimental design (n = 10). This resulted in seven studies included in the systematic review (see Fig. 1).

Of the included seven studies, data were abstracted including: publication name; year; title; authors; participant characteristics; study design; description of the intervention; outcomes measured; theoretical framework; and study outcome results. Two articles were abstracted by two independent reviewers to assess consistency in abstraction. The remaining articles were abstracted by one reviewer.

Results

Study setting, demographics, and design

Studies were conducted in three different countries: five in the United States, one in Canada, and

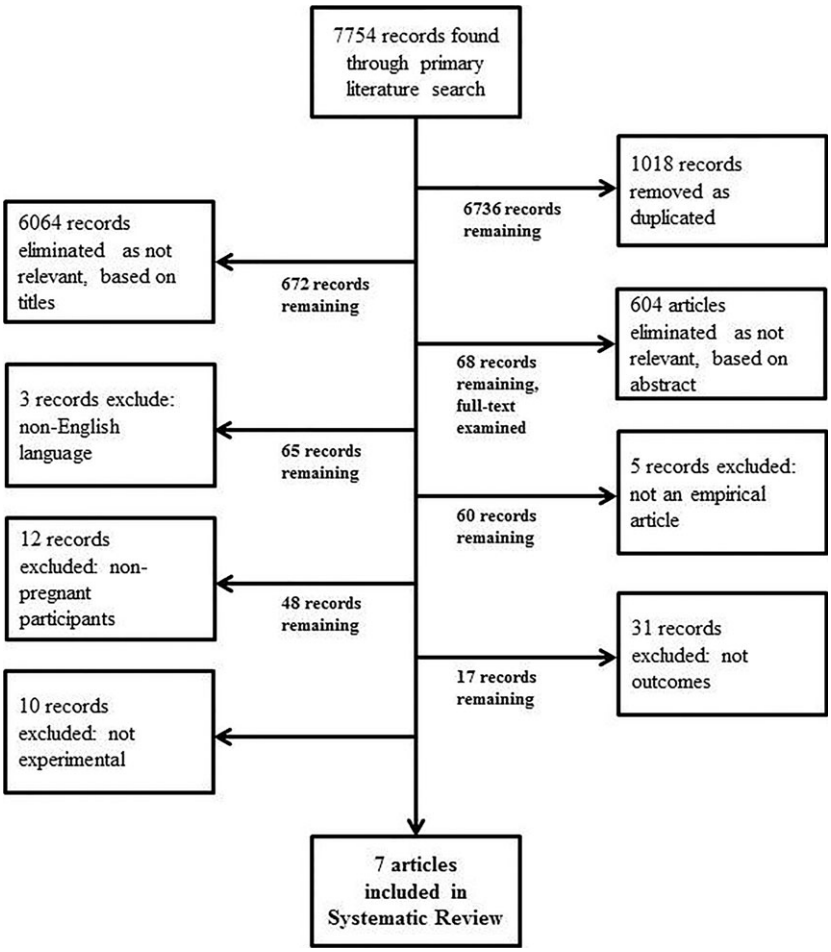

Fig. 1. Search strategy for oral health promotion interventions during pregnancy.

one in Lithuania. The age of the participants varied in each study with an age range of 18–45 years. Two of the studies conducted in the United States did not provide detailed demographics on their participants; the only information provided was that there were 40 pregnant women from the San Antonio, TX area (33) and 150 participants were from the Boston area (34). Five of the studies provided information about race/ethnicity and only three provided information on education level. The studies included diverse samples of participants; none of the samples had similar characteristics to another study (see Table 1). In total, there were two randomized control trials (35, 36), two quasi-experimental (15, 19), and three pretest/post-test designs (14, 16, 18).

Intervention

The intervention methods varied across studies, and included individual and group prenatal visits, instructions on oral hygiene, lectures, audiovisual presentations, and dental supplies. The Centering Pregnancy Smiles program was the only one that used a theoretical framework to evaluate the efficacy of their intervention (37). Specifically, the extended parallel process model was used for fear appeals and persuasive messages for expectant mothers regarding the severity of poor oral health (37). The two randomized control trials provided dental supplies, in addition to education in the experimental group. The Nurse Practitioner-Directed Oral Care Program provided toothbrush, fluoridated toothpaste, dental floss, and scheduled dentists' appointments (35). The study in Lithuania provided fluoride varnish applications, mouthwash, oral hygiene instructions and scheduled examinations to the experimental group (36).

Outcomes and findings

The outcomes measured in the studies included knowledge, attitudes, beliefs, and self-reported compliance with regard to oral health. Five of the seven studies measured knowledge as an outcome and it was considered the main determinant of behavior change (33–35, 37, 38). All but one of the studies had significant improvements in their findings. Shein et al. (34) focused on oral health education only in their last session (of six sessions) for 20 min. The results indicated that a single session on oral health was ineffective in improving outcomes (34). However, two other studies that provided one session on oral health demonstrated significant improvements. A study that presented a 10-min audiovisual presentation that included topics on health during pregnancy and infant/child oral health reported that all 40 expectant mothers had improved knowledge scores in their post-test. In the pretest, 53.75% of the questions were answered correctly and in the post-test 87.08%, producing a 33.33% improvement (33). Another study in Chicago demonstrated that African American and Hispanic of Mexican origin participants increased their knowledge with minimal intervention by listening to a one 40-min lecture covering topics on baby bottles, breast feeding, oral hygiene, first dental visit for children, nutrition, bottled water, and fluoride. Both ethnic groups had improved scores in the post-test; the average was 79% compared with the pretest where the scores were below 50% (38).

The two randomized control trials also demonstrated significant improvements. The Nurse Practitioner-Directed Oral Care Program had a pretest and post-test component with 20 items measuring oral health knowledge and practices. The questions were measured using a 5-point Likert scale where 1 = strongly disagree and 5 = strongly agree. In addition, the experimental group had an educational intervention where they viewed a 5-min movie discussing periodontal disease followed by a discussion on oral health during pregnancy with a nurse or research assistant. While there was no statistically significant improvement in knowledge postintervention, there was a statistically significant increase in the frequency of brushing/flossing and visiting a dentist during pregnancy in the experimental group. The study found that oral health can be improved by providing dental supplies and educational material (35). The second randomized control trial did not have a pretest and post-test component; however, the oral health status of women in the experimental and control group was examined three times (during the first, second, and third trimester), and all women in both groups had dental caries. In addition to the dental supplies, the experimental group received oral hygiene instructions and examinations. After intervention, the experimental group was more likely to brush their teeth twice a day compared with the control group ($P < 0.001$) (36).

The Centering Pregnancy Smiles program provided group prenatal care sessions to 10–12 participants. The program included ten 1-h sessions, and in each session, about 15 min was allocated to oral health during pregnancy. The pretest and post-test survey questions measured attitudes and beliefs

Table 1. Selected characteristics of studies included in the systematic review on oral health promotion interventions during pregnancy

Author and year	Purpose	Characteristics of participants	Design of the study	Content of the intervention	Outcomes	Main findings
Kaste et al. (2007)	Assess the knowledge gained of African American and Hispanic of Mexican origin pregnant women from a lecture on children's oral health that utilized the urban community health center prenatal education program	60 African American and Hispanic of Mexican origin pregnant women with a mean age of 24.5. The majority had less than a high school education, half were first-time mothers and half were born in the US	Pretest and post-test	A 45-min prenatal dental education lecture on baby bottle use, breastfeeding, oral hygiene, age of first dental visit, use of bottled water, nutrition, fluoride, non-nutritive snacking habits	19 questions assessing knowledge on topics on fluoride, bottle use, snacks/nutrition, oral hygiene, first dental visit, and dental sealants	There was an improvement in knowledge after a 45-min lecture overall in each subgroup. A higher prelecture score was seen in African Americans compared with Hispanic of Mexican origin. There were no differences in postlecture scores between groups
Shein et al. (1991)	Evaluate self-reported compliance in a group of parents who received a lecture on dental education and compare their infant oral health habits with a control group	150 parents living in the Boston area	Quasi-experimental	The session included 20 min on oral health education at the beginning of the last session. Information presented included role of medication, fluoride, bottle and nursing caries, and the child's first visit to the dentist	Self-reported compliance knowledge questions related to oral health in children	A single lecture was ineffective in improving dental health awareness
Cardenas et al. (2010)	Develop an electronic educational material that can easily be presented to pregnant women on oral health care and evaluate the gain of knowledge and retention of the program in pregnant women	40 women between 21 and 38 years (mean 27) that were 12–40 weeks pregnant. Number of participants in each age bracket include: 21–25 years = 19, 26–30 years = 12, 31–32 years = 6, and 36–40 years = 4	Pretest and Post-test and a 1-month follow-up	A 10-min audiovisual presentation on maternal health during pregnancy, infant oral health, and child's oral health	Oral health knowledge	An average of 34.67% improvement from pretest to post-test with a slight decrease in average of 3.04% from post-test to follow-up test. This immediate gain in knowledge went from a total score of 12.9 (53.75% correct answers) to 20.9 (87.08% correct answers) in post-testing, which was clinically and statistically significant ($P < 0.05$). The mean overall questions answered correctly for the follow-up test was 84.05%. Brief educational intervention increased pregnant women's knowledge, and information was retained for a month

Table 1. **Continued**

Author and year	Purpose	Characteristics of participants	Design of the study	Content of the intervention	Outcomes	Main findings
Lawrence et al. (2004)	Evaluate the effectiveness of the dental hygiene-coordinated prenatal nutrition program on caregivers' beliefs and their behavioral decisions related to dental preventive practices and feeding habits of infants and toddlers. In addition, assess the oral health status and treatment of children and early childhood obesity	471 and 704 caregivers and child pairs, majority were birth mothers during evaluation; intervention was for pregnant women; Canadian Aboriginal	Quasi-experimental	The dental component of prenatal education was not described	Knowledge, beliefs, attitudes, and behaviors related to child oral health	Community-based prenatal nutrition program increased the caregivers' knowledge of early childhood caries. Program had a positive effect on the child's oral hygiene and body mass index
Vasiliauskiene et al. (2007)	Determine the efficacy in applying preventive measures during pregnancy and improve oral health status of pregnant women to prevent early childhood caries	89 test group, 91 control; a total of 180 women in Lithuania between the age of 22 and 35	Randomized control trial	Provided fluoride varnish applications, mouthwash, oral hygiene instructions and scheduled examinations to the experimental group	Tooth brushing frequency behavior	Application of preventive measures and instruction on oral hygiene gave positive results
Anderson et al. (2010)	Assesses the impact of the expanded model, called Centering Pregnancy Smiles® (CPS), on oral health attitudes and beliefs of rural expectant mothers	486 expectant mothers from a Women's Healthcare Center in a Midwestern rural community; primarily Caucasian; mean age 22.6; mean education 12.6 years; most had Medicaid and lived in poverty	Pretest and post-test	Ten 45-min education sessions; 15 min at each session dedicated to oral health. Oral health topics: connection with systemic health, myths, plaque, brushing, flossing; caries prevention, baby's teeth, and oral evaluation	Tooth brushing response efficacy, tooth brushing self-efficacy, cleaning response efficacy, cleaning self-efficacy, susceptibility, and severity	Significant mean differences for most variables related to gum disease/tooth decay self-efficacy, susceptibility, and severity. No significant differences in tooth brushing self-efficacy for gum disease and susceptibility to tooth decay. CPS is an effective program for learning oral health behaviors for rural women

Table 1. **Continued**

Author and year	Purpose	Characteristics of participants	Design of the study	Content of the intervention	Outcomes	Main findings
Cibulka et al. (2009)	Increase knowledge of the importance of oral health during pregnancy in low-income pregnant women, increase use of preventive oral hygiene practices, and increase utilization of oral health services during pregnancy using an advanced practice nurse model of care to improve oral health	170 recruited; 146 completed pretest and post-test (73 experimental) low-income pregnant women with Medicaid	Randomized control trial with pretest and post-test	5-min movie including graphic pictures of periodontal disease and the proper techniques for brushing and flossing teeth. A nurse or research assistant discussed an information sheet that was targeted to oral health and pregnancy issues and distributed a toothbrush, a tube of fluoridated toothpaste, and dental floss for personal use after the movie	Oral health knowledge, attitudes and practices	The findings of this study show that preventive oral hygiene practices, utilization of oral health services, and oral health in low-income inner-city women can be improved with an APN-directed program of care delivered early in pregnancy

about tooth decay and gum disease. The survey consisted of 18 items measured on a 7-Likert scale where 1 = strongly disagree and 7 = strongly agree. With regard to tooth decay, the participants' perceived severity, tooth brushing response efficacy, flossing response efficacy, tooth brushing self-efficacy, and flossing self-efficacy significantly improved from baseline to follow-up ($P < 0.05$). With regard to gum disease, the participants' perceived severity, perceived susceptibility, tooth brushing response efficacy, flossing response efficacy, and flossing self-efficacy significantly improved from baseline to follow-up ($P < 0.05$) (37).

A community-based quasi-experimental study included a dental component in the prenatal nutrition program, although the curriculum was not described. The program was delivered in 28 communities. Communities were considered either 'high' intervention (i.e., 70% or greater program coverage in the community) or 'low' intervention (i.e., 10% or less program coverage in the community); high (n = 8) and low (n = 8) intervention groups were selected for the program evaluation. Survey questions assessed dental treatment, dental history, hygiene practices, oral health knowledge, and oral health issues. However, it was not mentioned how the items were measured and what scale was used. The program had a significant impact on the caregiver's knowledge, beliefs, and attitudes in infant oral health. In communities where the program was considered 'high', caregivers scored significantly higher in areas of dental knowledge compared with communities labeled 'low'. In addition, the same areas where the program was predominant, caregivers showed an increase in reporting higher frequency of cleaning the child's teeth at an earlier age (39).

Oral–systemic connection and application to guidelines

In summary, all seven interventions were conducted in prenatal care settings and focused on educating women, primarily on infant oral health. Although the consolidated guidelines of both the American Dental Association and the American College of Obstetricians and Gynecologists are relatively recent, only two of the seven interventions made minimal reference to any previous discipline-specific guidelines on oral health during pregnancy. Cibulka et al. (35) referenced the American Academy of Periodontology recommendation for pregnant women to have an oral health exami-

nation. In addition, at the time of the intervention, the American College of Obstetricians and Gynecologists did not have official guidelines regarding oral health during pregnancy, but did have a general advisement for pregnant women to have an oral health visit during pregnancy (35). Cardenas et al. (33) referred to the guidelines introduced by the American Academy of Pediatric Dentistry, which conferred the importance of the mother's education on diet, oral hygiene, fluoride, and professional oral care. These same two interventions, as well as the Centering Pregnancy Smiles program, were the only studies to highlight the importance and association between periodontal disease and adverse pregnancy outcomes such as, preterm birth and low birthweight (33, 35, 37). Only one study mentioned the connection between periodontal disease and systemic diseases such as diabetes, cardiovascular disease, and pneumonia (35).

Discussion

This systematic review examined the range, scope and impact of existing oral health promotion interventions during pregnancy. In addition, this review aimed to serve as an initial step toward identifying evidence-based interventions that translate prenatal oral–systemic research and guidelines into practice. Although the evidence underscoring the importance of oral health during pregnancy has been documented and numerous practice guidelines by both medical and dental associations have existed for some time, including the recently consolidated interprofessional practice guidelines, there remains a significant gap in translating this evidence to pregnant women through health promotion efforts. Overall, this review found few oral health promotion interventions during the pregnancy period, and specifically, only seven interventions that have been evaluated on defined health outcomes.

Overall, studies included diverse samples of pregnant women across three countries, yielding to some heterogeneity within the findings. In addition, all of the studies were conducted in prenatal care settings. Although 71% of U.S. women reported receiving prenatal care in their first trimester in 2008 (40), a time when delivery of health promotion interventions is ideal for promoting behavior change (41, 42), none of the studies delivered interventions in the oral healthcare setting. In addition, other settings and contexts have been used to assess oral health literacy among parents/caregivers, such as the Women, Infants and Children's (WIC) Supplemental Food Program, and these alternative settings could serve as prime environments to further reach pregnant women (43). Thus, clearer descriptions of participant demographics and more research on interventions delivered in other settings, contexts, and populations are required.

Intervention methods and content also varied across studies and included individual and group prenatal visits, instructions on oral hygiene, lectures, audiovisual presentations, and dental supplies. Time allotted for the interventions ranged from a video (13), 15-min at each of the 10 session program (150 min) (11), to unspecified time requirements (44). Moreover, only one study (13) focused on topical areas and information specific to the pregnant women's oral health (e.g., oral health hygiene behaviors to prevent periodontal disease during pregnancy). The majority of the studies presented content that was focused on children's oral health, such as: breastfeeding, baby bottle use, first dental visit, nutrition, fluoride use, and other issues related to early childhood caries prevention. Although pregnancy is a critical time for promoting children's oral health and preventing early childhood caries, there appears to be a bias toward children's oral health. Most of the interventions neglected pregnant women's oral health, including oral–systemic health issues and concerns of relevance to women during this period (e.g., swollen and/or bleeding gums; best practices for oral health hygiene if experiencing frequent nausea/vomiting) as well as those of concern and that may impact her own health across the lifecourse. In addition, descriptions were not provided regarding how and why intervention methods and content were developed. With an increasing emphasis on patient-centered interventions and outcomes research (45), future research should include end users throughout all phases of intervention development, implementation, and evaluation.

In addition, there was a reliance on concrete knowledge and provision of oral health hygiene supplies (e.g., toothbrush; toothpaste). A meaningful use of health literacy to prenatal oral health promotion interventions may serve as an effective mechanism to improving oral health across the lifecourse. For example, drawing on the Institute of Medicine (44) and the Calgary Charter of the Center for Health Literacy (46), health literacy can be defined as a pregnant woman's ability to obtain,

process, understand, and communicate health information to make appropriate health decisions. Knowledge, skills, self-efficacy, attitudes, and beliefs also serve as key determinants of oral health literacy (44). Thus, a more comprehensive health promotion intervention could facilitate pregnant women in obtaining (e.g., finding/accessing oral health information and services), processing (e.g., evaluate the content), understanding (e.g., recognize how the content applies to their own and their children's health), and communicating (e.g., discuss and engage in shared decision-making with providers) on oral health issues to facilitate appropriate health behaviors (46). A health literacy approach should also extend from individuals (pregnant women) to healthcare professionals (prenatal and oral health providers) and health systems (46). For example, prenatal and oral health providers should provide information and services in a manner that helps pregnant women understand and engage in positive oral health hygiene and care-seeking behaviors and which facilities patient–provider communication and shared decision-making. Moreover, systems need to be able to provide access to oral health information and services to all individuals, regardless of ability to pay and facilitate the technological and social infrastructures needed to coordinate care between medical and dental practices. Although, access to oral health services among priority populations and collaboration between disciplines remain significant problems in public health (47), it is beyond the scope of this paper.

In addition, many of the studies provided vague intervention description, with at least one of the studies not providing any description of the oral health curriculum delivered (39). Thus, clearer descriptions are needed to understand the link between intervention components and measured outcomes. Moreover, only one study (11) used theory to inform the intervention. Health behavior theories can play a critical role in designing and evaluating oral health promotion programs. Specifically, theory can assist in (i) understanding factors that contribute to a health problem; (ii) guiding intervention development, including identifying appropriate health intervention strategies and health messages; (iii) providing a framework for assumptions about how a program will produce behavior change; and (iv) providing a framework for program evaluation (48).

With regard to measured outcomes, all but one study showed significant improvements, demonstrating oral health promotion interventions are effective during pregnancy. However, similar to the intervention content described above, most of the studies included focused on outcomes related to knowledge of children's oral health (e.g., preventing early childhood caries through fluoride use and dental sealants, proper nutrition, first dental visits, etc.). Yet, some studies did assess mother's oral health hygiene behaviors (e.g., tooth brush response efficacy, self-efficacy, and frequency). Only one study measured pregnant women's oral hygiene practices, utilization of oral health services, and oral health outcomes (35). Although knowledge is often the first and essential step in changing attitudes and behaviors, it is well documented that knowledge alone is not always the main determinant, nor always sufficient for sustained health behavior change (48). The most effective health promotion strategies address multilevel determinants across the socio-ecological system at the intrapersonal level (e.g., attitudes, beliefs, self-efficacy), interpersonal level (e.g., social norms, patient–provider communication), organizational level (e.g., prenatal and oral health clinics), community level (e.g., social and physical environmental barriers to prenatal oral health information and services), and societal level (e.g., healthcare access and reimbursement policies) (48, 49). In addition, the use of more rigorous evaluation designs, longer follow-up periods, and measurement of long-term health outcomes (e.g., periodontal disease and dental caries among women; early childhood caries among offspring) would further strengthen the evidence regarding the effectiveness and impact of oral health promotion interventions during pregnancy. Moreover, although a randomized control trial experimental design in community-based interventions is not always feasible, the use of quasi-experimental designs is acceptable and often reflects the true setting in which interventions are implemented into community practice and increases external validity (50). Regardless of the chosen evaluation design and whether short, intermediate or long-term outcomes are used, authors should justify research designs and explicitly provide clear descriptions of how the variables were operationalized and measured.

This review also found that there was little reference to oral–systemic research and the various individual and consolidated professional associations' recommendations and guidelines regarding oral health during pregnancy. It has well been established that the mouth is the 'window to a per-

son's general health' (1, 51). There have also been established associations between oral and systemic health (e.g., cardiovascular disease, diabetes, eating disorders, sexually transmitted infections), which include intersections between biological, social-behavioral, and structural factors (see, DeBate et al. for review) (52). The pregnancy period has also been identified by the National Institutes of Health Office of Research on Women's Health as a priority foci area (51). Moreover, given the established evidence and public health implications, the importance of oral health promotion during pregnancy has not been refuted. Nonetheless, several significant gaps in oral–systemic research remain, particularly during the pregnancy period, including but not limited to the effect of behavioral research during pregnancy and associated long-term health outcomes (as corroborated by the lack of evidence found in this systematic review); impact of oral health status during pregnancy on future diseases; and development and evaluation of health policy and the impact on oral health care access and use (51). The paucity of discussion related to current oral–systemic health research and the previous existing recommendations and guidelines from professional associations in the articles included in this systematic review suggests a significant gap in translating and providing a clear rationale between evidence and health promotion practice and may also position published interventions to be questioned if they are not responding to clear and identified evidence. Moreover, because oral health is key to overall health and well-being (1) and the importance of the lifecourse perspective to oral health–systemic health (2), future interventions should also be directed toward women in the preconception period, to help promote oral health prior to and in between pregnancy periods.

Review of the main findings of this systematic review must be considered in light of noted limitations. First, only studies that comprised pregnant women as participants were included. Interventions that focused on increasing prenatal oral–systemic health efforts among prenatal and oral health providers were not included. Although some previous research has demonstrated significant impacts in improving oral health care providers' knowledge and practice behaviors with regards to early childhood caries prevention (50, 53), efforts focused on increasing prenatal and oral health providers' practice behaviors with regard to the prenatal oral health guidelines remain understudied and should be included in future research. Second, only studies that were published in a peer-reviewed publication and that had an evaluation component were included in this review. There could be other innovative health promotion interventions that target pregnant women; however, unless interventions include an evaluation component and are effectively disseminated and published, there will be little evidence-based interventions for program planners to consider and adopt. Moreover, there is often a bias where only those studies that produce significantly positive results are published. It is also important to know which interventions were not effective in certain populations and contexts and possible reasons for their failure.

In conclusion, few oral health interventions targeting pregnant women were found, and even fewer actually addressed oral-related symptoms, hygiene behaviors, and potential oral–systemic implications specific to pregnant women. This review demonstrates that there is a significant lag in evidence-based oral health promotion interventions despite the clear evidence of the importance oral–systemic health. Subsequently, more theory- and evidence-based interventions addressing the prenatal oral health guidelines using rigorous designs are needed to improve oral–systemic health for both women and their offspring across the lifecourse.

References

1. U.S. Department of Health and Human Services. Oral health in America: a report of the surgeon general. Rockville, MD: Department of Health and Human Services, National Institute of Dental and Craniofacial Research, National Institutes of Health; 2000.
2. Nicolau B, Thomson WM, Steele JG, Allison PJ. Lifecourse epidemiology: concepts and theoretical models and its relevance to chronic oral conditions. Community Dent Oral Epidemiol 2007;35:241–9.
3. Boggess KA, Edelstein BL. Oral health in women during preconception and pregnancy: implications for birth outcomes and infant oral health. Matern Child Health J 2006;10:169–74.
4. Xiong X, Buekens P, Fraser W, Beck J, Offenbacher S. Periodontal disease and adverse pregnancy outcomes: a systematic review. BJOG 2006;113:135–43.
5. Daley E, Debate R, Vamos C, Marsh L, Kline N, Albino J, et al. Transforming women's oral-systemic health through discovery, development, and delivery. J Womens Health (Larchmt) 2013;22:299–302.
6. Beck JD, Offenbacher S. Systemic effects of periodontitis: epidemiology of periodontal disease and cardiovascular disease. J Periodontol 2005;76(11 Suppl):2089–100.

7. Cullinan MP, Ford PJ, Seymour GJ. Periodontal disease and systemic health: current status. Aust Dent J 2009;54(Suppl 1):S62–9.
8. Kamer AR, Craig RG, Dasanayake AP, Brys M, Glodzik-Sobanska L, de Leon MJ. Inflammation and Alzheimer's disease: possible role of periodontal diseases. Alzheimers Dement 2008;4:242–50.
9. Scannapieco FA, Bush RB, Paju S. Associations between periodontal disease and risk for atherosclerosis, cardiovascular disease, and stroke. A systematic review. Ann Periodontol 2003;8:38–53.
10. Scannapieco FA, Bush RB, Paju S. Associations between periodontal disease and risk for nosocomial bacterial pneumonia and chronic obstructive pulmonary disease. A systematic review. Ann Periodontol 2003;8:54–69.
11. Kloetzel MK, Huebner CE, Milgrom P. Referrals for dental care during pregnancy. J Midwifery Womens Health 2011;56:110–7.
12. Lachat MF, Solnik AL, Nana AD, Citron TL. Periodontal disease in pregnancy: review of the evidence and prevention strategies. J Perinat Neonatal Nurs 2011;25:312.
13. Silk H, Douglass AB, Douglass JM, Silk L. Oral health during pregnancy. Am Fam Physician 2008;77:1139–44.
14. Lieff S, Boggess KA, Murtha AP, Jared H, Madianos PN, Moss K, et al. The oral conditions and pregnancy study: periodontal status of a cohort of pregnant women. J Periodontol 2004;75:116–26.
15. Boggess KA, Lieff S, Murtha AP, Moss K, Beck J, Offenbacher S. Maternal, periodontal disease is associated with an increased risk for preeclampsia. Obstet Gynecol 2003;101:227–31.
16. Offenbacher S, Lieff S, Boggess KA, Murtha AP, Madianos PN, Champagne CM, et al. Maternal periodontitis and prematurity. Part I: obstetric outcome of prematurity and growth restriction. Ann Periodontol 2001;6:164–74.
17. Moore S, Ide M, Coward PY, Randhawa M, Borkowska E, Baylis R, et al. A prospective study to investigate the relationship between periodontal disease and adverse pregnancy outcome. Br Dent J 2004;197:251–8.
18. CDA Foundation. Oral health during pregnancy & early childhood: evidence-based guidelines for health professionals. Sacramento, CA: CDA Foundation; 2010; available at: http://www.cdafoundation.org/Portals/0/pdfs/poh_guidelines.pdf [last accessed January 11 2015].
19. Casamassimo PS, Thikkurissy S, Edelstein BL, Maiorini E. Beyond the dmft: the human and economic cost of early childhood caries. J Am Dent Assoc 2009;140:650–7.
20. American Academy of Pediatric Dentistry. Policy on early childhood caries (ECC): classifications, consequences, and preventive strategies; 2014; available at: http://www.aapd.org/media/Policies_Guidelines/P_ECCClassifications.pdf [last accessed January 12 2015].
21. Polyzos NP, Polyzos IP, Mauri D, Tzioras S, Tsappi M, Cortinovis I, et al. Effect of periodontal disease treatment during pregnancy on preterm birth incidence: a metaanalysis of randomized trials. Am J Obstet Gynecol 2009;200:225–32.
22. Michalowicz BS, Hodges JS, DiAngelis AJ, Lupo VR, Novak MJ, Ferguson JE, et al. Treatment of periodontal disease and the risk of preterm birth. N Engl J Med 2006;355:1885–94.
23. Task Force on Periodontal Treatment of Pregnant Women, American Academy of Periodontology. American Academy of Periodontology statement regarding periodontal management of the pregnant patient. J Periodontol 2004;75:495.
24. American Dental Association. Oral health during pregnancy. J Am Dent Assoc 2011;142:574.
25. American Academy of Pediatric Dentistry. Perinatal oral health care. 2011; available at: http://www.aapd.org/media/Policies_Guidelines/G_PerinatalOralHealthCare.pdf [last accessed January 12 2015].
26. American Academy of Pediatrics and the American College of Obstetricians and Gynecologists. Guidelines for perinatal care, 7th edn. Elk Grove Village, IL: American Academy of Pediatrics and the American College of Obstetricians and Gynecologists; 2012; 138–9.
27. Oral Health Care during Pregnancy Expert Workgroup. Oral health care during pregnancy: a national consensus statement - summary of an Expert Workgroup Meeting. Washington, DC: National Maternal and Child Oral Health Resource Center; 2012; available at: http://www.mchoralhealth.org/PDFs/Oralhealthpregnancyconsensusmeetingsummary.pdf [last accessed January 11 2015].
28. World Health Organization. Ottawa charter for health promotion: first international conference on health promotion. Ottawa, ON: World Health Organization; 1986; available at: http://www.who.int/healthpromotion/conferences/previous/ottawa/en/ [last accessed January 16 2015].
29. US Department of Health and Human Services. Healthy People 2020: Maternal, Infant, and Child Health; 2014; available at: http://www.healthypeople.gov/2020/topics-objectives/topic/maternal-infant-and-child-health/objectives [last accessed January 16 2015].
30. American Academy of Periodontology. American Academy of Periodontology statement regarding periodontal management of the pregnant patient. J Periodontol 2004;75:495. available at: http://www.perio.org/resources-products/pdf/44-pregnancy.pdf [last accessed June 12 2012].
31. American Academy of Pediatric Dentistry. Guideline on perinatal oral health care. Pediatr Dent 2011;33:11–2.
32. American Academy of Pediatrics and the American College of Obstetricians and Gynecologists. Guidelines for perinatal care, 6th edn. Elk Grove Village, IL: American Academy of Pediatrics and the American College of Obstetricians and Gynecologists, 2007; 123–4.
33. Cardenas LM, Ross DD. Effects of an oral health education program for pregnant women. J Tenn Dent Assoc 2010;90:23–6; quiz 6-7.
34. Shein B, Tsamtsouris A, Rovero J. Self reported compliance and the effectiveness of prenatal dental education. J Clin Pediatr Dent 1991;15:102–8.
35. Cibulka NJ, Forney S, Goodwin K, Lazaroff P, Sarabia R. Improving oral health in low-income pregnant women with a nurse practitioner-direc-

ted oral care program. J Am Acad Nurse Pract 2011;23:249–57.
36. Vasiliauskiene I, Milciuviene S, Bendoraitiene E, Narbutaite J, Slabsinskiene E, Andruskeviciene V. Dynamics of pregnant women's oral health status during preventive programme. Stomatologija 2007;9:129–36.
37. Anderson C, Harris MS, Kovarik R, Skelton J. Discovering expectant mothers' beliefs about oral health: an application of the Centering Pregnancy Smiles program. Int Q Community Health Educ 2009;30:115–40.
38. Kaste LM, Sreenivasan D, Koerber A, Punwani I, Fadavi S. Pediatric oral health knowledge of African American and Hispanic of Mexican origin expectant mothers. Pediatr Dent 2007;29:287–92.
39. Lawrence HP, Romanetz M, Rutherford L, Cappel L, Binguis D, Rogers JB. Oral health of aboriginal preschool children in northern Ontario. Probe 2004;38:172–90.
40. U.S. Department of Health and Human Services. Health resources and services administration, maternal and child health bureau. Child health USA 2011. Rockville, MD: U.S. Department of Health and Human Services; 2011; available at: http://mchb.hrsa.gov/chusa11/ [last accessed January 11 2015].
41. Thoele MJ, Asche SE, Rindal DB, Fortman KK. Oral health program preferences among pregnant women in a managed care organization. J Public Health Dent 2008;68:174–7.
42. Committee on Health Care for Underserved Women. Committee Opinion No. 569: oral health care during pregnancy and through the lifespan. Obstet Gynecol 2013;1(2 Pt 1):417–22.
43. Lee JY, Divaris K, Baker AD, Rozier RG, Lee S-YD, Vann WF Jr. Oral health literacy levels among a low-income WIC population. J Public Health Dent 2011;71:152–60.
44. Institute of Medicine. Oral health literacy: workshop summary. The National Academies Press; 2013; available at: http://www.iom.edu/Reports/2013/Oral-Health-Literacy.aspx [last accessed January 11 2015].
45. Patient-Centered Outcomes Research Institute. Patient-Centered Outcomes Research Institute; n.d.; available at: http://www.pcori.org/ [last accessed September 3 2014].
46. Coleman C, Kurtz-Rossi S, McKinney J, Pleasant A, Rootman I, Shohet L. Calgary charter on health literacy; 2009; available at: http://www.centreforliteracy.qc.ca/sites/default/files/CFL_Calgary_Charter_2011.pdf [last accessed January 11 2015].
47. Allukian M Jr. The neglected epidemic and the surgeon general's report: a call to action for better oral health. Am J Public Health 2000;90:843.
48. National Cancer Institute. Theory at a glance: application to health promotion and health behavior, 2nd edn. National Institutes of Health, U.S. Department of Health and Human Services; 2005; available at: http://www.sbccimplementationkits.org/demandrmnch//wp-content/uploads/2014/02/Theory-at-a-Glance-%E2%80%93-A-Guide-For-Health-Promotion-Practice.pdf [last accessed January 11 2015].
49. McLeroy KR, Bibeau D, Steckler A, Glanz K. An ecological perspective on health promotion programs. Health Educ Q 1988;15:351–77.
50. Vamos CA, Quinonez R, Gaston A, Sinton J. Addressing early preventive oral health care among children: a pilot evaluation of the Baby Oral Health Program (bOHP) among dental staff. J Dent Hyg. 2014;88:202–12.
51. Office of Research on Women's Health. Moving into the future with new dimensions and strategies: A vision for 2020 for women's health research. Volume II Regional scientific reports; available at: http://orwh.od.nih.gov/research/strategicplan/ [last accessed March 9 2015].
52. DeBate R, Daley EM, Vamos CA, Kline N, Marsh L, Smith S. Transdisciplinary women's health: a call to action. Health Care Women Int 2013;35:1113–32.
53. Fein JE, Quinonez RB, Phillips C. Introducing infant oral health into dental curricula: a clinical intervention. J Dent Educ 2009;73:1171–7.

Review

Motivational Interviewing in Improving Oral Health: A Systematic Review of Randomized Controlled Trials

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Background: The control and management of many oral health conditions highly depend on one's daily self-care practice and compliance to preventive and curative measures. Conventional (health) education (CE), focusing on disseminating information and giving normative advice, is insufficient to achieve sustained behavioral changes. A counseling approach, motivational interviewing (MI), is potentially useful in changing oral health behaviors. This systematic review aims to synthesize the evidence on the effectiveness of MI compared with CE in improving oral health.

Methods: Four databases (PubMed MEDLINE, Web of Science, Cochrane Library, and PsycINFO) were searched to identify randomized controlled trials that evaluated the effectiveness of MI compared with CE in changing oral health behaviors and improving oral health of dental patients and the public. The scientific quality of the studies was rated, and their key findings were qualitatively synthesized.

Results: The search yielded 221 potentially relevant papers, among which 20 papers (on 16 studies) met the eligibility criteria. The quality of the studies varied from 10 to 18 out of a highest possible score of 21. Concerning periodontal health, superior effect of MI on oral hygiene was found in five trials and was absent in two trials. Two trials targeting smoking cessation in adolescents failed to generate a positive effect. MI outperformed CE in improving at least one outcome in four studies on preventing early childhood caries, one study on adherence to dental appointments, and two studies on abstinence of illicit drugs and alcohol use to prevent the reoccurrence of facial injury.

Conclusions: Reviewed randomized controlled trials showed varied success of MI in improving oral health. The potential of MI in dental health care, especially on improving periodontal health, remains controversial. Additional studies with methodologic rigor are needed for a better understanding of the roles of MI in dental practice. *J Periodontol 2014;85:426-437.*

KEY WORDS

Dental caries; health behavior; motivational interviewing; periodontal diseases; randomized controlled trials.

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The control and management of many oral health conditions highly depend on one's daily self-care and compliance to preventive and curative measures. Under the current biopsychosocial model of health care, there is little dispute that empowering people to adopt healthy behaviors should be incorporated as part of the treatment plan for dental patients and oral health programs for a community.[1,2]

Two positive behaviors are of particular relevance to periodontal health, namely smoking cessation[3] and self-maintenance of oral hygiene (by brushing and interdental cleaning).[4] Both behaviors are essential for preventing occurrence and controlling progression of periodontal diseases[4,5] and are the prerequisites for treatment success of periodontal diseases.[6,7] Without patients' adherence to these two behaviors, even the most meticulous periodontal therapy is likely to be ineffective.[2,7]

Diligent efforts are made by periodontists and dental hygienists in educating their patients to adhere to plaque-control measures and quitting smoking. Nevertheless, the rate of patient compliance in long-term therapy appeared to be low.[8,9] Similar dilemmas also exist in other disciplines of dentistry for managing other oral health problems.[10] Conventionally, patient education focuses on disseminating information and giving normative advice. Although patients' knowledge may be improved,

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Conference Paper

Motivational Interviewing for Parent-child Health Interventions: A Systematic Review and Meta-Analysis

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Abstract: ***Purpose:*** *Motivational interviewing (MI) is a patient-centered approach focusing on building intrinsic motivation for change. This paper presents a meta-analysis of parent-involved MI to improve pediatric health behavior and health outcomes.* ***Methods:*** *Study inclusion criteria: (1) examined modifiable pediatric health behaviors (< 18 years old); (2) used MI or motivational enhancement; (3) conducted a randomized controlled trial with a comparison group (non-MI control or active treatment group); (4) conducted the intervention with only a parent or both a parent and child; and (5) were written in English. Twenty-five studies (with 5,130 participants) were included and independently rated. Weighted mean effect sizes, using random-effects assumptions, were calculated.* ***Results:*** *Relative to comparison groups, MI was associated with significant improvements in health behaviors (e.g., oral health, diet, physical activity, reduced screen time, smoking cessation, reduced second hand smoke) and reduction in body mass index. Results suggest that MI may also outperform comparison groups in terms of dental caries, but more studies are needed. MI interventions were more successful at improving diets for Caucasians and when the intervention included more MI components.* ***Conclusions:*** *Our findings provide support for providing motivational interviewing to parents and children to improve pediatric health behaviors.* *(Pediatr Dent 2015;37(3):254-65) Received January 22, 2015 | Last Revision April 1, 2015 | Accepted April 10, 2015*

KEYWORDS: MOTIVATIONAL INTERVIEWING, META-ANALYSIS, ORAL HEALTH, PEDIATRICS, HEALTH BEHAVIORS

Motivational interviewing (**MI**) is a patient-centered treatment that focuses on building intrinsic motivation for change by exploring and resolving ambivalence.[1] MI is patient centered in that the provider attempts to understand the patient's expectations, beliefs, perspectives, and concerns about changing their health behaviors. Counseling techniques are calibrated to the patient's level of readiness to change, with educational approaches given only when the patient is ready and willing to hear the information, and provided in a collaborative, autonomy-promoting manner. Providing education to patients who are ambivalent about change has paradoxical effects, producing resistance to change.[2-4] MI is directive in that the conversation is structured to produce movement toward change. A comfortable and nonjudgmental atmosphere is created that allows the patient to talk about the pros and cons of changing, without coercion to change or premature suggestions of change options. The core of MI involves strengthening intrinsic motivation by discussing how change is consistent with the patient's own values and goals.[5] Patients are given the autonomy to make their own decisions about change, which has been shown to increase commitment to change.[3]

MI was first developed by William Miller in 1983 for the treatment of alcoholism; it was later expanded by Miller and Rollnick[1] to target a variety of mental health and physical conditions.[1,6] MI has been successfully used to promote healthy behaviors, such as exercise,[7] glycemic control,[8] oral health,[9,10] medication adherence,[11,12] and weight loss,[13] as well as reduce maladaptive behaviors such as smoking,[14,15] sexual risk behaviors,[16] and gambling.[17] Meta-analyses have shown that MI significantly outperforms controls (no treatment and waitlist), and treatments based on education, across a wide variety of health behaviors, including exercise, diet, weight loss, oral health, smoking, substance abuse, and safe-sex behaviors[15,18-21] One meta-analysis has shown that MI outperforms traditional advice-giving in approximately 80 percent of studies, with significant effects for body mass index (**BMI**), blood cholesterol, systolic blood pressure, and blood alcohol concentration.[22] If MI is used as a stand-alone treatment, positive effects are seen early and tend to diminish across a year of follow-up; however, when MI is used in conjunction with other treatments, the effect of MI is maintained or increased over time.[20]

Meta-analyses of the effect of MI on adolescent and young adult health behaviors have shown weaker effects for risky behaviors (e.g., alcohol use and abuse[23]) but more positive effects for health-promoting behaviors (e.g., weight, diet, sleep, and physical activity[24,25]). For example, in their meta-analysis of the effect of MI on eight different health promotion behaviors, Gayes and Steele[25] found that MI had an effect size (Hedges' g) of 0.28 when compared to other active treatments and to no treatment. Their results also suggest that interventions focused on parent-child dyads are more effective at improving pediatric health outcomes and behaviors than those focused on either the child or parent alone. However, this conclusion is tentative, as it is based on three studies and because parent-directed or parent-child dyad-directed interventions were not part of the inclusion criteria for this meta-analysis.

Family focused interventions have been found to be an effective means for enacting pediatric health behavior change across a wide range of behaviors.[26] One advantage of involving the parent in the intervention is that the intervention has greater potential to impact all of the children in the family, not just the index child.[24]

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Therefore, the purpose of this study was to conduct a meta-analysis to specifically examine the effect of parent-directed or parent-child dyad-directed motivational interviewing to improve pediatric health behaviors relative to controls. We examined effect sizes by type of health behavior and investigated several important predictors of the effect, identified a priori (e.g., child race/ethnicity, intervention setting, delivery method, dose, provision of feedback, intensity of MI, and degree of parental involvement).

Methods

Sample of studies and selection criteria. Studies were retrieved from: (1) electronic reference databases (PubMED, PsycINFO, CINAHL, The Cochrane Library, ERIC, and Web of Science) using a Boolean search strategy with the following keywords: (motivational interviewing OR motivational enhancement therapy) AND (parent OR caregiver OR guardian OR mother OR father OR birth parent OR biological parent OR adoptive parent OR foster parent OR step parent) AND (intervention OR prevention OR education*); (2) reference sections of relevant review or published studies; and (3) sending manuscript requests to relevant authors. Two authors independently examined the full-text papers of relevant records obtained from the electronic database searches using our inclusion criteria.

To be included, studies had to: (1) sample parents of children and/or adolescents 18 years old or younger (participants); (2) implement an intervention that used MI or motivational enhancement that targeted either a parent or a parent-child dyad (interventions); (3) compare the intervention group to a control condition (e.g., assessment only, active comparison; comparisons); (4) examine modifiable health behaviors related to one of the leading health indicators specified in Healthy People 2020[27] (e.g., oral health, physical activity, diet and obesity, tobacco use, substance use, and responsible sexual behavior); (5) use a randomized controlled trial (RCT) design (study design); (6) be written in English; and (7) provide sufficient statistical information to calculate effect sizes.

Studies that fulfilled the selection criteria and were available by August 2014 were included. If an author reported insufficient statistical information, they were contacted for additional information. Two authors were contacted, but one was unable to provide the data by the date of data analysis (October 2014), resulting in the exclusion of a single study. (The number of studies is referred to as *k* throughout the manuscript).

Overview of the data collection process. Independent raters coded study information, participant characteristics, design and methodological features, treatment fidelity and methodological quality (**MQ**), and intervention content for the studies included in the meta-analysis. A coding protocol and form were developed to extract the aforementioned data from each individual study. Studies that reported intervention details or data from the same sample were linked together in the database and coded as a single study to avoid violating the assumption of independence. When a study used more than one comparison condition (e.g., usual care or usual care with reduced measurement[28]), the condition with the least intervention contact and the same assessment schedule was used as the comparison condition for ease of interpretation of treatment effects. (The magnitude of the effect sizes will be stronger when comparing an assessment only control versus an active comparison.[29])

Study features coded. Studies were coded for a number of characteristics, including sample characteristics, intervention setting, intervention dose, provider characteristics, target of intervention (parent only, parent-child dyad, child with ancillary parental involvement, group treatment), and MI components (see Table 2 for details).

Methodological quality and treatment fidelity. MQ was assessed using 14 items (e.g., random assignment, retention) adapted from validated measures[30-32]; and the total possible MQ score was 20 points. Treatment fidelity was assessed using a shortened, 15-item version of the validated treatment fidelity checklist developed by the National Institutes of Health (**NIH**) Treatment Fidelity Framework.[33,34] Items were scored as present (1) or absent (0). Studies that did not report the treatment fidelity item were also assigned a zero. Overall proportion of adherence to treatment fidelity was calculated by summing the total number of items coded as present by the total number of items considered applicable to the trial (Table 3).

Study outcomes coded. Estimates of effect sizes were calculated by one of this study's authors and verified by the first and/or second authors. Effect sizes were calculated from the information provided in the study or in a related study (i.e., when study outcomes were reported in multiple papers). Effect sizes were calculated for behavioral or biomedical health outcomes. Behavioral outcomes included: (1) oral health hygiene and maintenance behaviors (i.e., brushing, visiting the dentist, precavity checks, not sharing utensils); (2) overweight and obesity concerns (i.e., physical activity, healthy food servings, screen viewing access and time); (3) tobacco use (i.e., smoking cessation, environmental smoking restrictions); and (4) alcohol use. Biomedical outcomes included: (1) oral health (i.e., dental caries); (2) body composition (i.e., BMI, proportion of overweight or obese, waist circumference, proportion of body fat); and (3) tobacco exposure (i.e., secondhand smoking). Self-report and objective measures were used to evaluate the behavioral and biomedical outcomes.

Hypothesized predictors. Based on a priori hypotheses, several features of the studies were evaluated as potential predictors of the variation in the effect size distribution. Sample characteristics included parent and child race/ethnicity (Caucasian versus non-Caucasian). Intervention features included: (1) setting (clinical versus nonclinical); (2) delivery method (intervention delivered in person only versus any other method or combination of methods); (3) number of intervention sessions using MI; (4) treatment dose (total number of minutes of contact besides assessment) (5) the provision of personalized health-related feedback (versus no feedback); (6) number of MI components; (7) target of the intervention (e.g., whether studies with more parental involvement had better outcomes than those in which the parent had only ancillary involvement); and (8) provider type (whether interventions that were delivered by those with a professional terminal degree, with or without paraprofessional involvement, had better outcomes than those delivered by para-professionals alone, or lay providers alone).

Effect size derivation. Study effect sizes were calculated as the standardized mean difference between the treatment and comparison groups divided by the pooled standard deviation.[35] We used other statistical information, such as *t*- or *F*-values, when means and standard deviations were not available.[36] If a study reported dichotomous outcomes, we calculated an odds ratio and transformed it to *d* using the Cox transformation.[37] Effect sizes were adjusted for baseline differences when preintervention measures were available.[38] If no statistical

information was available (and could not be obtained from the authors) and the study reported no significant between-group differences, we estimated that effect size to be zero.[36,39] Multiple effect sizes were calculated from individual studies when they reported more than one outcome of interest or assessed outcomes across multiple follow-ups. If a study contained multiple measures of the same outcome (e.g., nutrition measured using two items for fruit and vegetable servings), the effect sizes were averaged. All effect sizes were corrected for sample size bias.[40]

The effect sizes from the last study assessment (50 percent of the studies reported more than one follow-up) were used in the analyses because initial intervention effects tend to decay over time.[41] Using the last assessment as the point of analysis provides a stronger test of the robustness of the interventions. Positive effect sizes indicate that participants receiving the MI-based intervention indicated a greater health benefit (e.g., lower tobacco use, fewer dental caries) relative to comparison groups.

Statistical analyses. Weighted mean effect sizes (d_+) were calculated using random-effects procedures, such that individual studies' effect sizes were weighted by the inverse of their random-effects variance.[36] The homogeneity statistic, Q, was calculated for each health behavior or biomedical outcome. A significant Q indicates a lack of homogeneity and an inference of heterogeneity. The I^2 index and the corresponding 95 percent confidence intervals (**CIs**) were also calculated to assess the extent to which outcomes were consistent across studies (homogeneous).[42,43] If the 95% CI around the I^2 index includes a zero, the hypothesis of homogeneity is confirmed.[42] To explain variability in effect sizes, meta-regression was conducted to determine the relationship between sample, methodological, or intervention characteristics and the magnitude of the effect sizes using a modified weighted regression analysis, with weights equivalent to the inverse of the variance for each effect size.[36,44] These analyses were conducted if the weighted mean effect size for a health behavior or biomedical outcome indicated significant heterogeneity and was reported in five or more studies. All analyses were conducted in Stata 13 (StataCorp LP, College Station, Texas, USA) using published macros.[36,45]

Publication bias. Publication bias (i.e., when studies with significant findings are published, whereas studies with nonsignificant findings remain unpublished; also known as the file-drawer effect)[46] was assessed by inspecting funnel plots[47] assessing the degree of funnel plot asymmetry using Begg's[48] and Egger's[49] methods and by determining the number of studies that could be missing using trim and fill procedures.[50]

Results

Study selection and reliability of coding. A total of 25 studies were included in the meta-analysis (Figure 1). For the categorical dimensions, raters agreed on 74 percent of the judgments (mean Cohen's κ=0.47, indicating moderate agreement[51]). Reliability for the continuous variables was calculated using the intraclass correlation coefficient (**ICC**); and the mean ICC equaled 0.78 across categories. Coding disagreements were resolved through discussion or by a third rater when consensus could not be achieved. Details for each study are provided in Table 1.

Study and sample characteristics. Table 2 provides aggregate information on the sample and intervention characteristics

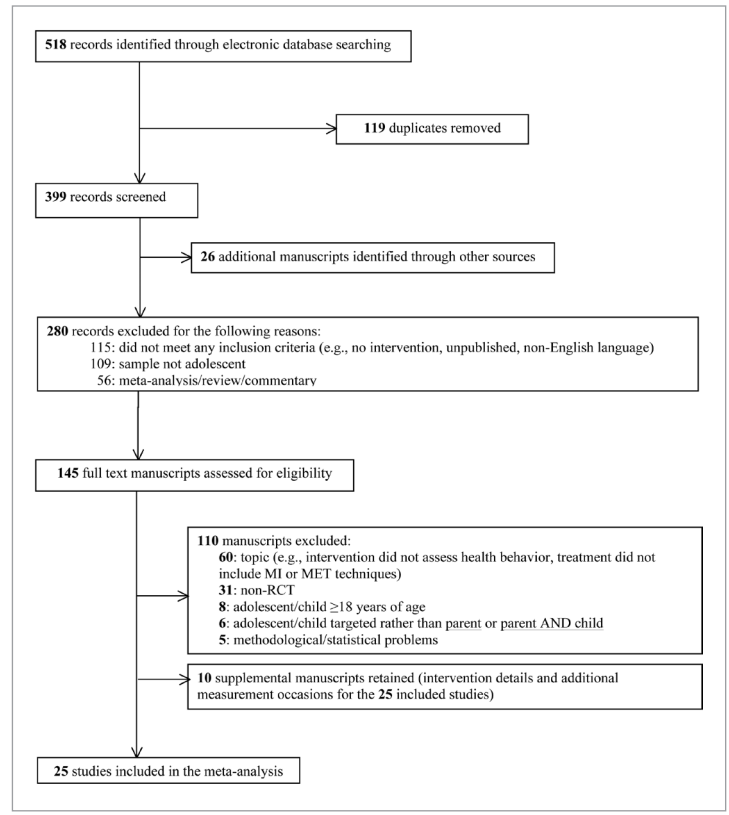

Figure 1. Selection process for study inclusion in the meta-analysis.

of the 25 studies included in the meta-analysis. Studies were published between 2001 and 2014, with a median publication date of 2011. Studies were typically conducted in the United States (72 percent) and in clinical settings (56 percent). Interventions focused on: (1) overweight and obesity (diet, weight, physical activity, and/or diabetes; 48 percent); (2) smoking and tobacco (cessation, secondhand smoke exposure; 32 percent); (3) oral health (e.g., dental caries, brushing; 16 percent); and (4) alcohol use (four percent). The median number of postinter-vention assessments was two (range = 1 to 3). The final postintervention assessment (used in the data analyses) occurred a median of 26 weeks (mean equals 38 weeks; ± standard deviation [**SD**] equals 35), but ranged from immediate post-intervention to 104 weeks. Our sample consisted of 5,130 parents (mean age=33 years, 93 percent female) or children (mean age=nine years, 56 percent female) with an average retention rate of 79 percent.

MI intervention characteristics. Interventions were typically delivered over multiple sessions, with a median of 26 minutes per session, by a single facilitator. MI was used in 74 percent (±0.36 SD) of the intervention sessions (median equals three sessions, range = 1 to 16), and 16 of the 25 studies used MI in 100 percent of their sessions. Interventions were typically delivered to a parent alone (52 percent), a child with ancillary parental involvement (12 percent), and parent-child dyads (eight percent); 28 percent of studies used a combination of these targets (e.g., parent-child dyads plus groups). All of the studies delivered MI in person for at least one session; approximately half were supplemented by telephone counseling and/or print. All 25 studies also stated that the intervention

Table 1. STUDY, SAMPLE, AND INTERVENTION DETAILS FOR THE 25 RANDOMIZED CONTROLLED TRIALS INCLUDED IN THE META-ANALYSIS*

Study	N	Intervention composition	Child's age (mean yrs)	Child's ethnicity	Target	Study outcomes	Sessions (no.)	MI sessions (no.)	Total dose[c]	MI components (no.)
Ball et al.[60]	31[a]	C/AP	15	90% CA	Overweight and obesity	Body mass index (+) Waist circumference (+)	16	16	840	2
Barkin et al.[61]	72	Dyad/GRP	9	100% L	Overweight and obesity	Body mass index (+)	6	6	345	0
Black et al.[62]	235	C/AP	13	100% AA	Overweight and obesity	Physical activity (-) Nutrition (+) Body mass index (+) % overweight/obese (+)	12	12	NR	2
Borrelli et al.[14]	133	P	7	100% L	Smoking and tobacco	Smoking cessation (+)	4	2	166	11
Brown et al.[63]	191	C/AP	15	95% CA	Smoking and tobacco	Smoking cessation (+)	5	2	150	3
Colby et al.[64]	162	P/C	16	72% CA	Smoking and tobacco	Smoking cessation (+)	3	3	80	5
Davoli et al.[65]	372	Dyad	4	NR	Overweight and obesity	Physical activity (+) Screen viewing time (+) Nutrition (+) Body mass index (+) % overweight/obese (+)	5	5	225	4
Eakin et al.[66]	350	P	4	92% AA	Smoking and tobacco	Smoking cessation (+) Smoking ban (+) Secondhand smoking (NR)	5	5	103	11
Emmons et al.[67] Linked studies[68]	323	P	NR	NR	Smoking and tobacco	Smoking cessation (NR) Secondhand smoking (+)	5	1	78	6
Freudenthal and Brown[58]	72	P	1	NR	Oral health	Oral health management (+)	3	1	55	8
Haines et al.[69]	121	P	4	51% L	Overweight and obesity	Screen viewing time (+) Screen access (+) Body mass index (+)	8	8	NR	1
Halterman et al.[70]	530	P	7	63% AA	Smoking and tobacco	Secondhand smoking (+)	3	3	50	11
Harrison et al.[57] Linked studies[71]	272	P	NR	100% Cree	Oral health	Dental caries (+)	7	7	158	2
Harutunyan et al.[54]	250	Dyad	4	100% Armenian	Smoking and tobacco	Smoking cessation (+) Smoking ban (+) Secondhand smoking (+)	3	3	60	1
Ismail et al.[53]	1021	P	5	100% AA	Oral health	Nutrition (+) Dental caries (NR) Oral health management (+)	1	1	55	7
Linakis et al.[52]	89	Dyad	13	71% CA	Alcohol	Alcohol use (-)	3	3	43	6
MacDonell et al.[72]	49	Dyad	15	100% AA	Overweight and obesity	Physical activity (-) Nutrition (+) Body mass index (+)	4	4	240	3
Neumark-Sztainer et al.[73] Linked studies[74-76]	433	C/AP/GRP	16	28% AA	Overweight and obesity	Physical activity (+) Screen viewing time (+) Nutrition (+) Body mass index (+)	103	6	NR	7
Resnicow et al.[77]	147	C/Dyad/GRP	14	100% AA	Overweight and obesity	Body mass index (-) Waist circumference (+)	29	5	NR	5

Table continues on next page

Table 1. Continued

Study	N	Intervention composition	Child's age (mean yrs)	Child's ethnicity	Target	Study outcomes	Sessions (no.)	MI sessions (no.)	Total dose[c]	MI components (no.)
Small et al.[78]	67	P	6	NR	Overweight and obesity	Body mass index (+) Waist circumference (+)	8	4	240	3
Stotts et al.[28]	104[b]	P	NR	NR	Smoking and tobacco	Smoking ban (+)	2	2	75	5
Taveras et al.[79]	475	P	5	57% CA	Overweight and obesity	Screen viewing time (+) Screen access (+) Nutrition (+) Body mass index (+)	7	7	145	3
Van Grieken et al.[80] Linked studies[81,82]	637	P	6	78% Dutch	Overweight and obesity	Body mass index (-) % overweight/obese (-) Waist circumference (+) Physical activity (+) Nutrition (+) Screen viewing time (+)	3	3	180	0
Van Wely et al.[83] Linked studies[84]	50	C/Dyad/GRP	10	100% Dutch	Overweight and obesity	Physical activity (+)	5	2	NR	2
Weinstein et al.[10] Linked studies[9,85]	240	P	11	100% Punjabi	Oral health	Dental caries (+)	7	1	150	9

*N=number of consenting participants; C=child; P=parent; AP=ancillary parent; Dyad=parent-child dyad; GRP=group; CA=Caucasian; AA=African. American; L=Latino (a); MI=motivational interviewing; NR=not reported. A positive (+) or negative (-) sign after the study outcomes indicates the direction of the study-level effect size (i.e., treatment group improved or control group improved).

[a] The Youth Lifestyle Program (YLP) treatment condition is excluded because it did not use motivational interviewing techniques.

[b] The Usual Care—Reduced Measurement control condition is excluded because measures were unavailable for 1- and 3-month follow-up.

[c] Estimated number of minutes of intervention content excluding measurement.

content was tailored to the population, but only 64 percent (16/25) said they developed targeted intervention content from formative work.

Intervention content included: health-related education (100 percent); strategies to modify health behaviors (68 percent); and personalized risk assessments (44 percent). Most interventions provided general health-related materials (e.g., pamphlets; 76 percent) and/or boosters to enhance the intervention (88 percent). As shown in Table 2, the MI components used by more than half of the studies were collaboration (k=20), evocation (k=15), patient-centeredness (k=14), and autonomy (k=13). Studies, on average, described five MI components (±3.39 SD, range = zero to 11).

Description of the comparison conditions. Comparison conditions included assessment-only controls (28 percent) as well as active treatment comparisons (72 percent). The latter were typically delivered in a single session with a median of 13 minutes. Of the 18 studies with active controls, 13 provided content relevant to the target behavior (11 not time matched; two time-matched), two provided general health content (one not time matched; one time-matched), and three provided standard education only.

Methodological quality and treatment fidelity. Methodological quality of the studies ranged from nine to 17 (out of 20), with an average score of 14 (±1.96 SD). Overall, the studies satisfied an average of 70 percent (±0.10 SD) of the MQ criteria, indicating moderate to strong MQ. The total MQ score was not significantly correlated with any behavioral or biological outcome (P>.16).

The mean proportion adherence to treatment fidelity strategies was 40 percent (±19 SD). Most studies reported using theoretical models or clinical guidelines to guide their intervention (76 percent), but only a minority of studies assessed whether the provider acquired the intervention skills after training (20 percent) or included an assessment to examine whether the provider adhered to the intervention during the delivery (40 percent). Full details of the treatment fidelity strategies assessed appear in Table 3.

Efficacy of the MI interventions compared with comparison groups by health outcome. Table 4 provides the weighted mean effect sizes and homogeneity statistics by health-related behavioral and biomedical outcomes. Compared to comparison groups, participants who received an MI intervention reported improvements in their health-related behaviors at the final postintervention assessment. Parents in the MI intervention condition were more likely than comparison groups to report: increasing the oral health hygiene and management of their children (d_+=0.38, 95% CI =0.08, 0.68); increases in children's level of physical activity (d_+=0.15, 95% CI=0.03, 0.28); reductions in children's screen viewing time (d_+=0.16, 95% CI= 0.03, 0.29); less screen access for their children (d_+=0.19, 95% CI=0.02, 0.36); improvement in their children's

Table 2. DESCRIPTION OF STUDY, SAMPLE, AND INTERVENTION CHARACTERISTICS OF THE 25 INCLUDED STUDIES

Study characteristics	
Publication year, median (range)	2011 (2001-2014)
U.S. region: No. (%)	18 (72)
Research design and implementation	
Intervention setting: No. (%)	
Clinical	14 (56)
Nonclinical	11 (44)
Target outcome, no. (%)	
Alcohol	1 (4)
Oral health	4 (16)
Overweight and obesity	12 (48)
Smoking and tobacco	8 (32)
Postintervention assessments, median (range)	2 (1-3)
Methodological quality rating, median (range)	14 (9-17)
Sample characteristics	
Sample size, initial/final	6,513/5,130
Child	
Age, M±(SD)	9±(5)
Girls, M%±(SD)	56±(18)
Race/ethnic, M%±(SD)‡	
Caucasian	25±(36)
African American	36±(43)
Hispanic/Latino	20±(34)
Asian	2±(7)
Other	37±(48)
Parent	
Age, M±(SD)	33±(6)
Women, M%±(SD)	93±(7)
Race/ethnic, M%±(SD)‡	
Caucasian	13±(24)
African American	17±(33)
Hispanic/Latino	27±(40)
Asian	<1±(<1)
Other	54±(51)
Intervention characteristics	
Intervention dose, median (range)	
Sessions	5 (1-103)
MI sessions	3 (1-16)
Mins per session	26 (14-60)
Intervention session participant, no. studies†	
Parent only	15
Child only	3
Parent-child dyad	5
Child with ancillary parent	4
Group	3
Other	1
Facilitators, median (range)	1 (1-4)
Facilitators, no. studies†	
Peers	2
Paraprofessionals	11
Professional-in-training	2
Professionals	16
None/NR	2

Table 2. Continued

Intervention characteristics (continued)	
Delivery, no. studies†	
In-person	25
Facilitated by computer/technology	4
Electronic/postal mail	6
Print materials	6
Phone and/or pager	14
Intervention content tailored, no. (%)	25 (100)
Intervention content targeted, no (%)	16 (64)
Intervention content, no. (%)†	
Health information/education	25 (100)
Personalized risk assessment	11 (44)
Oral feedback	4 (36)
Written feedback	2 (18)
Both	5 (45)
Moderation strategies provided	17 (68)
Provided general health-related materials	19 (76)
Boosters or other relevant materials	22 (88)
MI components, no. (%)†	
Patient-centered	14 (56)
Autonomy	13 (52)
Expresses empathy	9 (36)
Evocation	15 (60)
Collaboration	20 (80)
Open-ended questions	8 (32)
Reflections	9 (36)
Affirmation	8 (32)
Permission	8 (32)
Values clarification	6 (24)
Decisional balance exercise	7 (28)
Treatment fidelity, M%±(SD)	40±(19)
Control characteristics	
Active control, no. (%)	18 (72)
Control dose, median (range)	
Sessions	2 (1-64)
Minutes per session	13 (5-60)
Control session participant, no. studies†	
Parent only	11
Child only	4
Parent-child dyad	4
Group	2
Facilitators, median (range)	1 (0-4)
Facilitators, no. studies†	
Peers	1
Paraprofessionals	5
Professionals	7
None/NR	7
Delivery, no. studies†	
In-person	10
Facilitated by computer/technology	2
Electronic/postal mail	3
Print materials	7
Phone and/or pager	3

* M=mean; SD=standard deviation; NR=not reported.
† Multiple categories were possible.
‡ Complete or partial race/ethnic information was provided in a subset of studies for the child ($k \leq 18$) and/or the parent ($k \leq 10$).

diet (d_+=0.24, 95% CI=0.09, 0.39); quitting smoking (d_+=0.33, 95% CI=0.03, 0.68); and employing greater smoking restrictions (d_+=0.17, 95% CI=0.01, 0.34). Linakis et al.[52] met the inclusion criteria, but we could not calculate an overall weighted mean effect size, because it was the only study that measured alcohol use (d=0.91; 95% CI=0.45, 1.37).

In terms of biometric measures, children in the MI intervention conditions had a lower BMI at the final assessment (d_+=0.13, 95% CI=0.02, 0.25) versus children in the comparison groups. The weighted mean effect size for dental caries was not significant but included one study in which the effect size was estimated as zero.[53] Removing this study resulted in an overall weighted mean effect size for dental caries: d_+=0.36 (95% CI=0.18, 0.55); k=2, Q [1]=0.24; heterogeneity was not significant. There were no differences between the MI intervention and comparison parents on the other biometric measures assessed (i.e., proportion of overweight/obese, waist circumference, proportion of body fat, or objectively measured secondhand smoke exposure).

Table 3. TREATMENT FIDELITY CHECKLIST

Treatment fidelity categories	Treatment fidelity strategies	Proportion (%)
Treatment design	Mention of provider credentials	72
	Mention of a theoretical model or clinical guidelines on which the intervention is based	76
Training providers	Description of how providers were trained	44
	Standardized provider training	60
	Measured provider skill acquisition post-training	20
	Described how provider skills maintained over time	56
Delivery of treatment	Method used to ensure that the content of the intervention was being delivered as specified	36
	Method used to ensure that the dose of the intervention was being delivered as specified	20
	Included mechanisms to assess if the provider actually adhered to the intervention	40
	Assessment of nonspecific treatment effects	12
	Use of treatment manual	56
Receipt of treatment	Assessment of the degree to which the participants understood the intervention	4
	Specified strategies used to improve the participant comprehension of the intervention	64
Enactment of treatment skills	Assessed participant performance of the intervention skills in settings in which the skills might be applied	20
	Assessed strategy to improve participant performance of the intervention skills in settings in which the skills might be applied	24

Homogeneity tests revealed significant heterogeneity for dental caries and the proportion of overweight/obese (P≥.001). Sources of heterogeneity could not be explored for these outcomes due to the limited number of studies assessing dental caries (k=3) and the proportion of overweight/obese (k=3). The hypothesis of homogeneity was supported for BMI and all behavioral outcomes, except for diet (i.e., healthy food consumption) and smoking cessation; meta-regression analyses were conducted for these two variables.

Meta-regression analyses. Meta-regression analyses were used to examine whether sample or intervention characteristics (determined a priori) related to the variability in the effect size distribution associated with diet (i.e., consumption) and smoking cessation rates.

Diet. MI interventions were more successful at improving diet when the study sampled more Caucasians (β=0.80, P=.051, $Q_{Residual}$ [1]=3.81) and the intervention included more MI components (β=0.81, P=.047, $Q_{Residual}$ [1]=3.93). The interventions were less successful at improving diet when the intervention was delivered in person (β = -0.80, P=.051, $Q_{Residual}$ [1] = 3.81); however, this finding may be spurious, as only a single study used delivery methods other than in person alone. No other intervention feature moderated the intervention impact on diet (i.e., food consumption).

Smoking cessation. Participants in the MI intervention were more successful at quitting smoking when the intervention with the total dose delivered (number of sessions times number of minutes) was less (β equals -0.38, P=.035, $Q_{Residual}$ [1]=4.43), used fewer MI components (β=-0.59, P<.001, $Q_{Residual}$ [1]=11.00), and had less parental involvement (β=-0.67, P<.001, $Q_{Residual}$ [1]=13.95). No other sample or intervention features moderated the intervention impact on smoking cessation. Supplemental analyses indicated that the meta-regression analyses were substantially influenced by a single study.[54] No significant predictors of smoking cessation were detected when the outlier was excluded.

Publication bias. We intended to assess funnel plot asymmetry and perform formal statistical tests for publication bias (i.e., Egger,[49] Begg[48]) but were unable to do so given the small number of studies available for each outcome (i.e., less than 10 studies).[55] Assessment of the funnel plot for BMI revealed no asymmetries that might be interpreted as publication bias. Results from Egger's[49] (P=.952) and Begg's[48] (P=.472) tests were non-significant. The funnel plot for BMI is presented in the supplemental digital content.

Discussion

The aim of our meta-analysis was to evaluate the effect of parent-involved MI on modifiable pediatric health behaviors and biomedical outcomes. Our results showed that, relative to comparison groups, parent-involved MI was associated with significant improvements in health behaviors (oral health management, diet, physical activity, reduced screen time and access, smoking cessation, and household smoking restrictions) and biomedical outcomes (reduced BMI and dental caries). Because there were only two studies on dental caries with usable data, these results, while promising, should be interpreted with caution. We did not find an effect of parent-involved MI on other biomedical outcomes (proportion of overweight/obese, waist circumference, proportion of body fat, or objectively measured second hand smoke exposure). Our meta-analysis contributes to extant literature because of its evaluation of the:

(1) effect of parental involvement in pediatric health behavior change; (2) number and type of MI components included in the intervention; and (3) treatment fidelity in general and in relation to specific features important for the delivery of MI (e.g., type of training, acquisition of MI skills, maintenance of MI skills over time). We also used rigorous criteria to evaluate outcomes, such that only the final evaluation point was used to assess the effect of MI on outcomes.

We found a significant effect of MI on oral health behaviors and management (e.g., toothbrushing, visiting the dentist) versus comparison groups across the four studies that met inclusion criteria. While three of these studies also included dental caries as an outcome, only two had sufficient data to be included in the analyses. Consistent with meta-analytic methodology,[36] we conservatively estimated the effect of the study to be zero. When all three studies were included in analyses, there was no MI effect on reducing pediatric dental caries; however, when only the studies with data were included, there was a significant MI effect. Although this estimate is based on a moderate sample size (N equals 443), additional studies are needed to confirm this effect. Gao et al.[56] performed a systematic review of 16 randomized controlled trials that evaluated the effectiveness of MI compared with health education on oral health behaviors among adults and children. Among adults, they found that MI was associated with improved periodontic health in five of seven trials, but the five trials with positive effects had short-term outcomes (less than eight weeks), whereas the two trials with negative effects had longer-term outcomes.

In terms of preventing early childhood caries, Gao et al.'s review included four studies that targeted oral health in children; all were included in our meta-analysis.[10,53,57,58] Our meta-analyses supports their finding that MI is associated with improvements in pediatric oral health behavior; however, our finding should be interpreted with caution, as it is based on a small number of studies evaluating parent-based MI interventions. Additional studies of the effect of parent-based MI on oral health behaviors and outcomes are needed, particularly those that involve objective measures of caries. One such trial is underway (NIDCR U54 DEO192745), involving training of lay providers to deliver MI to low-income and ethnically diverse caregivers of zero- to five-year-olds to improve pediatric oral health. In this trial, both oral health behaviors and objectively measured caries are assessed longitudinally.

Table 4. EFFICACY OF MOTIVATIONAL INTERVIEWING (MI) INTERVENTIONS RELATIVE TO CONTROL CONDITIONS*

Outcome	N	*k*	*d*+ (95% CI)	*Q*	I^2 (95% CI)
Behaviors					
Oral health					
Hygiene/management	667	2	0.38 (0.08, 0.68)	1.75	43 (0, 84)
Overweight/obesity					
Physical activity	1,223	6	0.15 (0.03, 0.28)	5.97	16 (0, 61)
Screen viewing time	1,554	5	0.16 (0.03, 0.29)	6.52	39 (0, 77)
Screen viewing access	549	2	0.19 (0.02, 0.36)	0.78	0
Diet	2,231	7	0.24 (0.09, 0.39)	17.88**	66 (25, 85)
Smoking/tobacco					
Smoking cessation†	1,153	6	0.33 (0.03, 0.63)	31.17**	84 (67, 92)
Smoking restrictions	574	3	0.17 (0.01, 0.34)	0.27	0
Biometric screening					
Oral health					
Dental caries†	1,045	3	0.23 (-0.05, 0.50)	8.64**	77 (25, 93)
Overweight/obesity					
Body mass index	2,259	11	0.13 (0.01, 0.25)	16.98	41 (0, 71)
Proportion of overweight/obese	1,188	3	0.17 (-0.10, 0.44)	9.80**	80 (35, 94)
Waist circumference	670	4	0.08 (-0.07, 0.23)	0.39	0
Proportion body fat	642	3	0.10 (-0.12, 0.32)	3.45	42 (0, 82)
Smoking/tobacco					
Secondhand smoking†	1,226	4	0.05 (-0.06, 0.16)	0.21	0

* CI=confidence interval. Weighted mean effect sizes (*d*+) are positive for differences that favor the treatment group relative to the control group. N=number of participants; k=number of studies; CI=confidence interval; Q=homogeneity statistic; I2=consistency of effect sizes.

** Heterogeneity is significant at $P<.05$.

† The weighted mean effect sizes for smoking cessation,[67] dental caries,[53] and secondhand smoking[66] was estimated as 0 for a single study. The overall weighted mean effect size for smoking cessation, dental caries, and secondhand smoking, after eliminating the estimated effect size, is $d+=0.40$ (95% CI=0.08, 0.73), $k=5$, $Q(4)=22.11$, $P<.001$, $d+=0.36$ (95% CI=0.18, 0.55), $k=2$, $Q(1)=0.24$, $d+=0.06$ (95% CI=-0.06, 0.19), $k=2$, $Q(2)=0.01$.

MI outperformed comparison treatments across all other health behaviors that were included in the articles in our meta-analysis, such as employing greater household smoking restrictions, quitting smoking, physical activity, screen viewing time and access, and diet. Effects ranged from small ($d_+^+=0.17$ for household smoking restrictions) to medium ($d_+^+=0.38$ for oral health behaviors). These results are conservative, as we used the final assessment point to estimate the effect of MI. Use of more proximal assessment points may have resulted in stronger effects. It was surprising that MI had a clearly significant effect on only one biomedical outcome (BMI) and a promising effect for another (dental caries). Meta-analyses of the effect of MI on physical health outcomes in adults have shown significant effects for BMI, HbA1c, blood cholesterol, and systolic blood pressure.[22]

Meta-regression analyses assessed whether sample or intervention characteristics were related to the variability of the effect size distribution for two outcomes that met the criteria for heterogeneity: diet and smoking cessation. MI interventions were more successful at improving diet when the study had a greater number of Caucasians in the sample. Our findings are in contrast to prior meta-analyses that found significantly larger effects of MI for minority versus nonminority populations.[20] Differences may be due to the isolation of specific health behaviors (i.e., diet) rather than combining all behavioral outcomes. Future research should evaluate whether parent-based MI interventions are more effective for minority versus nonminority populations. We also found that MI interventions were more successful at improving diet when the intervention included more MI components. Previous meta-analyses have not found a relationship between the intensity of MI and outcome; this may be due to the fact that effect sizes were computed across behaviors.[25] (Contemporary

meta-analytic methods compare subcategories of mean effect sizes rather than averaging the effect sizes from distinctly different outcomes.[36]) Several predictors of smoking cessation (e.g., intervention dose, level of parental involvement, and use of MI components) were found, but these results must be interpreted with caution as subsequent analyses indicated that the results were largely influenced by a single study. Therefore, more studies should be conducted to add to these data.

Treatment fidelity was low across the studies in our sample. The proportion of adherence to treatment fidelity strategies was 0.40 (±0.19 SD). Borrelli et al.[34] evaluated treatment fidelity in papers published in five peer-reviewed health behavior journals over 10 years and found a 55 percent adherence rate to treatment fidelity strategies, with only 16 percent of articles achieving more than 0.80 proportion adherence to the checklist. In the current study, none of the studies achieved greater than 0.80 proportion adherence, and only nine studies achieved more than 50 percent adherence to strategies. Only four of the studies in our sample used the Motivational Interviewing Treatment Integrity Coding[59] to objectively rate whether or not MI was delivered. Therefore, we cannot conclude with certainty that MI was actually implemented in the majority of the studies included in the meta-analysis. Future studies of the effect of MI on pediatric health can benefit from greater attention to treatment fidelity, especially in the areas of assessment of initial acquisition of MI skills, monitoring skills over time, and assessment of whether or not the intervention was delivered as specified.

Our meta-analysis is the only one that assessed whether or not the articles mentioned delivering specific MI components. The vast majority of trials included in our meta-analysis indicated that their MI intervention involved collaboration (k=20 out of 25), and most of the trials indicated that their MI intervention involved evocation (k=15), patient-centeredness (k=14), and autonomy (k=13). Less than half of the trials indicated that they delivered other components that are central to the spirit of MI (e.g., empathy, reflections, open-ended questions, affirmations, asking permission, decisional balance, and values clarification). It is unknown whether these components were delivered and not mentioned in the papers or whether these components were not delivered at all. Either way, lack of reporting or lack of implementation makes it difficult for readers to make strong conclusions about the effect of MI or to replicate findings and test mechanisms of the effects.

Our meta-analysis shows that parent-involved MI is effective in changing pediatric health behaviors, reducing BMI, and having a promising effect on dental caries. As of October 2014, 192 trials are currently funded by the NIH using MI. Many more trials have been conducted and concluded since the inception of MI. MI is increasingly being incorporated into medical education as a patient-centered method of assessment and intervention. The majority of the studies included in our meta-analyses were implemented in clinical settings or by phone supporting the feasibility of implementation by providers. Future research should focus on examining the effects of parent-involved MI on both behavior and health outcomes in longitudinal designs. Furthermore, greater attention needs to be paid to treatment fidelity in order to improve both internal and external validity. Additionally, MI training and intervention features should be described in greater detail in published articles or online supplements for the purpose of aiding in interpretability and replicability.

Conclusions

Based on this study's results, the following conclusions can be made:

1. There is evidence to support the use of parent-involved motivational interviewing in improving a variety of pediatric health behaviors and outcomes (e.g., oral health, diet, physical activity, reduced screen time, smoking cessation, reduced secondhand smoke, body mass index).
2. Parent-involved MI improves pediatric oral health behaviors. MI may be useful for reducing dental caries, but more studies are needed.
3. Parent-involved MI interventions were more successful at improving diet when the intervention included a greater number of MI components.
4. There is insufficient evidence to support the use of MI interventions for other weight-related outcomes (i.e., proportion of overweight/obese, waist circumference, proportion of body fat) or objectively measured secondhand smoke exposure.

References

1. Miller WR, Rollnick S. Motivational Interviewing: Preparing People for Change. 2nd ed. New York, N.Y., USA: Guilford Press; 2002.
2. Boardman T, Catley D, Grobe JE, Little TD, Ahluwalia JS. Using motivational interviewing with smokers: do therapist behaviors relate to engagement and therapeutic alliance? J Subst Abuse Treat 2006;31:329-39.
3. Miller WR, Benefield RG, Tonigan JS. Enhancing motivation for change in problem drinking: a controlled comparison of two therapist styles. J Consult Clin Psychol 1993;61:455-61.
4. Moyers TB, Martin T. Therapist influence on client language during motivational interviewing sessions. J Subst Abuse Treat 2006;30:245-51.
5. Miller WR. Motivational interviewing in service to health promotion. Am J Health Promot 2004;18:a1-a10.
6. Rollnick S, Miller WR, Butler C. Motivational Interviewing in Health Care: Helping Patients Change Behavior. New York, N.Y., USA: Guilford Press; 2008.
7. Hardcastle S, Taylor A, Bailey M, Castle R. A randomised controlled trial on the effectiveness of a primary health care based counselling intervention on physical activity, diet and CHD risk factors. Patient Educ Couns 2008; 70:31-9.
8. Channon SJ, Huws-Thomas MV, Rollnick S, et al. A multicenter randomized controlled trial of motivational interviewing in teenagers with diabetes. Diabetes Care 2007;30:1390-5.
9. Weinstein P, Harrison R, Benton T. Motivating mothers to prevent caries: confirming the beneficial effect of counseling. J Am Dent Assoc 2006;137:789-93.
10. Weinstein P, Harrison R, Benton T. Motivating parents to prevent caries in their young children: one-year findings. J Am Dent Assoc 2004;135:731-8.
11. Kemp R, Kirov G, Everitt B, Hayward P, David A. Randomised controlled trial of compliance therapy: 18-month follow-up. Br J Psychiatry 1998;172:413-9.
12. Drymalski WM, Campbell TC. A review of motivational interviewing to enhance adherence to antipsychotic medication in patients with schizophrenia: evidence and recommendations. J Ment Health 2009;18:6-15.

13. Greaves CJ, Middlebrooke A, O'Loughlin L, et al. Motivational interviewing for modifying diabetes risk: a randomised controlled trial. Br J Gen Pract 2008;58:535-40.
14. Borrelli B, McQuaid EL, Novak SP, Hammond SK, Becker B. Motivating Latino caregivers of children with asthma to quit smoking: a randomized trial. J Consult Clin Psych 2010;78:34-43.
15. Lundahl B, Moleni T, Burke BL, et al. Motivational interviewing in medical care settings: a systematic review and meta-analysis of randomized controlled trials. Patient Educ Couns 2013;93:157-68.
16. Rongkavilit C, Naar-King S, Wang B, et al. Motivational interviewing targeting risk behaviors for youth living with HIV in Thailand. AIDS Behav 2013;17:2063-74.
17. Hodgins DC, Currie SR, el-Guebaly N. Motivational enhancement and self-help treatments for problem gambling. J Consult Clin Psychol 2001;69:50-7.
18. Armstrong MJ, Mottershead TA, Ronksley PE, Sigal RJ, Campbell TS, Hemmelgarn BR. Motivational interviewing to improve weight loss in overweight and/or obese patients: a systematic review and meta-analysis of randomized controlled trials. Obes Rev 2011;12:709-23.
19. Burke BL, Arkowitz H, Menchola M. The efficacy of motivational interviewing: a meta-analysis of controlled clinical trials. J Consult Clin Psychol 2003;71:843-61.
20. Hettema J, Steele J, Miller WR. Motivational interviewing. Annu Rev Clin Psychol 2005;1:91-111.
21. Vasilaki EI, Hosier SG, Cox WM. The efficacy of motivational interviewing as a brief intervention for excessive drinking: a meta-analytic review. Alcohol Alcohol 2006; 41:328-335.
22. Rubak S, Sandbaek A, Lauritzen T, Christensen B. Motivational interviewing: a systematic review and meta-analysis. Br J Gen Pract 2005;55:305-12.
23. Foxcroft DR, Coombes L, Wood S, Allen D, Almeida Santimano NM. Motivational interviewing for alcohol misuse in young adults. Cochrane Database Syst Rev 2014;8:CD007025.
24. Seitz V, Apfel NH. Parent-focused intervention: diffusion effects on siblings. Child Dev 1994;65:677-83.
25. Gayes LA, Steele RG. A meta-analysis of motivational interviewing interventions for pediatric health behavior change. J Consult Clin Psychol 2014;82:521-35.
26. Carr A. The effectiveness of family therapy and systemic interventions for child-focused problems. J Fam Ther 2009;31:3-45.
27. U.S. Department of Health and Human Services, Office of Disease Prevention and Health Promotion. Healthy People 2020. Available at: "http://www.healthypeople.gov/". Accessed October 8, 2014. Archived by WebCite® at: "http://www.webcitation.org/6XoPQvAP0". Accessed April 15, 2015.
28. Stotts AL, Green C, Northrup TF, et al. Feasibility and efficacy of an intervention to reduce secondhand smoke exposure among infants discharged from a neonatal intensive care unit. J Perinatol 2013;33:811-6.
29. Grissom RJ. The magical number .7 +/- .2: meta-meta-analysis of the probability of superior outcome in comparisons involving therapy, placebo, and control. J Consult Clin Psychol 1996;64(2):973-82.
30. Jadad AR, Moore RA, Carroll D, et al. Assessing the quality of reports of randomized clinical trials: is blinding necessary? Controlled Clin Trials 1996;17:1-12.
31. Miller WR, Brown JM, Simpson TL, Handmaker NS, Bien TH, Luckie LF. What works? A methodological analysis of the alcohol treatment outcome literature. In: Hester RK, Miller WR, eds. Handbook of Alcoholism Treatment Approaches: Effective Alternatives. 2nd ed. Needham Heights, Mass., USA: Allyn and Bacon; 1995: 12-44.
32. Miller WR, Wilbourne PL. Mesa Grande: A methodological analysis of clinical trials of treatments for alcohol use disorders. Addiction 2002;97:265-77.
33. Borrelli B. The assessment, monitoring, and enhancement of treatment fidelity in public health clinical trials. J Public Health Dent 2011;71:s52-s63.
34. Borrelli B, Sepinwall D, Ernst D, et al. A new tool to assess treatment fidelity and evaluation of treatment fidelity across 10 years of health behavior research. J Consult Clin Psychol 2005;73:852-60.
35. Cohen J. Statistical Power Analysis for the Behavioral Sciences. 2nd ed. New York, N.Y., USA: Erlbaum; 1988.
36. Lipsey MW, Wilson DB. Practical Meta-Analysis. Thousand Oaks, Calif., USA: Sage; 2001.
37. Sanchez-Meca J, Marin-Martinez F, Chacon-Moscoso S. Effect-size indices for dichotomized outcomes in meta-analysis. Psychol Methods 2003;8:448-67.
38. Morris SB, DeShon RP. Combining effect size estimates in meta-analysis with repeated measures and independent-groups designs. Psychol Methods 2002;7:105-25.
39. Pigott TD. Handling missing data. In: Cooper H, Hedges LV, Valentine JC, eds. The Handbook of Research Synthesis. 2nd ed. New York, N.Y., USA: Sage; 1994:399-416.
40. Hedges LV. Distribution theory for Glass's estimator of effect size and related estimators. J Educ Stat 1981;6: 107-28.
41. Johnson BT, Scott-Sheldon LA, Carey MP. Meta-synthesis of health behavior change meta-analyses. Am J Public Health 2010;100:2193-8.
42. Huedo-Medina TB, Sanchez-Meca J, Marin-Martinez F, Botella J. Assessing heterogeneity in meta-analysis: Q statistic or I2 index? Psychol Methods 2006;11:193-206.
43. Higgins JP, Thompson SG. Quantifying heterogeneity in a meta-analysis. Stat Med 2002;21:1539-58.
44. Hedges LV. Fixed effects models. In: Cooper H, Hedges LV, eds. The Handbook of Research Synthesis. New York, N.Y., USA: Russell Sage Foundation; 1994:285-99.
45. StataCorp LP. Stata Statistical Software, 13.0. College Station, Texas, USA: StataCorp, LP; 2013.
46. Rosenthal R. The file drawer problem and tolerance for null results. Psychol Bull 1979;86:638-41.
47. Sterne JA, Egger M. Funnel plots for detecting bias in meta-analysis: guidelines on choice of axis. J Clin Epidemiol 2001;54:1046-55.
48. Begg CB, Mazumdar M. Operating characteristics of a rank correlation test for publication bias. Biometrics 1994;50:1088-101.
49. Egger M, Smith GD, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. BMJ 1997;315:629-34.
50. Duval S, Tweedie R. Trim and fill: a simple funnel-plot–based method of testing and adjusting for publication bias in meta-analysis. Biometrics 2000;56:455-63.
51. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics 1977;33: 159-74.

52. Linakis JG, Bromberg J, Baird J, et al. Feasibility and acceptability of a pediatric emergency department alcohol prevention intervention for young adolescents. Pediatr Emerg Care 2013;29:1180-8.
53. Ismail AI, Ondersma S, Jedele JMW, Little RJ, Lepkowski JM. Evaluation of a brief tailored motivational intervention to prevent early childhood caries. Community Dent Oral 2011;39:433-48.
54. Harutyunyan A, Movsisyan N, Petrosyan V, Petrosyan D, Stillman F. Reducing children's exposure to secondhand smoke at home: a randomized trial. Pediatrics 2013;132: 1071-80.
55. Lau J, Ioannidis JPA, Terrin N, Schmid C, Olkin I. The case of the misleading funnel plot. Br Med J 2006;333: 597-600.
56. Gao X, Lo EC, Kot SC, Chan KC. Motivational interviewing in improving oral health: a systematic review of randomized controlled trials. J Periodontol 2014;85: 426-37.
57. Harrison RL, Veronneau J, Leroux B. Effectiveness of maternal counseling in reducing caries in Cree children. J Dent Res 2012;91:1032-7.
58. Freudenthal JJ, Bowen DM. Motivational interviewing to decrease parental risk-related behaviors for early childhood caries. J Dent Hyg 2010;84:29-34.
59. Moyers TB, Martin T, Manuel JK, Hendrickson SM, Miller WR. Assessing competence in the use of motivational interviewing. J Subst Abuse Treat 2005;28:19-26.
60. Ball GD, Mackenzie-Rife KA, Newton MS, et al. One-on-one lifestyle coaching for managing adolescent obesity: findings from a pilot, randomized controlled trial in a real-world, clinical setting. Pediatr Child Health 2011; 16:345-50.
61. Barkin SL, Gesell SB, Poe EK, Ip EH. Changing overweight Latino preadolescent body mass index: the effect of the parent-child dyad. Clin Pediatr (Phila) 2011;50: 29-36.
62. Black MM, Hager ER, Le K, et al. Challenge! Health promotion/obesity prevention mentorship model among urban, black adolescents. Pediatrics 2010;126:280-8.
63. Brown RA, Ramsey SE, Strong DR, et al. Effects of motivational interviewing on smoking cessation in adolescents with psychiatric disorders. Tob Control 2003;12(Suppl 4): IV3-10.
64. Colby SM, Nargiso J, Tevyaw TOL, et al. Enhanced motivational interviewing versus brief advice for adolescent smoking cessation: Results from a randomized clinical trial. Addict Behav 2012;37:817-23.
65. Davoli AM, Broccoli S, Bonvicini L, et al. Pediatrician-led motivational interviewing to treat overweight children: an RCT. Pediatrics 2013;132:e1236-e1246.
66. Eakin MN, Rand CS, Borrelli B, Bilderback A, Hovell M, Riekert KA. Effectiveness of motivational interviewing to reduce Head Start children's secondhand smoke exposure: a randomized clinical trial. Am J Resp Crit Care 2014;189:1530-1537.
67. Emmons KM, Hammond SK, Fava JL, Velicer WF, Evans JL, Monroe AD. A randomized trial to reduce passive smoke exposure in low-income households with young children. Pediatrics 2001;108:18-24.
68. Emmons KM, Wong M, Hammond SK, et al. Intervention and policy issues related to children's exposure to environmental tobacco smoke. Prev Med 2001;32: 321-31.
69. Haines J, McDonald J, O'Brien A, et al. Healthy Habits, Happy Homes: randomized trial to improve household routines for obesity prevention among preschool-aged children. JAMA Pediatr 2013;167:1072-9.
70. Halterman JS, Szilagyi PG, Fisher SG, et al. Randomized controlled trial to improve care for urban children with asthma: results of the School-Based Asthma Therapy trial. Arch Pediatr Adolesc Med 2011;165:262-8.
71. Harrison R, Veronneau J, Leroux B. Design and implementation of a dental caries prevention trial in remote Canadian Aboriginal communities. Trials 2010;11:54.
72. Macdonell K, Brogan K, Naar-King S, Ellis D, Marshall S. A pilot study of motivational interviewing targeting weight-related behaviors in overweight or obese African American adolescents. J Adolesc Health 2012;50:201-3.
73. Neumark-Sztainer DR, Friend SE, Flattum CF, et al. New moves-preventing weight-related problems in adolescent girls a group-randomized study. Am J Prev Med 2010; 39:421-32.
74. Neumark-Sztainer D, Flattum CF, Story M, Feldman S, Petrich CA. Dietary approaches to healthy weight management for adolescents: the New Moves model. Adolesc Med State Art Rev 2008;19(3):421-30, viii.
75. Neumark-Sztainer D, Story M, Hannan PJ, Rex J. New Moves: a school-based obesity prevention program for adolescent girls. Prev Med 2003;37:41-51.
76. Flattum C, Friend S, Story M, Neumark-Sztainer D. Evaluation of an individualized counseling approach as part of a multicomponent school-based program to prevent weight-related problems among adolescent girls. J Am Diet Assoc 2011;111:1218-23.
77. Resnicow K, Taylor R, Baskin M, McCarty F. Results of go girls: a weight control program for overweight African-American adolescent females. Obes Res 2005;13: 1739-48.
78. Small L, Bonds-McClain D, Melnyk B, Vaughan L, Gannon AM. The preliminary effects of a primary care-based randomized treatment trial with overweight and obese young children and their parents. J Pediatr Health Care 2014;28:198-207.
79. Taveras EM, Gortmaker SL, Hohman KH, et al. Randomized controlled trial to improve primary care to prevent and manage childhood obesity: the High Five for Kids study. Arch Pediatr Adolesc Med 2011;165:714-22.
80. van Grieken A, Veldhuis L, Renders CM, et al. Population-based childhood overweight prevention: outcomes of the 'Be active, eat right' study. PloSOne 2013;8(5):1-9.
81. van Grieken A, Renders CM, Veldhuis L, Looman CW, Hirasing RA, Raat H. Promotion of a healthy lifestyle among 5-year-old overweight children: health behavior outcomes of the Be Ative, Eat Right study. BMC Public Health 2014;14:59.
82. Veldhuis L, Struijk MK, Kroeze W, et al. Be Active, Eat Right: evaluation of an overweight prevention protocol among 5-year-old children: design of a cluster randomised controlled trial. BMC Public Health 2009;9:177.
83. Van Wely L, Balemans AC, Becher JG, Dallmeijer AJ. Physical activity stimulation program for children with cerebral palsy did not improve physical activity: a randomised trial. J Physiother 2014;60:40-9.

84. Van Wely L, Balemans AC, Becher JG, Dallmeijer AJ. The effectiveness of a physical activity stimulation programme for children with cerebral palsy on social participation, self-perception and quality of life: a randomized controlled trial. Clin Rehabil 2014;28(10):972-82. doi: 10.1177/0269215513500971. Epub 2013 Sep 18.

85. Harrison R, Benton T, Everson-Stewart S, Weinstein P. Effect of motivational interviewing on rates of early childhood caries: a randomized trial. Pediatr Dent 2007; 29(1):16-22.

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Riley P, Moore D, Ahmed F, Sharif MO, Worthington HV

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WILEY

[Intervention Review]

Xylitol-containing products for preventing dental caries in children and adults

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ABSTRACT

Background

Dental caries is a highly prevalent chronic disease which affects the majority of people. It has been postulated that the consumption of xylitol could help to prevent caries. The evidence on the effects of xylitol products is not clear and therefore it is important to summarise the available evidence to determine its effectiveness and safety.

Objectives

To assess the effects of different xylitol-containing products for the prevention of dental caries in children and adults.

Search methods

We searched the following electronic databases: the Cochrane Oral Health Group Trials Register (to 14 August 2014), the Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library*, 2014, Issue 7), MEDLINE via OVID (1946 to 14 August 2014), EMBASE via OVID (1980 to 14 August 2014), CINAHL via EBSCO (1980 to 14 August 2014), Web of Science Conference Proceedings (1990 to 14 August 2014), Proquest Dissertations and Theses (1861 to 14 August 2014). We searched the US National Institutes of Health Trials Register (http://clinicaltrials.gov) and the WHO Clinical Trials Registry Platform for ongoing trials. No restrictions were placed on the language or date of publication when searching the electronic databases.

Selection criteria

We included randomised controlled trials assessing the effects of xylitol products on dental caries in children and adults.

Data collection and analysis

Two review authors independently screened the results of the electronic searches, extracted data and assessed the risk of bias of the included studies. We attempted to contact study authors for missing data or clarification where feasible. For continuous outcomes, we used means and standard deviations to obtain the mean difference and 95% confidence interval (CI). We used the continuous data to calculate prevented fractions (PF) and 95% CIs to summarise the percentage reduction in caries. For dichotomous outcomes, we reported risk ratios (RR) and 95% CIs. As there were less than four studies included in the meta-analysis, we used a fixed-effect model. We planned to use a random-effects model in the event that there were four or more studies in a meta-analysis.

Main results

We included 10 studies that analysed a total of 5903 participants. One study was assessed as being at low risk of bias, two were assessed as being at unclear risk of bias, with the remaining seven being at high risk of bias.

The main finding of the review was that, over 2.5 to 3 years of use, a fluoride toothpaste containing 10% xylitol may reduce caries by 13% when compared to a fluoride-only toothpaste (PF -0.13, 95% CI -0.18 to -0.08, 4216 children analysed, low-quality evidence).

The remaining evidence on children, from small single studies with risk of bias issues and great uncertainty associated with the effect estimates, was insufficient to determine a benefit from xylitol products. One study reported that xylitol syrup (8 g per day) reduced caries by 58% (95% CI 33% to 83%, 94 infants analysed, low quality evidence) when compared to a low-dose xylitol syrup (2.67 g per day) consumed for 1 year.

The following results had 95% CIs that were compatible with both a reduction and an increase in caries associated with xylitol: xylitol lozenges versus no treatment in children (very low quality body of evidence); xylitol sucking tablets versus no treatment in infants (very low quality body of evidence); xylitol tablets versus control (sorbitol) tablets in infants (very low quality body of evidence); xylitol wipes versus control wipes in infants (low quality body of evidence).

There was only one study investigating the effects of xylitol lozenges, when compared to control lozenges, in adults (low quality body of evidence). The effect estimate had a 95% CI that was compatible with both a reduction and an increase in caries associated with xylitol.

Four studies reported that there were no adverse effects from any of the interventions. Two studies reported similar rates of adverse effects between study arms. The remaining studies either mentioned adverse effects but did not report any usable data, or did not mention them at all. Adverse effects include sores in the mouth, cramps, bloating, constipation, flatulence, and loose stool or diarrhoea.

Authors' conclusions

We found some low quality evidence to suggest that fluoride toothpaste containing xylitol may be more effective than fluoride-only toothpaste for preventing caries in the permanent teeth of children, and that there are no associated adverse-effects from such toothpastes. The effect estimate should be interpreted with caution due to high risk of bias and the fact that it results from two studies that were carried out by the same authors in the same population. The remaining evidence we found is of low to very low quality and is insufficient to determine whether any other xylitol-containing products can prevent caries in infants, older children, or adults.

PLAIN LANGUAGE SUMMARY

Can xylitol used in products like sweets, candy, chewing gum and toothpaste help prevent tooth decay in children and adults?

Review question

This review has been produced to assess whether or not xylitol, a natural sweetener used in products such as sweets, candy, chewing gum and toothpaste, can help prevent tooth decay in children and adults.

Background

Tooth decay is a common disease affecting up to 90% of children and most adults worldwide. It impacts on quality of life and can be the reason for thousands of children needing dental treatment under general anaesthetic in hospital. However, it can easily be prevented and treated by good oral health habits such as brushing teeth regularly with toothpaste that contains fluoride and cutting down on sugary food and drinks. If left undisturbed, the unhelpful bacteria in the mouth - which cause decay - multiply and stick to the surfaces of teeth producing a sticky film. Then, when sugar is eaten or drank, the bad bacteria in the film are able to make acid resulting in tooth decay.

Xylitol is a natural sweetener, which is equally as sweet as normal sugar (sucrose). As well as providing an alternative to sugar, it has other properties that are thought to help prevent tooth decay, such as increasing the production of saliva and reducing the growth of bad bacteria in the mouth so that less acid is produced.

In humans, xylitol is known to cause possible side effects such as bloating, wind and diarrhoea.

Study characteristics

Authors from the Cochrane Oral Health Group carried out this review of existing studies and the evidence is current up to 14 August 2014. It includes 10 studies published from 1991 to 2014 in which 7969 participants were randomised (5903 of whom were included in the analyses) to receive xylitol products or a placebo (a substitute without xylitol) or no treatment, and the amount of tooth decay was compared. One study included adults, the others included children aged from 1 month to 13 years. The products tested were the kind that are held in the mouth and sucked (lozenges, sucking tablets and sweets) or slowly released through a dummy/pacifier, as well as toothpastes, syrups, and wipes.

Key results

There is some evidence to suggest that using a fluoride toothpaste containing xylitol may reduce tooth decay in the permanent teeth of children by 13% over a 3 year period when compared to a fluoride-only toothpaste. Over this period, there were no side effects reported by the children. The remaining evidence we found did not allow us to conclude whether or not any other xylitol-containing products can prevent tooth decay in infants, older children, or adults.

Quality of the evidence

The evidence presented is of low to very low quality due to the small amount of available studies, uncertain results, and issues with the way in which they were conducted.

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Chlorhexidine treatment for the prevention of dental caries in children and adolescents (Review)

Walsh T, Oliveira-Neto JM, Moore D

Walsh T, Oliveira-Neto JM, Moore D.
Chlorhexidine treatment for the prevention of dental caries in children and adolescents.
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[Intervention Review]

Chlorhexidine treatment for the prevention of dental caries in children and adolescents

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ABSTRACT

Background

Dental caries (tooth decay) is a common disease that is preventable by reducing the dietary intake of free sugars and using topical sodium fluoride products. An antibacterial agent known as chlorhexidine may also help prevent caries. A number of over-the-counter and professionally administered chlorhexidine-based preparations are available in a variety of formulations and in a range of strengths. Although previous reviews have concluded that some formulations of chlorhexidine may be effective in inhibiting the progression of established caries in children, there is currently a lack of evidence to either claim or refute a benefit for its use in preventing dental caries.

Objectives

To assess the effects of chlorhexidine-containing oral products (toothpastes, mouthrinses, varnishes, gels, gums and sprays) on the prevention of dental caries in children and adolescents.

Search methods

We searched the Cochrane Oral Health Group Trials Register (25 February 2015), the Cochrane Central Register of Controlled Trials (CENTRAL; 2014, Issue 12), MEDLINE via OVID (1946 to 25 February 2015), EMBASE via OVID (1980 to 25 February 2015) and CINAHL via EBSCO (1937 to 25 February 2015). We handsearched several journals placed no language restrictions on our search. After duplicate citations were removed, the electronic searches retrieved 1075 references to studies.

Selection criteria

We included parallel-group, randomised controlled trials (RCTs) that compared the caries preventive effects of chlorhexidine gels, toothpastes, varnishes, mouthrinses, chewing gums or sprays with each other, placebo or no intervention in children and adolescents. We excluded trials with combined interventions of chlorhexidine and fluoride or comparisons between chlorhexidine and fluoride interventions.

Data collection and analysis

Two review authors independently extracted trial data and assessed risk of bias. We resolved disagreements by consensus. We contacted trial authors for clarification or additional study details when necessary. The number of included studies that were suitable for meta-analysis was limited due to the clinical diversity of the included studies with respect to age, composition of intervention, and variation in outcome measures and follow-up. Where we were unable to conduct meta-analysis, we elected to present a narrative synthesis of the results.

Main results

We included eight RCTs that evaluated the effects of chlorhexidine varnishes (1%, 10% or 40% concentration) and chlorhexidine gel (0.12%) on the primary or permanent teeth, or both, of children from birth to 15 years of age at the start of the study. The studies randomised a total of 2876 participants, of whom 2276 (79%) were evaluated. We assessed six studies as being at high risk of bias overall and two studies as being at unclear risk of bias overall. Follow-up assessment ranged from 6 to 36 months.

Six trials compared chlorhexidine varnish with placebo or no treatment. It was possible to pool the data from two trials in the permanent dentition (one study using 10% chlorhexidine and the other, 40%). This led to an increase in the DMFS increment in the varnish group of 0.53 (95% confidence interval (CI) -0.47 to 1.53; two trials, 690 participants; very low quality evidence). Only one trial (10% concentration chlorhexidine varnish) provided usable data for elevated mutans streptococci levels $\geq$ 4 with RR 0.93 (95% CI 0.80 to 1.07, 496 participants; very low quality evidence). One trial measured adverse effects (for example, ulcers or tooth staining) and reported that there were none; another trial reported that no side effects of the treatment were noted. No trials reported on pain, quality of life, patient satisfaction or costs.

Two trials compared chlorhexidine gel (0.12% concentration) with no treatment in the primary dentition. The presence of new caries gave rise to a 95% confidence interval that was compatible with either an increase or a decrease in caries incidence (RR 1.00, 95% CI 0.36 to 2.77; 487 participants; very low quality evidence). Similarly, data for the effects of chlorhexidine gel on the prevalence of mutans streptococci were inconclusive (RR 1.26, 95% CI 0.95 to 1.66; two trials, 490 participants; very low quality evidence). Both trials measured adverse effects and did not observe any. Neither of these trials reported on the other secondary outcomes such as measures of pain, quality of life, patient satisfaction or direct and indirect costs of interventions.

Authors' conclusions

We found little evidence from the eight trials on varnishes and gels included in this review to either support or refute the assertion that chlorhexidine is more effective than placebo or no treatment in the prevention of caries or the reduction of mutans streptococci levels in children and adolescents. There were no trials on other products containing chlorhexidine such as sprays, toothpastes, chewing gums or mouthrinses. Further high quality research is required, in particular evaluating the effects on both the primary and permanent dentition and using other chlorhexidine-containing oral products.

PLAIN LANGUAGE SUMMARY

Antiseptic treatment (chlorhexidine) to prevent tooth decay in children and young people

Review question

This review examined the effectiveness of varnishes and gels containing chlorhexidine in preventing tooth decay in children and young people.

Background

Tooth decay is a very common disease that over time destroys the tooth surface. It has been estimated to affect up to 80% of people in high-income countries and, despite being preventable through oral hygiene and dietary measures and the use of agents such as fluoride that reduce risk of decay, it is likely to remain a problem, especially in low-income countries. Tooth decay can result in pain and infection, and in young children may require treatment in hospital under a general anaesthetic. As well as causing anxiety and pain, this may mean the child or young person missing time at school and their parents or carers having to take time off work, possibly losing income and incurring extra costs. Prevention of tooth decay is simpler and possibly cheaper than waiting until it occurs and then requires extensive treatment.

Tooth decay is largely preventable, and a range of things may assist this: twice-daily toothbrushing with a fluoride toothpaste, reducing both the amount of and number of times per day sugar is eaten, and drinking water that contains fluoride (bottled or tap, depending on where you live).

Tooth decay occurs when certain types of bacteria (germs) in the mouth, such as *Streptococcus mutans,* produce acids from the sugar we eat, which dissolve the hard enamel coating on our teeth. The chemical antiseptic treatment chlorhexidine is highly successful at destroying these bacteria and can be used safely at home in the form of a gel, spray, chewing gum, toothpaste or mouthrinse. Alternatively, chlorhexidine can be applied as a varnish to the surface of teeth by a dentist.

Study characteristics

The evidence in this review, carried out through the Cochrane Oral Health Group, is up-to-date at 25 February 2015. We found eight studies that were suitable to include in this review. The studies involved a total of 2876 children from birth to 15 years of age who were at moderate to high risk of tooth decay. Six of the studies looked at the effects of dental professionals applying different strengths of chlorhexidine varnishes to the baby teeth, permanent teeth or both types of teeth in children and adolescents. The other two studies looked at the effects of parents placing chlorhexidine gel on their children's baby teeth. There were no studies that examined other products containing chlorhexidine, such as sprays, toothpastes, chewing gums or mouthrinses.

Key results

The results did not provide evidence that chlorhexidine varnish or gel reduces tooth decay or reduces the bacteria that encourage tooth decay. The studies did not evaluate other outcomes such as pain, quality of life, patient satisfaction or direct and indirect costs of interventions. Four studies measured side effects and found none were observed.

Quality of the evidence

Due to the lack of suitable studies and concerns about possible bias in the included studies, the evidence is very low quality. As a result, we are not able to conclude whether or not chlorhexidine is effective in preventing tooth decay in children or adolescents, when compared to placebo (an inactive substitute for chlorhexidine) or no treatment. Future research on the use of chlorhexidine to prevent tooth decay is needed and should consider both primary and permanent teeth and should assess other chlorhexidine-containing products that can be used at home, such as toothpastes or mouthrinses.

Conference Paper

The Indian Health Service Early Childhood Caries Collaborative: A Five-year Summary

Timothy L. Ricks, DMD, MPH[1] • Kathy R. Phipps, DrPH[2] • Bonnie Bruerd, DrPH[3]

Abstract: ***Purpose:*** *The purpose of this study was to assess a national initiative's effect on prevalence of early childhood caries and untreated decay in zero- to five-year-old Indian/Alaska Native preschool children.* ***Methods:*** *The Indian Health Service (IHS) conducted a five-year Early Childhood Caries Collaborative from October 1, 2009 to September 30, 2014. The program used educational materials and routine communication with the 322 IHS and United States tribal dental programs, with an emphasis on early access to care, dental sealanth, fluoride varnish, and interim therapeutic restorations (ITRs). Prevalence and untreated decay data were obtained through the nationwide oral health survey (2010 and 2014). Data were also collected on access to care, sealants, fluoride, and ITRs.* ***Results:*** *The number of zero- to five-year-olds with a dental visit increased seven percent: dental sealants placed increased 65 percent; and fluoride varnish applications increased 161.2 percent. Between 2010 and 2014, the percentage of one- to two-year-olds with decay experience and untreated decay declined, but the difference was not statistically significant.* ***Conclusions:*** *Early childhood caries prevention strategies, such as early access to dental care, sealants, fluoride varnish, and interim therapeutic restorations, demonstrated some initial improvement in the oral health status of zero- to five-year-old Indian/Alaska Native children.*
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KEYWORDS: AMERICAN INDIAN, ALASKA NATIVE, EARLY CHILDHOOD CARIES, PREVALENCE

The Indian Health Service (**IHS**), an agency within the U.S. Department of Health and Human Services, is responsible for providing health services to 2.2 million American Indians and Alaska Natives (**AI/AN**) from 566 federally recognized tribes in the United States. Health care is provided through a Congressional appropriation of $4.4 billion and carried out through 45 hospitals, 310 health centers, 164 Alaska village clinics, and 104 health stations in 35 states. Oral health care is provided at 322 dental programs by 290 federally hired dentists and an estimated 300-plus tribally hired dentists.[1]

Shortly after it became an agency, the IHS began an annual nationwide oral health monitoring system in 1957, which was terminated in 1978 and replaced by nationwide surveys in 1984, 1991, and 1999. These surveys sampled IHS dental clinic patients to determine the prevalence and severity of dental diseases in specific age groups: two- to five-year-olds; six- to 14-year-olds; 15- to 19-year-olds, 35- to 44-year-olds; and 55 years and older.[2-4] In 2010, partly due to concerns about overrepresentation of early childhood caries (**ECC**) prevalence in a clinic-based sample of preschool children, the IHS began to use a community-based survey methodology: the Basic Screening Survey (**BSS**), developed by the Association of State and Territorial Dental Directors.[5] Subsequently, the IHS used the BSS to survey one- to five-year-old AI/AN children in 2010, six- to nine-year-old AI/AN children in 2011 to 2012, 13- to 15-year-old AI/AN youth in 2013, and one- to five-year-old AI/AN children once again in 2014.

The 1983 to 1984 survey first brought attention to the problem of baby bottle tooth decay (**BBTD**, now called early childhood caries) in AI/AN children. Using the definition of BBTD at the time (two or more maxillary incisors with decay), 52 percent of zero- to four-year-old AI/AN children experienced BBTD.[2] The 1991 survey showed a similar prevalence of BBTD (51.7 percent), but it also reported a decrease in the number of decayed, missing, and filled teeth (**dmft**) among zero- to nine-year-old AI/AN children: from 6.2 in 1974 to 5.9 in 1984 to 4.5 in 1991.[3] The 1999 survey showed a decrease in BBTD, as defined in the 1984 survey, to 46.2 percent; unfortunately, however, it showed that 79.3 percent of two- to five-year-old AI/AN children had caries experience.[4]

In 2010, 8,461 AI/AN children one to five years old were screened by 178 trained dentists, hygienists, and therapists at 63 different IHS or tribal sites, making this survey the largest ever sample of this age group in an IHS survey (the 1999 IHS Oral Health Survey, by comparison, had a sample of 2,663 AI/AN children two to five years old). The prevalence of caries experience among children two to five years old was 62.3 percent, a substantial decrease from the 79.3 percent reported in the 1999 survey. This decrease in prevalence could be at least partly explained by the different methodologies employed in the 1999 survey (a clinic-based sample) and the 2010 survey (a community-based sample).[6]

The 2010 survey also highlighted a key point: the disproportionate distribution of ECC in the AI/AN population. AI/AN children two to five years old had twice as many decayed and filled teeth (3.69) as the next highest racial/ethnic group, U.S. Hispanics (1.69), and almost four times that of U.S Caucasians (0.98). Another key finding from the 2010 survey was that the proportion of AI/AN children affected by ECC rises rapidly as they age: by age two, 44 percent of AI/AN children have decay experience, and by age five, 75 percent of children have decay experience.[7] As a result of these findings, the IHS Division of Oral Health created the IHS Early Childhood Caries Collaborative in 2010.

The IHS had conducted ECC (or BBTD) initiatives prior to the 2010 Early Childhood Caries Collaborative. In the late 1990s, for example, a pilot project was conducted to evaluate

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the effectiveness of fluoride varnish in preventing ECC; however, a final evaluation and subsequent published findings were never completed. In fact, there are few examples of published findings of past IHS ECC efforts, leading some to speculate that, "at best, we have had minor, transient victories from our efforts."[8]

The purpose of this study was to assess the effect of the Indian Health Service Early Childhood Caries Collaborative on increasing access to care, sealants, fluoride varnish, and interim therapeutic restorations (**ITRs**) in zero- to five-year-old Indian/Alaska Native preschool children.

Methods

The IHS Early Childhood Caries Collaborative was constructed as a five-year program based on the premise of promoting specific best practices to reduce the prevalence and severity of ECC in AI/AN children. With an overall goal of reducing the prevalence of ECC by 25 percent from fiscal year 2010 to 2015 in the AI/AN population, the program delineated four objectives to meet this goal in zero- to five-year-old AI/AN children: (1) increase access to dental care by 25 percent; (2) increase the number of children receiving fluoride varnish by 25 percent; (3) increase the number of sealants applied by 25 percent; and (4) increase the number of ITRs by 50 percent.[9]

To achieve maximum participation, the IHS Division of Oral Health invited other disciplines to engage in work aimed at educating the AI/AN population about ECC and increasing access to oral health care for zero- to five-year-olds. As reported in the 2010 survey, by age two almost half (44 percent) of AI/AN children had decay experience, yet children younger than two years old don't typically present to IHS or tribal dental clinics seeking routine preventive care.[7] However, other health care partners co-located in IHS or tribal health clinics—including physicians, mid-level providers, community/public health nurses, pharmacists, and community health representatives (field health workers specific to the IHS)—routinely treat children of this age for routine health care such as immunizations. Using these health care partners to help educate parents and refer young children to dental clinics would inevitably lead to increased access to care, and research had shown that early access to dental care decreased the incidence of developing caries in young children.[10] Thus, the IHS used the collaboration as a cornerstone of the five-year program.

Each of the components of the program (access, sealants, fluoride varnish, and ITRs) was based on well-established best or promising practices. Multiple studies over the last 40 years have shown the efficacy of fluoride varnish in reducing the incidence of dental caries in young children, with as much as a 44 percent reduction in caries incidence.[11-13] Similarly, research has shown that sealants applied on primary molars is a cost-effective population strategy for reducing caries and the need for further dental treatment.[14] ITRs, while not a primary prevention measure, were chosen as one of the key components of the IHS Early Childhood Caries Collaborative because of the large proportion of patients with untreated decay (43.6 percent), as reported in the 2010 survey and because the American Academy of Pediatric Dentistry developed a policy statement endorsing ITRs in 2010.[15] ITRs are glass ionomer restorations that can be placed on primary teeth to arrest caries, and often the procedure in placing ITRs requires little anesthesia or trauma to the patient, making this an optimal interim treatment for caries in very young children.

The IHS Division of Oral Health was responsible for promoting the Early Childhood Caries Collaborative throughout the Nation. A national team was created to promote this initiative in each of the 12 geographic and administrative regions of the IHS, with multiple national, regional, and local presentations given to dental staff and prospective health care collaborators. A packet of educational materials was distributed to both groups in early 2010 and again in 2013. Regular updates on the initiative and progress were reported by the national committee to IHS dentists, dental hygienists, dental assistants, physicians, mid-level providers, community health representatives, nurses, and community health representatives through established IHS electronic mail distribution lists. The national team also created four educational videos, continuing education courses on caries stabilization (which included some discussion of behavior management in the pediatric population), fluoride varnish applications (the latter of which was aimed at non-dental collaborative partners), a list of best practices (as reported by programs from across the country), and other resource material, all available on a specially designed web page: www.ihs.gov/doh/ecc.

Throughout the IHS Early Childhood Caries Collaborative, data were housed on a specially designed National Dental Data Mart and Reporting System. This Data Mart was populated from the National Data Warehouse used by the IHS to store and compile all data; the National Data Warehouse received data through monthly or quarterly data exports from the IHS and tribal health facilities across the country.

At the conclusion of the five-year IHS Early Childhood Caries Collaborative, the IHS once again embarked on a national oral health survey of one- to five-year-old AI/AN children. In both 2010 and 2014, data were collected through a basic screening survey conducted in community settings (Head Start centers, day care centers, medical clinics, health fairs, etc.) In 2010, a total of 63 sites conducted screenings on 8,461 AI/AN children one to five years old; in 2014, a total of 81 sites conducted screenings on 11,873 AI/AN children one to five years old. In both survey years, examiners were trained through participation in a national webinar, and a standard basic screening survey form was used by all examiners. For purposes of comparing the two surveys, only data from those sites (59 total) that participated in both surveys were compared. Data from these surveys were used to evaluate the impact of the five-year program on oral health outcomes, while data from the Dental Data Mart were used to evaluate the effectiveness of the five-year program in meeting the objectives set forth at the beginning of the initiative (increase access, sealants, fluoride varnish patients, and ITRs).

Results

Progress and results of the four aforementioned objectives of the IHS Early Childhood Caries Collaborative were tracked throughout the five years of the initiative, the results of which are described in Table 1.

Of the four IHS Early Childhood Caries Collaborative goals, access to dental care was perhaps the most critical. The number of zero- to five-year-olds with a visit to an IHS or tribal dental clinic rose from 50,421 per year between 2005 and 2009 to 54,415 per year between 2010 and 2014; an increase of 7.9 percent. Most significant was the increase in zero- to two-year-old access, from 13,897 per year from 2005 to 2009 to 14,924/year from 2010 to 2014, an increase of 7.4 percent (Figure).

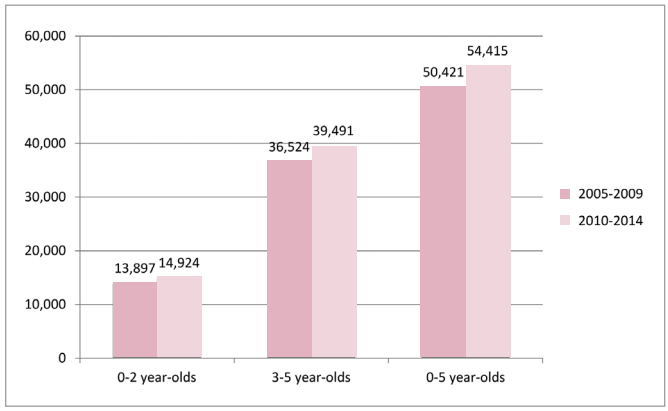

Figure. Changes in access to care, Indian Health Service Early Childhood Caries Collaborative 2010-14.

Regarding the objective of increasing the number of dental sealants, the sheer number of dental sealants placed in the five-year Collaborative increased by 65 percent, from 73,348 in the five-year period prior to the initiative to 121,018 during the five years of the program. The most dramatic gain was in the zero- to two-year-old age group, with an increase from 8,122 to 14,666 sealants, an 80.6 percent increase (Table 1). Moreover, the number of zero- to five-year-old patients benefitting from dental sealants on primary molars increased by 43.3 percent, from 20,276 in the five years prior to the initiative to 29,050 during the initiative, including a 50.3 percent increase in the critical zero- to two-year-old age group (Table 1). These increases, both in numbers of sealants and sealant patients, resulted in an increase in the number of sealants per patient in zero- to five-year-olds from 3.62 in the 2005 to 2009 period to 4.17 from 2010 to 2014 (Table 1).

Fluoride varnish applications and patients also increased as part of the IHS Early Childhood Caries Collaborative (Table 1). Total fluoride varnish applications increased by 82.3 percent over the course of the five-year initiative, from a mean of 42,394 per year between 2005 and 2009 to 77,279 per year from 2010 to 2014. The total number of applications by non-dental providers also increased significantly. Counting the medical International Classification of Diseases code of V07.31, the total number of fluoride varnish applications among medical providers increased by almost 300 percent, from a mean of 2,050 per year between 2005 and 2009 to 10,252 per year from 2010 to 14. Moreover, the overall contribution of total fluoride varnish applications by medical providers increased significantly, with 4.8 percent of total fluoride varnish applications per year being from medical providers between 2005 and 2009 compared to 10.5 percent of total fluoride varnish applications per year being from medical providers between 2010 and 2014.

Through a concerted effort by both dental clinics and collaborative partners, the number of zero- to five-year-old AI/AN children benefitting from at least one application of fluoride varnish increased from 28,373 per year from 2005-09 to 47,727 per year during the initiative, an increase of 68.2 percent, and this increase was apparent in both the zero- to two-year-old (64.3 percent) and three- to five-year-old (69.7 percent) age groups. More strikingly, a much larger proportion of children accessing dental services received fluoride varnish applications; prior to the initiative, only 56.3 percent of children accessing dental care received fluoride varnish applications, while during the initiative 87.7 percent of children accessing dental care received at least one application of fluoride varnish.

The number of ITRs, a secondary preventive measure aimed at reducing untreated decay rates, increased substantially as part of the IHS Early Childhood Caries Collaborative (Table 1).

Table 1. RESULTS OF THE FIVE-YEAR INDIAN HEALTH SERVICE EARLY CHILDHOOD CARIES COLLABORATIVE

	Year	0-2 ys	% change	3-5 ys	% change	0-5 ys	% change
Access to dental care	2010-14	14,924/year	7.4	39,491/year	8.1	54,415/year	7.9
	2005-09	13,897/year		36,524/year		50,421/year	
Sealants	2010-14	14,666	80.6	106,352	63.1	121,018	65.0
	2005-09	8,122		65,226		73,348	
Sealant patients	2010-14	3,558	50.3	25,492	42.3	29,050	43.3
	2005-09	2,368		17,908		20,276	
Sealants per patient	2010-14	4.12	20.1	4.17	14.6	4.17	15.2
	2005-09	3.43		3.64		3.62	
Fluoride varnish applications	2010-14	19,220/year	77.8	58,059/year	83.8	77,279/year	82.3
	2005-09	10,808/year		31,586/year		42,394/year	
Fluoride varnish patients	2010-14	12,536/year	64.3	35,191/year	69.7	47,727/year	68.2
	2005-09	7,631/year		20,742/year		28,373/year	
Fluoride applications per patient	2010-14	1.53	7.7	1.65	8.6	1.62	8.7
	2005-09	1.42		1.52		1.49	
Fluoride patients/patients accessing care	2010-14	84.0%	53.0	89.1%	56.9	87.7%	55.8
	2005-09	54.9%		56.8%		56.3%	
Interim therapeutic restorations	2010-14	11,251	323.3	34,742	132.4	45,993	161.2
	2005-09	2,658		14,952		17,610	

* All data reported is for five years, except as noted otherwise.

Overall, the number of ITRs increased by 161.2 percent in zero- to five-year-old AI/AN children: from 17,610 in the five years preceding the initiative to 45,993 during the five years of the initiative. This increase was even more evident in the zero- to two-year-old age group, with an increase of 323.3 percent, from 2,658 to 11,251, over the same time periods.

Data from the 2010 and 2014 oral health surveys were used to assess the impact of the Collaborative on oral health outcomes. Although not statistically significant ($P>0.05$), there was a trend toward a lower prevalence of decay experience and untreated decay in 2014 compared to 2010 (Table 2). This was especially true for one- to two-year-olds. In 2010, 21.2 percent of one-year-olds had decay experience compared to 18.1 percent in 2014, a 15 percent reduction. For two-year-olds, the percent with decay experience decreased by 10 percent, from 43.7 percent in 2010 to 39.4 percent in 2014. Among

Table 2. PERCENT OF AMERICAN INDIAN AND ALASKA NATIVE CHILDREN WITH DECAY EXPERIENCE, UNTREATED DECAY, PRIMARY MOLAR SEALANTS, AND URGENCY OF NEED FOR DENTAL CARE BY AGE, 2010 VERSUS 2014

Variable*	Year	1 y (N=890)	2 ys (N=1,112)	3 ys (N=2,398)	4 ys (N=2,827)	5 ys (N=1,234)	1-5 ys (N=8,461)	2-5 ys (N=7,571)	3-5 ys (N=6,459)
Decay experience percent (95% CI)	2010	21.2 (14.9-27.4)	43.7 (36.6-50.7)	60.8 (55.0-66.6)	69.5 (64.3-74.8)	75.1 (67.1-83.1)	54.1 (49.3-59.0)	62.3 (57.1-67.4)	68.4 (63.2-73.6)
	2014	18.1 (13.6-22.6)	39.4 (33.1-45.7)	59.9 (53.0-66.8)	69.4 (63.7-75.0)	75.6 (69.2-82.1)	54.1 (48.9-59.3)	61.7 (55.9-67.4)	68.5 (62.7-74.4)
Untreated decay percent (95% CI)	2010	18.2 (12.9-23.5)	36.7 (30.7-42.8)	46.0 (39.4-52.7)	44.4 (39.5-49.4)	47.1 (39.0-55.2)	38.5 (33.7-43.4)	43.6 (38.4-48.8)	45.8 (40.3-51.4)
	2014	16.9 (12.6-21.2)	34.0 (28.3-39.8)	43.0 (36.4-49.6)	42.6 (37.6-47.7)	43.8 (36.4-51.2)	36.8 (32.0-41.7)	41.0 (35.6-46.4)	43.2 (37.6-48.8)
Primary molar sealants percent (95% CI)	2010	1.2 (0.0-2.8)	3.5 (0.8-6.1)	6.0 (4.3-7.6)	11.7 (8.1-15.4)	12.8 (7.8-17.8)	7.1 (5.3-8.9)	8.5 (6.4-10.7)	10.2 (7.6-12.7)
	2014	0.3 (0.0-0.8)	3.3 (1.4-5.2)	8.5 (4.7-12.4)	7.9 (4.3-11.4)	10.2 (5.5-15.0)	6.3 (3.7-15.0)	7.6 (4.5-10.6)	8.9 (5.0-12.8)
Early or urgent care percent (95% CI)	2010	17.5 (12.6-22.5)	34.6 (28.6-40.6)	43.3 (37.1-49.6)	42.4 (37.4-47.4)	43.5 (37.5-49.5)	36.3 (31.9-40.7)	41.0 (36.4-45.5)	43.1 (38.4-47.8)
	2014	16.8 (12.4-21.1)	31.5 (26.3-36.7)	41.4 (35.3-47.4)	40.5 (34.4-46.5)	41.6 (33.6-49.5)	35.0 (30.0-40.0)	38.9 (33.2-44.5)	41.1 (35.1-47.1)
Urgent care percent (95% CI)	2010	3.6 (1.6-5.5)	4.3 (1.9-6.7)	6.1 (3.4-8.7)	5.8 (3.8-7.9)	8.8 (4.5-13.1)	5.7 (3.8-7.6)	6.2 (4.0-8.5)	6.9 (4.2-9.5)
	2014	2.9 (0.3-5.5)	5.9 (3.6-8.2)	6.5 (4.0-8.9)	6.5 (4.5-8.6)	6.1 (3.9-8.3)	5.7 (4.2-7.2)	6.2 (4.7-7.8)	6.4 (4.7-8.0)

* CI=confidence interval.

Table 3. MEAN NUMBER OF DECAYED, MISSING, AND FILLED TEETH (dmft) AMONG AMERICAN INDIAN AND ALASKA NATIVE CHILDREN BY AGE, 2010 VERSUS 2014

Variable*	Year	1 y (N=875)	2 ys (N=1,097)	3 ys (N=2,356)	4 ys (N=2,762)	5 ys (N=1,233)	1-5 ys (N=8,323)	2-5 ys (N=7,448)	3-5 ys (N=6,351)
Decayed teeth N (95% CI)	2010	0.79 (0.50-1.08)	1.69 (1.34-2.04)	2.26 (1.84-2.69)	1.98 (1.65-2.32)	2.05 (1.58-2.51)	1.76 (1.46-2.05)	2.00 (1.68-2.32)	2.10 (1.76-2.44)
	2014	0.70 (0.46-0.94)	1.65 (1.26-2.05)	2.25 (1.82-2.69)	2.08 (1.71-2.48)	1.97 (1.47-2.48)	1.77 (1.47-2.07)	1.99 (1.65-2.34)	2.10 (1.74-2.46)
Missing teeth N (95% CI)	2010	0.04 (0.00-0.08)	0.18 (0.10-0.25)	0.39 (0.29-0.49)	0.47 (0.35-0.58)	0.76 (0.53-0.99)	0.37 (0.28-0.46)	0.45 (0.33-0.56)	0.54 (0.40-0.67)
	2014	0.04 (0.01-0.07)	0.15 (0.07-0.23)	0.41 (0.29-0.54)	0.63 (0.49-0.78)	0.85 (0.64-1.07)	0.44 (0.34-0.53)	0.52 (0.41-0.64)	0.64 (0.51-0.77)
Filled teeth N (95% CI)	2010	0.11 (0.02-0.19)	0.47 (0.27-0.66)	1.26 (0.96-1.57)	2.13 (1.80-2.46)	2.90 (2.37-3.42)	1.37 (1.16-1.59)	1.69 (1.42-1.96)	2.09 (1.75-2.42)
	2014	0.05 (0.01-0.09)	0.36 (0.23-0.48)	1.41 (1.11-1.72)	2.62 (2.33-2.92)	3.27 (2.80-3.74)	1.63 (1.43-1.83)	1.96 (1.72-2.21)	2.46 (2.15-2.77)
dmft N (95% CI)	2010	0.94 (0.61-1.26)	2.33 (1.95-2.72)	3.91 (3.36-4.47)	4.58 (4.07-5.08)	5.70 (4.87-6.52)	3.50 (3.07-3.93)	4.13 (3.64-4.62)	4.72 (4.17-5.28)
	2014	0.80 (0.56-1.03)	2.16 (1.66-2.66)	4.08 (3.48-4.68)	5.34 (4.69-5.99)	6.10 (5.35-6.84)	3.84 (3.36-4.32)	4.48 (3.93-5.03)	5.20 (4.58-5.81)

* CI=confidence interval.

three-year-olds, there was only a slight decrease in decay experience, from 60.8 percent in 2010 to 59.9 percent in 2014, a result that was statistically not significant. Similarly, in four-year-olds and five-year-olds, there was only a slight decrease or increase (five-year-olds) in decay experience, and neither was statistically significant.

Untreated decay decreased across all age groups from 2010 to 2014 (Table 2). This included drops from 18.2 to 16.9 percent in one-year-olds, 36.7 to 34.0 percent in two-year-olds, 46.0 to 43.0 percent in three-year-olds, 44.4 to 42.6 percent in four-year-olds, and 47.1 to 43.8 percent in five-year-olds. Overall, the decrease was only 4.4 percent, from 38.5 to 36.8 percent, and this result was not statistically significant. Similarly, changes in the number of children with primary sealants, proportion of children requiring early or urgent care, and proportion of children requiring only urgent care all had small increases or decreases, but these results were not statistically significant.

As with decay prevalence, the dmft scores followed a similar trajectory (Table 3). The dmft scores decreased in AI/AN children, from 0.94 to 0.80 in one-year-olds and from 2.33 to 2.16 in two-year-olds from 2010 to 2014. In one-year-olds, the main reason for this drop was a decrease in decayed teeth, from 0.79 to 0.70; in two-year-olds, the main reason was a decrease in filled teeth, from 0.47 to 0.36. Both drops are somewhat indicative of the impact of the Collaborative on the youngest age groups. In three-, four-, and five-year-olds, dmft increased, with the primary reason being an increase in filled teeth, a fact that correlates with the decrease in untreated decay seen in three- and four-year-olds, as shown in Table 2.

Discussion

The five-year Early Childhood Caries Collaborative conducted by the Indian Health Service resulted in a substantial increase in early access to dental sealants on primary molars, multiple applications of fluoride varnish, and the placement of ITRs. These ECC prevention strategies may be associated with the trend toward a decline in the prevalence of decay experience and untreated decay in AI/AN one- to two-year-olds.

Many of the gains seen in specific prevention strategies during the initiative resulted from a paradigm shift in the way general dentists treated young children. The initiative promoted ECC prevention strategies and early care for young AI/AN children by general dentists, and the resulting paradigm shift is evident in the increases in zero- to two-year-old access (7.4 percent increase), sealants in zero- to two-year-olds (80.6 percent increase), the numbers of zero- to two-year-olds receiving fluoride varnish (64.3 percent increase), and the number of ITRs placed in zero- to two-year-olds (323.3 percent increase).

As part of the IHS Early Childhood Caries Collaborative, many best practices in ECC prevention were described by participating programs. However, it is difficult to measure the specific impact of the best practices, although this may be investigated in future research. One such best practice was case management; programs reporting high increases in access to care, particularly among zero- to two-year-olds, often had dedicated case managers who would track health system users and encourage parents to bring children into the dentist for a screening or examination, following up afterward with each family to encourage treatment completion and prevention services. Another best practice was the use of collaborative partners previously mentioned, although it is difficult to determine what role these partners had in increasing access to dental services. There were also examples of policy changes, such as including a dental exam as part of a well-child visit or requiring a dental screening before enrollment in tribal day care that increased dental access for zero- to two-year-olds in some communities. Finally, clinics reporting increases in access, sealants, fluoride, and ITRs all reported the paradigm shift previously mentioned, indicating that general dentists had adopted these prevention strategies for young children who were previously referred for all dental care to pediatric dentists.

Using ECC prevention strategies such as early access to dental care, sealants on primary molars, multiple applications of fluoride varnish, and, as a secondary prevention measure, ITRs, the five-year IHS Early Childhood Caries Collaborative demonstrated some initial improvement in the oral health status of zero- to five-year-old AI/AN children. Early results show some improvement in prevalence and untreated decay rates, but these early results are not statistically significant ($P>0.05$). Additional research or projects are needed to show long-term success in preventing ECC in the American Indian/Alaska Native population.

Conclusions

Based on this study's results, the following conclusions can be made:

1. Early childhood caries prevention strategies, including early access to care, sealants on primary molars, multiple fluoride varnish applications, and interim therapeutic restorations, showed a trend toward a lower prevalence of decay experience, especially in one- to two-year-olds.
2. These ECC strategies produced an initial improvement in the oral health status of zero- to five-year-old Indian/Alaska Native children.

References

1. Indian Health Service. IHS Year 2014 Profile. Available at: "http://www.ihs.gov/newsroom/factsheets/ihsyear2014profile". Accessed April 7, 2015. Archived by WebCite® at: "http://www.webcitation.org/6XcR0bept". Accessed April 7, 2015.
2. Centers for Disease Control and Prevention. Dental caries in American Indian and Alaskan native children. MMWR Morb Mortal Wkly Rep 1985;34:400-1.
3. Niendorff WJ, Jones CM. Prevalence and severity of dental caries among American Indians and Alaska Natives. J Public Health Dent 2000;60(suppl 1):243-9.
4. IHS. The 1999 oral health survey of American Indian and Alaska Native dental patients: findings, regional differences, and national comparisons. Rockville, Md., USA: U.S. Department of Health and Human Services, IHS; 2001.
5. Association of State and Territorial Dental Directors. Basic screening surveys: an approach to monitoring community oral health. Available at: "http://www.astdd.org/basic-screening-survey-tool/". Accessed April 7, 2015. Archived by WebCite® at: "http://www.webcitation.org/6XcR3XYrd". Accessed April 7, 2015.
6. Phipps KR, Ricks TL, Manz MC, Blahut P. Prevalence and severity of dental caries among American Indian and Alaska Native preschool children. J Public Health Dent 2014;72:208-15.

7. Indian Health Service. The 2010 Oral Health Survey of American Indian and Alaska Native Preschool Children. Rockville, Md., USA: U.S. DHHS, IHS; 2011.
8. American Dental Association. Symposium on Early Childhood Caries in American Indian and Alaska Native Children, Panel Report. Chicago, Ill., USA: ADA, Council on Access, Prevention, and Interprofessional Relations; 2009.
9. Indian Health Service, Department of Health and Human Services. Promoting awareness of early childhood caries. Available at: "http://www.ihs.gov/doh/ecc". Accessed April 7, 2015. Archived by WebCite® at: "http://www.webcitation.org/6XcR4snor". Accessed April 7, 2015.
10. Beil H, Rozier RG, Preisser JS, Steams SC, Lee JY. Effect of early preventive dental visits on subsequent dental treatment and expenditures. Med Care 2012;50:749-56.
11. Holm AK. Effect of fluoride varnish (Duraflor) in preschool children. Community Dent Oral Epidemiol 1979; 7:241-5.
12. Clark DC. Results of the Sherbrook-Lac Megantic fluoride varnish study after 20 months. Community Dent Oral Epidemiol 1985;13:61-4.
13. Koch G, Petersson LG. Caries preventive effect of a fluoride-containing varnish after 1 year's study. Community Dent Oral Epidemiol 1975;3:262-6.
14. Chi DL, van der Goes DN, Ney JP. Cost-effectiveness of pit-and-fissure sealants on primary molars in Medicaid-enrolled children. Am J Public Health 2014;104:55-61.
15. American Academy of Pediatric Dentistry. Policy on Interim Therapeutic Restorations (ITR). Available at: "http://www.aapd.org/media/Policies_Guidelines/P_IT". Accessed April 7, 2015. Archived by WebCite® at: "http://www.webcitation.org/6XcREGFGh". Accessed April 7, 2015.

Policy on Early Childhood Caries (ECC): Classifications, Consequences, and Preventive Strategies

Originating Group
A collaborative effort of the American Academy of Pedodontics and the American Academy of Pediatrics

Review Council
Council on Clinical Affairs

Adopted
1978

Revised
1993, 1996, 2001, 2003, 2007, 2008, 2011, 2014*

Purpose
The American Academy of Pediatric Dentistry (**AAPD**) recognizes early childhood caries [(**ECC**); formerly termed nursing bottle caries, baby bottle tooth decay] as a significant public health problem.[1] The AAPD encourages oral health care providers and caregivers to implement preventive practices that can decrease a child's risks of developing this devastating disease.

Methods
This document is a revision of the previous policy, last revised in 2008. The update used electronic and hand searches of English written articles in the dental and medical literature within the last 10 years, using the search terms infant oral health, infant oral health care, and early childhood caries. When data did not appear sufficient or were inconclusive, recommendations were based upon expert and/or consensus opinion by experienced researchers and clinicians.

Background
In 1978, the American Academy of Pedodontics released "Nursing Bottle Caries", a joint statement with the American Academy of Pediatrics, to address a severe form of caries associated with bottle usage.[2] Initial policy recommendations were limited to feeding habits, concluding that nursing bottle caries could be avoided if bottle feedings were discontinued soon after the first birthday. An early policy revision added ad libitum breastfeeding as a causative factor. Over the next two decades, however, recognizing that this distinctive clinical presentation was not consistently associated with poor feeding practices and that caries was an infectious disease, AAPD adopted the term ECC to reflect better its multifactoral etiology.

Dental caries is a common chronic infectious transmissible disease resulting from tooth-adherent specific bacteria, primarily Mutans Streptococci (**MS**), that metabolize sugars to produce acid which, over time, demineralizes tooth structure.[3] The disease of ECC is the presence of one or more decayed (noncavitated or cavitated lesions), missing (due to caries), or filled tooth surfaces in any primary tooth in a child under the age of six. In children younger than three years of age, any sign of smooth-surface caries is indicative of severe early childhood caries (S-ECC). From ages three through five, one or more cavitated, missing (due to caries), or filled smooth surfaces in primary maxillary anterior teeth or a decayed, missing, or filled score of greater than or equal to four (age 3), greater than or equal to five (age 4), or greater than or equal to six (age 5) surfaces also constitutes S-ECC.[4]

Epidemiologic data from national surveys clearly indicate that ECC is highly prevalent and increasing in poor and near poor US preschool children and is largely untreated in children under age three.[5] Those children with caries experience have been shown to have high numbers of teeth affected. Consequences of ECC include a higher risk of new carious lesions in both the primary and permanent dentitions,[6,7] hospitalizations and emergency room visits,[8,9] increased treatment costs,[10] risk for delayed physical growth and development,[11,12] loss of school days and increased days with restricted activity,[13,14] diminished ability to learn,[15] and diminished oral health-related quality of life.[16]

Dental caries is a transmissible infectious disease and understanding the acquisition of cariogenic microbes improves preventive strategies. Microbial risk markers for ECC include MS and Lactobacillus species.[17] MS maybe transmitted vertically from caregiver to child through salivary contact, affected by the frequency and amount of exposure. Infants whose mothers have high levels of MS, a result of untreated caries, are at greater risk of acquiring the organism earlier than children whose mothers have low levels.[18] Horizontal transmission (eg, between other members of a family or children in daycare) also occurs.[18] Eliminating saliva-sharing activities (eg, sharing utensils, orally cleansing a pacifier) may help decrease an infant's or toddler's acquisition of cariogenic microbes.[18]

** The 2014 revision is limited to use of fluoride toothpaste in young children.*

Newly-erupted teeth, because of immature enamel, and teeth with enamel hypoplasia may be at higher risk of developing caries. Current best practice includes twice-daily brushing with fluoridated toothpaste for all children in optimally fluoridated and fluoride-deficient communities. When determining the risk-benefit of fluoride, the key issue is mild fluorosis versus preventing devastating dental disease. A 'smear' or 'rice-size' amount of fluoridated toothpaste (approximately 0.1 mg fluoride; see Figure 1) should be used for children less than three years of age. A 'pea-size' amount of fluoridated toothpaste (approximately 0.25 mg fluoride) is appropriate for children aged three to six.[19,20] Parents should dispense the toothpaste onto a soft, age-appropriate sized toothbrush and perform or assist with toothbrushing of preschool-aged children. To maximize the beneficial effect of fluoride in the toothpaste, rinsing after brushing should be kept to a minimum or eliminated altogether.[21]

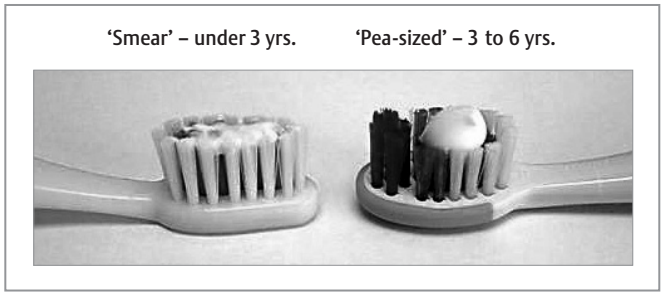

Figure 1. Comparison of a 'smear' (left) with a 'pea-size' (right) amount of toothpaste.

Professionally-applied topical fluoride treatments also are efficacious in reducing prevalence of ECC. The recommended professionally-applied fluoride treatments for children at risk for ECC who are younger than six years is five percent sodium fluoride varnish (NaFV; 22,500 ppm F).[22] An associated risk factor to microbial etiology is high frequency consumption of sugars. Caries-conducive dietary practices appear to be established by 12 months of age and are maintained throughout early childhood.[23,24] Frequent night time bottle feeding with milk and ad libitum breast-feeding are associated with, but not consistently implicated in, ECC.[25] Night time bottle feeding with juice, repeated use of a sippy or no-spill cup, and frequent in between meal consumption of sugar-containing snacks or drinks (eg, juice, formula, soda) increase the risk of caries.[26] While ECC may not arise from breast milk alone, breast feeding in combination with other carbohydrates has been found in vitro to be highly cariogenic.[27] Frequent consumption of between-meal snacks and beverages containing sugars increases the risk of caries due to prolonged contact between sugars in the consumed food or liquid and cariogenic bacteria on the susceptible teeth.[28] The American Academy of Pediatrics has recommended children one through six years of age consume no more than four to six ounces of fruit juice per day, from a cup (ie, not a bottle or covered cup) and as part of a meal or snack.[29]

Evidence increasingly suggests that preventive interventions within the first year of life are critical.[30] This may be best implemented with the help of medical providers who, in many cases, are being trained to provide oral screenings, apply preventive measures, counsel caregivers, and refer infants and toddlers for dental care.[31]

Policy statement

The AAPD recognizes caries as a common chronic disease resulting from an imbalance of multiple risk factors and protective factors over time. To decrease the risk of developing ECC, the AAPD encourages professional and at-home preventive measures that include:

1. Reducing the parent's/sibling's MS levels to decrease transmission of cariogenic bacteria.
2. Minimizing saliva-sharing activities (eg, sharing utensils) to decrease the transmission of cariogenic bacteria.
3. Implementing oral hygiene measures no later than the time of eruption of the first primary tooth. Toothbrushing should be performed for children by a parent twice daily, using a soft toothbrush of age-appropriate size. In all children under the age of three, a 'smear' or 'rice-size' amount of fluoridated toothpaste should be used. In all children ages three to six, a 'pea-size' amount of fluoridated toothpaste should be used.
4. Providing professionally-applied fluoride varnish treatments for children at risk for ECC.
5. Establishing a dental home within six months of eruption of the first tooth and no later than 12 months of age to conduct a caries risk assessment and provide parental education including anticipatory guidance for prevention of oral diseases.
6. Avoiding high frequency consumption of liquids and/or solid foods containing sugar. In particular:
    - Sugar-containing beverages (eg, juices, soft drinks, sweetened tea, milk with sugar added) in a baby bottle or no-spill training cup should be avoided.
    - Infants should not be put to sleep with a bottle filled with milk or liquids containing sugars.
    - Ad libitum breast-feeding should be avoided after the first primary tooth begins to erupt and other dietary carbohydrates are introduced.
    - Parents should be encouraged to have infants drink from a cup as they approach their first birthday. Infants should be weaned from the bottle between 12 to 18 months of age.[32]
7. Working with medical providers to ensure all infants and toddlers have access to dental screenings, counseling, and preventive procedures.

References

1. American Academy of Pediatric Dentistry. Symposium on the prevention of oral disease in children and adolescents. Chicago, Ill; November 11-12, 2005: Conference papers. Pediatr Dent 2006;28(2):96-198.
2. American Academy of Pediatrics, American Academy of Pedodontics. Juice in ready-to-use bottles and nursing bottle caries. AAP News and Comment 1978;29(1):11.
3. Loesche WJ. Role of *Streptococcus mutans* in human dental decay. Microbiol Rev 1986;50(4):353-80.
4. Drury TF, Horowitz AM, Ismail AI, et al. Diagnosing and reporting early childhood caries for research purposes. J Public Health Dent 1999;59(3):192-7.
5. Tinanoff N, Reisine S. Update on early childhood caries since the Surgeon General's Report. Academic Pediatr 2009;9(6):396-403.
6. O'Sullivan DM, Tinanoff N. The association of early childhood caries patterns with caries incidence in preschool children. J Public Health Dent 1996;56(2):81-3.
7. Al-Shalan TA, Erickson PR, Hardie NA. Primary incisor decay before age 4 as a risk factor for future dental caries. Pediatr Dent 1997;19(1):37-41.
8. Ladrillo TE, Hobdell MH, Caviness C. Increasing prevalence of emergency department visits for pediatric dental care 1997-2001. J Am Dent Assoc 2006;137(3):379-85.
9. Griffin SO, Gooch BF, Beltran E, Sutherland JN, Barsley R. Dental services, costs, and factors associated with hospitalization for Medicaid-eligible children, Louisiana 1996-97. J Public Health Dent 2000;60(3):21-7.
10. Kanellis MJ, Damiano PC, Monamy ET. Medicaid costs associated with the hospitalization of young children for restorative dental treatment under general anesthesia. J Public Health Dent 2000;60(1):28-32.
11. Acs G, Lodolini G, Kaminsky S, Cisneros GJ. Effect of nursing caries on body weight in a pediatric population. Pediatr Dent 1992;14(5):302-5.
12. Ayhan H, Suskan E, Yildirim S. The effect of nursing or rampant caries on height, body weight, and head circumference. J Clin Pediatr Dent 1996;20(3):209-12.
13. Reisine ST. Dental health and public policy: The social impact of disease. Am J Public Health 1985;75(1):27-30.
14. Gift HC, Reisine ST, Larach DC. The social impact of dental problems and visits. Am J Public Health 1992;82 (12):1663-8.
15. Blumenshine SL, Vann WF, Gizlice Z, Lee JY. Children's school performance: Impact of general and oral health. J Public Health Dent 2008;68(2):82-7.
16. Filstrup SL, Briskie D, daFonseca M, Lawrence L, Wandera A, Inglehart MR. The effects on early childhood caries (ECC) and restorative treatment on children's oral health-related quality of life (OHRQOL). Pediatr Dent 2003;25 (5):431-40.
17. Kanasi E, Johansson J, Lu SC, et al. Microbial risk markers for childhood caries in pediatrician's offices. J Dent Res 2010;89(4):378-83.
18. Berkowitz RJ. Mutans streptococci: Acquisition and transmission. Pediatr Dent 2006;28(2):106-9.
19. Wright JT, Hanson N, Ristic H, Whall CW, Estrich CG, Zentz RR. Fluoride toothpaste efficacy and safety in children younger than 6 years. J Am Dent Assoc 2014;145 (2):182-9.
20. ADA Council on Scientific Affairs. Fluoride toothpaste use for young children. J Am Dent Assoc 2014;145(2):190-1.
21. Sjögren K, Birkhed D. Factors related to fluoride retention after toothbrushing and possible connection to caries activity. Caries Res 1993;27(6):474-7.
22. Weyant RJ, Tracy SL, Anselmo T, Beltrán-Aguilar EJ, Donly KJ, Frese WA. Topical fluoride for caries prevention: Executive summary of the updated clinical recommendations and supporting systematic review. J Am Dent Assoc 2013;144(11):1279-91.
23. Douglass JM. Response to Tinanoff and Palmer: Dietary determinants of dental caries and dietary recommendations for preschool children. J Public Health Dent 2000; 60(3):207-9.
24. Kranz S, Smiciklas-Wright H, Francis LA. Diet quality, added sugar, and dietary fiber intake in American preschoolers. Pediatr Dent 2006;28(2)164-71.
25. Reisine S, Douglass JM. Psychosocial and behavioral issues in early childhood caries. Comm Dent Oral Epidem 1998;26(suppl 1):32-44.
26. Tinanoff NT, Kanellis MJ, Vargas CM. Current understanding of the epidemiology mechanism, and prevention of dental caries in preschool children. Pediatr Dent 2002;24(6):543-51.
27. Erickson PR, Mazhari E. Investigation of the role of human breast milk in caries development. Pediatr Dent 1999;21(2):86-90.
28. Tinanoff NT, Palmer C. Dietary determinants of dental caries in preschool children and dietary recommendations for preschool children. J Pub Health Dent 2000;60(3): 197-206.
29. American Academy of Pediatrics Committee on Nutrition. Policy statement: The use and misuse of fruit juices in pediatrics. Pediatrics 2001;107(5):1210-3. Reaffirmed October, 2006.
30. Lee JY, Bouwens TJ, Savage MF, Vann WF. Examining the cost-effectiveness of early dental visits. Pediatr Dent 2006;28(2):102-105, discussion 192-8.
31. Douglass AB, Douglass JM, Krol DM. Educating pediatricians and family physicians in children's oral health. Academic Pediatr 2009;9(6):452-6.
32. American Academy of Pediatrics. Patient education on line: Weaning to a cup. Available at: "http://patiented.aap.org/content.aspx?aid=6662". Accessed July 6, 2011.

Oral Health Care During Pregnancy: A National Consensus Statement

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Introduction

Pregnancy is a unique period during a woman's life and is characterized by complex physiological changes, which may adversely affect oral health. At the same time, oral health is key to overall health and well-being. Preventive, diagnostic, and restorative dental treatment is safe throughout pregnancy and is effective in improving and maintaining oral health.

However, health professionals often do not provide oral health care to pregnant women. At the same time, pregnant women, including some with obvious signs of oral disease, often do not seek or receive care. In many cases, neither pregnant women nor health professionals understand that oral health care is an important component of a healthy pregnancy.

In addition to providing pregnant women with oral health care, educating them about preventing and treating dental caries is critical, both for women's own oral health and for the future oral health of their children. Evidence suggests that most infants and young children acquire caries-causing bacteria from their mothers. Providing pregnant women with counseling to promote healthy oral health behaviors may reduce the transmission of such bacteria from mothers to infants and young children, thereby delaying or preventing the onset of caries.

For these reasons, it is essential for health professionals (e.g., dentists, dental hygienists, physicians, nurses, midwives, nurse practitioners, physician assistants) to provide pregnant women with appropriate and timely oral health care, which includes oral health education.

This national consensus statement was developed to help health professionals, program administrators and staff, policymakers, advocates, and other stakeholders respond to the need for improvements in the provision of oral health services to women during pregnancy. Ultimately, the implementation of the guidance within this consensus statement should bring about changes in the health-care-delivery system and improve the overall standard of care.

This consensus statement resulted from the Oral Health Care During Pregnancy Consensus Development Expert Workgroup Meeting convened by the Health Resources and Services Administration's Maternal and Child Health Bureau in collaboration with the American College of Obstetricians and Gynecologists and the American Dental Association and coordinated by the National Maternal and Child Oral Health Resource Center. The meeting was held on October 18, 2011, at Georgetown University in Washington, DC. A companion document, *Oral Health Care During Pregnancy: A National Consensus Statement—Summary of an Expert Workgroup Meeting,* which includes information about the meeting, resources, the meeting agenda, and a participant list, is available at http://www.mchoralhealth.org/PDFs/OralHealthPregnancyConsensus.pdf.

Guidance for Prenatal Care Health Professionals

Prenatal care health professionals may be the "first line" in assessing pregnant women's oral health and can provide referrals to oral health professionals and reinforce preventive messages.

Assess Pregnant Women's Oral Health Status

During the initial prenatal evaluation

- Take an oral health history. Following are examples of questions that prenatal care health professionals may ask pregnant women. This information may be gathered through a conversation or a questionnaire.
  - Do you have swollen or bleeding gums, a toothache (pain), problems eating or chewing food, or other problems in your mouth?
  - Since becoming pregnant, have you been vomiting? If so, how often?
  - Do you have any questions or concerns about getting oral health care while you are pregnant?
  - When was your last dental visit? Do you need help finding a dentist?
- Check the mouth for problems such as swollen or bleeding gums, untreated dental decay (tooth with a cavity), mucosal lesions, signs of infection (e.g., a draining fistula), or trauma.
- Document your findings in the woman's medical record.

Advise Pregnant Women About Oral Health Care

- Reassure women that oral health care, including use of radiographs, pain medication, and local anesthesia, is safe throughout pregnancy.
- If the last dental visit took place more than 6 months ago or if any oral health problems were identified during the assessment, advise women to schedule an appointment with a dentist as soon as possible. If urgent care is needed, write and facilitate a formal referral to a dentist who maintains a collaborative relationship with the prenatal care health professional.

- Encourage women to seek oral health care, practice good oral hygiene, eat healthy foods, and attend prenatal classes during pregnancy. (See *Guidance for Health Professionals to Share with Pregnant Women.*)
- Counsel women to follow oral health professionals' recommendations for achieving and maintaining optimal oral health.

Work in Collaboration with Oral Health Professionals

- Establish relationships with oral health professionals in the community. Develop a formal referral process whereby the oral health professional agrees to see the referred individual in a timely manner (e.g., that day, the following day) and to provide subsequent care.

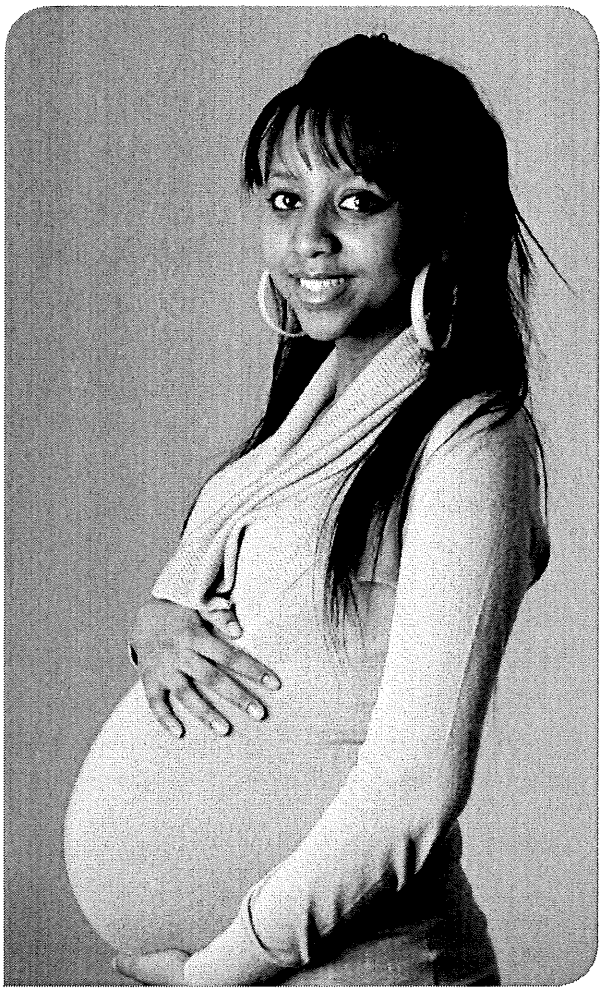
- Share pertinent information about pregnant women with oral health professionals, and coordinate care with oral health professionals as appropriate.

Provide Support Services (Case Management) to Pregnant Women

- Help pregnant women complete applications for insurance or other sources of coverage, social services (e.g., domestic violence services), or other needs (e.g., transportation, translation).
- If the woman does not have a dental home, explain the importance of optimal oral health during pregnancy. Help her obtain care by facilitating referrals to oral health professionals in the community, including those who serve pregnant women enrolled in Medicaid and other public insurance programs, or by contacting a dental office to schedule care.

Improve Health Services in the Community

- On the patient-intake form, include questions about oral health (e.g., name and contact information of oral health professional, reason for and date of last dental visit, previous dental procedures).
- Establish partnerships with community-based programs (e.g., Special Supplemental Nutrition Program for Women, Infants and Children [WIC], Early Head Start) that serve pregnant women with low incomes.
- Provide a referral to a nutrition professional if counseling (e.g., guidance on food choices or nutrition-related health problems) would be beneficial.
- Integrate oral health topics into prenatal classes.
- Provide culturally and linguistically appropriate care. Take the time to ensure that women understand the information shared with them.

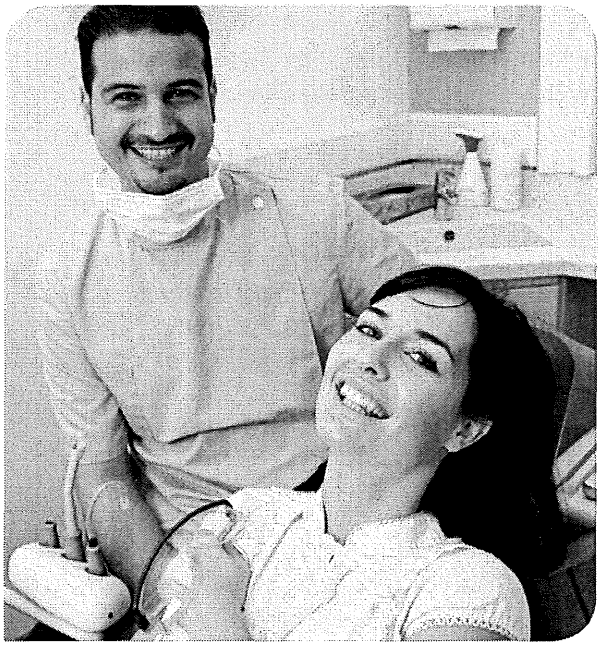


Guidance for Oral Health Professionals

Activities described below are performed by oral health professionals as allowed by state practice acts.

Assess Pregnant Women's Oral Health Status

- Take an oral health history. Following are examples of questions that oral health professionals may ask pregnant women. This information may be gathered through a conversation or a questionnaire.
  - When and where was your last dental visit?
  - Do you have swollen or bleeding gums, a toothache (pain), problems eating or chewing food, or other problems in your mouth?
  - How many weeks pregnant are you? (When is your due date?)
  - Do you have any questions or concerns about getting oral health care while you are pregnant?



  - Since becoming pregnant, have you been vomiting? If so, how often?
  - Have you received prenatal care? If not, do you need help making an appointment for prenatal care?
- In addition to reviewing the dental history, review medical and dietary histories, including use of tobacco, alcohol, and recreational drugs.
- Perform a comprehensive oral examination, which includes a risk assessment for dental caries and periodontal disease.
- Take radiographs to evaluate and definitively diagnose oral diseases and conditions when clinically indicated.

Advise Pregnant Women About Oral Health Care

- Reassure women that oral health care, including use of radiographs, pain medication, and local anesthesia, is safe throughout pregnancy.
- Encourage women to continue to seek oral health care, practice good oral hygiene, eat healthy foods, and attend prenatal classes during pregnancy. (See *Guidance for Health Professionals to Share with Pregnant Women.*)

Work in Collaboration with Prenatal Care Health Professionals

- Establish relationships with prenatal care health professionals in the community. Develop a formal referral process whereby the prenatal care health professional agrees to see the referred individual in a timely manner (e.g., that day, the following day) and to provide subsequent care.
- Share pertinent information about pregnant women with prenatal care health professionals, and coordinate care with prenatal care health professionals as appropriate.
- Consult with prenatal care health professionals, as necessary—for example, when considering the following:
  - Co-morbid conditions that may affect management of oral problems (e.g., diabetes, hypertension, pulmonary or cardiac disease, bleeding disorders).
  - The use of intravenous sedation or general anesthesia.
  - The use of nitrous oxide as an adjunctive analgesic to local anesthetics.

Provide Oral Disease Management and Treatment to Pregnant Women

- Provide emergency or acute care at any time during the pregnancy, as indicated by the oral condition.
- Develop, discuss with women, and provide a comprehensive care plan that includes prevention, treatment, and maintenance throughout pregnancy. Discuss benefits and risks of treatment and alternatives to treatments.
- Use standard practice when placing restorative materials such as amalgam and composite.
- Use a rubber dam during endodontic procedures and restorative procedures.
- Position pregnant women appropriately during care:
  - Keep the woman's head at a higher level than her feet.
  - Place woman in a semi-reclining position, as tolerated, and allow frequent position changes.
  - Place a small pillow under the right hip, or have the woman turn slightly to the left as needed to avoid dizziness or nausea resulting from hypotension.
- Follow up with pregnant women to determine whether preventive and restorative treatment has been effective.

Provide Support Services (Case Management) to Pregnant Women

- Help pregnant women complete applications for insurance or other sources of coverage, social services (e.g., domestic violence services), or other needs (e.g., transportation, translation).
- If the woman does not have a prenatal care health professional, explain the importance of care. Facilitate referrals to prenatal care health professionals in the community, especially those who accept Medicaid and other public insurance programs.

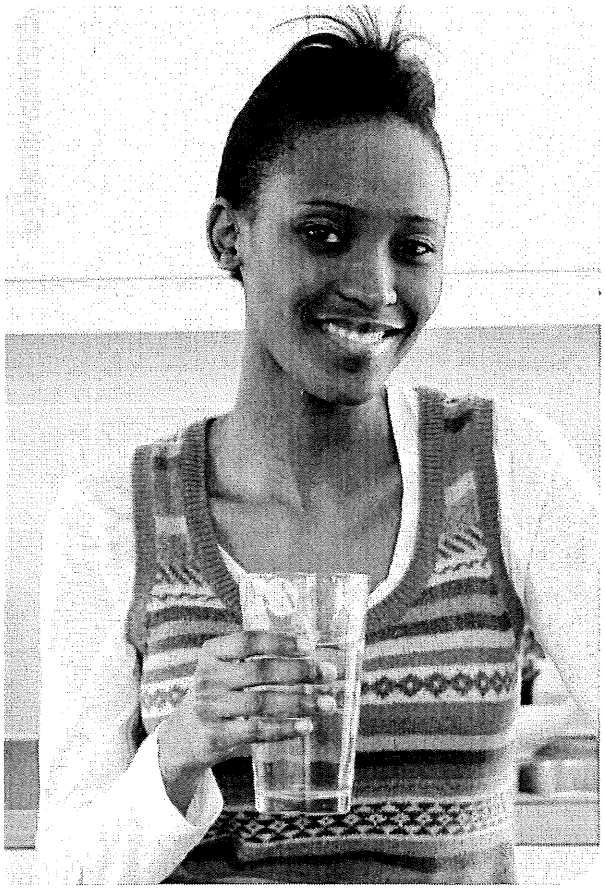
Improve Health Services in the Community

- On the patient-intake form, record the name and contact information of the prenatal care health professional.
- Accept women enrolled in Medicaid and other public insurance programs.
- Establish partnerships with community-based programs (e.g., WIC, Early Head Start) that serve pregnant women with low incomes.
- Provide a referral to a nutrition professional if counseling (e.g., guidance on food choices or nutrition-related health problems) would be beneficial.
- Provide culturally and linguistically appropriate care. Take the time to ensure that women understand information shared with them.

Pharmacological Considerations for Pregnant Women

The pharmacological agents listed below are to be used only for indicated medical conditions and with appropriate supervision.

Pharmaceutical Agent	Indications, Contraindications, and Special Considerations
Analgesics	
Acetaminophen	May be used during pregnancy.
Acetaminophen with Codeine, Hydrocodone, or Oxycodone	
Codeine	
Meperidine	
Morphine	
Aspirin	May be used in short duration during pregnancy; 48 to 72 hours. Avoid in 1st and 3rd trimesters.
Ibuprofen	
Naproxen	
Antibiotics	
Amoxicillin	May be used during pregnancy.
Cephalosporins	
Clindamycin	
Metronidazole	
Penicillin	
Ciprofloxacin	Avoid during pregnancy.
Clarithromycin	
Levofloxacin	
Moxifloxacin	
Tetracycline	Never use during pregnancy.
Anesthetics	Consult with a prenatal care health professional prior to using intravenous sedation or general anesthesia.
Local anesthetics with epinephrine (e.g., Bupivacaine, Lidocaine, Mepivacaine)	May be used during pregnancy.
Nitrous oxide (30%)	May be used during pregnancy when topical or local anesthetics are inadequate. Pregnant women require lower levels of nitrous oxide to achieve sedation; consult with prenatal care health professional.
Antimicrobials	Use alcohol-free products during pregnancy.
Cetylpyridinium chloride mouth rinse	May be used during pregnancy.
Chlorhexidine mouth rinse	
Xylitol	



Sources

American Academy of Pediatric Dentistry. 2011. Guideline on perinatal oral health care. *Reference Manual* 33(6):118–123. http://www.aapd.org/media/Policies_Guidelines/G_PerinatalOralHealthCare.pdf.

CDA Foundation. 2010. *Oral Health During Pregnancy & Early Childhood: Evidence-Based Guidelines for Health Professionals.* Sacramento, CA: CDA Foundation. http://www.cdafoundation.org/Portals/0/pdfs/poh_guidelines.pdf.

Kumar J, Iida H. 2008. *Oral Health Care During Pregnancy: A Summary of Practice Guidelines.* Washington, DC: National Maternal and Child Oral Health Resource Center. http://www.mchoralhealth.org/PDFs/Summary_PracticeGuidelines.pdf.

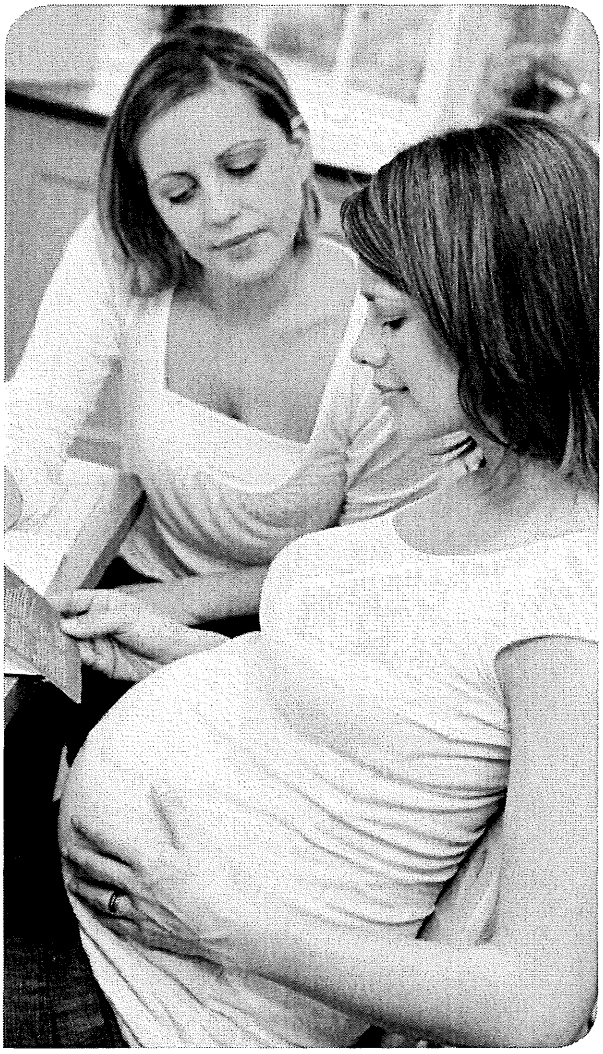
Kumar J, Samelson R, eds. 2006. *Oral Health Care During Pregnancy and Early Childhood: Practice Guidelines.* Albany, NY: New York State Department of Health. http://www.health.state.ny.us/publications/0824.pdf.

Northwest Center to Reduce Oral Health Disparities. 2009. *Guidelines for Oral Health Care in Pregnancy.* Seattle, WA: University of Washington School of Dentistry. http://depts.washington.edu/nacrohd/sites/default/files/oral_health_pregnancy_0.pdf.

Guidance for Health Professionals to Share with Pregnant Women

Guidance provided to pregnant women should be modified based on risk assessment. Creating opportunities for thoughtful dialogue between pregnant women and health professionals is one of the most effective ways to establish trust and build a partnership that promotes health and prevents disease.

Share the information on the following two pages with pregnant women. In addition to discussing the information with pregnant women, health professionals may photocopy the pages, or download and print them, to serve as a handout.



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