I-Smile @ School

School-Based Oral Health Programs

Iowa Department of Public Health

Table of Contents

Table of Contents

Appendices

Resources

1. **Evidence-based Clinical Recommendations for the Use of Pit-and-Fissure Sealants**
   Beauchamp J, et al. JADA 2008;139(3):257-268;
   http://jada.ada.org/content/139/3/257.full.pdf+html
2. **Techniques for Assessing Tooth Surfaces in School-Based Sealant Programs**
   Fontana M, et al. JADA 2010;141(7):854-860;
3. **Preventing Dental Caries Through School-Based Sealant Programs: Updated Recommendations and Reviews of Evidence**
   Gooch, BF et al. JADA 2009;140(11):1356-1365;
   http://jada.ada.org/content/140/11/1356.full.pdf+html
4. **Exploring Four-Handed Delivery and Retention of Resin-based Sealants**
   Griffin SO, et al. JADA 2008;139(3):281-289;
   http://jada.ada.org/content/139/3/281.full.pdf+html
5. **The Effect of Dental Sealants on Bacteria Levels in Caries Lesions**
   Oong EM, et al. JADA 2008;139(3):271-278;
   http://jada.ada.org/content/139/3/271.full.pdf+html
6. **A Comparison of the Effects of Toothbrushing and Handpiece Prophylaxis on Retention of Sealants**
   Gray SK, et al. JADA 2009;140(1):38-46;
   http://jada.ada.org/content/140/1/38.full.pdf+html
7. **Caries Risk in Formerly Sealed Teeth**
   Griffin SO, et al. JADA 2009;140(4):415-423;
   http://jada.ada.org/content/140/4/415.full.pdf+html
8. **The Effectiveness of Sealants in Managing Caries Lesions**
   Griffin SO, et al. J Dent Res 2008;87(2):169-174
9. **Infection Control Checklist for Dental Settings Using Mobile Vans or Portable Dental Equipment**
   OSAP; http://c.ymcdn.com/sites/www.osap.org/resource/resmgr/Checklists/OSAP.checklist.portabledenta.pdf
10. **Best Practice Approaches for State and Community Oral Health Programs: School-based Dental Sealant Programs**
    Association of State and Territorial Dental Directors Best Practices Committee;
    http://www.astdd.org/bestpractices/bpar-sealants-update-08-20-2014.pdf
11. **Dental Sealants and Bisphenol A (BPA) Policy Statement**
    Association of State and Territorial Dental Directors (ASTDD); Adopted February 3, 2011
    http://www.astdd.org/docs/dental-sealants-and-bpa-policy-statement-february-3-2011.pdf

Introduction to Iowa School-Based Oral Health Programs

The purpose of the I-Smile @ School School-Based Oral Health Program Manual is to provide all school-based dental sealant programs (SBSPs) with standardized information consistent with recent research and science and to clearly state program expectations and standards.

Dental sealants are effective in preventing decay and are particularly beneficial for children from low-income families who may not have access to regular dental care. A sealant is a tooth-colored material that is applied to the pit-and-fissure surface of posterior teeth. Sealants provide a physical barrier that prevents food debris and decay-causing bacteria from collecting in the pits and fissures of vulnerable teeth. Applying dental sealants within schools is an effective way to assure that children at greatest risk for tooth decay in newly erupting permanent molars have access to this low-cost, beneficial prevention.

The Iowa Department of Public Health (IDPH) provides grant funding to Title V Maternal and Child Health agencies to administer SBSPs. Several other Title V agencies operate SBSPs without specific funding from IDPH. All SBSPs provide services in schools with higher rates of free and reduced price lunch program participants, ensuring they are reaching the most at-risk children that may not otherwise have access to sealants.

All SBSPs must comply with the requirements detailed in this manual. While Maternal and Child Health and School-based Sealant Program Request for Proposals (RFPs) lay out the expectations of agencies receiving grant funds, this manual has been created to supplement those expectations and to aid all other Title V agencies in achievement of their SBSP goals.

This manual reflects professional recommendations based on systematic reviews of the literature by expert panels convened by the Centers for Disease Control and Prevention (CDC) and the American Dental Association (ADA). In addition, it incorporates information compiled by the Best Practices Committee of the Association of State and Territorial Dental Directors.

As part of its accountability to funders, IDPH maintains responsibility for assuring the success and positive impact of the SBSPs. This includes providing guidance and technical assistance to grantees and evaluating the performance of each program and the overall statewide effort.

IDPH provides assistance to help SBSPs improve performance, achieve program goals and meet standards. Technical assistance may be conducted via telephone, email, meetings or site visits as appropriate. IDPH may convene on-site or online meetings to provide program information, and require participation of specific local SBSP staff for these events.

Iowa Department of Public Health Policy Compliance

All School-based Sealant Programs (SBSPs) are components of Title V Maternal and Child Health (MCH) programs; therefore the policies and regulations for MCH are applicable to SBSPs.

SBSPs must:

- ensure services and staffing are consistent and appropriate as they pertain to the approved MCH plan and contract on file with IDPH and in accordance with federal legislation;
- adhere to the policies addressed in the Title V MCH Services Administrative Manual;
- adhere to applicable Department of Human Services policies and Iowa Administrative Code (IAC 441); and
- adhere to the IAC 641 rules for IDPH, including chapters 50 and 76.

School-based dental sealant program services (screenings, sealants, fluoride varnish) are within the direct services level of the MCH pyramid. Programs that include use of an I-Smile™ Coordinator to provide these direct services must ensure that the I-Smile™ Coordinator will continue to meet the minimum requirements for infrastructure-building, population-based, and enabling services, as outlined in the applicable IDPH MCH Contract.

Iowa Dental Board

The Iowa Dental Board (IDB) is the state agency charged with the overall responsibility for regulating the professions of dentistry, dental hygiene and dental assisting in Iowa. All dental sealant programs in Iowa must use appropriate dental professionals, working within their scope of practice, as identified in the IDB administrative rules.

Iowa Dental Board information can be found at: https://www.legis.iowa.gov/law/administrativeRules/chapters?pubDate=12-11-2013&agency=650.

Occupational Safety and Health Administration

The Occupational Safety and Health Act of 1970 was passed to prevent workers from being killed or seriously harmed at work. The law requires employers to provide their employees with working conditions that are free of known dangers. The act created the Occupational Safety and Health Administration (OSHA) that sets and enforces protective workplace safety and health standards. OSHA also provides information, training and assistance to workers and employers. OSHA regulations are found at www.osha.gov.

Each Maternal and Child Health agency is responsible for assuring their operation is in compliance with all applicable OSHA requirements. Questions regarding requirements or implementation of OSHA regulations should be directed to the Iowa Labor Services Division at www.iowaworkforce.org/labor/ .

The OSHA Bloodborne Pathogens Standard specifies safeguards to protect oral health care workers against the health hazards of bloodborne pathogens. The standard provides the following requirements for the oral health workforce:

- A written exposure control plan must be reviewed and updated annually to include common and potential health hazards.
- Infection control training is required prior to employees working in an environment where exposure to blood or other potentially infectious materials may occur, and on an annual basis thereafter.
- Personal protective equipment (eye protection, gloves and protective clothing) must be worn by all dental personnel.
- Appropriate hand washing must be performed.
- Instruments that can withstand heat must be sterilized in an autoclave. If the instruments cannot withstand heat, a high-level disinfectant must be used according to manufacturer's directions.
- Disposable items must not be re-used.
- Proper handling and disposal of sharps is required.
- The autoclave must be monitored weekly by biologic spore testing to ensure proper functioning.
- Environmental surfaces must be cleaned and disinfected. Barrier techniques must be used for items that are difficult to clean or disinfect.
- Food/drink is not permitted in clinic areas.

OSHA regulations and interpretations are available at: https://www.osha.gov/SLTC/dentistry/index.html and http://www.osha.gov/SLTC/bloodbornepathogens/index.html.

Infection Control

IDPH requires all SBSPs to comply with all infection control guidelines and standards. This would include OSHA and IDB regulations and Centers for Disease Control and Prevention (CDC) recommendations.

The portable nature of SBSPs presents particular challenges for infection control (e.g., safe transport of sharps). This section, which will help SBSPs meet IDPH expectations, is consistent with guidance developed by the Organization for Safety, Asepsis and Prevention (OSAP). OSAP provides an Infection Control Checklist for portable dental settings. This can be used by SBSPs to assess their infection control policies and procedures and is located in the Resources section of this handbook.

The CDC has identified levels of risk for transmission of infections and bloodborne diseases during dental services. These risk levels are based on the anticipated contact between the provider and patients' mucous membranes and/or blood and blood-contaminated saliva (see Table 1).

Table 1.
Risk Levels Based on Anticipated Contact Between Provider and Patients

Level	Anticipated contact with mucous membranes?	Anticipated contact with blood or saliva contaminated with blood?
I	Yes	Yes
II	Yes	No
III	No	No

Adapted from OSAP Infection Control Checklist for Dental Settings Using Mobile Vans or Portable Equipment. 2014
http://c.ymcdn.com/sites/www.osap.org/resource/resmgr/Checklists/OSAP.checklist.portabledenta.pdf

Sealant programs have two basic procedures: screening for tooth selection and sealant application. Each of these procedures pose a Level II risk, due to provider contact with patients' mucous membranes and saliva (but no anticipated contact with blood or saliva contaminated with blood). The CDC has four basic principles for infection control: 1.) take action to stay healthy, 2.) avoid contact with blood and other potentially infectious body substances, 3.) make instruments and equipment safe, and 4.) limit the spread of blood and other potentially infectious body substances. The following narrative is based on the four basic principles and a Level II risk.

Principle I: Take Action to Stay Healthy

Immunizations
Program staff immunizations should be current according to CDC's recommended adult immunization schedule. CDC's recommended adult immunization is available at: http://www.cdc.gov/vaccines/schedules/downloads/adult/adult-pocket-size.pdf. New staff should be tested for tuberculosis infection. Documentation of staff members' hepatitis B vaccination/immunity statuses must be kept on file.

Hand Hygiene
Appropriate hand washing must be performed. Although ideal to be in a room with a sink, this often is not possible. SBSP staff should select the best available site close to a sink. Soap and water, as well as alcohol-based hand sanitizers, may be used for cleansing hands. Hands must be cleansed before and after treating each patient, before donning or after removing gloves, after ungloved contact with surfaces or objects that may be contaminated by blood or other potentially infectious materials, before leaving the operatory, and when hands are visibly soiled. Soap and water (not hand sanitizers) must be used when hands are visibly soiled.

Staff should be trained in the procedures for hand washing and for the use of hand sanitizers. These procedures are as follows:

- Wash hands by vigorously rubbing soap and water over hands and fingers for 15 seconds before rinsing with cool water and thoroughly drying.
- If hand sanitizer is used, apply it to hands and rub hands together as if washing hands until hands are dry.
- Because hand sanitizers do not remove the powdery residue that can form under gloves, program staff using hand sanitizers should also wash hands periodically with soap and water.

Additional hand hygiene information is available at:
http://www.cdc.gov/oralhealth/InfectionControl/faq/hand.htm

Principle II: Avoid Contact with Blood and Other Potentially Infectious Body Substances

Personal Protective Equipment
Personal protective equipment (PPE) should be stored close to the patient care area and facilities should be available for disinfection of PPE (e.g., patient eyewear, utility gloves). PPE should be worn in the patient care area only.

Gloves
Gloves are single-use, disposable items, and they cannot be re-used or washed. Gloves that are damaged (e.g., torn, punctured) must be discarded. If gloves are damaged during a procedure, remove and discard them, wash hands immediately, and put on clean gloves.

Over-gloving (e.g., putting a clean pair of gloves over a used pair) between patients is not permitted. Gloves should be removed carefully to avoid exposure to microorganisms from patients. Wearing gloves does not replace hand washing.

Programs must use non-latex gloves, due to possible latex sensitivity among patients and staff. This sensitivity could result in allergic reactions that range from skin rash to anaphylaxis.

Heavy-duty puncture-resistant gloves, along with protective clothing and face protection, must be worn during clean-up and preparation of instruments for sterilization. Utility gloves may be decontaminated and used again, but damaged or worn-out gloves should be discarded.

Face Protection
During sealant application, oral health professionals must wear face protection. Face protection includes a chin-length face shield or a surgical mask and eyewear with solid side shields. Masks should be changed between patients or during treatment if they become damp or visibly contaminated. Program staff should remove masks by the fasteners because the front of the mask is considered contaminated and should not be touched. Masks should not be worn off the face or around the neck.

Eyewear and face shields must be cleaned and disinfected between patients, at the end of the day, and if visibly soiled.

Protective Clothing
Protective clothing must be worn during sealant application and for screenings where spatter is anticipated due to use of the air/water syringe. Protective clothing must be washed, or, if disposable, discarded.

Protective clothing should be removed immediately, or as soon as possible, if blood or other infectious materials have penetrated it. Protective clothing does not need to be changed after each patient unless it is visibly soiled.

Program staff does not need fluid-resistant gowns unless contact with body fluid that would seep through a garment is anticipated.

Avoid Injuries
Program staff must receive education and training at least once per year regarding infection control principles and rationale for recommended infection control practices. In addition, training must be provided upon initial employment or when a change in duties or procedures may affect exposure. Staff designated for specific task responsibilities (e.g., instrument sterilization, waste disposal) should receive appropriate training for that task. Training should address the portable environment and OSHA regulations.

Safe Handling of Sharps
For SBSPs, sharps are generally limited to explorers. All sharps, sterile and contaminated, should be transported in securely closed containers that are puncture-resistant to sharps.

All contaminated disposable sharps must be discarded in a closeable, leak-proof container that is manufactured for that purpose and that is impervious to sharps. The container must be red or labeled with the biohazard symbol, or both. The container must also be labeled "sharps." The sharps container should be placed in a secure location as close to the user as possible. Program staff should receive training on the proper handling of sharps and their disposal.

Non-disposable contaminated sharps (e.g. explorers) must also be stored in a closable, leak-proof container that is impervious to sharps. This container must be clearly labeled as containing contaminated sharps. Containers with contaminated instruments also should have a biohazard symbol.

Written Policy with Post-Exposure Control Plan
Programs must have a written infection control plan (including a post-exposure control plan) that describes protocols and procedures. The plan should be maintained by a program staff member designated as the infection-control coordinator. In the event that post-exposure care is needed, the program should have access to a health professional qualified to provide post-exposure care, counseling and follow-up. The infection control plan and procedures must be reviewed and evaluated at least annually by program staff and updated as necessary.

Infection Control: Management and Follow-up of Occupational Exposure is available in Appendix 1.

<u>Principle III: Make Instruments and Equipment Safe</u>

Instruments and Equipment
Between each patient, IDPH requires heat sterilization of all reusable patient-care items that touch mucous membranes and can withstand repeated exposure to high heat. Instruments may be heat sterilized on- or off-site. Disposable instruments are a good alternative to reusable instruments.

Programs that use handpieces or air/water syringes that are detachable from the unit must heat sterilize them between patients and follow the manufacturer's instructions for sterilization and care. If the handpiece or air/water syringe is permanently attached to the unit, programs should barrier protect the handle and either use disposable tips or sterilize metal tips between patients.

IDPH recommends single-use, disposable syringes for programs that use syringes to apply etchants and sealants. Multi-use syringes used in the sealant application process can easily become contaminated. Because these cannot be disinfected or heat-sterilized, the barrel of the

syringe should be covered with a replaceable barrier. Programs that use this item must use a new disposable syringe tip for each patient.

Instrument Cleaning and Sterilization
Programs are not required to clean instruments immediately after use; however, soaking instruments immediately after use in detergent, disinfectant/detergent, or enzymatic cleaner in a puncture-resistant container prevents patient matter from drying and makes cleaning easier. If instruments are to be transported off-site, they should be removed from the solution and transported in a securely closed, appropriately labeled, and puncture-proof container. It is recommended that containers storing instruments or sharps for transportation off-site be placed in an additional container, as an additional precaution against spillage of instruments.

Instruments should be cleaned (manually and/or with an ultrasonic cleaner) before being placed in bags or pouches for sterilization. Bags or pouches should be sealed prior to sterilization. A chemical indicator should be placed in the middle of each bag or pouch. If the indicator is not visible through the bag or pouch material, an additional indicator should be placed on the outside. If the indicator does not change color, this may indicate there was a problem during sterilization. Bags or pouches should be clearly labeled with the date, to ensure that the first instruments sterilized will be the first instruments used.

The instrument processing area should be divided into two separate zones: 1.) a “dirty” zone for intake, cleaning, and packaging of contaminated items, and 2.) a “clean” zone for sterilizing instruments, removing packaged items from the sterilizer, cooling them, and storing them. Personal protective equipment and utility gloves should be worn when handling and cleaning contaminated instruments.

After appropriate sterilization, a bag or pouch is considered sterile unless it is compromised (e.g., torn, wet, dropped on floor). If a bag or pouch is compromised, the instruments should be cleaned, placed in a new bag or pouch, and sterilized again. Store packaged instruments in clearly and appropriately labeled puncture-proof and secured containers.

Off-site sterilization
Proper instrument transport is critical for off-site sterilization. Sealant programs should use securely fastened containers for transporting instruments so that instruments will not spill when jostled. Cleaning instruments before transport is not required, but it can reduce possible exposure risk during transport.

On-site Sterilization
Adequate space for and design of the instrument-processing area is of primary importance for on-site sterilization. The sterilization area should have adequate ventilation, access to a sink, and be near the treatment area. It should have enough space to separate the dirty and clean zones and to allow for receiving, cleaning, packaging, sterilization/disinfection, and storing of processed instruments. Avoid carrying or scrubbing contaminated instruments at times when the area is crowded with children.

Sterilization Monitoring
The autoclave must be monitored every seven days, on the same day each week, by biologic testing (spore test) for proper functioning. Programs must document testing and keep a log with test results. Testing must be done weekly, even if a program operates only one day per week. If a spore test result is positive, IDPH requires that immediate action be taken to ensure that heat sterilization is accomplished. While programs may do biological spore testing themselves, most SBSPs choose to use independent sterilization-monitoring services.

If the autoclave has been idle for an extended period (e.g., during summer break), staff should perform a biologic spore test before program start-up to ascertain whether the autoclave is functioning correctly.

Portable Dental Unit Water Quality
CDC recommends that water used for routine dental treatment meets Environmental Protection Agency (EPA) regulatory standards for drinking water (e.g., <500 CFU/mL of heterotrophic water bacteria). Some manufacturers of portable dental equipment advise that tap water of good quality from a municipal supply or distilled or purified water be used in the water-supply bottle. Programs should consult with the manufacturer of their dental units for appropriate methods and equipment to maintain and monitor dental-unit water quality.

Dental water line cleaners should be used according to the manufacturer's directions and in accordance with the dental unit manufacturer's recommendations. Some manufacturers also recommend draining the water at the end of each day.

CDC recommends that water and air be flushed for a minimum of 20–30 seconds after each patient from any device connected to the dental water system that enters the patient's mouth (e.g., air/water syringe). This is to expel organisms that may have been drawn into the waterline.

Principle IV: Limit the Spread of Blood and Other Infectious Body Substances

Spatter
Use the air/water syringe carefully to avoid creating backsplash or spatter. The high-velocity evacuation (HVE) tubing and container should also be used in such a way as to limit potential spatter. Patients must not close lips around the HVE tip to prevent potential "suck-back" of bacteria that may be in the tubing.

Barriers and Disinfection of Surfaces
Clinical-contact surfaces (e.g., tabletops, instrument tray, light handles) must be covered with barriers or cleaned and disinfected between patients. Barriers must be discarded and replaced between patients. If a surface is not barrier-protected or if contact is made under a barrier, the surface must be cleaned and disinfected with a hospital-grade disinfectant product that is registered with the EPA.

Use the following procedures to clean and disinfect clinical contact surfaces:

1. Spray surface with disinfectant.
2. Wipe surface to clean it, and remove any debris.
3. Spray surface with disinfectant again.
4. Follow manufacturer's directions for the amount of contact time required to allow the product to achieve disinfection. Then wipe surface clean.

If disinfectant wipes are used, clean the surface and discard the wipe; then use a fresh wipe for disinfection. Follow the manufacturer's directions.

The HVE tubing and container should be disinfected. Refer to the manufacturer's instructions for proper disinfection. The entire system should be cleaned and disinfected by evacuating a cleaner/disinfectant through the entire hose assembly and waste bottle each time it is emptied. Thorough scrubbing of the entire assembly is also recommended each time the bottle is emptied.

Programs should have a protocol for the management, storage and disposal of chemical disinfectants. Products must be used appropriately for their intended purpose and with minimum exposure to the sealant team and patients. Areas where chemicals are used should be well-ventilated. Storage should prevent spills or contain them, in the event a spill occurs. Products should not be exposed to high temperatures. Refer to the manufacturer's instructions for proper handling, storage and disposal of products.

Waste Disposal

Disposal of regulated medical waste (e.g., sharps, blood-soaked gauze) must comply with OSHA rules. Sharps containers should never be emptied. When the contents reach the fill/full line, dispose of the entire container and begin using a new one.

In the unlikely event that a program generates regulated medical waste (e.g., blood-soaked gauze), that waste must be contained in a leak-resistant, securely fastened bag/container. The container should be red or conspicuously labeled with the international biohazard symbol. SBSPs are typically small generators of infectious waste (less than 50 lbs. per month, with proper documentation of infectious waste's weight available for each month). This allows for the disposal of both non-regulated waste (e.g., gloves, masks, disposable instruments, cotton rolls, protective coverings) and regulated waste (infectious waste) in regular trash bags without special handling. It is best to consult with school personnel about their preferences before discarding non-regulated waste on-site.

CDC guidelines related to waste removal may be found at: http://www.cdc.gov/OralHealth/infectioncontrol/guidelines/index.htm.

Infection Control Practices for School-Based Dental Sealant Programs are summarized in Appendix 2.

Site Assessment

Assessment of the site prior to the date for providing dental services can help prevent concerns with set-up and infection control. OSAP's *Site Assessment Checklist* can be found in Appendix 3. It is a useful checklist for confirming that a site meets program needs (e.g., space, utilities) for providing adequate infection control for screenings and sealant application.

Staffing/Personnel Requirements

The School-based Dental Sealant Program (SBSP) has the following staffing / personnel requirements:

- All dental providers – dentists, dental hygienists, and dental assistants – who provide services must be currently licensed or registered with the Iowa Dental Board (IDB).
- Lay people (unlicensed, unregistered, non-dental providers) may not be used in conjunction with any intra-oral, extra-oral, or infection control services.
- Sealant programs must use dentists to provide examinations or dental hygienists to provide screenings to determine which teeth will benefit from the application of dental sealants. Dental hygienists providing screenings must have a public health supervision agreement that allows the hygienist to provide dental screenings to make such a determination in a school setting.
- Programs must use dentists or dental hygienists to apply dental sealants. Dental hygienists applying sealants must have a public health supervision agreement that allows the hygienist to do so in a school setting.
- If applying fluoride varnish, the applicant must use dentists or dental hygienists. Dental hygienists applying fluoride varnish must have a public health supervision agreement that allows the hygienist to do so in a school setting.
- Programs are strongly encouraged to use registered dental assistants to assist dentists and/or dental hygienists to apply dental sealants. Four-handed sealant application may improve the quality and efficiency of sealant placement through shortened placement time, improved isolation, reduction in operator fatigue and enhanced patient care.
- All dental assistants must have a signed public health supervision agreement with a dentist on file at the Iowa Dental Board **and** the Iowa Department of Public Health (IDPH).

For more information on public health supervision of dental hygienists and assistants, go to: https://www.legis.iowa.gov/docs/ACO/agency/650.pdf

School, Grade, and Tooth Selection

School Selection

SBSPs target schools with a higher proportion of children at risk for tooth decay and lack of access to dental care. Guidelines for selection of schools include the following criteria:

- Forty percent or more of the student body is eligible for Free/Reduced Lunch (FRL) Program.
- Community is identified as high need based on Community Needs Assessment.
- Community has a high percentage of immigrant, migrant worker, refugee, and/or other vulnerable and underserved populations.
- The school is not receiving dental sealant services through another agency or organization.

IDPH sealant grant funds may only be used to provide services in schools in which 40 percent or more of the students are enrolled in FRL programs. Schools with less than 40 percent FRL rates may be served if they meet other guidelines for school selection; however, other sources of funding must be used.

Grade Selection

SBSPs are required to serve second and/or third graders to seal the first permanent molars shortly after eruption. If program funding and staffing allows, first graders may be targeted to seal permanent first molars that have erupted early; fourth and fifth graders may be targeted to seal permanent first molars that were not sealed previously; and sixth through eighth graders may also be targeted to seal second permanent molars and premolars (if indicated).

Tooth Selection

Only sound, noncavitated pit and fissure surfaces of posterior teeth may be sealed. Permanent first and second molars should be sealed shortly after eruption. Premolar (bicuspid) teeth and deciduous molars may be sealed as needed based on an individual risk assessment.

Equipment

Programs are required to use appropriate equipment, supplies, and techniques to apply dental sealants.

Appropriate equipment includes:

- portable dental unit
- patient chair
- provider stool
- assistant stool (if applicable)
- curing light
- overhead halogen light.

These products are widely available from a variety of vendors. Individual programs may select equipment to meet their program needs. Programs should consider cost-effectiveness and the ability to have the equipment quickly repaired when making selections.

Sealant program equipment should be serviced and maintained according to manufacturer's directions.

Sealant Materials

IDPH does not require the use of specific brands or types of sealant materials. Sealants should quickly self-adjust through normal occlusion; therefore, programs are encouraged to use resin-based sealant materials with a higher ratio of resin to filler material. Glass ionomer cements should be used when concerns about moisture control are present.

When choosing sealant materials for your program, consider: cost-effectiveness, prolonged retention properties, and simplicity of application. *Seal America: The Prevention Invention* (http://mchoralhealth.org/Seal/step4.html#sealant) provides a useful overview of the attributes of sealant materials that are appropriate for use in school-based programs.

Etching tooth surfaces prior to sealant placement is an essential step. According to the American Dental Association, a separate etching step (not combined with a bonding agent) may result in higher retention rates.

Hydrophilic bonding agents are not required and are considered a supplemental technique. If used, bonding agents should not be combined with etchant and must be compatible with the sealant material used. There is limited evidence that sealant retention can be improved if a bonding agent containing both an adhesive and a primer is used between the previously etched tooth surface and the sealant material.

IDPH has included a Dental Sealant Product List in Appendix 4.

Application of Sealants

All SBSPs must use techniques that assure dry tooth surfaces at critical points during the sealant application procedure. *Seal America: The Prevention Invention* (http://www.mchoralhealth.org/seal/step8.html#technique) describes the steps in sealant application technique. Each agency must have a written protocol in place describing sealant application procedures.

The following sealant application protocol is from *Seal America* and is recommended by IDPH. Sealant application technique will vary depending upon the type of material and isolation used. Before dental sealants are applied, be sure to read the manufacturer's instructions carefully, as different brands of sealants may require slightly different application techniques. The basic procedure for applying sealants is as follows:

Step 1. Thoroughly clean teeth to be sealed
Step 2. Isolate the teeth
Step 3. Etch tooth surface
Step 4. Rinse and dry
Step 4a. Apply bonding agent
Step 5. Place sealant material
Step 6. Polymerize sealants
Step 7. Inspect sealants

Step 1. Thoroughly Clean Teeth to Be Sealed

Sealant programs may use a dry toothbrush or a handpiece with a bristle brush to clean teeth to be sealed. *A Comparison of the Effects of Toothbrushing and Handpiece Phrophylaxis on Retention of Sealants*, The Journal of the American Dental Association (JADA) 2009, Gray, S.K. et al, shows that retention of sealants after a supervised toothbrush cleaning was at least as high as those associated with a traditional handpiece. Products containing fluoride should not be used prior to sealant placement to minimize probability of sealant failure. This translates to decreased costs for materials, equipment and personnel.

Step 2. Isolate the Teeth

Effective saliva control can be achieved by positioning the student so that the teeth to be sealed are visible and accessible. The student's head can be tilted so that saliva pools on the opposite side of the mouth from the side with teeth being sealed. A high-volume evacuator may be used. Cotton rolls or cotton roll holders and dry angles should be used and positioned as desired. Dry angles are most effective if placed over the parotid duct opening. Once the cotton rolls are in place, the teeth should be thoroughly dried. Evaluate the student's ability to tolerate sealant application before attempting to seal multiple teeth at a time.

Step 3. Etch Tooth Surface

The cleaned and dried tooth surfaces are etched with phosphoric acid for at least 20 seconds. A small cotton pellet, mini-sponge, or brush can be used to apply the etchant. Acid should be placed widely over the enamel surface so there is no chance that the sealant margin is placed

on un-etched enamel. If the acid inadvertently comes in contact with soft tissue, it needs to be rinsed immediately and thoroughly.

Step 4. Rinse and Dry

After 20 seconds, thoroughly rinse the etchant off the teeth. It is critical that saliva not come into contact with the prepared tooth surfaces during this step. When dry, a properly etched surface will have a dull matte or frosty appearance, in contrast to the glossy appearance of un-etched enamel. Should salivary contamination occur after this point, the surface must be washed, dried, re-etched for 10 seconds, and washed and dried again before the next sealant-application step.

Step 4a. Bonding Agents

If bonding agents are used, this step needs to be added in the sealant placement process. Once the tooth surface has been etched and thoroughly dried, the bonding agent should be placed on the tooth, and the agent should be air thinned before the sealant is applied. This step helps the sealant material flow into the deep fissures, helps bonding in areas of inadvertent moisture contamination, and improves sealant retention.

Step 5. Place Sealants

The application step will vary according to the product selected, and the dentist or dental hygienist should follow the manufacturer's instructions. The student's head should be positioned so that the occlusal plane is parallel to the floor so the sealant does not flow distally before it cures, leaving the mesial pits underfilled. Using the applicator provided by the manufacturer, the mixed sealant is flowed over the etched, dried surface. The sealant should be placed into the fissured surface, flowing from one end of the fissure carefully through the fissure complex to avoid air bubbles, and covering only the fissures and a small area of the fissure walls. If more than one tooth in a quadrant is being sealed, the most posterior tooth should be treated first, since maintaining dryness is more difficult in the back of the mouth.

Step 6. Polymerize Sealants

If using light-cured sealants, it is important that the curing light is set at the correct intensity and that the manufacturer's instructions on the length of time the sealant should be exposed to the curing light are followed. With autopolymerized sealants, sufficient time must be allowed so that the depth of the polymerization reaches the tooth surface under the sealant.

Step 7. Inspect Sealants

Isolation of the teeth should be maintained until the dental sealants are checked visually and with an explorer to make sure coverage of the pits or fissures is complete. If there is a surface air bubble, more sealant can be applied if the tooth has remained uncontaminated. Otherwise, the tooth must be re-etched for 10 seconds, washed, and dried before adding sealant material. A thin surface film of sealant will remain unpolymerized because of contact with air. This film has an unpleasant taste and should be wiped off with a wet cotton roll. The isolation materials can then be removed, and the student may rinse. The students should be told that the sealants may feel "high" but that the student's own teeth will wear them down during the next few days.

Additional Recommendations for Sealant Application

The use of a dental assistant is recommended whenever possible. Four-handed sealant application may improve the quality and efficiency of sealant placement through shortened placement time, improved isolation, reduction in operator fatigue and enhanced patient care.

Recommendations from *Techniques for Assessing Tooth Surfaces in School-Based Sealant Programs*, JADA 2010, Fontana, M. et al, have been adapted by IDPH and are expected of all SBSPs. These recommendations are as follows:

- Unaided visual examination is the method of choice when deciding whether a tooth is cavitated and whether a sealant should be placed.
- Dental explorers may be used in SBSPs; however, programs must be aware that noncavitated lesions can become damaged from pressure of the explorer during examination.
- Magnification may be used; however unaided visual assessment of tooth surfaces is the appropriate approach for detection of cavitation in SBSPs.
- Radiographs are not indicated in SBSPs. Radiographic images do not show images of approximal surfaces.
- Caries detection devices and technologies (e.g. DIAGNOdent) are not permitted to be used in SBSPs to determine the need for sealant placement. These devices do not detect lesion cavitation and their misuse could lead to teeth being misclassified and incorrectly precluded from sealant placement.

Retention Checks / Evaluation

Retention checks can be an effective way to evaluate staff performance, identify needed protocol changes, and detect clinical problems related to equipment and/or dental materials. Retention checks are recommended by the National Maternal and Child Oral Health Resource Center's document, *Seal America: The Prevention Invention,* and should be performed regularly for quality assurance purposes.

IDPH contractors will be notified of retention check requirements (e.g., the proportion of students checked and the frequency with which they are checked) at the beginning of each contract year.

Short-term Retention Checks

IDPH recommends that a sample of students who receive dental sealants be evaluated a few days or weeks after sealant application to ensure that the dental sealants are intact, adequately cover the occlusal pits and fissures, and have marginal integrity. These short-term retention checks should be completed on as many students as possible. The goal for short-term retention rates of properly applied sealants should be 98-100 percent.

Short-term retention checks can be especially useful in evaluating the performance of a new provider working in the SBSP.

Long-term Retention Checks

Long-term retention checks are done approximately one year following initial sealant placement and are required by IDPH for all contracted programs.

Annual retention checks will occur each year for as many students as possible, or as determined by IDPH. One-year retention rates of sealants should be high, averaging at least 90 percent.

Fluoride Varnish Application

The benefits of fluoride varnish make it extremely useful within public health programs. IDPH recommends that all SBSPs incorporate fluoride varnish applications as part of their preventive services.

Fluoride varnish is highly effective in preventing decay and remineralizing white spot lesions. It is recommended for use on at-risk children as soon as teeth begin to erupt. When applied to teeth, fluoride varnish sets upon contact with saliva. The hardened layer of fluoride is then absorbed into enamel. If not brushed off the teeth, it will continue to be absorbed for several hours. The absorption time is much longer than for traditional fluoride gels and foams. Fluoride varnish application may be applied up to four times a year, based on risk assessment.

Because of the hardening and small amount used, the risk of ingestion and toxicity of fluoride varnish is extremely low, making it safe for young children.

The criteria for application of fluoride varnish include:
- Suspected tooth decay
- White spot lesions
- Visible plaque
- History of decay (fillings or crowns)
- Low socio-economic status

Fluoride varnish application must be provided according to the manufacturers guidelines. The basic application guidelines are:

1. Clean the teeth. Teeth need to be “toothbrush clean” before fluoride varnish is applied.
2. Dry the quadrant to be treated with gauze or air.
3. Apply the varnish to all exposed surfaces of the teeth, including the chewing and interproximal surfaces.
4. Repeat for all remaining quadrants.
5. Provide patient instruction (to parent or patient):
    a. Patient should not brush or floss their teeth for four to six hours following the application.
    b. Patient should wait 2 hours after application before eating crunchy foods or drinking hot drinks.
    c. Patient should be informed that the teeth may appear discolored until the varnish is brushed off.

The IDPH fluoride varnish protocol may be accessed at: http://www.idph.state.ia.us/IDPHChannelsService/file.ashx?file=D3AF5755-9C3F-4442-A390-16DADDFD4366

Care Coordination and Referrals

Each student receiving services through a SBSP must be given a follow-up/referral letter for their parent/guardian which includes services provided, treatment needs, and agency contact information. This letter is further discussed in Section 400.

For those students identified with treatment needs, follow-up care coordination and referrals must be provided. For those students identified without a regular dentist, follow-up care coordination and referrals should be provided.

Care coordination links children and families to needed oral health care services and assures timeliness, appropriateness and completeness of care. Care coordination requires contact with families by face to face, telephone, email or text. Care coordination that is provided via email or text is billable as long as a response is received from the family.

Examples of dental care coordination activities include:

- Assisting clients with locating dentists
- Assisting with scheduling dentist appointments
- Reminding clients that periodic oral screenings or exams are due
- Counseling clients about the importance of keeping appointments
- Providing follow-up to assure that oral health care was received
- Arranging support services such as transportation, child care or translation/interpreter services
- Reinforcing anticipatory guidance
- Linking families to other community services (e.g., WIC)

All SBSPs are required to provide care coordination for those students identified with:

- probable or obvious tooth decay

All SBSPs <u>should</u> attempt to provide care coordination for those students identified with:

- no family dentist according to the student consent form
- a need for assistance to obtain dental or medical insurance
- a parental request for follow-up after sealant application

SBSPs must have protocols in place regarding care coordination and how it will be provided and follow all IDPH requirements for documenting and billing care coordination.

Forms and Reporting

All contracted SBSPs are required to use approved program forms including:

- Combined Consent and Release of Information form
- Sealant Data Recording form
- Parent/Guardian Letter
- Consent Tracking form

Combined Consent and Release of Information form

For the purposes of a sealant program, a combined consent and release of information may be used. The Iowa Department of Public Health (IDPH) has developed a template for use in sealant programs that contains the minimum information a program must incorporate. Each program has the option of modifying this template for their use; however, if modified, approval from the IDPH Sealant Coordinator must be received prior to use. The Combined Consent and Release of Information form is available in Appendix 5.

Sealant Data Recording form

The Sealant Data Recording form captures both screening information and the data indicators needed for the Microsoft Excel data file. A Sealant Data Recording form must be completed for each child examined/screened. IDPH has developed a template for use with this system that contains the minimum information a program must incorporate. Each sealant program has the option of modifying this template for their own use; however, if forms are modified, approval from the IDPH Sealant Coordinator must be received prior to use. The Sealant Data Recording form is available in Appendix 6 and the instructions for completing the Sealant Data Recording form are available in Appendix 7.

Parent/Guardian Letter

Every student receiving services through a SBSP must receive a parent/guardian letter to take home that indicates the findings of the screening and treatment needs, if any. Each sealant program has the option of creating its own parent letter, but the one developed for use with this system contains the minimum information a program must incorporate into its own form. If forms are modified, approval from the IDPH Sealant Coordinator must be received prior to use. The Parent Letter form is available in Appendix 8.

Consent Tracking form

For quality improvement and program monitoring, all SBSP are required to track annual consent rates for the schools and students in their service area. This includes:

- Number of students per grade per school in the SBSP
- Number of students per grade per school with returned consent
- Number of students per grade per school with positive consent

Consent Tracking forms are due to IDPH upon completion of each school. Consent Tracking forms should be emailed to the IDPH Sealant Coordinator with monthly MS Excel Sealant Data Files.

The consent tracking tool is located in Appendix 9.

Sealant Data Status Report

The Bureau of Oral and Health Delivery Systems within the Iowa Department of Public Health developed the IowaGrants.gov Sealant Data Status Report to capture specific information about children served through school-based sealant programs in Iowa. Data captured, including dental insurance coverage, frequency of dental visits, and untreated decay rates, are used to help assess the oral health status of Iowa children and programmatic needs.

All Title V MCH agencies providing SBSP services must report their sealant data to IDPH using the IowaGrants.gov Sealant Data Status Report. The files are available to programs at the beginning of each month, throughout the course of the contract year. The monthly Sealant Data Status Report must be submitted through the IowaGrants.gov system on or before the 15th of each month following services.

Information from the Sealant Data Recording Form that is completed for each child examined/screened is then used to complete the Sealant Data Status Report and Sealant Retention Data Report (if applicable) for each child.

All fields must be filled out and entered correctly into the Sealant Data Recording Form and Sealant Data Status Report to ensure data integrity. **Changes cannot be made to the Sealant Data Status Report.**

IDPH will use Statistical Package for Social Sciences (SPSS) software to compile the data from the Sealant Data Status Report and provide monthly reports to all programs.

Directions for completing the Sealant Data Status Report file are included in Appendix 10.

Retention Data

All school-based dental sealant program contractors must submit long-term sealant retention data as prescribed by the Iowa Department of Public Health. At the beginning of each contract year, IDPH will determine if state wide or individual agency retention checks will be required and also the protocols for the retention checks.

If required, contractors will collect sealant retention information on a prescribed number of students that received sealants within their sealant program in the previous year. Long-term retention checks must be completed on teeth that were sealed within the previous 9 to 12 months within the contractor's school-based sealant program. Each contractor must randomly select and collect information using the School-based Sealant Program Retention Data Form (Appendix 14).

Information to be collected includes:

- School type
    - elementary, or
    - middle/junior high school
- Retention Per Tooth (permanent first and second molars only)
    - sealant intact,
    - sealant partially retained,
    - sealant not intact, or
    - tooth not sealed in program

All school-based sealant program retention data will be reported to IDPH through the www.IowaGrants.gov system. IDPH will compile the retention data and disseminate reports and provide technical assistance (if appropriate).

Expense Reporting

Each SBSP contractor must complete and submit a monthly claim report in the Grant Tracking Site located in www.IowaGrants.gov. Claims are due 45 days following the close of each month as stated in the contract.

Only those IowaGrants.gov users that have been assigned to complete the monthly claim report will be able to do so and will receive a system generated notification of the upcoming due date for claims reports.

Client Records

All services provided to students through SBSPs must be entered into the Child and Adolescent Reporting System (CAReS) and in the client paper record or electronic medical record. The client record must detail all services provided, including sealant product used, tooth number and tooth surface.

MCH contract agencies must assure that employees are allowed access to client records (electronic or paper only) as necessary for the performance of their duties related to the contract and in accordance with policies and procedures.

MCH client records are the property of the Iowa Department of Public Health. In the event that an MCH contract is terminated, IDPH will provide direction for the transfer of client records.

All storage, retention and handling of client records must adhere to MCH policies as found in the MCH Administrative Manual, 4th Edition. You can access the MCH Manual here: http://www.idph.state.ia.us/hpcdp/common/pdf/family_health/mch_manual.pdf

Sealant Funding

School-based sealant programs (SBSP) are funded through a variety of sources:

- Iowa Department of Public Health (IDPH) SBSP grant funds
- Medicaid billing
- Other funding (community sources, grants)

IDPH SBSP grant funds

Use of grant funds is limited to schools with 40 percent or higher free and reduced lunch rates. Grant funds may be used for personnel and supplies based on limitations within applicable RFPs, RFAs and contracts.

A limited percent of grant funds are allowed to be used for the salaries and fringe or hourly wage of the dental personnel while providing direct services. Refer to the most recent RFP or RFA for details about percentage of grant funding available for direct service costs. Direct service costs only include personnel time spent providing screenings and application of sealant and/or fluoride.

IDPH sealant grant funds are considered payer of last resort and may not be used for services provided to children enrolled in Medicaid

Medicaid billing

Medicaid must be billed for services provided to children enrolled in Medicaid. Prior to billing Medicaid, each agency must have a Medicaid cost plan in place which includes dental sealants. Any Medicaid revenue (or other program income) generated from the sealant program must be used to enhance the sealant program.

Other funding

SBSPs are encouraged to seek funds from community and foundation resources to help expand and sustain their programs. It is the expectation that SBSPs develop a sustainability plan that includes collaboration with community partners and development of program best practices that will allow long-term program sustainability if funding is decreased or not available in the future. Examples of potential funders include: Delta Dental of Iowa Foundation, and service organizations such as Kiwanis and Rotary.

Note: I-Smile™ funds may not be used in the sealant program.

Infection Control: Management and Follow-Up of Occupational Exposure

SBSPs must have an exposure-control plan that delineates post-exposure policies and procedures to follow in case of occupational exposure to blood and other potentially infectious materials. Staff must receive training about these policies and procedures. OSHA has available a sample exposure control plan available at https://www.osha.gov/Publications/osha3186.pdf.

Programs should have access to up-to-date contact information for parents or guardians so that they can quickly obtain informed consent to test a child in case of an occupational exposure. If there is a blood exposure, the exposed person (or the health professional involved, if the exposed person is a patient) should immediately report the exposure to the agency infection-control coordinator. The infection-control coordinator should initiate a referral to appropriate healthcare personnel to provide post-exposure care, counseling, and follow-up and should complete necessary reports about the exposure.

If occupational exposure to a communicable disease occurs, the health professional affected should report the incident to his or her employer. The employer should immediately initiate post-exposure procedures, as appropriate, and should keep a detailed exposure report in the exposed employee's confidential medical record.

Because multiple factors contribute to the risk of infection after an occupational exposure to blood, the following information should be included in the exposure report, recorded in the exposed person's confidential medical record and provided to the qualified healthcare professional:

- Date and time of exposure;
- Where, when and how the exposure occurred;
- Identification of the source individual (unless infeasible or prohibited by law);
- Details of the exposure, including its severity and the depth of the wound;
- Details regarding whether the source material was known to contain HIV or other bloodborne pathogens, and, if the source was infected with HIV, the stage of disease, history of antiretroviral therapy, and viral load, if known;
- Details regarding the exposed person (e.g., Hepatitis B vaccination and vaccine response status);
- Details regarding counseling, post-exposure management, and follow-up; and
- Other pertinent information

The confidential medical evaluation must document the circumstances of exposure, identifying and testing the source individual if feasible, testing the exposed employee's blood (with consent), post-exposure prophylaxis, counseling and evaluation of reported illness. Health care professionals must be provided information to facilitate their evaluation.

The employer will be given a copy of the evaluating health care professional's written opinion. Findings and diagnoses, other than hepatitis B status, shall be kept confidential and not included in the written report. OSHA requires that employers ensure that employee medical records are kept confidential and not disclosed without the employee's written consent.

Adapted from CDC.gov. Updated U.S. Public Health Service Guidelines for the Management of Occupational Exposures to HBV, HCV, and HIV and Recommendations for Post-exposure Prophylaxis. MMWR June 29, 2001 / 50 (No. RR11).

Infection Control Practices for School-Based Dental Sealant Programs

Principles of Infection Control	SEALANT APPLICATION and ASSESSMENT to SELECT TEETH FOR SEALANTS Level II CONTACT is anticipated (with patient's mucous membranes and saliva; not with blood or saliva with blood).
1. Take action to stay healthy *Immunizations* • Hepatitis B • Vaccine preventable • Annual influenza *Hand hygiene*	 Yes[1] Yes, if not immune Yes Yes
2. Avoid contact with blood *Personal Protective Equipment (PPE)* • Gloves • Surgical Masks • Protective eyewear or chin-length face shield • Long sleeve outer clothing *Avoid injuries* *Safe Handling of Sharps* *Written policy with exposure control plan*	 Yes Yes Yes Yes Yes Yes Yes
3. Make patient care items safe for use *Instruments* *Sterilization* *Sterilization Monitoring* *Portable Dental Unit Water Quality*	 Dispose or heat sterilize[2] Yes Yes Yes
4. Limit the spread of blood and other infectious bloody substances *Control contamination* • High volume evacuation (HVE) • Disinfection/Barriers • Waste handling[3]	 Yes Yes Yes

[1] If dental provider – Hepatitis B immunity is not required for an individual who is solely recorded for tooth selection, is not subject to spray or splatter from the air/water syringe and has no contact with patients' mucous membranes and/or with instruments/items that have contact with patients' mucous membranes.
[2] If reusable instruments (e.g., mouth mirrors) are used, these must be cleaned and heat sterilized. If using disposable instruments or disposable tongue blades, place directly in waste container after use.
[3] Disposal of medical waste must comply with OSHA rules and IAC Chapter 109.

Infection Control Considerations for Dental Services in Sites Using Portable Equipment or Mobile Vans

Name and Type of Setting: _____ **Date of assessment:** _____

Range of Proposed Services: _____

Considerations	Acceptable?		Comments	
	Yes	No	NA	
PERSONNEL				
Site personnel available as point person for fielding questions and concerns				
Site personnel available for facilitating follow-up of exposures to infectious agents				
PHYSICAL				
Reasonably accessible route into/within building to transport equipment and supplies				
Adequate space for equipment (e.g., chairs, lights, sterilizers)				
Adequate space for supplies				
Adequate space for staff movement				

Considerations	Acceptable?		Comments	
	Yes	No	NA	
PHYSICAL, continued				
Adequate space for Patient intake and staging				
Adequate space for Radiographic equipment				
Adequate space for Instrument cleaning and processing or secured holding area				
Adequate space for safe handling of Medical waste (regulated and non-regulated)				
Adequate space for Sharps Disposal				
Adequate space for Long and short-term storage				
Non-carpeted areas to provide services				
Availability and close proximity of running water				
Close proximity of electrical outlets that accommodate electrical requirements of equipment				

Considerations	Acceptable?		Comments	
	Yes	No	NA	Yes
PHYSICAL, continued				
Adequate room lighting				
Waste disposal requirements for regulated and non-regulated waste known and acceptable				
Ability to cover or clean and disinfect environmental surfaces in service area				
Adequate ventilation for disinfectants, etc				
Acceptable housekeeping practices for site and treatment area				
Site restrictions on chemicals, sprays, etc are known and can be accommodated				

General Assessment of Site:

Adaptations Needed if Used:

Dental Sealant Product List

Major Resin-Based Dental Sealant Products
Listed by percent filler

Band Name (Manufacturer)	Technique	Filler (% wt.)	Color	Cure Method
Delton (Dentsply)	Traditional	0%	Clear Tinted White opaque	Auto
Delton DDS (Dentsply)	Traditional	0%	Clear White opaque	Light
Helioseal/Helioseal Clear (Ivoclar)	Traditional	0%	Clear White opaque	Light
Seal America (MPL, Inc.)	Traditional	0%	White opaque	Light Auto
Clinpro (3M ESPE)	Traditional	6%	Pink when applied → off-white when exposed to curing light	Light
ClinPro Adper Prompt-L-Pop (3M ESPE)	Self-etch	6%	Pink when applied → off-white when exposed to curing light	Light
Seal-Rite Low-viscosity (Pulpdent)	Traditional	7.7%	Off-white	Light
Embrace (Pulpdent)	Hydrophilic ("wet technique")	34.4%	Off-white natural	Light
Delton Plus (Dentsply)	Traditional	38%	White opaque	Light
Delton Seal-N-Glo (Dentsply)	Traditional	38%	Opaque UV-activated dye (blue-white)	Light
Helioseal F (Ivoclar)	Traditional	41.1%	White opaque	light

The Iowa Department of Public Health has no financial association with any of the manufacturers listed above. The manufacturers are listed as a service to assist SBSPs in finding appropriate products for their programs. This list is not an endorsement of any company or their products.

Consent and Release of Information – Template

Child's Name:				Age:	Date of Birth:
Address:				Cell Phone: Other Phone:	
☐ Male ☐ Female	Race:	☐ White ☐ Black ☐ Hispanic	☐ Asian/Pacific Islander ☐ Native American	☐ Other ☐ Undetermined / Unknown	
School:			Teacher's Name:		Grade:
Child's Physician:				Child's Dentist:	
If applicable, child's Medicaid ID Number:					

_____ **YES**, I give permission for my child to receive a dental screening, sealants, and fluoride varnish application.
If prophies will be provided, a more detailed medical history questions must be added to evaluate a client's risk for bacterial endocarditis or other conditions.
Please answer the following questions:

1. Is your child currently under a physician's care? ☐ Yes ☐ No
2. Is your child currently taking any medications? ☐ Yes ☐ No
3. Does your child have any allergies? ☐ Yes ☐ No

Please explain any YES answers: _____

_____ **NO**, I do not give permission for my child to receive a dental screening, sealants, and fluoride varnish application.

1. Does your child have a regular dentist? ☐ Yes ☐ No
2. If yes, does your child see that dentist at least once a year? ☐ Yes ☐ No
3. Is your child eligible for the free/reduced lunch program at school? ☐ Yes ☐ No
4. My child's most recent dental visit was within the past: (please check one)
   ☐ 6 months ☐ 12 months ☐ 3 years ☐ 5 years ☐ has never seen a dentist
5. How do you pay for your child's dental care? (please check one)
   ☐ Self ☐ Medicaid/Title XIX ☐ ***hawk-i*** ☐ Private dental insurance ☐ Other
6. List any concerns you have about your child's mouth or teeth? _____

I consent to the agency's use of email and texting to send me scheduling and child health services information.
☐ Yes ☐ No

- I was offered a Notice of Privacy Practices.
- I understand that this consent is valid for one (1) year unless withdrawn in writing by parent or guardian.
- I understand that the services that will be received do not take the place of regular dental checkups at a dental office.
- I understand that these services are provided under the Iowa Department of Public Health, Maternal and Child Health Program.
- I understand records created and maintained as part of this program are the property of the Iowa Department of Public Health.
- I understand that the information from these records may be shared with the Iowa Department of Public Health, Iowa Medicaid Enterprise, or designee for audit and quality improvement purposes or other legally authorized purposes.

_____
Parent/Guardian Signature **Date**

I voluntarily authorize (insert your agency name) to release, obtain, or exchange information with the following: (insert a list of specific possibilities – e.g. physicians, dentists, Head start centers) .
This release does *not* authorize disclosure of material protected by federal and/or state law applicable to substance abuse, mental health, and/or AIDS-related information.

_____
Parent/Guardian Signature **Date**

Sample Sealant Data Recording form

Risk Level: ☐ Low ☐ Moderate ☐ High

Decay: ☐Yes ☐ No
Filled: ☐Yes ☐ No
Sealed: ☐Yes ☐ No

ID#	Name	County #	DOB	Age
Sex: ☐**M** ☐**F**	School District	School		Grade

Date of Service	Race	Translator Needed? ☐**Yes** ☐**No**	Medicaid ID #

Has a Dentist? ☐**Y**es ☐ **N**o	Free/Reduced Lunch? ☐**Y**es ☐**N**o
Most Recent Visit? ☐**6**m ☐**12**m ☐**3**y ☐**5**y ☐**N**ever	Payment? ☐**S**elf ☐**X**IX ☐**h**awk-i ☐**I**ns ☐**O**ther

Oral Screening:

☐ **Medical history reviewed from consent form**

☐**D0190CC (initial screening)** ☐**D0190 (periodic screening)**

Visible plaque: ☐none ☐light ☐moderate ☐heavy

Soft Tissues:

☐no problems ☐gingivitis: localized___/generalized___
☐trauma ☐ lesions ☐swelling
Describe:_____

Hard Tissues:

☐no problems ☐chip ☐stained pits/fissures
☐decay ☐demineralized ☐other_____
Describe:_____

D1351 Sealant application: ☐yes ☐no Date:_____

Products used: (ex: 40% Phosphoric Acid Etch Gel & Clinpro Sealant)

D1206 Fluoride Varnish application: ☐ yes ☐ no

Product used: (ex: Varnish America 0.25mL)
Fluoride concentration: (ex: 5% NaFl2 varnish)

Education given: ☐ yes ☐ no

☐Dietary ☐Home Care ☐Fluoride ☐Other
Notes:

D1330 Oral Hygiene Instruction: ☐yes ☐no

Time In:____ Time Out: ____
Notes:

Referral to:_____
Referral: ☐Immediate ☐Within ___ months
CAReS Follow-up Date: ☐3mo ☐6mo ☐1 year
Parent letter with post-op instructions given for ☐varnish ☐sealants
Provider Name/Credentials:
Provider Signature:

	Tooth		Exam	Seal
UPPER RIGHT	1			
	2			
	3			
	4	A		
	5	B		
	6	C		
	7	D		
	8	E		
UPPER LEFT	9	F		
	10	G		
	11	H		
	12	I		
	13	J		
	14			
	15			
	16			
LOWER LEFT	17			
	18			
	19			
	20	K		
	21	L		
	22	M		
	23	N		
	24	O		
LOWER RIGHT	25	P		
	26	Q		
	27	R		
	28	S		
	29	T		
	30			
	31			
	32			

Sample Sealant Data Recording form

Risk Level:	☐ Low	☐ Moderate	☐ High	**Decay**: ☐Yes ☐ No **Filled**: ☐Yes ☐ No **Sealed**: ☐Yes ☐ No

Recording Key

RACE

1 White
2 Black
3 Hispanic
4 Asian/Pacific Islander
5 Native American
6 Other
7 Undetermined/Unknown

COUNTY CODE *(enter service area counties)*

01 County A
02 County B
03 County C
04 County D

CARIES PREVALENCE

0 Unerupted / congenitally missing permanent tooth
1 Sound permanent tooth
2 Filled permanent tooth
3 Questionable permanent tooth
4 Decayed permanent tooth
5 Crowned permanent tooth

a Sound primary tooth
b Filled primary tooth
c Questionable primary tooth
d Decayed primary tooth
e Crowned primary tooth

S Sealed permanent or primary tooth

Instructions for Completing the Sealant Data Recording Form

The Sealant Data Recording Form serves as the charting for oral screenings and sealant applications and also captures the data to be used to complete theIowaGrants.gov Sealant Data Status Report.

A Sealant Data Recording form must be completed for every student seen in the program. The oral screening and individual risk assessment must be completed before any other service is provided. Following the oral screening, use the Caries Prevalence Recording Key on the back of the Sealant Data Recording Form to enter an assessment code for each tooth on the tooth chart.

Once the screening is complete and the assessment data has been recorded, the sealant application may occur. Sealants should not be recorded until they are placed.

Fluoride Varnish, Education and Referrals should be completed after the conclusion of sealant placement. Every student must receive a referral, referral time frame, and a CAReS follow-up date. Every Sealant Data Recording Form must be complete with the provider's name, credentials and signature.

DEMOGRAPHIC INFORMATION

STEP	PROCEDURE
1	Enter an **ID number** for each student examined. This is for the purpose of identifying a student for data clarification only. Each agency may begin with "1" and proceed to higher numbers or create their own numbering system. **DO NOT RE-USE ANY NUMBER DURING A SCHOOLYEAR**.
2	Enter the **student's first and last name**.
3	Enter the **county number** where the student lives. The Recording Key on the back of the Sealant Data Recording Form identifies county numbers in your service area and contiguous counties.
4	Enter the student's **date of birth** (DOB).
5	Enter the student's **age**.
6	Mark **"M"** if the student is male **or "F"** if the student is female.
7	Write in the **school district** name. An abbreviation may be used, but the

Instructions for Completing the Sealant Data Recording Form

	abbreviation must be defined when submitting the Sealant Data Status Report.
8	Write in the **name of the school building**.
9	Enter the student's **grade number**.
10	Enter the date **of service** for the oral screening.
11	If provided by the parent/guardian, use the Recording Key on the back of the Sealant Data Recording Form to enter the correct number to identify the **race** of the student.
12	Mark **"yes" or "no"** to indicate the need for a **translator** for the student.
13	Enter the student's **Medicaid ID** number. If the student is not enrolled in Medicaid, mark the space N/A.
14	Mark **"yes" or "no**" to match the response on the consent form to "Does your **child have a dentist**".
15	Mark **"yes" or "no**" to match the response on the consent form to "Is your child eligible for the **free/reduced lunch** program at school".
16	Mark **"6m", "12m", "3y", "5y", or "never"** to match the response on the consent form to "My child's **most recent dental visit** was within".
17	Mark **"self", "XIX", "hawk-I", "ins", or "other"** to match the response on the consent form to "How do **you pay for your child's dental care**".

Instructions for Completing the Sealant Data Recording Form

ORAL SCREENING

1	Mark the box to indicate that the student's **medical history** has been reviewed from the consent form.
2	Mark "**D0190CC**" that this was an initial screening or "**D0190**" to indicate that this was a recall screening.
3	Mark the appropriate response for **visible plaque** to indicate the student's plaque level.
4	Mark the appropriate response(s) to indicate the status of the student's **soft tissues**. Provide detail if necessary.
5	Mark the appropriate response(s) to indicate the status of the student's **hard tissues**. Provide detail if necessary.
6	After completing an I-Smile risk assessment, in the upper right margin, mark one **Risk Level** (Low, Moderate, High) based on the I-Smile Risk Assessment guidelines. Mark "yes" or "no" to indicate whether or not the student has at least one **decayed, filled** or **sealed** tooth.

CARIES PREVALENCE RECORDING

1	This section applies to 'Exam' column on the table on the right side of this form. <u>Following the oral examination or screening</u>, use the Caries Prevalence Recording Key on the back of the Sealant Data Recording Form to enter an

Instructions for Completing the Sealant Data Recording Form

	assessment code for each tooth. **Each TOOTH will receive one code**, not each surface. Observe the following hierarchy for teeth that may have more than one assessed criterion: • sealed teeth have precedence over sound teeth, • restored teeth have precedence over sealed teeth, • teeth with untreated decay have precedence over restored teeth. Note: There is distinctive coding for PRIMARY vs. PERMANENT teeth, so there is no need to differentiate them in any other way.

SEALANT APPLICATION

1	Mark **"yes" or "no"** to indicate **D1351 sealant application.**
2	If "yes", indicate the **products used** for sealant application, including etchant.
3	Indicate the **date** of sealant placement.
4	Notes may be made in the space provided if necessary.

Instructions for Completing the Sealant Data Recording Form

SEALANT RECORDING

1	This section applies to 'Seal' column on the table on the right side of this form. Following sealant placement, identify any tooth that was sealed in your school-based clinic with an "S" in the Seal column. Only teeth that were sealed should be coded in this column. DO NOT FILL IN THIS COLUMN UNTIL AFTER THE SEALANT IS PLACED. If a tooth was not sealed, there is no documentation required in the 'Seal' column on the right side of the form.

FLUORIDE VARNISH APPLICATION

1	Mark **"yes" or "no"** to indicate **D1206 fluoride varnish application.**
2	If "yes", indicate the type of fluoride varnish **product used** and the **fluoride concentration**.
3	Notes may be made in the space provided if necessary.

EDUCATION GIVEN

1	Mark **"yes" or "no"** to indicate **education** given**.** **If "yes", indicate the type of education provided (dietary, home care, fluoride, or other)**.
2	Mark **"yes" or "no"** to indicate **D1330 Oral Hygiene Instruction** provided. If "yes", record the time in and time out for this service. Documentation of discussion and demonstration in the **Notes:** is also required for this service.

Instructions for Completing the Sealant Data Recording Form

	Note: This is a reimbursable service if instruction is provided for a minimum of 8 minutes.

REFERRAL, FOLLOW-UP AND SIGNATURE

1	Indicate the dentist to whom the student was **referred to** following this screening or if the student was provided a dental list.
2	Mark the appropriate response to **Referral** based upon the individual risk assessment.
3	Indicate the timeframe of the **CARes Follow-up date** by marking the appropriate box.
4	Mark the appropriate response(s) (varnish, sealants) to indicate **parent letter with post-op instructions given**.
5	Type, print or stamp the **Provider name/Credentials.**
6	Provide **provider signature.**

Date:

Student Name:

Your child participated in the dental sealant program at school. As part of the program, your child received a dental screening. No x-rays were taken and the screening does not take the place of a complete dental exam by your family dentist.

The results of the dental screening indicate:

☐ Your child has no obvious dental problems but needs to have regular checkups by a dentist.
☐ Your child has something that should be checked by a dentist. The dentist will tell you if treatment is needed. Notes: _____
☐ Your child needs **immediate** care from a dentist. Contact a dentist as soon as possible for a checkup. Notes: _____

Dental sealants:

☐ Were applied today. Sealants were placed on ___ back teeth.
☐ Were not applied today due to:
  ☐ Possible decay. Your child's teeth should be checked by your family dentist.
  ☐ Your child already has sealants and/or fillings intact.
  ☐ Your child's back teeth that we seal were not fully erupted.
  ☐ Your child could not tolerate sealant placement today.
  ☐ Other:

Fluoride varnish:

☐ Was applied today. Your child's teeth may be temporarily discolored. Please have your child avoid crunchy foods today, and please do not brush or floss until tomorrow morning.
☐ Was not applied today.

If you have questions about the school dental sealant program, if you do not have a family dentist, or if you have difficulty making a dental appointment, please contact the I-Smile™ coordinator at (phone number).

Consent Tracking form

School Name: Sample Elementary School						
Targeted Grade	3					
A. Students receiving consent forms	47					
B. Students returning consent forms	33					
% CONSENT RETURN (B÷Ax100)	70.2%					
C. Students with positive consent	30					
% POSITIVE CONSENT (C÷Bx100)	90.9%					

Instructions for Entering Monthly Sealant Data into IowaGrants.gov

All contractors must enter sealant data through the IowaGrants.gov system on a monthly basis. Anyone entering sealant data must be registered in IowaGrants.gov with the organization for which the data is being entered.

Two forms must be submitted on Iowagrants.gov every month, whether sealant program services were provided the previous month or not. You must complete the information on both forms BEFORE using the "Submit" function. **These forms must be submitted to the IowaGrants.gov system at the same time**.

Use the following instructions to enter monthly information in the Sealant Data Status Report and the Consent Tracking Form.

Sealant Data Status Report

STEP	PROCEDURE
1	Log into www.IowaGrants.gov. • Select "My Grants". • From the "Title" column, select the current Sealant grant name (e.g. Blue County Health Department). • From the "Grant/Project Components" section, select "Progress Reports".
All sealant programs must access the progress report **MONTHLY**, even if no services were provided the previous month. At the beginning of each month, you will start a new Sealant Data Status Report. All sealant data is due on the 15th of the month following services, but data may be entered from the first of the month when services are being provided (and may continue to be entered until the date of submission the following month). To do this:	
2	From the "Progress Reports" screen, locate "monthly" in the "Type" column and then click on the ID number to the left of "monthly".
3	From the "Components" section of this screen, click on "Monthly Dental Sealant Report".
4	Using the bottom scroll bar, scroll as far to the right on the screen as possible. Select "Edit" near the top of the screen.

Instructions for Entering Monthly Sealant Data into IowaGrants.gov

5	Go to the “Sealant Data” section and in the “Month of Data” text box, type in the month (e.g. October) of the data for which you are (or are not) reporting.
6	Respond to the question “Is there sealant data to report this month?” by selecting “yes” or “no”. If “no”, use the bottom scroll bar to scroll as far to the right as possible, click on “Save”. • From the next screen, use the bottom scroll bar to scroll as far right as possible again, click on “Mark as Complete”. • From the next screen, click on “Submit” in the center of the page. If “yes”, use the bottom scroll bar to scroll as far to the right as possible, click on “Save”. • From the next screen, scroll as far to the right again and click on “Add”. Begin to enter the monthly sealant data using the remaining instructions below.
Using your completed Sealant Data Recording Form, enter the data per child into the fields listed.	
7	• For each tooth number/letter, enter the result of the exam/screening in the “exam” box. All teeth with an “exam” box must have a Caries Prevalence assessment code. • For any tooth that was sealed within your program, enter “S” in the “Seal” box. If a tooth was NOT sealed, DO NOT enter anything into the “Seal” box. • After the data for each child is entered, select “Save” at the upper right of the screen.
8	REPEAT this process to enter the data for each child, until all children/data for the month are completed.
9	After you “Save” the information for the last child seen for a month, scroll to the right and click on “Mark as Complete”.

Instructions for Entering Monthly Sealant Data into IowaGrants.gov

Consent Tracking

STEP	PROCEDURE
1	From the “Components” section for this grant, click on “Consent Tracking Form”.
All sealant programs must enter Consent Tracking form data **MONTHLY**. • If there is no data to report, you may click on “Mark as Complete”. • If there is data to report, you will start a new Consent Tracking Form at the beginning of each new month. This data will be due on the 15th of the month following services, but data may be entered from the first of the month of services, until submission. To enter data:	
2	In the “Type” column, locate “monthly”, and then click on the ID number to the left of that.
3	Click on “Consent Tracking Form”.
4	Select “Edit” at the upper right.
5	In the “Consent Tracking Form” section, type in the month for which the data is being reported (e.g. October) in the “Month of Data” box.
6	Click on “Save” at the upper right of the screen.
7	In the “Category” section, click on “Add”.
Complete the fields as indicated, using the completed Consent Tracking Form (Appendix 9).	

Instructions for Entering Monthly Sealant Data into IowaGrants.gov

8	Information must be entered based on each grade served per each school served.
9	Once the consent information per grade per school is entered, click on "Save". If additional grades/schools need to be entered, click on "Add" in the "Category" section to do so for each grade/school.
10	Once all of the information is completed, click on "Mark as Complete".

Both the monthly Sealant Data Status Report form and the Consent Tracking form are submitted through the IowaGrants.gov system to IDPH at the same time.

After both forms are completed for the month, to submit your monthly data:

1	From the "Components" screen, click on "Submit" in the center of the screen. Once you click on "Submit", both of the the monthly sealant data reports are submitted to IDPH.

Instructions for Completing the Sealant Retention Data Recording Form

See Section 403.1 for details regarding how to conduct retention checks. Use the instructions below to complete the Sealant Retention Data Recording Form.

STEP	PROCEDURE
1	Using Appendix 16, determine the random sample of students to be screened.
2	For each child to be screened, indicate the type of school they were in by marking the appropriate box on the Sealant Retention Data Recording Form (Appendix 14). Mark **1** if: elementary school Mark **2** if: middle/junior high school
3	The recording form lists student numbers (1, 2, 3…); no additional identification numbers are to be used.
4	For each student, following the oral examination/screening, use the Retention Per Tooth codes on the Sealant Retention Data Recording Form to enter an assessment code for each molar listed on the form (only first and second permanent molars). The teeth may only be described with an assessment code of 1, 2, 3, or 4. Cells on the recording form may not be left blank. Mark **1** if: the tooth was sealed, and the sealant is still intact and does not need to be replaced. Mark **2** if: the tooth was sealed, and the sealant is partially intact and needs to be replaced. Mark **3** if: the tooth was sealed, and the sealant is not intact and needs to be replaced. Mark **4** if: the tooth was not sealed in the program last year.
5	Repeat until the prescribed numbers of retention checks (number of students) are completed.

Instructions for Completing the Sealant Retention Data Recording Form

6	Retain this document until information is entered and submitted via the www.IowaGrants.gov system.

Instructions for Entering Sealant Retention Data into IowaGrants.gov

Anyone entering sealant data must be registered in IowaGrants.gov with the organization for which the data is being entered. Use the following steps to enter sealant retention data.

STEP	PROCEDURE
1	Log into www.IowaGrants.gov. • Select "My Grants". • From the "Title" column, select the current Sealant grant name (e.g. Blue County Health Department). • From the "Grant/Project Components" section, select "Progress Reports".
2	In the "Type" column, locate "Annual Report", and then click on the ID number to the left of that.
3	Click on "Sealant Retention Data Report".
4	Click on "Add" at the upper right.
5	In the "Sealant Retention Data" section, enter information as instructed, following the order of the completed Sealant Retention Data Recording Form.
6	Click on "Save" at the upper right of the screen.
7	To add additional students, click on "Add" in the "Category" section.
8	Once the data for the required number of students to be checked for retention has been entered, click on "Mark as Complete".
9	You must then click on "Submit" to complete the submission of the retention data. This must be done prior to the due date.

Acronym List

ACRONYMS	
ADA	American Dental Association
CAReS	Child and Adolescent Reporting System
CDC	Centers for Disease Control and Prevention
EPA	Environmental Protection Agency
FRL	Free/Reduced Lunch
HVE	High-Velocity Evacuation
IAC	Iowa Administrative Code
IDB	Iowa Dental Board
IDPH	Iowa Department of Public Health
JADA	Journal of the American Dental Association
MCH	Title V Maternal and Child Health Program
MOU	Memorandum of Understanding
MS	Microsoft
OSAP	Organization for Safety, Asepsis and Prevention
OSHA	Occupational Safety and Health Act
PPE	Personal Protective Equipment
RFA	Request for Application
RFP	Request for Proposal
SBSP	School-Based Sealant Program
WIC	Special Supplemental Nutrition Program for Women, Infants, and Children

Sealant Retention Data Recording Form

Appendix 14

School Type:

1 for Elementary

2 for Middle/Junior High

Retention Per Tooth:

1 sealant intact, does not need replacement

2 sealant partially retained, needs to be replaced

3 sealant not intact, needs to be replaced

4 tooth not sealed in program

		Tooth Number							
School Type	**Student**	**2**	**3**	**14**	**15**	**18**	**19**	**30**	**31**
	1								
	2								
	3								
	4								
	5								
	6								
	7								
	8								
	9								
	10								
	11								
	12								
	13								
	14								
	15								
	16								
	17								
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								
	26								
	27								
	28								
	29								
	30								
	31								
	32								
	33								
	34								
	35								
	36								
	37								
	38								
	39								
	40								
	41								
	42								
	43								

Sealant Retention Data Recording Form									Appendix 14
School Type:		**Retention Per Tooth:**							
1 for Elementary		1 sealant intact, does not need replacement							
2 for Junior High		2 sealant partially retained, needs to be replaced							
		3 sealant not intact, needs to be replaced							
		4 tooth not sealed in program							
		Tooth Number							
School Type	**Student**	**2**	**3**	**14**	**15**	**18**	**19**	**30**	**31**
	44								
	45								
	46								
	47								
	48								
	49								
	50								
	51								
	52								
	53								
	54								
	55								
	56								
	57								
	58								
	59								
	60								
	61								
	62								
	63								
	64								
	65								
	66								
	67								
	68								
	69								
	70								
	71								
	72								
	73								
	74								
	75								
	76								
	77								
	78								
	79								
	80								
	81								
	82								
	83								
	84								
	85								
	86								

Sealant Retention Data Recording Form									Appendix 14
School Type:		**Retention Per Tooth:**							
1 for Elementary		1 sealant intact, does not need replacement							
2 for Junior High		2 sealant partially retained, needs to be replaced							
		3 sealant not intact, needs to be replaced							
		4 tooth not sealed in program							
		Tooth Number							
School Type	**Student**	**2**	**3**	**14**	**15**	**18**	**19**	**30**	**31**
	87								
	88								
	89								
	90								
	91								
	92								
	93								
	94								
	95								
	96								
	97								
	98								
	99								
	100								

Random Sampling Instructions

Random sampling helps to accurately determine the retention rate. A random sample gives each student an equal chance to be selected, regardless of their characteristics, such as which school they go to or which provider served them.

Microsoft Excel can be used to generate a random sample, following these steps**. If your sample will include both elementary school students and middle/junior high students, repeat the process for each school type separately.**

1. Based on IDPH guidelines, determine the list of all students eligible for retention checks. This list should broadly represent the students served, though for practical reasons, it may not be from all schools. For example, if your program is not returning to a school this year, you may exclude that school.

2. Put each eligible student ID number in column A of an Excel spreadsheet, in any order (alphabetical, by student number, etc.).

3. In column B, type *=RAND()* into the first cell.

4. Click, hold and drag the first cell to copy it down to every student. This produces a random number for each student.

5. Use the sort option to sort on column B. Use this sorted list to determine your student sample.

Sample Press Release

{Agency/I-Smile @ School logo}

{Date}

PRESS RELEASE – For Immediate Release
Contact: {Name, title, phone number}

I-Smile™ @ School Program

{Community Name} – On {date(s)}, the I-Smile™ @ School program will provide **FREE** preventive dental services to {number} grade students at {Name of school}. Iowa licensed dentists and dental hygienists will be on-site to provide dental screenings, dental sealants, fluoride varnish, and oral health education during the school day.

Dental sealants are a tooth-colored coating that is painted on the chewing surfaces of the back teeth. Dental sealants protect teeth from germs and food that can cause tooth decay and are quickly applied without pain. Fluoride varnish is a sticky liquid that is applied to strengthen teeth and prevent tooth decay. Fluoride and dental sealants are recommended by the American Dental Association, Centers for Disease Control and Prevention, and the U.S. Surgeon General as important decay prevention measures for assuring optimal oral health.

For additional information on the I-Smile™ @ School program in your area, contact {name and phone number}

###

Executive summary follows page 356

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

A report of the American Dental Association Council on Scientific Affairs

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

While dental sealants have been recognized as an effective approach to preventing pit-and-fissure caries in children,[1-5] clinical questions remain about the indications for placing pit-and-fissure sealants, the criteria for their placement over early caries (that is, noncavitated caries) and techniques to optimize retention and effectiveness. This report on the clinical recommendations for use of pit-and-fissure sealants presents a critical evaluation and summary of relevant scientific evidence to assist clinicians with their clinical decision-making process.

ABSTRACT

Background. This article presents evidence-based clinical recommendations for use of pit-and-fissure sealants developed by an expert panel convened by the American Dental Association Council on Scientific Affairs. The panel addressed the following clinical questions: Under what circumstances should sealants be placed to prevent caries? Does placing sealants over early (noncavitated) lesions prevent progression of the lesion? Are there conditions that favor the placement of resin-based versus. glass ionomer cement sealants in terms of retention or caries prevention? Are there any techniques that could improve sealants' retention and effectiveness in caries prevention?

Types of Studies Reviewed. Staff of the ADA Division of Science conducted a MEDLINE search to identify systematic reviews and clinical studies published after the identified systematic reviews. At the panel's request, the ADA Division of Science staff conducted additional searches for clinical studies related to specific topics. The Centers for Disease Control and Prevention also provided unpublished systematic reviews that since have been accepted for publication.

Results. The expert panel developed clinical recommendations for each clinical question. The panel concluded that sealants are effective in caries prevention and that sealants can prevent the progression of early noncavitated carious lesions.

Clinical Implications. These recommendations are presented as a resource to be considered in the clinical decision-making process. As part of the evidence-based approach to care, these clinical recommendations should be integrated with the practitioner's professional judgment and the patient's needs and preferences. The evidence indicates that sealants can be used effectively to prevent the initiation and progression of dental caries.

Key Words. Sealant; pit-and-fissure sealant; caries; caries prevention; primary prevention; secondary prevention; evidence-based dentistry; clinical recommendations.

JADA 2008;139(3):257-267.

USE OF SEALANTS: AN EVIDENCE-BASED APPROACH

Dentistry is a dynamic profession, continually reshaped by

Dr. Beauchamp is in private practice in Clarksville, Tenn. At the time these recommendations were developed, she was a member, Council on Access, Prevention and Interprofessional Relations, American Dental Association, Chicago.
Dr. Caufield is a professor, Department of Cariology and Comprehensive Care, New York University College of Dentistry, New York City.
Dr. Crall is a professor and the chair, Section of Pediatric Dentistry, School of Dentistry, University of California Los Angeles.
Dr. Donly is a professor and the chair, Department of Pediatric Dentistry, University of Texas Health Sciences Center San Antonio Dental School.
Dr. Feigal is a professor, Pediatric Dentistry, University of Minnesota, Minneapolis.
Dr. Gooch is a dental officer, Division of Oral Health, National Center for Health Promotion and Disease Prevention, Centers for Disease Control and Prevention, Atlanta.
Dr. Ismail is a professor, School of Dentistry, University of Michigan, Ann Arbor.
Dr. Kohn is the associate director for science, Division of Oral Health, Centers for Disease Control and Prevention, Atlanta.
Dr. Siegal is the chief, Bureau of Oral Health Services, Ohio Department of Health, Columbus.
Dr. Simonsen is the dean and a professor, College of Dental Medicine, Midwestern University, Glendale, Ariz.
Address reprint requests to Julie Frantsve-Hawley, director, Research Institute and Center for Evidence-based Dentistry, American Dental Association, 211 E. Chicago Ave., Chicago, Ill. 60611, e-mail "frantsvej@ada.org".

new science, devices, techniques and materials, all of which have increased rapidly since many of today's practicing dentists were trained. During the past 30 years, evidence-based approaches have developed that involve rigorous summary of findings from clinical studies about the effectiveness of preventive and treatment strategies, with the aim of providing the best available information to clinicians for decision making. In a changing practice environment, it is important that educational institutions and providers of continuing education continually update the state of the evidence related to the effectiveness of sealants in dental caries prevention and management.

Clinical decision making reflects the intersection of science, professional judgment and patients' desires. Decisions about sealant use should be based on the best available evidence about the effectiveness of the intervention and on knowledge of the epidemiology of dental caries (risk factors and patterns of disease). Therefore, this report includes a section addressing caries prevalence according to tooth surface and population group. This information should help to ensure that sealants are used appropriately within the context of these recommendations.

This report was developed through a critical evaluation of the collective body of published scientific evidence, conducted by an expert panel that was convened by the American Dental Association Council on Scientific Affairs. These clinical recommendations are not a standard of care, but rather a useful tool for dentists to use in making clinically sound decisions about sealant use. These clinical recommendations should be integrated with the practitioner's professional judgment and the individual patient's needs and preferences. While these recommendations are applicable to multiple settings, the Centers for Disease Control and Prevention (CDC) is developing recommendations for use of pit-and-fissure sealants specific for school-based programs.

CARIES: DEFINITION AND PREVENTION

Definition of dental caries. This report defines caries as the manifestation of the stage of the caries process at any given point in time.[6] The caries process occurs across time as an interaction between biofilm (that is, dental plaque) and the tooth surface and subsurface.[6] The bacteria in biofilm are metabolically active, which causes fluctuations in plaque fluid pH. These fluctuations may cause a loss of mineral from the tooth when the pH level is dropping or a gain of mineral when the pH level is increasing.[7,8] Progression occurs when the equilibrium between demineralization and remineralization is imbalanced, leading to a net mineral loss. In clinical care settings, diagnosis of caries implies not only determining whether caries is present (that is, detection) but also determining if the disease is arrested or active and, if active, progressing rapidly or slowly.[7,9]

Caries is an infectious oral disease that can be arrested in its early stages. Caries can be prevented and managed in many ways. Approaches include primary prevention, defined as interventions provided to avert the onset of caries, and secondary prevention, defined as interventions to avert the progression of early caries to cavitation.

Epidemiology. In data from 2004, 42 percent of children and young adults aged 6 to 19 years had dental caries (decayed or filled) in their permanent teeth.[10] Prevalence of dental caries increases with age, ranging from 21 percent among those aged 6 to 11 years to 67 percent among adolescents aged 16 to 19 years.[10] The prevalence of dental caries is higher among children from low-income families and those of Mexican-American ethnicity.[10] Overall, about one-quarter of carious surfaces remain untreated in children and young adults with any caries. About 90 percent of carious lesions are found in the pits and fissures of permanent posterior teeth.[10] These data also indicate that around 40 percent of children aged 2 to 8 years have experienced dental caries (decayed or filled) in their primary teeth.[10] Similar to the findings for the permanent teeth, the prevalence of dental caries and of untreated decay in the primary teeth is higher among children from low-income families and those of Mexican-American ethnicity.[10] Overall, about one-half of carious surfaces remain untreated among children with any caries. About 44 percent of carious lesions in primary teeth are found on the pits and fissures of molars.[10]

The role of pit-and-fissure sealants in primary and secondary prevention. Pit-and-fissure sealants can be used effectively as part of a comprehensive approach to caries prevention on

ABBREVIATION KEY. ADA CEBD: American Dental Association Center for Evidence-based Dentistry. **BPA:** Bisphenol-A. **CDC:** Centers for Disease Control and Prevention.

an individual basis or as a public health measure for at-risk populations. Sealants are placed to prevent caries initiation and to arrest caries progression by providing a physical barrier that inhibits microorganisms and food particles from collecting in pits and fissures. It is generally accepted that the effectiveness of sealants for caries prevention depends on long-term retention.[5,11,12] Full retention of sealants can be evaluated through visual and tactile examinations. In situations in which a sealant has been lost or partially retained, the sealant should be reapplied to ensure effectiveness.

Pit-and-fissure sealants are underused, particularly among those at high risk of experiencing caries; that population includes children in lower-income and certain racial and ethnic groups.[13] The national oral health objectives for dental sealants, as stated in the U.S. Department of Health and Human Services initiative Healthy People 2010, includes increasing the proportion of children who have received dental sealants on their molar teeth to 50 percent.[14] However, national data collected from 1999 through 2002 indicated that sealant prevalence on permanent teeth among children aged 6 to 11 years was 30.5 percent,[15] but this represents a substantial increase over the 8 percent prevalence reported in a survey conducted in 1986 and 1987.[16]

Types of sealant materials and placement techniques. Two predominant types of pit-and-fissure sealant materials are available: resin-based sealants and glass ionomer cements. Available resin-based sealant materials can be polymerized by autopolymerization, photopolymerization using visible light or a combination of the two processes.[11]

Glass ionomer cements are available in two forms, both of which contain fluoride: conventional and resin-modified.[17] Glass ionomer cements, which do not require acid etching of the tooth surface, generally are easier to place than are resin-based sealants. They also are not as moisture-sensitive as their resin-based counterparts. Glass ionomer materials, which were developed for their ability to release fluoride, can bond directly with enamel. It is hypothesized that release of fluoride from this material may contribute to caries prevention. However, the clinical effect of fluoride release from glass ionomer cement is not well-established. Clinical studies have provided conflicting evidence as to whether these materials significantly prevent or inhibit caries and affect the growth of caries-associated bacteria compared with materials not containing fluoride.[18-20]

A transient amount of bisphenol-A (BPA) may be detected in the saliva of some patients immediately after initial application of certain sealants as a result of the action of salivary enzymes on bisphenol-dimethacrylate, a component of some sealant materials.[21-24] According to research, systemic BPA has not been detected as a result of the use of such sealants, and potential estrogenicity at such low levels of exposure has not been documented.[22]

Pit-and-fissure sealant materials vary, as do the techniques used to place them. Manufacturers' instructions for effective placement and long-term retention of resin-based sealants typically include cleaning pits and fissures, appropriately acid etching surfaces and maintaining a dry field uncontaminated by saliva until the sealant is placed and cured. Supplemental techniques and recommendations as cited in the literature may include using bonding agents; using various forms of mechanical enamel preparation, such as air abrasion and modification with a bur (enameloplasty); and using the four-handed application technique.

Bonding agents, also known as adhesives, may be used when applying pit-and-fissure sealants. Current bonding systems are marketed as total- and self-etch systems. The total-etch systems involve a three- or two-step placement technique, with a separate step for acid etching. The self-etch systems are packaged either as self-etching primers with separate adhesives or all-in-one systems that combine acid etchants, primers and adhesives. Both systems are available in single or multiple bottles.[25]

Clinical questions regarding pit-and-fissure sealants. Although the scientific evidence supports the use of pit-and-fissure sealants as an effective caries-preventive measure, clinical questions remain about the indications for placing pit-and-fissure sealants, criteria for their placement over early (noncavitated) caries and techniques to optimize retention and caries prevention. To address these topics, the expert panel considered the following clinical questions:

- Under what circumstances should sealants be placed to prevent caries?
- Does placing sealants over early (noncavitated) lesions prevent progression of the lesions?
- Are there conditions that favor the placement

of resin-based versus glass ionomer cement sealants in terms of retention or caries prevention?

- Are there any techniques that could improve sealants' retention and effectiveness in caries prevention?

These clinical recommendations do not address the cost-effectiveness of using pit-and-fissure sealants. However, multiple models have shown that basing selection criteria for sealant placement on caries risk is cost-effective.[26,27] Readers are referred to resources cited in the reference list for further discussion of cost-effectiveness.[26-33]

METHODS

In this report, we provide an abbreviated description of the review method we used. The full methods, including the complete search strategy, are provided as Appendix 1 in supplemental data to the online version of this article (visit "http://jada.ada.org").

The ADA Council on Scientific Affairs convened a panel of experts to evaluate the systematic reviews and clinical trials identified by staff of the ADA Center for Evidence-based Dentistry (CEBD). The council selected panelists on the basis of their expertise in the relevant subject matter. The expert panel convened at a workshop held at the ADA Headquarters in Chicago Nov. 13-15, 2006, to evaluate the collective evidence and develop evidence-based clinical recommendations for use of pit-and-fissure sealants.

CEBD staff members searched MEDLINE to identify systematic reviews that addressed the four clinical questions.[2,5,34-42] They conducted a second search to identify clinical studies published since the identified systematic reviews were conducted.[17,33,43-78]

Members of the expert panel (B.G. and W.K.) presented an unpublished manuscript that examined individual studies included in three recent systematic reviews regarding sealant effectiveness.[2,5,79] (That manuscript now has been published.[80]) CDC completed a multivariate analysis of factors associated with sealant retention, including use of the two-handed method versus the four-handed method. The included studies evaluated the retention of second- or third-generation resin-based sealant materials and provided data on whether the sealant was applied with the two-handed or the four-handed method.[80]

For each identified systematic review and clinical study, the panel determined the final exclusion of publications. They excluded publications on the basis of the following criteria: they did not directly address one of the identified clinical questions; the sealant materials they described were not available in the United States; and the panelists had concerns about the methodology described. Appendix 2 in the supplemental data online is a list of excluded publications.

For each included publication, the panel developed an evidence statement and graded it according to a system modified from that of Shekelle and colleagues[81] (Table 1). The panel developed clinical recommendations that were based on the evidence statements. They classified clinical recommendations according to the strength of the evidence that forms the basis for the recommendation, again using a system modified from that of Shekelle and colleagues[81] (Table 2). It is important to note that while the classification of the recommendation may not directly reflect the importance of the recommendation, it does reflect the quality of scientific evidence that supports the recommendation. Because the effectiveness of sealants depends on clinical retention,[5,11,12] the panelists chose to accept clinical sealant retention as a reasonable proxy for caries prevention.

The panel submitted these clinical recommendations to numerous scientific experts and organizations for review. The expert panel scrutinized all comments received and made appropriate revisions in the recommendations. (Appendix 3 in the supplemental data online provides a list of external reviewers.) The final clinical recommendations were approved by the ADA Council on Scientific Affairs.

PANEL CONCLUSIONS BASED ON THE EVIDENCE

The following evidence statements and corresponding classification of evidence (in parentheses) represent the conclusions of the expert panel.

Evidence regarding sealants for caries prevention.

- Placement of resin-based sealants on the permanent molars of children and adolescents is effective for caries reduction[5] (Ia).
- Reduction of caries incidence in children and adolescents after placement of resin-based sealants ranges from 86 percent at one year to 78.6 percent at two years and 58.6 percent at four years[2,5] (Ia).

- Sealants are effective in reducing occlusal caries incidence in permanent first molars of children, with caries reductions of 76.3 percent at four years, when sealants were reapplied as needed. Caries reduction was 65 percent at nine years from initial treatment, with no reapplication during the last five years[47] (Ib).
- Pit-and-fissure sealants are retained on primary molars at a rate of 74.0 to 96.3 percent at one year[59] and 70.6 to 76.5 percent at 2.8 years[59,61] (III).
- There is consistent evidence from private dental insurance and Medicaid databases that placement of sealants on first and second permanent molars in children and adolescents is associated with reductions in the subsequent provision of restorative services[33,66] (III).
- Evidence from Medicaid claims data for children who were continuously enrolled for four years indicates that sealed permanent molars are less likely to receive restorative treatment, that the time between receiving sealants and receiving restorative treatment is greater, and that the restorations were less extensive than those in permanent molars that were unsealed[46] (III).

TABLE 1

System used for grading the evidence.*

GRADE	CATEGORY OF EVIDENCE
Ia	Evidence from systematic reviews of randomized controlled trials
Ib	Evidence from at least one randomized controlled trial
IIa	Evidence from at least one controlled study without randomization
IIb	Evidence from at least one other type of quasiexperimental study, such as time series analysis or studies in which the unit of analysis is not the individual
III	Evidence from nonexperimental descriptive studies, such as comparative studies, correlation studies, cohort studies and case-control studies
IV	Evidence from expert committee reports or opinions or clinical experience of respected authorities

* Amended with permission of the BMJ Publishing Group from Shekelle and colleagues.[81]

TABLE 2

System used for classifying the strength of the recommendations.*

CLASSIFICATION	STRENGTH OF RECOMMENDATIONS
A	Directly based on category I evidence
B	Directly based on category II evidence or extrapolated recommendation from category I evidence
C	Directly based on category III evidence or extrapolated recommendation from category I or II evidence
D	Directly based on category IV evidence or extrapolated recommendation from category I, II or III evidence

* Amended with permission of the BMJ Publishing Group from Shekelle and colleagues.[81]

Evidence regarding placing sealants over early (noncavitated) lesions.

- Placement of pit-and-fissure sealants significantly reduces the percentage of noncavitated carious lesions that progress in children, adolescents and young adults for as long as five years after sealant placement, compared with unsealed teeth[82] (Ia).
- There are no findings that bacteria increase under sealants. When placed over existing caries, sealants lower the number of viable bacteria by at least 100-fold and reduce the number of lesions with any viable bacteria by 50 percent[83] (Ia).

Evidence regarding sealant materials.

- Results in two of three reviewed studies indicate that resin-based sealants are more effective in caries reduction at 24 to 44 months after placement than is glass ionomer cement in permanent teeth of children and adolescents[5,65,84,85] (Ia).
- There is limited and conflicting evidence that glass ionomer cement reduces caries incidence in permanent teeth of children[17,50,51,55,65] (Ib), although retention rates of glass ionomer cement are low[5] (Ia).
- In a population with a low caries incidence, use of glass ionomer cement is not effective in reducing the incidence of caries when placed in caries-free first primary molars[48] (Ib).

Evidence regarding sealant placement techniques.

- There is limited and inconclusive evidence in favor of using air abrasion as a cleaning method before acid etching to improve sealant retention[57] (IIb).
- The use of air abrasion instead of acid etching

reduces the rate of sealant retention[74,75] (Ib).
➖ There is limited and conflicting evidence that mechanical preparation with a bur results in higher retention rates in children[72,73,77] (IIb).
➖ There is indirect evidence that use of the four-handed technique when placing resin-based sealants is associated with improved retention rates[80] (III).
➖ Sealant retention can be improved if the clinician applies a bonding agent that contains both an adhesive and a primer between the previously acid-etched enamel surface and the sealant material[67,68] (Ib).
➖ Presently available self-etching bonding agents, which do not involve a separate etching step, provide comparable or less retention than do bonding agents that involve a separate acid-etching step[69,70] (Ib).

CLINICAL RECOMMENDATIONS

The expert panel makes the following evidence-based recommendations for each question regarding the placement of pit-and-fissure sealants (Table 3). The strength of each recommendation is assigned on the basis of the level of evidence associated with each recommendation, as described in the Methods section. In instances in which the recommendation is extrapolated from the evidence, the strength of the recommendation is lowered to reflect the extrapolation. Qualifying notes on the recommendations appear in Box 1. After reviewing the evidence and developing the recommendations, the expert panel identified several areas in which additional research is necessary to answer many questions regarding pit-and-fissure sealants and provide further evidence (Box 2, page 264).

Pit-and-fissure sealant placement for caries prevention.
➖ Sealants should be placed on pits and fissures of children's primary teeth when it is determined that the tooth, or the patient, is at risk of experiencing caries[59,61] (III, D).*†
➖ Sealants should be placed on pits and fissures of children's and adolescents' permanent teeth when it is determined that the tooth, or the patient, is at risk of experiencing caries[2,5,33,46,47,55,66] (Ia, B).*†
➖ Sealants should be placed on pits and fissures of adults' permanent teeth when it is determined that the tooth, or the patient, is at risk of experiencing caries[2,5,33,46,47,55,66] (Ia, D).*†

Pit-and-fissure sealant placement over early (noncavitated) carious lesions‡ to prevent progression.
➖ Pit-and-fissure sealants should be placed on early (noncavitated) carious lesions, as defined in this document, in children, adolescents and young adults to reduce the percentage of lesions that progress[82] (Ia, B).†
➖ Pit-and-fissure sealants should be placed on early (noncavitated) carious lesions, as defined in this document, in adults to reduce the percentage of lesions that progress[82] (Ia, D).†

Conditions that favor the placement of resin-based versus glass ionomer cement.
➖ Resin-based sealants are the first choice of material for dental sealants[5,50] (Ia, A).
➖ Glass ionomer cement may be used as an interim preventive agent when there are indications for placement of a resin-based sealant but concerns about moisture control may compromise such placement[17,50,51,55,65] (IV,D).§

Placement techniques for pit-and-fissure sealants.
➖ A compatible¶ one-bottle bonding agent, which

BOX 1

Qualifying notes on clinical recommendations.

* Change in caries susceptibility can occur. It is important to consider that the risk of developing dental caries exists on a continuum and changes across time as risk factors change. Therefore, clinicians should re-evaluate each patient's caries risk status periodically.
† Clinicians should use recent radiographs, if available, in the decision-making process, but should not obtain radiographs for the sole purpose of placing sealants. Clinicians should consult the American Dental Association/U.S. Food and Drug Administration[86] guidelines regarding selection criteria for dental radiographs.
‡ "Noncavitated carious lesion" refers to pits and fissures in fully erupted teeth that may display discoloration not due to extrinsic staining, developmental opacities or fluorosis. The discoloration may be confined to the size of a pit or fissure or may extend to the cusp inclines surrounding a pit or fissure. The tooth surface should have no evidence of a shadow indicating dentinal caries, and, if radiographs are available, they should be evaluated to determine that neither the occlusal nor proximal surfaces have signs of dentinal caries.
§ These clinical recommendations offer two options for situations in which moisture control, such as with a newly erupted tooth at risk of developing caries, patient compliance or both are a concern. These options include use of a glass ionomer cement material or use of a compatible one-bottle bonding agent, which contains both an adhesive and a primer. Clinicians should use their expertise to determine which technique is most appropriate for an individual patient.
¶ Clinicians should consult with the manufacturer of the adhesive and/or sealant to determine material compatibility.

TABLE 3

Summary of evidence-based clinical recommendations regarding pit-and-fissure sealants.

The clinical recommendations in this table are a resource for dentists to use in clinical decision making. These clinical recommendations must be balanced with the practitioner's professional judgment and the individual patient's needs and preferences.

Dentists are encouraged to employ caries risk assessment strategies to determine whether placement of pit-and-fissure sealants is indicated as a primary preventive measure. The risk of experiencing dental caries exists on a continuum and changes across time as risk factors change. Therefore, caries risk status should be re-evaluated periodically. Manufacturers' instructions for sealant placement should be consulted, and a dry field should be maintained during placement.

TOPIC	RECOMMENDATION	GRADE OF EVIDENCE	STRENGTH OF RECOMMENDATION
Caries Prevention	Sealants should be placed in pits and fissures of **children's** primary teeth when it is determined that the tooth, or the patient, is at risk of developing caries*†	III	D
	Sealants should be placed on pits and fissures of **children's** and **adolescents'** permanent teeth when it is determined that the tooth, or the patient, is at risk of developing caries*†	Ia	B
	Sealants should be placed on pits and fissures of **adults'** permanent teeth when it is determined that the tooth, or the patient, is at risk of developing caries*†	Ia	D
Noncavitated Carious Lesions‡	Pit-and-fissure sealants should be placed on early (noncavitated) carious lesions, as defined in this document, in **children**, **adolescents** and **young adults** to reduce the percentage of lesions that progress†	Ia	B
	Pit-and-fissure sealants should be placed on early (noncavitated) carious lesions, as defined in this document, in **adults** to reduce the percentage of lesions that progress†	Ia	D
Resin-Based Versus Glass Ionomer Cement	Resin-based sealants are the first choice of material for dental sealants	Ia	A
	Glass ionomer cement may be used as an interim preventive agent when there are indications for placement of a resin-based sealant but concerns about moisture control may compromise such placement§	IV	D
Placement Techniques	A compatible¶ one-bottle bonding agent, which contains both an adhesive and a primer, may be used between the previously acid-etched enamel surface and the sealant material when, in the opinion of the dental professional, the bonding agent would enhance sealant retention in the clinical situation§	Ib	B
	Use of available self-etching bonding agents, which do not involve a separate etching step, may provide less retention than the standard acid-etching technique and is not recommended	Ib	B
	Routine mechanical preparation of enamel before acid etching is not recommended	IIb	B
	When possible, a four-handed technique should be used for placement of resin-based sealants	III	C
	When possible, a four-handed technique should be used for placement of glass ionomer cement sealants	IV	D
	The oral health care professional should monitor and reapply sealants as needed to maximize effectiveness	IV	D

* Change in caries susceptibility can occur. It is important to consider that the risk of developing dental caries exists on a continuum and changes across time as risk factors change. Therefore, clinicians should re-evaluate each patient's caries risk status periodically.

† Clinicians should use recent radiographs, if available, in the decision-making process, but should not obtain radiographs for the sole purpose of placing sealants. Clinicians should consult the American Dental Association/U.S. Food and Drug Administration[86] guidelines regarding selection criteria for dental radiographs.

‡ "Noncavitated carious lesion" refers to pits and fissures in fully erupted teeth that may display discoloration not due to extrinsic staining, developmental opacities or fluorosis. The discoloration may be confined to the size of a pit or fissure or may extend to the cusp inclines surrounding a pit or fissure. The tooth surface should have no evidence of a shadow indicating dentinal caries, and, if radiographs are available, they should be evaluated to determine that neither the occlusal nor the proximal surfaces have signs of dentinal caries.

§ These clinical recommendations offer two options for situations in which moisture control, such as with a newly erupted tooth at risk of developing caries, patient compliance or both are a concern. These options include use of a glass ionomer cement material or use of a compatible one-bottle bonding agent, which contains both an adhesive and a primer. Clinicians should use their expertise to determine which technique is most appropriate for an individual patient.

¶ Clinicians should consult with the manufacturer of the adhesive and/or sealant to determine material compatibility.

BOX 2

Research recommendations.

The expert panel identified the following topics as areas for additional research to provide a stronger evidence base for the application of pit-and-fissure sealants for caries prevention. These research topics have not been arranged in order of priority.

PREVENTIVE EFFECTIVENESS AND COST-EFFECTIVENESS OF VARIOUS PROTOCOLS FOR SELECTION OF PATIENTS AND TEETH FOR SEALANT PLACEMENT

- Systematic review of evidence from insurance databases regarding the effectiveness and potential cost-effectiveness of sealants in preventing caries
- Clinical trials regarding the sealing of noncavitated and cavitated carious lesions using standardized diagnostic criteria
- Clinical trials regarding the sealing of noncavitated smooth-surface lesions
- Clinical trials regarding placement of sealants in adults
- Clinical trials regarding placement of sealants on surfaces other than the occlusal surfaces of permanent molars, including premolars, buccal and lingual pits of molars and cingula of anterior teeth
- Effectiveness of different management options for noncavitated carious lesions
- Methods to determine arrest of dentinal caries as measure of sealant effectiveness
- Clinical trials regarding minimally invasive techniques to manage early caries (noncavitated) and cavitated carious lesions
- Clinical methods to detect when an early (noncavitated) carious lesion is active or nonactive (that is, arrested)
- Cost-effectiveness of caries-management strategies

TIMING OF SEALANT APPLICATION

- Clinical trials using sealants in adults
- Clinical trials using sealants in primary teeth
- The timing of caries initiation and subsequent progression of pit-and-fissure caries in contemporary populations of various caries-risk status

RESEARCH REGARDING SEALANT MATERIALS AND RETENTION

- Enamel penetration of the materials used in the sealant application process
- Depth of polymerization of sealant materials as it affects sealant retention
- Additional studies regarding the factors that affect clinical retention and effectiveness of sealants
- Evaluation of the effect of fissure-cleansing methods and materials, including laser use, on clinical outcomes
- Effectiveness of self-etching primers in enhancing clinical sealant retention
- Effectiveness of isolation techniques, including rubber-dam and four-handed technique
- Evaluation of changes in retention associated with new products (such as bonding agents)
- Research and systematic reviews regarding the use of bonding agents to enhance sealant retention
- Effect of one-step adhesives on sealant retention
- Retention of light-cured sealants
- Effect of mechanical preparation on sealant retention

POINT-OF-CARE APPLICATION OF GUIDELINES

- Translation of sealant guidelines into clinical practice

contains both an adhesive and a primer, may be used between the previously acid-etched enamel surface and the sealant material when, in the opinion of the dental professional, the bonding agent would enhance sealant retention in the clinical situation[67,68] (Ib, B).[§]

- Use of available self-etching bonding agents, which do not involve a separate etching step, may provide less retention than the standard acid-etching technique and is not recommended[69,70] (Ib, B).
- Routine mechanical preparation of enamel before acid etching is not recommended[57,72-75,77] (IIb, B).
- When possible, a four-handed technique should be used for placement of resin-based sealants[80] (III, C).
- When possible, a four-handed technique should be used for placement of glass ionomer cement sealants[80] (IV, D).
- The oral health care professional should monitor and reapply sealants as needed to maximize effectiveness (IV, D). He or she should consult the manufacturer's instructions for sealant placement and maintain a dry, isolated field during placement.

CARIES RISK

The panel encourages dentists to use caries risk assessment strategies in their practices. Multiple models have showed that basing selection criteria for sealants on the patient's caries risk is cost-effective.[26,27] It also is important to consider that the risk of experiencing dental caries exists on a continuum and changes across time as risk factors change.[87] Therefore, a patient's caries risk status should be re-evaluated periodically. The panel recognizes that there is not a single system of caries risk assessment that has been shown to be valid and reliable. However, dentists can use clinical indicators to classify caries risk status to predict future caries experience. Caries risk assessment should be integrated with the practitioner's professional expertise to determine treatment

Figure 1. Tooth surface with an early (noncavitated) carious lesion that exhibits a white demineralization line around the margin of the pit and fissure and /or a light brown discoloration within the confines of the pit-and-fissure area. Image provided courtesy of Dr. Amid I. Ismail, the Detroit Dental Health Project (National Institute of Dental and Craniofacial Research grant U-54 DE 14261-01).

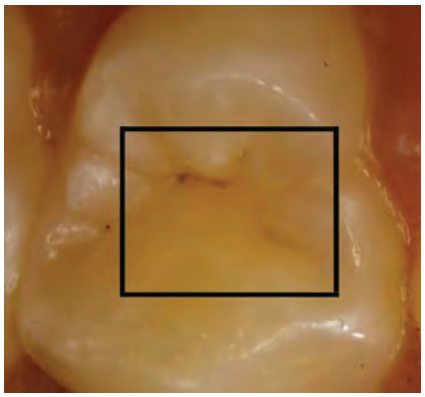


Figure 2. A small, distinct, dark brown early (noncavitated) carious lesion within the confines of the fissure. Image provided courtesy of Dr. Amid I. Ismail, the Detroit Dental Health Project (National Institute of Dental and Craniofacial Research grant U-54 DE 14261-01).

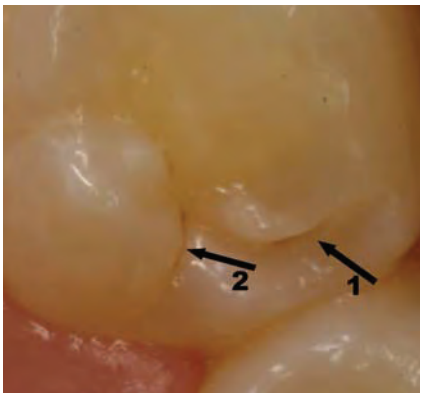


Figure 3. A deep fissure area (arrow 1) and another area exhibiting a small light brown pit and fissure (arrow 2). Note that the lesion does not extend beyond the confines of the pit and fissure. Image provided courtesy of Dr. Amid I. Ismail, the Detroit Dental Health Project (National Institute of Dental and Craniofacial Research grant U-54 DE 14261-01).

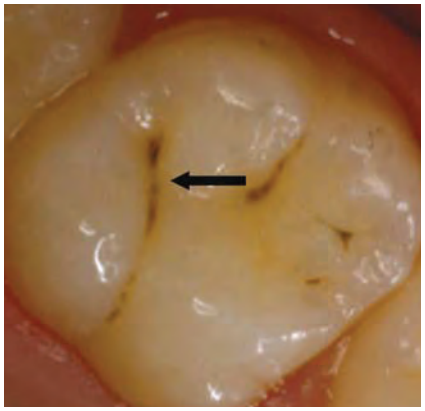


Figure 4. A more distinct early (noncavitated) carious lesion (arrow) that is larger than the normal anatomical size of the fissure area. Image provided courtesy of Dr. Amid I. Ismail, the Detroit Dental Health Project (National Institute of Dental and Craniofacial Research grant U-54 DE 14261-01).

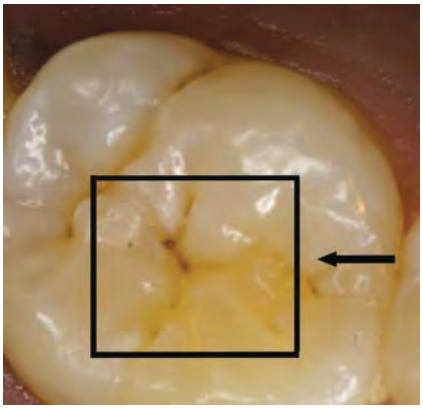


Figure 5. A more distinct early (noncavitated) carious lesion (arrow) that is larger than the normal anatomical size of the fissure area. Image provided courtesy of Dr. Amid I. Ismail, the Detroit Dental Health Project (National Institute of Dental and Craniofacial Research grant U-54 DE 14261-01).

options. The reader is referred to other resources for further discussion of caries risk.[88-94]

CLINICAL DETECTION OF NONCAVITATED PIT-AND-FISSURE CARIOUS LESIONS

Visual examination after cleaning and drying the tooth is sufficient to detect early noncavitated lesions in pits and fissures. The clinician should clean the tooth surface to remove debris and plaque before examining it for the presence of white demineralization lines or light yellow-brown discoloration surrounding the pit or fissure area. Noncavitated lesions also may appear as light to dark yellow-brown demineralization in the pit or fissure. It is important to note that external stain is not equivalent to a noncavitated carious lesion.

Figures 1 through 5 display examples of the range of lesions that are classified as noncavitated and indicated for sealing. All teeth in these figures were cleaned using a toothbrush and a periodontal probe or explorer before their surfaces were examined. Initially, the examiner (A.I.) conducted the examinations without drying the tooth surface. After determining that a visibly cavitated lesion was not present, the examiner dried the tooth surface with an air syringe to enable identification of early signs of dental caries.

The use of explorers is not necessary for the detection of early lesions, and forceful use of a sharp explorer can damage tooth surfaces.[89,95-97] The clinician should use recent radiographs, if available, in the decision-making process but should not obtain radiographs for the sole purpose of placing sealants. The Guide to Patient Selection for Dental Radiographs written by the ADA and the U.S. Food and Drug Administration[86] should be incorporated into the comprehensive care of the patient. There are many technologies that detect caries. Recent reviews suggest that these devices should be used only as adjunc-

tive devices to assist in caries diagnosis.[98,99] These devices should serve primarily as a support tool for making preventive treatment plan decisions in conjunction with caries risk assessment, and sole reliance on these devices to detect caries may result in premature restorative intervention.[98]

CONCLUSION

These evidence-based recommendations are a resource to be considered in the clinical decision-making process, which also includes the practitioner's professional judgment and the patient's needs and preferences. The recommendations address circumstances in which sealants should be placed to prevent caries, sealant placement over early (noncavitated) lesions, conditions that favor the placement of resin-based versus glass ionomer cement, and techniques to improve sealants' retention and effectiveness in caries prevention.

Pit-and-fissure sealants can be used effectively as part of a comprehensive approach to caries prevention. While sealants have been used for primary caries prevention, current evidence indicates that sealants also are an effective secondary preventive approach when placed on early noncavitated carious lesions. Caries risk assessment is an important component in the decision-making process, and it is important to re-evaluate a patient's caries risk status periodically. ■

Disclosure: None of the authors reported any disclosures.

The American Dental Association Council on Scientific Affairs and the expert panel thank the following people for their contribution to this project: Laurie Barker, MSPH, Centers for Disease Control and Prevention, Atlanta; Eugenio D. Beltrán-Aguilar, DMD, DrPH, Centers for Disease Control and Prevention, Atlanta; Susan Griffin, PhD, Centers for Disease Control and Prevention, Atlanta; Chien-Hsun Li, MS, MA, Centers for Disease Control and Prevention, Rockville, Md., and National Institute for Dental and Craniofacial Research, Bethesda, Md. They also thank members of the staff of the ADA Division of Science, Chicago: Daniel M. Meyer, DDS, senior vice president, science and professional affairs; Julie Frantsve-Hawley, RDH, PhD, director, Research Institute and Center for Evidence-based Dentistry; Helen Ristic, PhD, director, scientific information; Krishna Aravamudhan, BDS, MS, assistant director, laboratory professional product evaluations; Jane McGinley, RDH, MBA, manager, fluoridation and preventive health activities.

1. National Institutes of Health Consensus Development Conference Statement. Dental sealants in the prevention of tooth decay. J Dent Educ 1984;48(2 suppl):126-131.
2. Llodra JC, Bravo M, Delgado-Rodriguez M, Baca P, Galvez R. Factors influencing the effectiveness of sealants: a meta-analysis. Community Dent Oral Epidemiol 1993;21(5):261-268.
3. ADA Council on Access, Prevention and Interprofessional Relations; ADA Council on Scientific Affairs. Dental sealants. JADA 1997;128(4):485-488.
4. National Institute of Health Consensus Development Panel. National Institutes of Health Consensus Development Conference statement. Diagnosis and management of dental caries throughout life, March 26-28, 2001. JADA 2001;132(8):1153-1161.
5. Ahovuo-Saloranta A, Hiiri A, Nordblad A, Worthington H, Mäkelä M. Pit and fissure sealants for preventing dental decay in the permanent teeth of children and adolescents. Cochrane Database Syst Rev 2004(3):CD001830.
6. Pitts NB, Stamm JW. International Consensus Workshop on Caries Clinical Trials (ICW-CCT): final consensus statements—agreeing where the evidence leads. J Dent Res 2004;83(spec. no. C) C125-C128.
7. Kidd EA, Fejerskov O. What constitutes dental caries? Histopathology of carious enamel and dentin related to the action of cariogenic biofilms. J Dent Res 2004;83(spec. no. C):C35-C38.
8. Manji F, Fejerskov O, Nagelkerke NJ, Baelum V. A random effects model for some epidemiological features of dental caries. Community Dent Oral Epidemiol 1991;19(6):324-328.
9. Kidd EA. How "clean" must a cavity be before restoration? Caries Res 2004;38(3):305-313.
10. National Center for Health Statistics, Centers for Disease Control and Prevention. National Health and Nutrition Examination Surveys 1999-2004. "www.cdc.gov/nchs/nhanes.htm". Accessed Oct. 2, 2007.
11. Ripa LW. Sealants revisted: an update of the effectiveness of pit-and-fissure sealants. Caries Res 1993;27(suppl 1):77-82.
12. U.S. Department of Health and Human Services. Oral health in America: a report of the surgeon general. Rockville, Md.: U.S. Department of Health and Human Services, National Institute of Dental and Craniofacial Research, National Institutes of Health; 2000:166.
13. Centers for Disease Control and Prevention. Oral health: Preventing cavities, gum disease, and tooth loss; 2007. "www.cdc.gov/nccdphp/publications/aag/oh.htm". Accessed Jan. 8, 2008.
14. U.S. Department of Health and Human Services. Healthy People 2010. Washington: U.S. Department of Health and Human Services; 2000.
15. Beltrán-Aguilar ED, Barker LK, Canto MT, et al. Surveillance for dental caries, dental sealants, tooth retention, edentulism, and enamel fluorosis—United States, 1988-1994 and 1999-2002. MMWR Surveill Summ 2005;54(3):1-43.
16. Cohen LA, Horowitz AM. Community-based sealant programs in the United States: results of a survey. J Public Health Dent 1993;53(4):241-245.
17. Pardi V, Pereira AC, Mialhe FL, Meneghim Mde C, Ambrosano GM. A 5-year evaluation of two glass-ionomer cements used as fissure sealants. Community Dent Oral Epidemiol 2003;31(5):386-391.
18. Donly KJ, Segura A, Wefel JS, Hogan MM. Evaluating the effects of fluoride-releasing dental materials on adjacent interproximal caries. JADA 1999;130(6):817-825.
19. Mjör IA, Moorhead JE, Dahl JE. Reasons for replacement of restorations in permanent teeth in general dental practice. Int Dent J 2000;50(6):361-366.
20. Wiegand A, Buchalla W, Attin T. Review on fluoride-releasing restorative materials: fluoride release and uptake characteristics, antibacterial activity and influence on caries formation. Dent Mater 2007;23(3):343-362.
21. Arenholt-Bindslev D, Breinholt V, Preiss A, Schmalz G. Time-related bisphenol-A content and estrogenic activity in saliva samples collected in relation to placement of fissure sealants. Clin Oral Investig 1999;3(3):120-125.
22. Fung EY, Ewoldsen NO, St Germain HA, et al. Pharmacokinetics of bisphenol A released from a dental sealant. JADA 2000;131(1):51-58.
23. Söderholm KJ, Mariotti A. BIS-GMA–based resins in dentistry: are they safe? JADA 1999;130(2):201-209.
24. Völkel W, Colnot T, Csanády GA, Filser JG, Dekant W. Metabolism and kinetics of bisphenol a in humans at low doses following oral administration. Chem Res Toxicol 2002;15(10):1281-1287.
25. ADA Council on Scientific Affairs. Bonding agents. Professional Product Review 2006;2(1). "www.ada.org/prof/resources/pubs/ppr/archives/07_winter.asp". Accessed Jan. 15, 2008.
26. Griffin SO, Griffin PM, Gooch BF, Barker LK. Comparing the costs of three sealant delivery strategies. J Dent Res 2002;81(9): 641-645.
27. Quiñonez RB, Downs SM, Shugars D, Christensen J, Vann WF Jr. Assessing cost-effectiveness of sealant placement in children. J Public Health Dent 2005;65(2):82-89.
28. Deery C. The economic evaluation of pit and fissure sealants. Int J Paediatr Dent 1999;9(4):235-241.
29. Kervanto-Seppälä S, Lavonius E, Kerosuo E, Pietilä I. Can glass ionomer sealants be cost-effective? J Clin Dent 2000;11(1):1-3.
30. Kitchens DH. The economics of pit and fissure sealants in preventive dentistry: a review. J Contemp Dent Pract 2005;6(3):95-103.
31. Riordan PJ. Can organised dental care for children be both good and cheap? Community Dent Oral Epidemiol 1997;25(1):119-125.

32. Söderholm KJ. The impact of recent changes in the epidemiology of dental caries on guidelines for the use of dental sealants: clinical perspectives. J Public Health Dent 1995;55(5 spec. no.):302-311.
33. Weintraub JA, Stearns SC, Rozier RG, Huang CC. Treatment outcomes and costs of dental sealants among children enrolled in Medicaid. Am J Public Health 2001;91(11):1877-1881.
34. Bader JD, Shugars DA, Bonito AJ. A systematic review of selected caries prevention and management methods. Community Dent Oral Epidemiol 2001;29(6):399-411.
35. Bader JD, Shugars DA, Bonito AJ. Systematic reviews of selected dental caries diagnostic and management methods. J Dent Educ 2001;65(10):960-968.
36. Hiiri A, Ahovuo-Saloranta A, Nordblad A, Makela M. Pit and fissure sealants versus fluoride varnishes for preventing dental decay in children and adolescents. Cochrane Database Syst Rev 2006(4):CD003067.
37. Källestål C, Norlund A, Söder B, et al. Economic evaluation of dental caries prevention: a systematic review. Acta Odontol Scand 2003;61(6):341-346.
38. Mejáre I, Lingström P, Petersson LG, et al. Caries-preventive effect of fissure sealants: a systematic review. Acta Odontol Scand 2003;61(6):321-330.
39. Muller-Bolla M, Lupi-Pégurier L, Tardieu C, Velly AM, Antomarchi C. Retention of resin-based pit and fissure sealants: a systematic review. Community Dent Oral Epidemiol 2006;34(5):321-336.
40. Rozier RG. Effectiveness of methods used by dental professionals for the primary prevention of dental caries. J Dent Educ 2001;65(10):1063-1072.
41. Tinanoff N, Douglass JM. Clinical decision-making for caries management in primary teeth. J Dent Educ 2001;65(10):1133-1142.
42. Beiruti N, Frencken JE, van't Hof MA, van Palenstein Helderman WH. Caries-preventive effect of resin-based and glass ionomer sealants over time: a systematic review. Community Dent Oral Epidemiol 2006;34(6):403-409.
43. Beiruti N, Frencken JE, van't Hof MA, Taifour D, van Palenstein Helderman WH. Caries-preventive effect of a one-time application of composite resin and glass ionomer sealants after 5 years. Caries Res 2006;40(1):52-59.
44. Albani F, Ballesio I, Campanella V, Marzo G. Pit and fissure sealants: results at five and ten years. Eur J Paediatr Dent 2005;6(2):61-65.
45. Benteke M, Berntsson L, Broman U, Edfeldt K, Sköld-Larsson K, Twetman S. Population- vs. risk-based applications of fissure sealants in first permanent molars: a 13-year follow-up. Oral Health Prev Dent 2006;4(2):151-156.
46. Bhuridej P, Damiano PC, Kuthy RA, et al. Natural history of treatment outcomes of permanent first molars: a study of sealant effectiveness. JADA 2005;136(9):1265-1272.
47. Bravo M, Montero J, Bravo JJ, Baca P, Llodra JC. Sealant and fluoride varnish in caries: a randomized trial. J Dent Res 2005;84(12):1138-1143.
48. Chadwick BL, Treasure ET, Playle RA. A randomised controlled trial to determine the effectiveness of glass ionomer sealants in preschool children. Caries Res 2005;39(1):34-40.
49. Lekic PC, Deng D, Brothwell D. Clinical evaluation of sealants and preventive resin restorations in a group of environmentally homogeneous children. J Dent Child (Chic) 2006;73(1):15-19.
50. Pardi V, Pereira AC, Ambrosano GM, Meneghim Mde C. Clinical evaluation of three different materials used as pit and fissure sealant: 24-months results. J Clin Pediatr Dent 2005;29(2):133-137.
51. Pereira AC, Pardi V, Mialhe FL, Meneghim Mde C, Ambrosano GM. A 3-year clinical evaluation of glass-ionomer cements used as fissure sealants. Am J Dent 2003;16(1):23-27.
52. Pinar A, Sepet E, Aren G, Bölükbasi N, Ulukapi H, Turan N. Clinical performance of sealants with and without a bonding agent. Quintessence Int 2005;36(5):355-360.
53. Poulsen P. Retention of glassionomer sealant in primary teeth in young children. Eur J Paediatr Dent 2003;4(2):96-98.
54. Poulsen S, Laurberg L, Vaeth M, Jensen U, Haubek D. A field trial of resin-based and glass-ionomer fissure sealants: clinical and radiographic assessment of caries. Community Dent Oral Epidemiol 2006;34(1):36-40.
55. Taifour D, Frencken JE, van't Hof MA, Beiruti N, Truin GJ. Effects of glass ionomer sealants in newly erupted first molars after 5 years: a pilot study. Community Dent Oral Epidemiol 2003;31(4):314-319.
56. Yakut N, Sönmez H. Resin composite sealant vs. polyacid-modified resin composite applied to post eruptive mature and immature molars: two-year clinical study. J Clin Pediatr Dent 2006;30(3):215-218.
57. Yazici AR, Kiremitçi A, Celik C, Ozgünaltay G, Dayangaç B. A two-year clinical evaluation of pit and fissure sealants placed with and without air abrasion pretreatment in teenagers. JADA 2006;137(10):1401-1405.
58. Bagramian RA, Srivastava S, Graves RC. Pattern of sealant retention in children receiving a combination of caries-preventive methods: three-year results. JADA 1979;98(1):46-50.
59. Hotuman E, Rølling I, Poulsen S. Fissure sealants in a group of 3-4-year-old children. Int J Paediatr Dent 1998;8(2):159-160.
60. Li SH, Kingman A, Forthofer R, Swango P. Comparison of tooth surface-specific dental caries attack patterns in US schoolchildren from two national surveys. J Dent Res 1993;72(10):1398-1405.
61. Hardison JR, Collier DR, Sprouse LW, Van Cleave ML, Hogan AD. Retention of pit and fissure sealant on the primary molars of 3- and 4-year-old children after 1 year. JADA 1987;114(5):613-615.
62. Jones RB. The effects for recall patients of a comprehensive sealant program in a clinical dental public health setting. J Public Health Dent 1986;46(3):152-155.
63. Richardson BA, Smith DC, Hargreaves JA. A 5-year clinical evaluation of the effectiveness of a fissure sealant in mentally retarded Canadian children. Community Dent Oral Epidemiol 1981;9(4):170-174.
64. Cline JT, Messer LB. Long term retention of sealants applied by inexperienced operators in Minneapolis. Community Dent Oral Epidemiol 1979;7(4):206-212.
65. Songpaisan Y, Bratthall D, Phantumvanit P, Somridhivej Y. Effects of glass ionomer cement, resin-based pit and fissure sealant and HF applications on occlusal caries in a developing country field trial. Community Dent Oral Epidemiol 1995;23(1):25-29.
66. Dennison JB, Straffon LH, Smith RC. Effectiveness of sealant treatment over five years in an insured population. JADA 2000;131(5):597-605.
67. Feigal RJ, Musherure P, Gillespie B, Levy-Polack M, Quelhas I, Hebling J. Improved sealant retention with bonding agents: a clinical study of two-bottle and single-bottle systems. J Dent Res 2000;79(11):1850-1856.
68. Boksman L, McConnell RJ, Carson B, McCutcheon-Jones EF. A 2-year clinical evaluation of two pit and fissure sealants placed with and without the use of a bonding agent. Quintessence Int 1993;24(2):131-133.
69. Feigal RJ, Quelhas I. Clinical trial of a self-etching adhesive for sealant application: success at 24 months with Prompt L-Pop. Am J Dent 2003;16(4):249-251.
70. Venker DJ, Kuthy RA, Qian F, Kanellis MJ. Twelve-month sealant retention in a school-based program using a self-etching primer/adhesive. J Public Health Dent 2004;64(4):191-197.
71. Mascarenhas A, Nazar H, Soparkar P, Al-Mutawaa S. Effectiveness of primer and bond in sealant retention and caries prevention. Pediatr Dent 2008;30(1):500-504.
72. Shapira J, Eidelman E. The influence of mechanical preparation of enamel prior to etching on the retention of sealants. J Pedod 1982;6(4):283-287.
73. Shapira J, Eidelman E. The influence of mechanical preparation of enamel prior to etching on the retention of sealants: three-year follow-up. J Pedod 1984;8(3):272-277.
74. Kanellis MJ, Warren JJ, Levy SM. Comparison of air abrasion versus acid etch sealant techniques: six-month retention. Pediatr Dent 1997;19(4):258-261.
75. Kanellis MJ, Warren JJ, Levy SM. A comparison of sealant placement techniques and 12-month retention rates. J Public Health Dent 2000;60(1):53-56.
76. Le Bell Y, Forsten L. Sealing of preventively enlarged fissures. Acta Odontol Scand 1980;38(2):101-104.
77. Shapira J, Eidelman E. Six-year clinical evaluation of fissure sealants placed after mechanical preparation: a matched pair study. Pediatr Dent 1986;8(3):204-205.
78. Lygidakis NA, Oulis KI, Christodoulidis A. Evaluation of fissure sealants retention following four different isolation and surface preparation techniques: four years clinical trial. J Clin Pediatr Dent 1994;19(1):23-25.
79. Gooch BF, Truman BI, Griffin SO, et al. A comparison of selected evidence reviews and recommendations on interventions to prevent dental caries, oral and pharyngeal cancers, and sports-related craniofacial injuries. Am J Prev Med 2002;23(1 suppl):55-80.
80. Griffin SO, Jones K, Gray SK, Malvitz DM, Gooch BF. Exploring four-handed delivery and retention of resin-based sealants. JADA 2008;139(3):281-289.
81. Shekelle PG, Woolf SH, Eccles M, Grimshaw J. Clinical guide-

lines: developing guidelines. BMJ 1999;318(7183):593-596.
82. Griffin SO, Oong E, Kohn W, Vidakovic B, Gooch BF, CDC Dental Sealant Systematic Review Work Group, et al. The effectiveness of sealants in managing carious lesions. J Dent Res 2008;87(2):169-174.
83. Oong EM, Griffin SO, Kohn W, Gooch BF, Caufield P. The effect of dental sealants on bacteria levels in caries lesions: a review of the evidence. JADA 2008;139(3):271-278.
84. Poulsen S, Beiruti N, Sadat N. A comparison of retention and the effect on caries of fissure sealing with a glass-ionomer and a resin-based sealant. Community Dent Oral Epidemiol 2001;29(4):298-301.
85. Arrow P, Riordan PJ. Retention and caries preventive effects of a GIC and a resin-based fissure sealant. Community Dent Oral Epidemiol 1995;23(5):282-285.
86. American Dental Association, U.S. Food and Drug Administration. The selection of patients for dental radiographic examinations. Revised 2004. "www.ada.org/prof/resources/topics/radiography.asp". Accessed Jan. 12, 2008.
87. Recommendations for using fluoride to prevent and control dental caries in the United States. Centers for Disease Control and Prevention. MMWR Recomm Rep 2001;50(RR-14):1-42.
88. American Academy of Pediatric Dentistry, Council on Clinical Affairs. Policy on the use of a caries-risk assessment tool (CAT) for infants, children, and adolescents. In: American Academy of Pediatric Dentistry. Reference manual 2002-2003. Chicago: American Academy of Pediatric Dentistry;2002.
89. American Dental Association, Council on Access, Prevention and Interprofessional Relations. Caries diagnosis and risk assessment: a review of preventive strategies and management. JADA 1995;126(suppl):1S-24S.
90. Bader JD, Perrin NA, Maupomé G, Rindal B, Rush WA. Validation of a simple approach to caries risk assessment. J Public Health Dent 2005;65(2):76-81.
91. Featherstone JD. The caries balance: the basis for caries management by risk assessment. Oral Health Prev Dent 2004;2(suppl 1):259-264.
92. Featherstone JD, Adair SM, Anderson MH, et al. Caries management by risk assessment: consensus statement, April 2002. J Calif Dent Assoc 2003;31(3):257-269.
93. Tinanoff N. Dental caries risk assessment and prevention. Dent Clin North Am 1995;39(4):709-719.
94. Fontana M, Zero DT. Assessing patients' caries risk. JADA 2006;137(9):1231-1239.
95. Bader JD, Brown JP. Dilemmas in caries diagnosis. JADA 1993;124(6):48-50.
96. Dodds MW. Dilemmas in caries diagnosis: applications to current practice and need for research. J Dent Educ 1993;57(6):433-438.
97. van Dorp CS, Exterkate RA, ten Cate JM. The effect of dental probing on subsequent enamel demineralization. ASDC J Dent Child 1988;55(5):343-347.
98. Zandoná AF, Zero DT. Diagnostic tools for early caries detection. JADA 2006;137(12):1675-1684.
99. Bader JD, Shugars DA. A systematic review of the performance of a laser fluorescence device for detecting caries. JADA 2004;135(10):1413-1426.

Techniques for assessing tooth surfaces in school–based sealant programs

Margherita Fontana, DDS, PhD; Domenick T. Zero, DDS, MS; Eugenio D. Beltrán-Aguilar, DMD, MPH, MS, DrPH; Shellie Kolavic Gray, DMD, MPH

ABSTRACT

JADA CE CONTINUING EDUCATION ARTICLE 3

Background. The authors reviewed the evidence supporting current guidelines for the detection of cavitated carious lesions. Currently, cavitation is the point at which sealants are not placed in school-based programs.

Types of Studies Reviewed. The authors did not perform a formal systematic review. However, they examined existing systematic reviews of caries detection and diagnosis, including those presented at the 2001 National Institutes of Health Consensus Conference on Management of Caries, published evidence related to the International Caries Detection and Assessment System criteria and other peer-reviewed publications. Where the authors found ambiguity or uncertainty in the evidence, they consulted with fellow members of an expert work group.

Results. Visual examination is appropriate and adequate for caries assessment before placing sealants. The clinician should not use an explorer under force. Radiographs are not indicated solely for the placement of sealants, and the use of magnification and caries detection devices is not necessary to determine cavitation.

Clinical Implications. This report focuses on tooth assessment, in particular the detection of carious lesion cavitation in school-based sealant programs. These recommendations must be balanced with the dentist's expertise, available treatment options, the patient's preferences and access to care.

Key Words. Sealants; caries; cavitated lesions; noncavitated lesions; detection; assessment; occlusal surfaces.

JADA 2010;141(7):854-860.

In 2009, the Centers for Disease Control and Prevention (CDC), Atlanta, and an expert work group updated recommendations for school-based dental sealant programs (SBSPs), which provide sealants to high-risk children in schools with large proportions of low-income students. Work group members included professionals with expertise in caries detection and assessment, sealant materials and techniques, and SBSPs, as well as representatives from key professional dental organizations.[1]

During this process, CDC's expert work group conducted a systematic review of sealant effectiveness in managing caries and bacterial infection.[2,3] An expert panel convened by the American Dental Association (ADA) Council on Scientific Affairs conducted a similar process, using recently published systematic reviews to provide recommendations for sealant placement in clinical settings.[4] Both sets of recommendations indicate that sound pit and fissure surfaces and those with noncavitated lesions should be sealed.[1,4] Because of the lack of evidence regarding sealant effectiveness on cavitated lesions, they do not recommend that sealants be placed on teeth with cavitated lesions.[1,4]

Dr. Fontana is an associate professor, Department of Cariology, Restorative Sciences and Endodontics, School of Dentistry, University of Michigan, 1011 N. University, Ann Arbor, Mich. 48109, e-mail "mfontan@umich.edu". Address reprint requests to Dr. Fontana.
Dr. Zero is director, Oral Health Research Institute, and chair, Department of Preventive and Community Dentistry, School of Dentistry, Indiana University, Indianapolis.
Dr. Beltrán-Aguilar is a senior scientist/epidemiologist, Division of Oral Health, Centers for Disease Control and Prevention, Atlanta.
Dr. Kolavic Gray is an epidemiologist, Public Health Division, Northrop Grumman, Atlanta.

When deciding which tooth surfaces to seal, clinicians need to ask one important question: "What methods are used to identify sound surfaces and noncavitated lesions and to discriminate them from cavitated lesions?" To reach an answer, the expert work group sought evidence from systematic reviews, including those presented at the National Institutes of Health Consensus Development Conference on Diagnosis and Management of Dental Caries Throughout Life[5]; from criteria proposed by international groups building on best evidence—that is, the International Consensus Workshop on Caries Clinical Trials[6] and the International Caries Detection and Assessment System (ICDAS)[7]; and from studies published after 2001, as identified in MEDLINE searches, such as the work by Bader and colleagues.[8]

The approach to identifying tooth surfaces to be sealed differs between clinical practices and SBSPs. In clinical practice, treatment planning is based on risk factors at the individual tooth or patient level, a range of caries diagnostic and management options are available, and care likely is continuous. In SBSPs, which target high-risk populations, all permanent molars that can be appropriately isolated and assessed as sound or as having noncavitated carious lesions are sealed. In SBSPs, the decision to seal rests almost entirely on visual detection of the presence or absence of surface cavitation. To target the first permanent molars, most programs focus on children in the second and third grades. If resources permit, many programs also target second permanent molars in the sixth grade. According to the State and Territorial Dental Public Health Programs,[9] in 2008, 39 of 51 states and the District of Columbia had sealant programs benefiting almost 355,000 children.

The primary objective of this report was to review the state of the science and underlying rationale of methods used to determine the presence or absence of occlusal surface cavitation (and that of pit and fissure surfaces, such as buccal pits) in molars before sealant placement in school programs. In preparing this report, we did not perform a formal systematic review. However, the evidence reviewed included existing systematic reviews of caries detection and diagnosis (including those presented at the 2001 National Institutes of Health Consensus Development Conference on Management of Dental Caries Throughout Life[5]), published evidence related to the ICDAS criteria and other peer-reviewed publications. Where we found ambiguity or uncertainty in the evidence, we consulted with other members of the expert work group.

Dental professionals can better understand the objectives and context of sealant placement in school programs by knowing the rationale behind tooth-surface assessment and caries-detection methods in SBSPs. This may be especially important when dental professionals speak with parents or see children in their offices who have participated in these programs. In addition, dentists and dental hygienists who participate in SBSPs can use this information to guide their treatment decisions.

DENTAL CARIES AND CAVITATED VERSUS NONCAVITATED LESIONS

U.S. data indicate that about 90 percent of carious lesions are found in the pits and fissures of permanent teeth, with molars being the most susceptible.[10,11] Teeth are most susceptible to dental caries during the earlier years after eruption. At the demographic level, the disease is distributed unequally across the population, with certain groups (for example, people of lower socioeconomic status, minorities), such as those targeted by SBSPs, experiencing larger numbers and greater severity of carious lesions.[12,13]

Dental caries develops in places in which plaque accumulates and remains relatively undisturbed for extended periods in stagnant sites such as pits and fissures of surfaces. Initially, the process remains clinically undetected. At some point, however, the first clinical signs of dental caries appear[6] and can progress across time.[14] Because dental caries follows a dynamic but not necessarily continuous process, carious lesions can be arrested or even reversed[15]—for example, via use of fluorides—before progressing to cavitation. In the case of pit and fissure caries, the process also can be arrested mechanically with dental sealants.[2] The ability to differentiate between the stages of lesion development or to establish the appropriate detection thresholds for these stages depends on the detection method being used, the criteria being used or both.

On the basis of currently available data in the

ABBREVIATION KEY. ADA: American Dental Association. **CDC:** Centers for Disease Control and Prevention. **ICDAS:** International Caries Detection and Assessment System. **SBSPs:** School-based sealant programs.

literature, clinicians do not need to differentiate lesion staging before cavitation, because cavitation is the point at which sealants no longer should be placed.[1,4] This is especially the case in SBSPs in which treatment options are limited, thus greatly simplifying the choice of caries detection methods in these settings.

DIAGNOSIS VERSUS DETECTION

Sometimes the terms "caries diagnosis" and "caries detection" are incorrectly thought to be equivalent. A clinician diagnoses the disease dental caries in a patient on the basis of a variety of signs and symptoms and detects the consequences of the caries process, which manifest as a carious lesion. Therefore, to diagnose means not only to find the existing carious lesions (that is, detection), but, most importantly, to decide if they are active (that is, disease present), progressing rapidly or slowly, or already arrested. Without this information, a clinician cannot make a logical decision about treatment.[16,17] Assessing the patient's risk of developing new carious lesions is associated with diagnosis. Both diagnosis and risk assessment should help the clinician decide on appropriate and effective treatment options,[6,16,18] in particular for carious lesions at earlier stages.

However, as stated previously, in SBSPs the decision to seal rests almost entirely on visual detection of the presence or absence of surface cavitation. Detected cavitated lesions generally are not self-cleaning and, thus, are likely to progress. Therefore, dental professionals usually consider them to be sites of active disease. Consequently, the criteria and methods discussed in this report focus primarily on the ability to detect cavitated lesions as the cutoff point for sealant placement in SBSPs. We do not discuss the ability of methods to diagnose dental caries.

VALIDITY OF DETECTION METHODS IN RELATIONSHIP TO SCHOOL-BASED SEALANT PROGRAMS

Ideally, we would like to use a caries detection method that always identifies sound surfaces (that is, a highly specific method) and carious lesions (that is, a highly sensitive method). Identifying sound surfaces as having carious lesions (that is, a false-positive finding) can lead to unnecessary treatment and missing carious lesions (a false-negative finding) can lead to undertreatment. However, none of the currently available caries detection methods have both high sensitivity and high specificity. Therefore, choosing the best approach depends on the particular clinical situation.

For SBSPs, it is important to correctly identify sound and noncavitated lesions, because these are the targets for sealant placement. Because detection methods seek to detect positive outcomes (that is, caries), SBSPs would benefit from the use of a method that favors false-negative over false-positive results. Thus, a highly specific test is most desirable. The current clinical examination for dental caries involving the use of visual or visual and tactile methods has low sensitivity (that is, it does not allow for correct identification of all existing carious lesions)[19,20]; the clinical implication of this is that some noncavitated lesions may be missed. Two systematic reviews[8,21] showed that visual or visual and tactile methods have higher specificity than some commercially available detection methods, such as laser fluorescence or fiber optic transillumination. Thus, visual methods result in fewer false-positive results and are desirable for use in SBSPs.

ASSESSING PIT AND FISSURE SURFACES FOR CARIOUS LESIONS

Clinicians have used several methods during the assessment of occlusal surfaces to detect carious lesions, including visual assessment, use of an explorer, air-drying, use of magnification and radiographic examination. We discuss each of these relative to its ability to detect cavitated lesions in SBSPs (Table[7,21-26]). Of course, for any surface to be assessed with these methods, the tooth must be erupted sufficiently to be considered for sealant placement.[1,4]

Visual assessment to detect cavitation. The ADA and CDC both support the use of unaided visual examination as the method of choice for deciding whether a tooth is cavitated and whether a sealant should be placed.[1,4] The array of options available in a traditional clinical setting enables private practitioners to differentiate between cavitated, noncavitated and sound pit and fissure surfaces and allows for targeted prevention or treatment. SPSPs, however, focus on identifying cavitated pit and fissure surfaces to determine whether or not to place a sealant. As stated in a 2001 systematic review,[20] however, little high-quality evidence exists and a limited number of studies are available to judge the accuracy of methods (including visual, visual and tac-

tile, and radiographic methods) used to identify carious lesions.

Investigators have developed many criteria for the visual examination of teeth for carious lesion assessment.[19,27-29] A team of international caries researchers and clinicians reviewed the best available evidence regarding caries detection criteria and used it to develop ICDAS,[6,7,30-32] which has some level of histologic validation.[32,33] These criteria provide scoring that is based on visual assessment and support unaided visual assessment as adequate and appropriate to categorize surface cavitation, signs of dentinal involvement or both.

A noncavitated lesion, commonly referred to as a "white spot lesion," is a carious lesion whose surface appears macroscopically to be intact[34] (Figure). It may appear as a white, yellow or brown coloration that may be limited to the confines of the pits and fissures. A cavitated lesion, on the other hand, is identified by a discontinuity or break in the surface (Figure). By the time this occurs, demineralization in most cases has progressed histologically, radiographically, clinically or a combination of these into the dentin.[32,33] The break can be limited to enamel but with signs of undermined enamel (that is, dark coloration around the pit and fissure) or it can expose dentin directly to the oral cavity. The clinician can determine the presence of dentinal involvement, such as an underlying dark shadow, without extensive drying of the tooth surface.[1,7] However, he or she must clean the tooth surface to remove debris and plaque before examining it. This can be done simply by using a toothbrush and water.

TABLE

Recommendations for assessment of occlusal surfaces for sealant placement in school-based sealant programs.

RECOMMENDATION	SUMMARY OF EVIDENCE
Unaided visual assessment is appropriate and adequate	Although systematic reviews do not allow definitive confirmation of the accuracy of unaided visual assessment to identify cavitated lesions, the recommendation is based on best available evidence and expert opinion*
Use of the explorer does not improve the accuracy of visual assessment and can damage the tooth; thus, its use, especially under force, is not recommended	Although systematic reviews do not allow definitive confirmation of the accuracy of explorer use to identify cavitated lesions, the recommendation is based on best available evidence and expert opinion†
Use of magnification cannot be recommended because no data exist to suggest it is necessary, but it is not contraindicated	Limited evidence‡ from in vitro studies suggests that use of magnification does not increase the ability to identify sound surfaces (that is, it has the same specificity as that of unaided visual examination), while the data regarding its usefulness to help detect carious lesions (that is, sensitivity) are conflicting
Radiographs are not indicated solely for the placement of sealants	Systematic reviews and other evidence do not allow definitive confirmation of an improvement in accuracy resulting from the addition of radiographs to visual assessment of occlusal surfaces. Existing data§ suggest that radiographs have low sensitivity and high specificity regarding the detection of early occlusal lesions
Technologically advanced methods are not helpful in the detection of cavitated lesions	Technologically advanced methods have been developed and tested primarily for detection and monitoring of early noncavitated lesions; systematic reviews¶ conclude that these devices increase the likelihood that sound teeth or those with noncavitated lesions will be classified as carious (owing to low specificity compared with that of visual assessment), and their usefulness to detect cavitated lesions has not been established

* Source: Ismail and colleagues.[7]
† Sources: Lussi[22] and Penning and colleagues.[23]
‡ Sources: Lussi[24] and Forgie and colleagues.[25]
§ Source: Dove.[26]
¶ Source: Bader and Shugars.[21]

Explorer use. Until about the early 1980s, the use of an explorer or a probe to confirm cavitation (catch), especially in pits and fissures, was one of the most common procedures to detect dental caries, and researchers used these instruments widely in early protocols.[35,36] Up until the 1990s, dental schools taught this technique, despite calls for less invasive use of the explorer.[37-39] Even though reports in the current literature[7,38] highly discourage the forceful use of a sharp explorer for the sole purpose of detecting carious lesions, some clinicians continue to use one. The ICDAS does not include the use of a sharp explorer or probe under force for caries detection.[7,31] The evidence shows clearly that noncavitated lesions can become damaged simply through pressure from the explorer during an examination,[37-39] which, in turn, introduces a pathway for continued caries progression.[40,41] Furthermore, limited evidence suggests that use of an explorer does not improve the accuracy of visual assessment in the detection of pit and fissure lesions.[22,23]

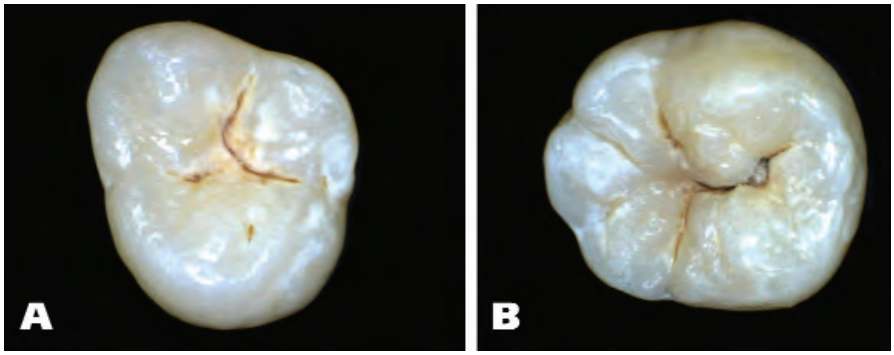


Figure. Two stages of severity of an occlusal carious lesion. **A.** Noncavitated. **B.** Cavitated.

However, clinicians may use an explorer safely in several applications[7,27]:

- to gently remove plaque and debris from the tooth surface;
- to detect changes or breaks in the surface contour by moving it gently, in cases in which there is doubt about the presence of a cavitation;
- to evaluate the smoothness or roughness of the tooth surface to help determine lesion activity;
- to help in the assessment of sealant integrity and retention.

Magnification. Magnification may be useful for surface assessment, sealant application and retention checks; however, relatively little research exists regarding its use to assess the caries status of occlusal surfaces of permanent teeth. Among the in vitro studies that do exist, analyses of visual assessment with or without magnification produced conflicting results. In 1993, Lussi[24] compared unaided visual inspection with inspection with a ×2 magnifying glass, visual inspection with conventional bitewing radiographs, and visual and tactile inspection with gentle probing, as well as analyzed bitewings alone. He found that magnification did not result in significantly improved sensitivity with regard to caries detection. In 2002, Forgie and colleagues[25] reported that use of a ×3.25 loupe for occlusal and approximal surface assessment resulted in significantly higher sensitivity than that of unaided visual inspection. Specificity, however, was similar to that of unaided visual inspection.

Thus, there is limited evidence in the scientific literature to support the use of magnification with visual assessment of tooth surfaces for sealant placement. In addition, its impact on SBSPs in terms of effectiveness and sealant retention is unknown. Moreover, we have found no evidence that other magnification methods, such as the use of operating microscopes with magnifications of ×16 or ×24, add any benefit to the assessment of tooth surfaces, and because of the cost and operational burden, there would be little benefit to SBSPs. Although magnification is not contraindicated, the unaided visual assessment of occlusal surfaces is the appropriate approach for detection of cavitation in SBSPs.

Radiographs. Most SBSPs target children with newly erupted permanent molars and typically do not obtain radiographs. The recently published guidelines[1] for SBSPs indicate that a low likelihood of caries in newly erupted teeth, coupled with current recommendations to seal sound surfaces and those with noncavitated lesions, argue against the use of radiographs. In addition, national surveys conducted since the late 1980s have shown that the most affected surfaces are occlusal, not approximal, with carious lesions starting in the pits and fissures, especially for children in second and third grades.[9,42]

The most recent guidelines developed by the ADA and the U.S. Food and Drug Administration[43] state that "radiographs should be taken only when there is an expectation by dentists that the diagnostic yield will affect patient care." Radiographic images of approximal surfaces are not necessary to evaluate pit and fissure surfaces for sealant placement. In addition, a 2001 systematic review[20] could not judge definitively the accuracy of radiographic examination to identify carious lesions. Furthermore, evidence suggests that radiographs have low sensitivity and high specificity with regard to the detection of early occlusal lesions.[26] In other words, the early development of caries into enamel and dentin is more likely to be missed than detected. In addition, any improvement in accuracy resulting from the addition of radiographs to a visual assessment of lesion cavitation on occlusal surfaces has not been established.

Other assessment methods. During the last decade, researchers have made a concerted effort to identify more technologically advanced methods to detect and quantify demineralization in teeth with noncavitated lesions. Some of these technologies include quantitative light-induced fluorescence (QLF, Inspektor Research Systems,

Amsterdam) and DIAGNOdent (Kavo Dental, Biberach, Germany). These devices aid in the detection and monitoring of noncavitated lesions, but they are not stand-alone methods that can be used in place of the dentist's clinical judgment. When used correctly, they can play an important role in the diagnosis of lesion activity by monitoring changes across time and helping the dentist stage the severity of a carious lesion.[19,44-51] This, in turn, helps the dentist select the most appropriate treatment for a particular patient in a private practice setting. However, because these devices do not help detect lesion cavitation and are expensive, their use is not justified in SBSPs.

Systematic reviews have concluded that these instruments have higher sensitivity (thus, more carious lesions will be detected) but lower specificity (resulting in more false-positive findings—that is, sound surfaces incorrectly classified as carious) than traditional visual assessment methods in the detection of lesions at earlier, noncavitated stages in the caries process.[21,51] In the United States, caries rates have declined among certain age groups[12] and caries progression rates have slowed.[13] Therefore, the indiscriminant use of these technologies might result in a high number of false-positive findings. Depending on how the user interprets the instrument's findings, this could result in a decrease in the number of teeth that would benefit from sealants in SBSPs. In addition, these instruments are not helpful in detecting lesion cavitation. Therefore, we cannot recommend the use of advanced caries-detection aids in SPSPs.

CONCLUSIONS

We need to make distinctions between assessing children for placement of sealants in SBSPs and assessing them in clinical practice. In clinical practice, the clinician conducts caries risk assessment, diagnosis and treatment planning at the individual tooth level with a high expectation of continuity of care. In school-based programs, the clinician assesses each child, but he or she makes the caries risk assessment at the group level. Regardless of the setting, however, available evidence supports the conclusion that the placement of sealants over noncavitated carious lesions arrests the disease process[2,52-56] and is cost effective.[57] Furthermore, recent evidence does not justify distinguishing between enamel and dentin caries as the cutoff point for sealant placement, as earlier guidelines have suggested.[58] Evidence now supports the detection of cavitation as the point at which sealants are not placed.[1,4]

To distinguish between noncavitated and cavitated carious lesions, clinicians should use visual assessment. Teeth should be free of debris; clinicians should not use an explorer under force; magnification is not necessary; radiographs are not indicated solely for the placement of sealants, especially in SBSPs targeting children in second through sixth grades; and insufficient evidence exists to recommend other methods to determine the presence or absence of cavitation.

These recommendations are based primarily on an analysis of the literature, including systematic reviews when available, and on the opinions of the CDC expert work group members. Even if a sealant is placed on a tooth with approximal caries that is diagnosed at the child's next clinical examination, no harm has been done, as the dentist can place a restoration at that time. Moreover, no evidence indicates that placement of a sealant increases caries progression. ■

Disclosure. None of the authors reported any disclosures.

The findings and conclusions in the report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention, Atlanta.

The authors thank Drs. Barbara Gooch and William Kohn for their help and input in preparation of the manuscript of this article.

1. Gooch BF, Griffin SO, Gray SK; Centers for Disease Control and Prevention. Preventing dental caries through school-based sealant programs: updated recommendations and reviews of evidence. JADA 2009; 140(11):1356-1365.
2. Griffin SO, Oong E, Kohn W, Vidakovic B, Gooch BF; CDC Dental Sealant Systematic Review Work Group: Bader J, Clarkson J, Fontana MR, et al. The effectiveness of sealants in managing caries lesions. J Dent Res 2008;87(2):169-174.
3. Oong EM, Griffin SO, Kohn WG, Gooch BF, Caufield PW. The effect of dental sealants on bacteria levels in caries lesions: a review of the evidence. JADA 2008;139(3):271-278.
4. Beauchamp J, Caufield PW, Crall JJ, et al; American Dental Association Council on Scientific Affairs. Evidence-based clinical recommendations for the use of pit-and-fissure sealants: a report of the American Dental Association Council on Scientific Affairs. JADA 2008;139(3): 257-268.
5. Diagnosis and management of dental caries throughout life. National Institutes of Health Consensus Development Conference statement, March 26-28, 2001. J Dent Educ 2001;65(10):1162-1168.
6. Pitts NB, Stamm JW. International Consensus Workshop on Caries Clinical Trials (ICW-CCT): final consensus statements—agreeing where the evidence leads. J Dent Res 2004;83(spec no. C): 125-128.
7. Ismail AI, Sohn W, Tellez M, et al. The International Caries Detection and Assessment System (ICDAS): an integrated system for measuring dental caries. Community Dent Oral Epidemiol 2007;35(3): 170-178.
8. Bader JD, Shugars DA, Bonito AJ. A systematic review of the performance of methods for identifying carious lesions. J Public Health Dent 2002;62(4):201-213.
9. Centers for Disease Control and Prevention. Synopses of State and Territorial Dental Public Health Programs. Trends. United States. "http://apps.nccd.cdc.gov/synopses/NatTrendTableV.asp#Programs". Accessed May 7, 2010.
10. Centers for Disease Control and Prevention. National Health and Nutrition Examination Survey. Questionnaires, datasets, and related documentation. "www.cdc.gov/nchs/nhanes/nhanes_

questionnaires.htm". Accessed June 3, 2010.
11. Macek MD, Beltrán-Aguilar ED, Lockwood SA, Malvitz DM. Updated comparison of the caries susceptibility of various morphological types of permanent teeth. J Public Health Dent 2003;63(3):174-182.
12. Beltrán-Aguilar ED, Barker LK, Canto MT, et al; Centers for Disease Control and Prevention. Surveillance for dental caries, dental sealants, tooth retention, edentulism, and enamel fluorosis: United States, 1988-1994 and 1999-2002. MMWR Surveill Summ 2005;54(3):1-43.
13. 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;(248):1-92.
14. Pitts NB. Clinical diagnosis of dental caries: a European perspective. J Dent Educ 2001;65(10):972-978.
15. Cury JA, Tenuta LM. Enamel remineralization: ontrolling the caries disease or treating early caries lesions? Braz Oral Res 2009;23(suppl 1):23-30.
16. Fontana M, Zero DT. Assessing patients' caries risk. JADA 2006;137(9):1231-1239.
17. Kidd EA. How 'clean' must a cavity be before restoration? Caries Res 2004;38(3):305-313.
18. Nyvad B. Diagnosis versus detection of caries. Caries Res 2004;38(3):192-198.
19. Neuhaus KW, Longbottom C, Ellwood R, Lussi A. Novel lesion detection aids. Monogr Oral Sci 2009;21:52-62. Published online: June 3, 2009 (doi: 10.1159/000224212).
20. Bader JD, Shugars DA, Bonito AJ. Systematic reviews of selected dental caries diagnostic and management methods. J Dent Educ 2001;65(10):960-968.
21. Bader JD, Shugars DA. A systematic review of the performance of a laser fluorescence device for detecting caries. JADA 2004;135(10):1413-1426.
22. Lussi A. Validity of diagnostic and treatment decisions of fissure caries. Caries Res 1991;25(4):296-303.
23. Penning C, van Amerongen JP, Seef RE, ten Cate JM. Validity of probing for fissure caries diagnosis. Caries Res 1992;26(6):445-449.
24. Lussi A. Comparison of different methods for the diagnosis of fissure caries without cavitation. Caries Res 1993;27(5):409-416.
25. Forgie AH, Pine CM, Pitts NB. The use of magnification in a preventive approach to caries detection. Quintessence Int 2002;33(1):13-16.
26. Dove SB. Radiographic diagnosis of dental caries. J Dent Educ 2001;65(10):985-990.
27. Nyvad B, Machiulskiene V, Baelum V. Reliability of a new caries diagnostic system differentiating between active and inactive caries lesions. Caries Res 1999;33(4):252-260.
28. Ekstrand KR, Zero DT, Martignon S, Pitts NB. Lesion activity assessment. Monogr Oral Sci 2009;21:63-90. Published online: June 3, 2009 (doi: 10.1159/000224213).
29. Ekstrand KR, Ricketts DN, Kidd EA, Qvist V, Schou S. Detection, diagnosing, monitoring and logical treatment of occlusal caries in relation to lesion activity and severity: an in vivo examination with histological validation. Caries Res 1998;32(4):247-254.
30. Ismail AI, Sohn W. A systematic review of clinical diagnostic criteria of early childhood caries. J Pub Health Dent 1999;59(3):171-191.
31. Pitts N. "ICDAS": an international system for caries detection and assessment being developed to facilitate caries epidemiology, research and appropriate clinical management. Community Dent Health 2004;21(3):193-198.
32. Jablonski-Momeni A, Stachniss V, Ricketts DN, Heinzel-Gutenbrunner M, Pieper K. Reproducibility and accuracy of the ICDAS-II for detection of occlusal caries in vitro. Caries Res 2008;42:79-87.
33. Shoaib L, Deery C, Ricketts DNJ, Nugent ZJ. Validity and reproducibility of ICDAS II in primary teeth Caries Res 2009;43:442-448.
34. Longbottom CL, Huysmans MC, Pitts NB, Fontana M. Glossary of key terms. Mongr Oral Sci 2009;21(3):209-216.
35. Radike AW. Criteria for diagnosis of dental caries. American Dental Association. In: Proceedings of the Conference on the Clinical Testing of Cariogenic Agents; Oct. 14-16, 1968; Chicago: American Dental Association; 1968:87-88.
36. World Health Organization. Oral Health Surveys Basic Methods. 3rd ed. Geneva: World Health Organization; 1987:34-39.
37. Ekstrand K, Qvist V, Thylstrup A. Light microscope study of the effect of probing in occlusal surfaces. Caries Res 1987;21(4):368-374.
38. American Dental Association, Council on Scientific Affairs. Treating caries as an infectious disease. JADA 1995;125(spec iss):2S-15S.
39. Kühnisch J, Dietz W, Stosser L, Hickel R, Heinrich-Weltzien R. Effects of dental probing on occlusal surfaces: a scanning electron microscopy evaluation. Caries Res 2007;41(1):43-48.
40. van Dorp CS, Exterkate RA, ten Cate JM. The effect of dental probing on subsequent enamel demineralization. ASDC J Dent Child 1988;55(5):343-347.
41. Yassin OM. In vitro studies of the effect of a dental explorer on the formation of an artificial carious lesion. ASDC J Dent Child 1995;62(2):111-117.
42. Dye BA, Arevalo O, Vargas CM (2010). Trends in paediatric dental caries by poverty status in the United States, 1988-1994 and 1999-2004. Int J Paediatr Dent 2010;20(2):132-143.
43. American Dental Association, Council on Dental Benefit Programs, Council on Scientific Affairs, U.S. Department of Health and Human Services, Public Health Service, Food and Drug Administration. The Selection of Patients for Dental Radiographic Examinations. Revised 2004. "www.fda.gov/downloads/RadiationEmittingProducts/RadiationEmittingProductsandProcedures/MedicalImaging/MedicalX-Rays/ucm116505.pdf". Accessed May 9, 2010.
44. Angmar-Månsson B, al-Khateeb S, Tranaeus S. Monitoring the caries process: optical methods for clinical diagnosis and quantification of enamel caries. Eur J Oral Sci 1996;104(4 part 2):480-485.
45. al-Khateeb S, Oliveby A, de Josselin de Jong E, Angmar-Månsson B. Laser fluorescence quantification of remineralisation in situ of incipient enamel lesions: influence of fluoride supplements. Caries Res 1997;31(2):132-140.
46. Ando M, van Der Veen MH, Schemehorn BR, Stookey GK. Comparative study to quantify demineralized enamel in deciduous and permanent teeth using laser- and light-induced fluorescence techniques. Caries Res 2001;35(6):464-470.
47. Ferreira Zandoná AG, Analoui M, Beiswanger BB, et al. An in vitro comparison between laser fluorescence and visual examination for detection of demineralization in occlusal pits and fissures. Caries Res 1998;32(3):210-218.
48. Tranaeus S, Al-Khateeb S, Björkman S, Twetman S, Angmar-Månsson B. Application of quantitative light-induced fluorescence to monitor incipient lesions in caries-active children: a comparative study of remineralisation by fluoride varnish and professional cleaning. Eur J Oral Sci 2001;109(2):71-75.
49. Lussi A, Imwinkelried S, Pitts N, Longbottom C, Reich E. Performance and reproducibility of a laser fluorescence system for detection of occlusal caries in vitro. Caries Res 1999;33(4):261-266.
50. Lussi A, Megert B, Longbottom C, Reich E, Francescut P. Clinical performance of a laser fluorescence device for detection of occlusal caries lesions. Eur J Oral Sci 2001;109(1):14-19.
51. Stookey GK, González Cabezas C. Emerging methods of caries diagnosis. J Dent Educ 2001;65(10):1001-1006.
52. Handelman SL, Washburn F, Wopperer P. Two-year report of sealant effect on bacteria in dental caries. JADA 1976;93(5):967-970.
53. Handelman SL, Leverett DH, Espeland MA, Curzon JA. Clinical radiographic evaluation of sealed carious and sound tooth surfaces. JADA 1986;113(5):751-754.
54. Handelman SL. Therapeutic use of sealants for incipient or early carious lesions in children and young adults. Proc Finn Dent Soc 1991;87(4):463-475.
55. Mertz-Fairhurst EJ, Curtis JW Jr, Ergle JW, Rueggeberg FA, Adair SM. Ultraconservative and cariostatic sealed restorations: results at year 10. JADA 1998;129(1):55-66.
56. Messer LB, Calache H, Morgan MV. The retention of pit and fissure sealants placed in primary school children by Dental Health Services, Victoria. Aust Dent J 1997;42(4):233-239.
57. Heller KE, Reed SG, Bruner FW, Eklund SA, Burt BA. Longitudinal evaluation of sealing molars with and without incipient dental caries in a public health program. J Public Health Dent 1995;55(3):148-153.
58. Workshop on Guidelines for Sealant Use: Recommendations. The Association of State and Territorial Dental Directors, the New York State Health Department, the Ohio Department of Health and the School of Public Health, University of Albany, State University of New York. J Public Health Dent 1995;55(5 spec no.):263-273.

COVER STORY

Preventing dental caries through school–based sealant programs

Updated recommendations and reviews of evidence

Barbara F. Gooch, DMD, MPH; Susan O. Griffin, PhD; Shellie Kolavic Gray, DMD, MPH; William G. Kohn, DDS; R. Gary Rozier, DDS, MPH; Mark Siegal, DDS, MPH; Margherita Fontana, DDS, PhD; Diane Brunson, RDH, MPH; Nancy Carter, RDH, MPH; David K. Curtis, DMD; Kevin J. Donly, DDS, MS; Harold Haering, DMD; Lawrence F. Hill, DDS, MPH; H. Pitts Hinson, DDS, MS; Jayanth Kumar, DDS, MPH; Lewis Lampiris, DDS, MPH; Mark Mallatt, DDS, MSD; Daniel M. Meyer, DDS; Wanda R. Miller, RN, MA, NCSN, FNASN; Susan M. Sanzi-Schaedel, RDH, MPH; Richard Simonsen, DDS, MS; Benedict I. Truman, MD, MPH; Domenick T. Zero, DDS, MS

Health care professionals often provide prevention services in schools to protect and promote the health of students.[1] School programs can increase access to services, such as dental sealant placement, especially among vulnerable children less likely to receive private dental care.[2] In addition, school programs have the potential to link students with treatment services in the community and facilitate enrollment of eligible children in public insurance programs, such as Medicaid and the Children's Health Insurance Program.[3]

In 2001, the independent, nongovernmental Task Force on Community Preventive Services completed a systematic review of published scientific studies demonstrating strong evidence that school sealant programs were effective in reducing the incidence of caries.[4,5] The median decrease in occlusal caries in posterior teeth among children aged 6 through 17 years was 60 percent. On the basis of these findings, the task force recommended that school sealant programs be part of a comprehensive community strategy to prevent dental caries.[4,5] These programs typically are implemented in schools that serve children from low-income families and focus primarily on those

ABSTRACT

JADA CE CONTINUING EDUCATION ARTICLE 1

Background. School-based sealant programs (SBSPs) increase sealant use and reduce caries. Programs target schools that serve children from low-income families and focus on sealing newly erupted permanent molars. In 2004 and 2005, the Centers for Disease Control and Prevention (CDC), Atlanta, sponsored meetings of an expert work group to update recommendations for sealant use in SBSPs on the basis of available evidence regarding the effectiveness of sealants on sound and carious pit and fissure surfaces, caries assessment and selected sealant placement techniques, and the risk of caries' developing in sealed teeth among children who might be lost to follow-up. The work group also identified topics for which additional evidence review was needed.

Types of Studies Reviewed. The work group used systematic reviews when available. Since 2005, staff members at CDC and subject-matter experts conducted several independent analyses of topics for which no reviews existed. These reviews include a systematic review of the effectiveness of sealants in managing caries.

Results. The evidence supports recommendations to seal sound surfaces and noncavitated lesions, to use visual assessment to detect surface cavitation, to use a toothbrush or handpiece prophylaxis to clean tooth surfaces, and to provide sealants to children even if follow-up cannot be ensured.

Clinical Implications. These recommendations are consistent with the current state of the science and provide appropriate guidance for sealant use in SBSPs. This report also may increase practitioners' awareness of the SBSP as an important and effective public health approach that complements clinical care.

Key Words. Caries; evidence-based dentistry; pit-and-fissure sealants; preventive dentistry; public health/community dentistry.

JADA 2009;140(11):1356-1365.

in second and sixth grades, because high percentages of these children are likely to have newly erupted permanent molars.[6]

Available data show that children aged 6 through 11 years from families living below the federal poverty threshold (approximately $21,800 annually for a family of four in 2008)[7] are almost twice as likely to have developed caries in their permanent teeth as are children from families with incomes greater than two times the federal poverty threshold (28 percent versus 16 percent).[8] Overall, about 90 percent of carious lesions are found in the pits and fissures of permanent posterior teeth, with molars being the most susceptible tooth type.[9,10] Unfortunately, only about one in five children, or 20 percent, aged 6 though 11 years from low-income families has received sealants, a proportion that is notably less than the 40 percent of children from families with incomes greater than two times the poverty threshold.[8] Significant disparities also exist according to race/ethnicity, with non-Hispanic African American (21 percent) and Mexican American (24 percent) children aged 6 through 11 years less likely to have received sealants than non-Hispanic white children (36 percent).[8]

School sealant programs can be an important intervention to increase the receipt of sealants, especially among underserved children. For example, the results of a study in Ohio confirmed that programs directed toward low-income children substantially increased the use of dental sealants.[11] Furthermore, sealant programs could reduce or eliminate racial and economic disparities in sealant use if programs were provided to all eligible, high-risk schools,[11] such as those in which 50 percent or more of the children are eligible for free or reduced-price meals.[6]

Differences of opinion among clinicians regarding the management of caries, caries assessment and sealant placement procedures[12-14] have led some to question the effectiveness of certain practices, such as sealing teeth that have incipient caries or sealing without first obtaining diagnostic radiographs. Partly on the basis of the need to address these questions, the Association of State and Territorial Dental Directors asked the Centers for Disease Control and Prevention (CDC), Atlanta, to review and update sealant guidelines last revised in 1994.[15] Staff members of CDC agreed to undertake this review, especially because new information had become available regarding the effectiveness of sealants, the prevalence of caries and sealants in children and young adults in the United States, and techniques for caries assessment and sealant placement.

This report provides updated recommendations for sealant use in school-based sealant programs (SBSPs) (that is, programs that provide sealants in schools).[2] We also inform dental practitioners about the evidence regarding the effectiveness of SBSPs and practices. This evidence provides the basis for the updated recommendations.

Practitioner awareness is important because dentists in private practice likely will see children who have received sealants in school-based programs and might themselves be asked to participate in or even implement such programs. In addition, this report can help address questions from parents, school administrators and other stakeholders. Finally, we discuss the consistency between these recommendations for SBSPs and evidence-based clinical recommendations for sealant use developed recently by an expert panel convened by the American Dental Association (ADA) Council on Scientific Affairs[16] (the ADA sealant recommendations).

METHODS

The CDC supported two meetings (in June 2004 and April 2005) of a work group consisting of experts in sealant research, practice and policy, as well as caries assessment, prevention and treatment. The work group also included representatives from professional dental organizations. The work group addressed questions about the following topics (Box):

- effectiveness of sealants on sound and carious pit and fissure surfaces;
- methods for caries assessment before sealant application;
- effectiveness of selected placement techniques;
- risk of developing caries in sealed teeth among children who might be lost to follow-up and for whom sealant retention cannot be ensured.

Based in part on the content of the meeting presentations and discussions, the work group drafted recommendations and identified areas in which additional evidence review was necessary.

The work group used published findings of systematic reviews when available. Since the last

ABBREVIATION KEY. ADA: American Dental Association. **CDC:** Centers for Disease Control and Prevention. **IFUs:** Instructions for use. **RCTs:** Randomized controlled trials. **SBSPs:** School-based sealant programs.

BOX

Topics and questions discussed by work group.

EFFECTIVENESS OF SEALANTS

- What is the effectiveness of sealants in preventing the development of caries on sound pit and fissure surfaces?
- What is the effectiveness of sealants in preventing the progression of noncavitated or incipient carious lesions to cavitation?
- What is the effectiveness of sealants in reducing bacteria levels in cavitated carious lesions?

ASSESSMENT METHODS

- Which caries assessment methods should be used in school-based sealant programs (SBSPs) to differentiate pit and fissure surfaces that are sound or noncavitated from those that are cavitated or have signs of dentinal caries?

SURFACE PREPARATION BEFORE ACID ETCHING

- What surface cleaning methods or techniques are recommended by manufacturers for unfilled resin-based sealants (self-curing and light-cured) commonly used in SBSPs?
- What is the effect of clinical procedures—specifically, surface cleaning or mechanical preparation methods with use of a bur before acid etching—on sealant retention?

FOUR-HANDED TECHNIQUE

- Does use of a four-handed technique in comparison with a two-handed technique improve sealant retention?

CARIES RISK ASSOCIATED WITH LOST SEALANTS

- Are teeth in which sealants are lost at a higher risk of developing caries than are teeth that were never sealed?

meeting of the group in 2005, staff members of CDC and another expert group completed a systematic review to determine the effectiveness of sealants in managing caries progression and bacteria levels in carious lesions. The results of that review[17,18] also supported the ADA sealant recommendations.[16] For questions about other topics for which there were no existing reviews, CDC staff members conducted analyses of the available evidence and published these results in peer-reviewed journals.[19-21]

Clinical studies. For these analyses, we searched electronic databases (that is, MEDLINE, Embase, Cochrane Library and Web of Science) to identify clinical studies that focused primarily on sealant outcomes resulting from different surface preparation and placement techniques. In some cases, few, if any, clinical trials directly compared in the same study sealant retention resulting from different placement techniques. In these situations, we performed bivariate and multivariate analyses to compare sealant retention across studies. For example, we compared sealant retention in studies that involved handpiece prophylaxis with retention in studies that involved toothbrush prophylaxis, and studies that involved a four-handed technique with studies that involved a two-handed technique.[19,21] Lastly, in light of the work group's recommendation that clinicians consult manufacturers' instructions regarding surface preparation before acid etching, we described the range of manufacturers' instructions for surface preparation for unfilled resin-based sealants,[21] which commonly are used in school programs.[22]

Scientific evidence. For each question addressed by the work group, we summarized the relevant scientific information. On the basis of recognized systems for grading the quality of scientific evidence, we assigned the highest level of confidence generally to findings of systematic reviews and randomized controlled trials (RCTs).[23-25] Random assignment of study participants to treatment and control groups is the study design most likely to fully control for the effect of other factors on sealant effectiveness or retention. The systematic review involves the use of a standard procedure to synthesize findings from the best available clinical studies, usually RCTs.

We generally assigned lower levels of confidence to findings from studies with other designs. Beyond this qualitative assessment of the evidence, neither the work group nor CDC staff members made any attempt to grade the quality of the evidence or directly relate each recommendation to the strength of the evidence. We did not independently review the design or quality of the systematic reviews and comparative studies. All included studies were published in the peer-reviewed scientific literature.

QUESTIONS AND KEY FINDINGS

The work group addressed the following questions.

Sound pit and fissure surfaces. What is the effectiveness of sealants in preventing the development of caries on sound pit and fissure surfaces?

Systematic reviews have found strong evidence of sealant effectiveness on sound permanent posterior teeth in children and adolescents. A meta-analysis of 10 studies of a one-time placement of autopolymerized sealants on permanent molars in children found that the sealants reduced dental caries by 78 percent at one year and 59 percent at four or more years of follow-up.[26] (A meta-analysis is a review that involves the use of quantitative methods to combine the statistical measures from two or more studies and generates a weighted

average of the effect of an intervention, the degree of association between a risk factor and a disease or the accuracy of a diagnostic test.)[27]

Similarly, a meta-analysis of five studies of resin-based sealants found reductions in caries ranging from 87 percent at 12 months to 60 percent at 48 to 54 months.[28] A third meta-analysis of 13 studies also found that sealants were effective, but estimates of caries reductions attributed to sealant placement were lower (33 percent from two to five years after placement).[29] The lower estimates might reflect the inclusion of studies that examined sealants polymerized by ultraviolet light (that is, first-generation sealant materials no longer marketed in the United States) and studies involving exposures to other preventive interventions, such as fluoride mouthrinses.[29]

Summary of evidence. Systematic reviews[26,28,29] have found that sealants are effective in preventing the development of caries on sound pit and fissure surfaces in children and adolescents.

Systematic reviews have found that sealants are effective in preventing the development of caries on sound pit and fissure surfaces in children and adolescents.

Noncavitated or incipient lesions. What is the effectiveness of sealants in preventing the progression of noncavitated or incipient carious lesions to cavitation?

A meta-analysis of six studies of sealant placement on teeth with noncavitated carious lesions found that sealants reduced by 71 percent the percentage of lesions that progressed up to five years after placement in children, adolescents and young adults.[17] We define noncavitated carious lesions as lesions with no discontinuity or break in the enamel surface. Findings across each of the six studies were consistent.

Summary of evidence. A systematic review[17] found that pit-and-fissure sealants are effective in reducing the percentage of noncavitated carious lesions that progressed to cavitation in children, adolescents and young adults.

Bacteria levels. What is the effectiveness of sealants in reducing bacteria levels in cavitated carious lesions?

A systematic review of the effects of sealants on bacteria levels in cavitated carious lesions found no significant increases in bacteria under sealants.[18] Sealants lowered the number of viable bacteria, including *Streptococcus mutans* and lactobacilli, by at least 100-fold and reduced the number of lesions with any viable bacteria by about 50 percent.

Summary of evidence. A systematic review[18] found that pit-and-fissure sealants are effective in reducing bacteria levels in cavitated carious lesions in children, adolescents and young adults.

Assessment of caries on surfaces to be sealed. Which caries assessment methods should be used in SBSPs to differentiate pit and fissure surfaces that are sound or noncavitated from those that are cavitated or have signs of dentinal caries?

In 2001, investigators conducting a systematic review for the National Institutes of Health Consensus Development Conference on Diagnosis and Management of Dental Caries Throughout Life[30] concluded that the relative accuracy of methods of identifying carious lesions could not be determined from the available studies. The systematic review evaluated evidence regarding the following methods: visual inspection, visual/tactile inspection, radiographic assessment, fiber-optic transillumination, electrical conductance and laser fluorescence. The authors also examined the improvement in accuracy resulting from the addition of radiographs to visual assessment in the detection of dentinal lesions on occlusal surfaces.

The review judged the quality of evidence available for assessment of the relative accuracy of the diagnostic methods as "poor." The authors rated the evidence as poor because there were few relevant studies, the study quality was lower than average and/or the studies included a wide range of observed measures of accuracy. Because of the poor quality of the available evidence, the investigators could not determine the relative accuracy of the assessment methods. Most of the studies compared assessment methods with a histologic determination of caries. For the identification of cavitated lesions, however, the authors of the systematic review also accepted visual or visual/tactile inspection—the principal methods dentists use to identify cavitated lesions—as a valid standard.[31,32]

More recently, an international team of caries researchers developed an integrated system for caries detection based on a review of the best available evidence and contemporary caries detection criteria.[33,34] In this system, clinicians use

visual criteria alone to document the extent of enamel breakdown, including distinct cavitation into dentin, the presence of an underlying dark shadow from dentin and the exposure of dentin. Researchers have correlated the visual criteria in this integrated system with the extent of carious demineralization into dentin.[33,35] With this system, clinicians can determine cavitation into dentin or find evidence of dentinal involvement, such as an underlying dark shadow, without extensive drying of the tooth.[16,33]

Other widely used criteria for epidemiologic and clinical caries studies also have relied on visual and visual/tactile assessment.[36-38] These criteria describe frank cavitation as "a discontinuity of the enamel surface caused by loss of tooth substance"[38] or an "unmistakable cavity."[36] In these assessments, the examiner uses an explorer primarily in noncavitated lesions to determine the softness of the floor or walls or the presence of weakened enamel. Findings of clinical and in vitro studies, however, indicate that use of a sharp explorer, even with gentle pressure, can result in defects or cavitations that could introduce a pathway for caries progression.[39-42]

Technologically advanced tools such as laser fluorescence are designed to assist the dentist in interpreting visual cues in detecting and monitoring lesions over time, especially early noncavitated lesions. Findings of validation studies indicate that these tools increase the percentage of early carious lesions that are detected, but they also increase the likelihood that a sound surface will be described as carious.[31,32,43,44]

Finally, investigators in two in vitro studies[45,46] assessed changes in the accuracy of detecting carious lesions resulting from the addition of low-powered magnification to unaided visual inspection. One study found that inspection with a ×2 magnifying glass did not improve the accuracy of visual inspection alone in the detection of dentinal caries on noncavitated occlusal surfaces.[46] The other study[45] found that the addition of ×3.25 loupes to visual inspection alone did improve accuracy in the assessment of occlusal and interproximal surfaces, although more than 90 percent of the clinical decisions to describe a surface as decayed were correct with the use of either technique. The researchers did not report the percentage of clinically decayed surfaces that were limited to enamel or extended into dentin on histologic examination.[45] They also did not document the prevalence of cavitation among the decayed surfaces.[45]

Summary of evidence. In 2001, a systematic review[30] concluded that the relative accuracy of methods used to identify carious lesions could not be determined from the available studies. More recently, a team of international caries researchers supported visual assessment alone to detect the presence of surface cavitation and/or signs of dentinal caries.[33,34] They based this determination on their review of the best available evidence and on contemporary caries detection criteria.

Published studies have suggested that use of a sharp explorer under pressure could introduce a pathway for caries progression[39-42] and that use of technologically advanced tools, such as laser fluorescence, increases the likelihood that a sound surface will be deemed carious.[31,32,43,44] Investigators in two in vitro studies[45,46] could not determine improvement in the accuracy of detecting cavitation or dentinal caries on occlusal surfaces with the addition of low-powered magnification.

Surface preparation. What surface cleaning methods or techniques are recommended by manufacturers for unfilled resin-based sealants (self-curing and light-cured) commonly used in SBSPs?

Gray and colleagues[21] reviewed instructions for use (IFUs) for 10 unfilled sealant products from five manufacturers and found that all directed the operator to clean the tooth surface before acid etching. None of the IFUs specifically stated which cleaning method should be used. Five of the IFUs mentioned the use of pumice slurry or prophylaxis paste and/or a prophylaxis brush, thereby implying, but not directly stating, that the operator should use a handpiece.

Summary of evidence. A review of manufacturers' IFUs for unfilled resin-based sealants[21] found that they do not specify a particular method of cleaning the tooth surface.

Effect of clinical procedures. What is the effect of clinical procedures—specifically, surface cleaning or mechanical preparation methods with use of a bur before acid etching—on sealant retention?

Recent reviews, including one systematic review,[21,47] identified two controlled clinical trials that directly compared surface cleaning methods.[48,49] Donnan and Ball[49] found no difference in complete sealant retention between surfaces cleaned with a handpiece and prophylaxis brush with pumice and those cleaned with an air-water syringe after the clinician ran an explorer

along the fissures. Similarly, Gillcrist and colleagues[48] observed no difference between surfaces cleaned with a handpiece and prophylaxis brush with prophylaxis paste and those cleaned with a dry toothbrush. Reported retention rates were greater than 96 percent at 12 months after sealant placement for all four surface cleaning methods. Furthermore, bivariate and multivariate analyses of retention data from published studies involving the use of supervised toothbrushing by the patient or a handpiece prophylaxis (also called rubber-cup prophylaxis or pumice prophylaxis) by the operator revealed similar, if not higher, retention rates for supervised toothbrushing.[19,21]

The ADA's expert panel,[16] in its review of evidence for the ADA sealant recommendations, found "limited and conflicting evidence" that mechanical preparation with a bur results in higher sealant retention rates in children.[50-52] In addition, a systematic review[47] identified only one controlled clinical trial[53] that compared use of a bur and acid etching with acid etching alone. The researchers found no difference in sealant retention at 48 months.[47,53]

Summary of evidence. The effect of specific surface cleaning or enamel preparation techniques on sealant retention cannot be determined because of the small number of clinical studies comparing specific techniques and, for mechanical preparation with a bur, inconsistent findings. Bivariate and multivariate analyses of retention data[19,21] across existing studies suggest that supervised toothbrushing or use of a handpiece prophylaxis may result in similar sealant retention rates over time.

Four-handed technique for applying dental sealant. Does use of a four-handed technique in comparison with a two-handed technique improve sealant retention?

The four-handed technique involves the placement of sealants by a primary operator with the assistance of a second person. The two-handed technique is the placement of sealants by a single operator. The work group could not find any direct comparative studies of the four-handed technique versus the two-handed technique with regard to sealant retention or effectiveness.

Furthermore, retention rates in single studies generally reflect multiple factors.[19] For example, Houpt and Shey[54] reported a sealant retention rate of more than 90 percent at one year in a single study that involved the use of two-handed delivery to apply sealants, while other authors[55,56] reported retention rates of less than 80 percent at one year for single studies in which four-handed delivery was used. Results of a multivariate analysis[19] of sealant effectiveness studies showed that use of the four-handed technique increased sealant retention by 9 percentage points when the investigators controlled for other factors.

Summary of evidence. In the absence of direct comparative studies, the results of a multivariate study of available data[19] suggest that use of the four-handed placement technique is associated with a 9 percentage point increase in sealant retention.

Caries risk associated with lost sealants. Are teeth in which sealants are lost at a higher risk of developing caries than are teeth that were never sealed?

A recent meta-analysis of seven RCTs found that teeth with fully or partially lost sealants were not at a higher risk of developing caries than were teeth that were never sealed.[20] In addition, although sealant effectiveness in preventing caries is related to retention over time, researchers conducting a systematic review that included only studies in which lost sealants were not reapplied found that sealants reduced caries by more than 70 percent.[20,26] Thus, children from low-income families, who are more likely to move between schools than are their higher-income counterparts,[57,58] will not be placed at a higher risk of developing caries because they missed planned opportunities for sealant reapplication in SBSPs.

Summary of evidence. Findings from a meta-analysis[20] indicate that the caries risk for sealed teeth that have lost some or all sealant does not exceed the caries risk for never-sealed teeth. Thus, the potential risk associated with loss to follow-up for children in school-based programs does not outweigh the potential benefit of dental sealants.

RECOMMENDATIONS FOR SCHOOL-BASED SEALANT PROGRAMS

The table presents the recommendations of the work group. These are based on the best available scientific evidence and are an update to earlier guidelines.[15] They provide guidance regarding planning, implementing and evaluating SBSPs and should be helpful for dental professionals working with sealant programs.

TABLE

Recommendations for school-based sealant programs.

These recommendations update earlier guidelines[15] and support policies and practices for school-based dental sealant programs that are appropriate, feasible and consistent with current scientific information. This update focuses on indications for sealant placement on permanent posterior teeth that are based on caries status, and methods of assessing tooth surfaces. These recommendations also address methods of cleaning tooth surfaces, use of an assistant during sealant placement and follow-up issues. These topics should be considered in the context of the essential steps in sealant placement, including cleaning pits and fissures, acid-etching surfaces and maintaining a dry field while the sealant is placed and cured.[16] Practitioners should consult manufacturers' instructions for specific sealant products.

School-based sealant programs also can connect participating students with sources of dental care in the community and enroll eligible children in public insurance programs.[3] Programs should prioritize referral of students with cavitated carious lesions and urgent treatment needs. For students with cavitated carious lesions who are unlikely to receive treatment promptly, dental practitioners in sealant programs may use interim management strategies. Strategies could include placement of sealants for small cavitations with no visual signs of dentinal caries and atraumatic restorative procedures.[15,62-64]

TOPIC	RECOMMENDATION
Indications for Sealant Placement	Seal sound and noncavitated pit and fissure surfaces of posterior teeth, with first and second permanent molars receiving highest priority.
Tooth Surface Assessment	Differentiate cavitated and noncavitated lesions. ▬ Unaided visual assessment is appropriate and adequate. ▬ Dry teeth before assessment with cotton rolls, gauze or, when available, compressed air. ▬ An explorer may be used to gently confirm cavitations (that is, breaks in the continuity of the surface); do not use a sharp explorer under force. ▬ Radiographs are unnecessary solely for sealant placement. ▬ Other diagnostic technologies are not required.
Sealant Placement and Evaluation	Clean the tooth surface. ▬ Toothbrush prophylaxis is acceptable. ▬ Additional surface preparation methods, such as air abrasion or enameloplasty, are not recommended. Use a four-handed technique, when resources allow. Seal teeth of children even if follow-up cannot be ensured. Evaluate sealant retention within one year.

DISCUSSION

In the updated recommendations in this report, we use the presence or absence of surface cavitation as a key factor in the decision to apply sealant to the tooth surface. These recommendations complement the ADA sealant recommendations and are consistent with them on virtually all topics addressed by both (for example, sealing teeth that have noncavitated lesions and using a four-handed technique when possible).

The effectiveness of sealants in preventing the development of caries is well established.[5,26,28,29] Findings of a recent systematic review[17,18] also confirmed that sealants are effective in managing early carious lesions by reducing the percentage of noncavitated lesions that progress to cavitation and by lowering bacteria levels in carious lesions. These results should ease practitioners' concerns that placement of sealants on pit and fissure surfaces with early or incipient noncavitated carious lesions or on surfaces of questionable caries status is not beneficial.

One notable difference between the recommendations for sealant use in clinical versus school settings concerns the approach to caries risk assessment.[16] Clinicians periodically assess caries risk at the level of the patient or the tooth to determine if sealant placement is indicated as a primary preventive measure. In SBSPs, clinicians also must consider risk at the level of the school and community. Local and state health departments commonly use the percentage of children participating in the free or reduced-cost federal meal program as a proxy for income to prioritize schools for sealant programs.[6,11,22]

As described earlier in this report, children from low-income families are at a higher risk of developing caries than are children from wealthier families.[7] Caries risk among children from low-income families is sufficiently high to justify sealing all eligible permanent molars and is the most cost-effective prevention strategy.[59,60] Furthermore, providing sealants only to children in a free or reduced-cost lunch program is viewed as stigmatizing and is unacceptable in many schools and communities.[22] Thus, children participating in SBSPs usually receive sealants as a primary preventive measure without undergoing a routine assessment of their caries risk.

The context for making decisions in clinical care and in SBSPs also differs. Important distinctions exist related to the availability of diagnostic and treatment services and the use of care.[15] Clinical care in the private or public sectors typically includes comprehensive diagnostic and treatment services; in contrast, SBSPs limit services to those necessary for successful sealant placement and retention.[15] Furthermore, children who receive sealants only in SBSPs are likely to be from low-income families. Recent data indicate that less than 50 percent of children aged 6 through 12 years from families with incomes of

less than two times the federal poverty threshold had a dental visit in the previous year compared with about 70 percent of their higher-income counterparts.[61]

As resources allow, SBSPs work with partners, such as local dental practices, public health clinics, parents, school nurses and local dental associations, to help students without a source of dental care receive comprehensive dental services. For children with cavitated lesions who are unlikely to receive treatment services promptly, dental practitioners in SBSPs may choose to use interim treatment strategies. These could include application of sealants for small cavitations with no visually detectable signs of dentinal caries and atraumatic restorative procedures for larger carious lesions.[15,62-64]

The following information might be helpful for practitioners who see children who have received sealants through SBSPs. First, sealants do not eliminate dental caries but predictably reduce the occurrence of disease. Thus, practitioners might observe a child with a permanent molar sealed in a school program in which caries has developed. They should keep in mind that the failure to prevent caries in that one sealed tooth does not constitute failure of the entire school sealant program. Similarly, the failure of a sealant to prevent caries in a patient treated in a private dental practice does not constitute failure of the entire sealant protocol. Available evidence consistently indicates that the overall incidence of caries in permanent molars is lower among children who received sealants compared with the incidence in similar children who did not.[5,26,28,29] Finally, sealant placement is a reversible procedure that easily allows the dentist to administer additional caries management and treatment strategies, such as placement of a restoration, if needed.

School-based sealant programs work with partners, such as local dental practices, to help students without a source of dental care receive comprehensive dental services.

In preparing these recommendations, the work group and CDC staff members also reviewed assessment methods for tooth surfaces in SBSPs. Visual assessment for the detection of cavitation is supported by many international experts.[33,65] Most SBSPs target children with newly erupted permanent molars. The low likelihood of caries in these newly erupted teeth, along with recommendations to seal both sound surfaces and those with noncavitated lesions, argue against the use of radiographs or technologically advanced tools to detect cavitated lesions in children in SBSPs.

Furthermore, when the likelihood of caries is low, such as in newly erupted molars, these modalities might increase the possibility that a sound surface will be misclassified as carious and be restored prematurely.[16,32] Thus, these teeth might not receive the preventive benefit of a sealant. In addition, children in SBSPs who are in need of treatment services will be referred to private dental offices or public dental clinics where dentists will obtain radiographs as necessary—and in accordance with current ADA/U.S. Food and Drug Administration guidelines[66]—and conduct additional diagnostic procedures, as appropriate.

The essential steps in placement of unfilled resin-based sealants include cleaning pits and fissures, acid etching tooth surfaces and maintaining a dry field while the sealant is placed and cured.[16] Available evidence suggests that cleaning pits and fissures with a toothbrush by the patient under supervision or with a handpiece prophylaxis by the operator results in similar sealant retention rates.[19,21,47,48]

Application of a hydrophilic bonding agent between the etched surface and the sealant is a supplemental technique that is not used routinely in SBSPs, and the work group did not evaluate the technique. The ADA's expert panel reviewed the evidence, developed guidance for practitioners and described current types of bonding systems.[16] The ADA panel noted that use of currently available self-etching bonding agents that do not include a separate etching step might result in lower retention than that achieved with the standard acid-etching technique and is not recommended.[16] In addition, the bonding agent must be compatible with the sealant material.

The work group also reaffirmed the importance of evaluating sealants after placement, but it stressed that children for whom follow-up cannot be ensured should still receive sealants. A recent meta-analysis found that teeth with partially or completely lost sealants were at no greater risk of developing dental caries than were teeth that were never sealed.[20] Dental professionals can check sealant retention among a sample of participants in an SBSP shortly after placement to ensure the quality of the procedure and materials

used.[6,22] They also can check sealant retention and integrity during the following school year and seal any permanent molars that might have erupted since the procedure. The timing of the evaluation of sealant retention and integrity can depend on several factors, such as local program objectives; changes in dental materials, techniques or personnel; and student movement in and out of the school and school district.

CONCLUSION

The recommendations of the expert work group update earlier guidelines for SBSPs and support practices that are appropriate, feasible and based on the best available scientific evidence. These updated recommendations, along with the supporting rationale, should increase practitioners' awareness of the SBSP as an important and effective public health approach that complements clinical care systems in promoting the oral health of children and adolescents. ■

Dr. Gooch is a dental officer, Division of Oral Health/Surveillance, Investigations, and Research Branch, Centers for Disease Control and Prevention, 4770 Buford Highway, NE, MS-F10, Atlanta, Ga. 30341, e-mail "oralhealth@cdc.gov". Address reprint requests to Dr. Gooch.

Dr. Griffin is a health economist, Division of Oral Health, Centers for Disease Control and Prevention, Atlanta.

Dr. Gray is an epidemiologist, Public Health Division, Northrop Grumman, Atlanta.

At the time this study was conducted, Dr. Kohn was the associate director for science, Division of Oral Health, Centers for Disease Control and Prevention, Atlanta. He now is the director, Division of Oral Health.

Dr. Rozier is a professor, Department of Health Policy and Management, Gillings School of Global Public Health, University of North Carolina at Chapel Hill, Chapel Hill.

Dr. Siegal is chief, Bureau of Oral Health Services, Ohio Department of Health, Columbus.

Dr. Fontana is an associate professor, Department of Cariology, Restorative Sciences and Endodontics, School of Dentistry, the University of Michigan, Ann Arbor.

Ms. Brunson is the director, Public Health and Community Outreach, University of Colorado Denver School of Dental Medicine, Aurora, Colo.

Ms. Carter is associate dental director, Division of Oral Health, Cincinnati Health Department, Cincinnati.

Dr. Curtis was a representative, American Academy of Pediatric Dentistry, Chicago.

Dr. Donly is a professor and chair, Pediatric Dentistry, Dental School, The University of Texas Health Science Center at San Antonio, and a representative, American Academy of Pediatric Dentistry, Chicago.

Dr. Haering was a member of the Council on Access, Prevention and Interprofessional Relations, American Dental Association, Chicago.

Dr. Hill is the executive director, CincySmiles Foundation, Cincinnati.

Dr. Hinson was a representative, American Academy of Pediatric Dentistry, Chicago.

Dr. Kumar is the director, Oral Health Surveillance and Research, Bureau of Dental Health, New York State Department of Health, Albany, N.Y.

Dr. Lampiris is the director, Council on Access, Prevention and Interprofessional Relations, American Dental Association, Chicago.

Dr. Mallatt was a representative, Association of State and Territorial Dental Directors, Sparks, Nev.

Dr. Meyer is the senior vice-president, Science/Professional Affairs, American Dental Association, Chicago.

Ms. Miller is a past executive director, National Association of School Nurses, Silver Spring, Md.

Ms. Sanzi-Schaedel was a representative, American Association of Public Health Dentistry, Springfield, Ill.

Dr. Simonsen is the dean, College of Dental Medicine, Midwestern University, Glendale, Ariz.

Dr. Truman is the associate director for science, Office of Minority Health and Health Disparities, Centers for Disease Control and Prevention, Atlanta.

Dr. Zero is a professor and the associate dean for research and the director, Oral Health Research Institute, School of Dentistry, Indiana University, Indianapolis.

Disclosure. Dr. Donly receives research support (no consulting fees) from 3M ESPE, St. Paul, Minn., and Ivoclar Vivadent, Amherst, N.Y., manufacturers of sealants. None of the other authors reported any disclosures.

The authors acknowledge the following people for their guidance and critical review of the information reported during the expert work group meetings and in earlier versions of the manuscript of this article: Dr. William Bailey, Ms. Laurie Barker, Dr. Eugenio Beltrán, Dr. Maria Canto, Ms. Kathleen Heiden, Dr. William Maas, Dr. Mark Macek, Dr. Dolores Malvitz, Ms. Linda Orgain, Dr. Scott Presson, Dr. John Rossetti, Dr. Robert Selwitz.

1. Centers for Disease Control and Prevention. National Center for Chronic Disease Prevention and Health Promotion, Division of Adolescent and School Health. Healthy Youth! Coordinated School Health Program. Archived at: "www.webcitation.org/5bDm6yMQT". Accessed Sept. 23, 2009.

2. U.S. Department of Health and Human Services. Oral health in America: a report of the surgeon general. Rockville, Md.: U.S. Department of Health and Human Services. National Institute of Dental and Craniofacial Research, National Institutes of Health, 2000.

3. Zimmerman B. Improving the oral health of school-aged children: strengthening school-based dental sealant program linkages with Medicaid/SCHIP and dental homes—summary of an expert meeting convened by the Maternal and Child Health Bureau. Washington: Health Systems Research; 2006. Archived at: "www.webcitation.org/5bOm8amsY". Accessed Sept. 23, 2009.

4. Centers for Disease Control and Prevention. Promoting oral health: interventions for preventing dental caries, oral and pharyngeal cancers, and sports-related craniofacial injuries—a report on recommendations of the Task Force on Community Preventive Services. MMWR Recomm Rep 2001;50(RR-21):1-13.

5. Truman BI, Gooch BF, Sulemana I, et al; Task Force on Community Preventive Services. Reviews of evidence on interventions to prevent dental caries, oral and pharyngeal cancers, and sports-related craniofacial injuries. Am J Prev Med 2002;23(1 suppl):21-54.

6. Association of State and Territorial Dental Directors. Best practice approaches for state and community oral health programs: school-based dental sealant programs. June 2003. Archived at: "www.webcitation.org/5b4vXyabi". Accessed Sept. 23, 2009.

7. U.S. Census Bureau, Housing and Household Economic Statistics Division. Poverty thresholds for 2008 by size of family and number of related children under 18 years. Washington: U.S. Census Bureau. "www.census.gov/hhes/www/poverty/threshld/thresh08.html". Accessed Sept. 23, 2009.

8. 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;248:1-92.

9. Centers for Disease Control and Prevention, National Center for Health Statistics. National Health and Nutrition Examination Surveys 1999-2004. "www.cdc.gov/nchs/nhanes.htm". Accessed Sept. 23, 2009.

10. Macek MD, Beltrán-Aguilar ED, Lockwood SA, Malvitz DM. Updated comparison of the caries susceptibility of various morphological types of permanent teeth. J Public Health Dent 2003;63(3):174-182.

11. Centers for Disease Control and Prevention. Impact of targeted, school-based dental sealant programs in reducing racial and economic disparities in sealant prevalence among schoolchildren: Ohio, 1998-1999. MMWR Morb Mortal Wkly Rep 2001;50(34):736-738.

12. Feigal RJ, Donly KJ. The use of pit and fissure sealants. Pediatr Dent 2006;28(2):143-150.

13. Simonsen RJ. Pit and fissure sealant: review of the literature. Pediatr Dent 2002;24(5):393-414.

14. Primosch RE, Barr ES. Sealant use and placement techniques among pediatric dentists. JADA 2001;132(10):1442-1451.

15. Workshop on guidelines for sealant use: recommendations. The Association of State and Territorial Dental Directors, the New York State Health Department, the Ohio Department of Health and the School of Public Health, University at Albany, State University of New York. J Public Health Dent 1995;55(5 spec no):263-273.

16. Beauchamp J, Caufield PW, Crall JJ, et al; American Dental

Association Council on Scientific Affairs. Evidence-based clinical recommendations for the use of pit-and-fissure sealants: a report of the American Dental Association Council on Scientific Affairs. JADA 2008; 139(3):257-268.

17. Griffin SO, Oong E, Kohn W, Vidakovic B, Gooch BF; CDC Dental Sealant Systematic Review Work Group, Bader J, Clarkson J, Fontana MR, et al. The effectiveness of sealants in managing caries lesions. J Dent Res 2008;87(2):169-174.

18. Oong EM, Griffin SO, Kohn WG, Gooch BF, Caufield PW. The effect of dental sealants on bacteria levels in caries lesions: a review of the evidence. JADA 2008;139(3):271-278.

19. Griffin SO, Jones K, Gray SK, Malvitz DM, Gooch BF. Exploring four-handed delivery and retention of resin-based sealants. JADA 2008;139(3):281-289.

20. Griffin SO, Gray SK, Malvitz DM, Gooch BF. Caries risk in formerly sealed teeth. JADA 2009;140(4):415-423.

21. Gray SK, Griffin SO, Malvitz DM, Gooch BF. A comparison of the effects of toothbrushing and handpiece prophylaxis on retention of sealants. JADA 2009;140(1):38-46.

22. Carter N, American Association for Community Dental Programs, National Maternal and Child Oral Health Resource Center. Seal America: the prevention invention. 2nd ed. Washington: National Maternal and Child Oral Health Resource; 2007. Archived at: "www.webcitation.org/5Rnk5yjJ3". Accessed Sept. 23, 2009.

23. Shekelle PG, Woolf SH, Eccles M, Grimshaw J. Clinical guidelines: developing guidelines. BMJ 1999;318(7183):593-596.

24. Higgins JPT, Green S, eds. Systematic reviews and the Cochrane Handbook. In: Cochrane Handbook for Systematic Reviews of Interventions 4.2.6. Updated September 2006. Archived at: "www.webcitation.org/5b30kQuG9". Accessed Sept. 23, 2009.

25. Kunz R, Vist G, Oxman AD. Randomisation to protect against selection bias in healthcare trials. Cochrane Database Syst Rev 2007; (2):MR000012.

26. Llodra JC, Bravo M, Delgado-Rodriguez M, Baca P, Galvez R. Factors influencing the effectiveness of sealants: a meta-analysis. Community Dent Oral Epidemiol 1993;21(5):261-268.

27. American Dental Association, Center for Evidence-Based Dentistry. Evidence-based dentistry: glossary of terms. American Dental Association. "http://ebd.ada.org/About.aspx". Accessed Sept. 23, 2009.

28. Ahovuo-Saloranta A, Hiiri A, Nordblad A, Mäkelä M, Worthington HV. Pit and fissure sealants for preventing dental decay in the permanent teeth of children and adolescents. Cochrane Database Syst Rev 2008;(4)CD001830.

29. Mejàre I, Lingström P, Petersson LG, et al. Caries-preventive effect of fissure sealants: a systematic review. Acta Odontol Scand 2003;61(6):321-330.

30. National Institutes of Health. Diagnosis and management of dental caries throughout life: NIH consensus statement. 2001;18(1):1-23.

31. Bader JD, Shugars DA, Bonito AJ. Systematic reviews of selected dental caries diagnostic and management methods. J Dent Educ 2001; 65(10):960-968.

32. Bader JD, Shugars DA, Bonito AJ. A systematic review of the performance of methods for identifying carious lesions. J Public Health Dent 2002;62(4):201-213.

33. Ismail AI, Sohn W, Tellez M, et al. The International Caries Detection and Assessment System (ICDAS): an integrated system for measuring dental caries. Community Dent Oral Epidemiol 2007;35(3): 170-178.

34. Pitts N. "ICDAS": an international system for caries detection and assessment being developed to facilitate caries epidemiology, research and appropriate clinical management. Community Dent Health 2004; 21(3):193-198.

35. Ekstrand KR, Kuzmina I, Bjørndal L, Thylstrup A. Relationship between external and histologic features of progressive stages of caries in the occlusal fossa. Caries Res 1995;29(4):243-250.

36. World Health Organization. Oral Health Surveys: Basic Methods. 4th ed. Geneva: World Health Organization; 1997:41-42.

37. World Health Organization. Oral Health Surveys: Basic Methods. 3rd ed. Geneva: World Health Organization; 1987:35-36.

38. Radike AW. Criteria for diagnosis of dental caries. In: Proceedings of the Conference on the Clinical Testing of Cariostatic Agents. Oct. 14-16, 1968; Chicago; American Dental Association; 87-88.

39. Ekstrand K, Qvist V, Thylstrup A. Light microscope study of the effect of probing in occlusal surfaces. Caries Res 1987;21(4):368-374.

40. Kuhnisch J, Dietz W, Stosser L, Hickel R, Heinrich-Weltzien R. Effects of dental probing on occlusal surfaces: a scanning electron microscopy evaluation. Caries Res 2007;41(1):43-48.

41. van Dorp CS, Exterkate RA, ten Cate JM. The effect of dental probing on subsequent enamel demineralization. ASDC J Dent Child 1988;55(5):343-347.

42. Yassin OM. In vitro studies of the effect of a dental explorer on the formation of an artificial carious lesion. ASDC J Dent Child 1995; 62(2):111-117.

43. Bader JD, Shugars DA. A systematic review of the performance of a laser fluorescence device for detecting caries. JADA 2004;135(10): 1413-1426.

44. Zandoná AF, Zero DT. Diagnostic tools for early caries detection. JADA 2006;137(12):1675-1684.

45. Forgie AH, Pine CM, Pitts NB. The use of magnification in a preventive approach to caries detection. Quintessence Int 2002;33(1): 13-16.

46. Lussi A. Comparison of different methods for the diagnosis of fissure caries without cavitation. Caries Res 1993;27(5):409-416.

47. Muller-Bolla M, Lupi-Pégurier L, Tardieu C, Velly AM, Antomarchi C. Retention of resin-based pit and fissure sealants: a systematic review. Community Dent Oral Epidemiol 2006;34(5):321-336.

48. Gillcrist JA, Vaughan MP, Plumlee GN Jr, Wade G. Clinical sealant retention following two different tooth-cleaning techniques. J Public Health Dent 1998;58(3):254-256.

49. Donnan MN, Ball IA. A double-blind clinical trial to determine the importance of pumice prophylaxis on fissure sealant retention. Br Dent J 1988;165(8):283-286.

50. Shapira J, Eidelman E. Six-year clinical evaluation of fissure sealants placed after mechanical preparation: a matched pair study. Pediatr Dent 1986;8(3):204-205.

51. Shapira J, Eidelman E. The influence of mechanical preparation of enamel prior to etching on the retention of sealants: three-year follow-up. J Pedod 1984;8(3):272-277.

52. Shapira J, Eidelman E. The influence of mechanical preparation of enamel prior to etching on the retention of sealants. J Pedod 1982; 6(4):283-287.

53. Lygidakis NA, Oulis KI, Christodoulidis A. Evaluation of fissure sealants retention following four different isolation and surface preparation techniques: four years clinical trial. J Clin Pediatr Dent 1994; 19(1):23-25.

54. Houpt M, Shey Z. The effectiveness of a fissure sealant after six years. Pediatr Dent 1983;5:104-106.

55. Erdogan B, Alaçam T. Evaluation of a chemically polymerized pit and fissure sealant: results after 4.5 years. J Paediatr Dent 1987;3:11-13.

56. Rock WP, Bradnock G. Effect of operator variability and patient age on the retention of fissure sealant resin: 3-year results. Community Dent Oral Epidemiol 1981;9(5):207-209.

57. Schachter JP. Geographic Mobility: 2002 to 2003. Current Population Reports. Washington: U.S. Department of Commerce, Economics and Statistics Administration, U.S. Census Bureau. March 2004. Archived at: "www.webcitation.org/5avllq6p6". Accessed Sept. 23, 2009.

58. U.S. General Accounting Office. Elementary School Children: Many Change Schools Frequently, Harming Their Education. Report to the Honorable Marcy Kaptur, House of Representatives. Gaithersburg, Md.: U.S. General Accounting Office; February 1994. Publication GAO/HEHS-94-45.

59. Griffin SO, Griffin PM, Gooch BF, Barker LK. Comparing the costs of three sealant delivery strategies. J Dent Res 2002;81(9):641-645.

60. Quiñonez RB, Downs SM, Shugars D, Christensen J, Vann WF Jr. Assessing cost-effectiveness of sealant placement in children. J Public Health Dent 2005;65(2):82-89.

61. U.S. Department of Health and Human Services, Agency for Healthcare Research and Quality. MEPS: Medical Expenditure Panel Survey 2004. MEPSnet/HC. Archived at: "www.webcitation.org/5jSyLSKRy". Accessed Sept. 23, 2009.

62. Going RE, Conti AJ, Haugh LD, Grainger DA. Two-year clinical evaluation of a pit and fissure sealant, part II: caries initiation and progression. JADA 1976;92(3):578-585.

63. Mertz-Fairhurst EJ, Schuster GS, Fairhurst CW. Arresting caries by sealants: results of a clinical study. JADA 1986;112(2):194-197.

64. American Academy of Pediatric Dentistry, Council on Clinical Affairs. Policy on alternative restorative treatment (ART). Revised 2004. Archived at: "www.webcitation.org/5Ziq15JiH". Accessed Sept. 23, 2009.

65. Ismail AI, Sohn W, Tellez M, Willem JM, Betz J, Lepkowski J. Risk indicators for dental caries using the International Caries Detection and Assessment System (ICDAS). Community Dent Oral Epidemiol 2008;36(1):55-68.

66. American Dental Association, Council on Dental Benefit Programs, Council on Dental Practice, Council on Scientific Affairs; U.S. Food and Drug Administration, Public Health Service, Food and Drug Administration. The selection of patients for dental radiographic examinations. Revised 2004. Archived at: "www.webcitation.org/5bRMUml68". Accessed Sept. 23, 2009.

Exploring four-handed delivery and retention of resin-based sealants

Susan O. Griffin, PhD; Kari Jones, PhD; Shellie Kolavic Gray, DMD, MPH; Dolores M. Malvitz, DrPH; Barbara F. Gooch, DMD, MPH

Expert panels assembled by the American Dental Association (ADA) and the Centers for Disease Control and Prevention, Atlanta, have been reviewing available scientific information about sealant effectiveness to support the generation of evidence-based guidelines for clinical care and school-based sealant programs, respectively. Although the aims and scope of comprehensive clinical care and the more limited school-based sealant programs may vary, information about the impact of specific clinical practices, such as the use of an assistant (that is, the four-handed technique), on sealant retention, effectiveness and costs can inform practitioners' decisions and practices in both settings.

The Association of State and Territorial Dental Directors supports the use of four-handed delivery in school-based programs.[1] In addition, an expert panel convened by the ADA Council on Scientific Affairs considered the topic important enough to address in evidence-based clinical recommendations for sealant use.[2] Although we are unaware of any data describing the frequency of four-handed sealant delivery in clinical settings in the

ABSTRACT

JADA CE CONTINUING EDUCATION ARTICLE 2

Background. To date, no trials have been published that examine whether four-handed delivery of dental sealants increases their retention and effectiveness. In the absence of comparative studies, the authors used available data to explore the likelihood that four-handed delivery increased sealant retention.

Methods. The authors examined data regarding the retention of autopolymerized resin-based sealants from studies included in systematic reviews of sealant effectiveness. The explanatory variable of primary interest was the presence of a second operator. To examine the unique contribution of four-handed delivery to sealant retention, the authors used linear regression models.

Results. Eleven of the 36 studies from systematic reviews met explicit criteria and were included in this analysis. The high level of heterogeneity among studies suggested that multivariate analysis was the correct approach. According to the regression model, the presence of a second operator increased retention by 9 percentage points.

Conclusions. For this group of studies, four-handed delivery of autopolymerized sealants was associated with increased sealant retention.

Clinical Implications. Using four-handed delivery to place resin-based sealants may increase retention.

Key Words. Pit-and-fissure sealants; sealant retention; four-handed delivery.

JADA 2008;139(3):281-289.

Dr. Griffin is a health economist, Surveillance, Investigations, and Research Branch, Division of Oral Health, Centers for Disease Control and Prevention, 4770 Buford Highway, Mailstop F10, Chamblee, Ga. 30341, e-mail "sig1@cdc.gov". Address reprint requests to Dr. Griffin.
Dr. Jones is a health economist, Quantitative Health Research, Elberton, Ga.
Dr. Kolavic Gray is a dental epidemiologist, Public Health Division, Northrop Grumman, Atlanta.
Dr. Malvitz is a public health consultant, Palladian Partners, Silver Spring, Md.
Dr. Gooch is a dental officer, Surveillance, Investigations, and Research Branch, Division of Oral Health, Centers for Disease Control and Prevention, Chamblee, Ga.

United States, almost 94 percent of dentists reported in a recent ADA survey of dental practice that they employed a chairside assistant.[3]

A recent systematic review that examined the retention of resin-based pit-and-fissure sealants according to different clinical procedures used during sealant delivery, however, did not address two-handed versus four-handed delivery.[4] In addition, the ADA conducted a Medline search of the literature from 1975 through 2006, which identified no studies that directly compared sealant outcomes associated with two- and four-handed delivery (Julie Frantsve-Hawley, RDH, PhD, ADA Division of Science, director, Research Institute and Center for Evidence-based Dentistry and Helen Ristic, PhD, ADA Division of Science, director, scientific information, oral communication, January 2007). (The search strategy is available from the authors on request.) Theoretical rationale and expert opinion support the use of a trained auxiliary during sealant placement.[5-8] The four-handed technique may improve the quality and efficiency of sealant placement through shortened placement time, improved isolation, reduction in operator fatigue and enhanced patient care.[5,9,10]

The primary objective of this secondary data analysis was to determine whether evidence existed that sealant retention increased with four-handed placement, while controlling for other factors that could affect retention.

While we could find no comparative studies directly estimating improvements in outcomes associated with the use of an assistant, the studies included in systematic reviews of sealant effectiveness offer a potentially rich source of relevant information. These studies have met established rules of study design, conduct and measurement for inclusion in final bodies of evidence. In addition, they usually provide a detailed description of the intervention (for example, the preparation and placement procedures) and outcomes, in addition to the study participants, the time period and the setting.

A multivariate analysis of the association between the outcome in these studies (sealant retention) and four-handed delivery, in addition to other preparation and placement procedures, can provide indirect evidence of possible benefits. In the absence of randomized controlled trials, a multivariate approach can control for the effects of potential confounders measured in the studies, as well as provide estimates of the unique contribution of each procedure (such as four-handed delivery). Because such approaches may not account for all confounders, however, findings provide only indirect evidence of possible benefit. Information about the contribution of selected aspects of the sealant delivery protocol is important for clinical and public health decision making.

The primary objective of this secondary data analysis was to determine whether evidence existed that sealant retention increased with four-handed placement, while controlling for other factors that could affect retention. We chose retention instead of effectiveness as the outcome of interest, because retention would be affected less by differences in caries risk among the sample populations of multiple studies. In addition, the effectiveness of resin-based sealants is highly associated with retention, because these sealants act by providing a physical barrier that prevents microorganisms and food particles from collecting in pits and fissures.[11]

METHODS

Definitions. We defined four-handed delivery as the placement of sealants by a primary operator with a second person present to provide assistance. Similarly, we defined two-handed delivery as the placement of sealants by a single operator. We used World Bank designations to classify countries where the studies were conducted as "high" income or "not high" income (a combination of low income, lower middle income and upper middle income).[12]

Inclusion criteria. We searched Medline and the Cochrane Library for systematic reviews of sealant effectiveness that were published in English between 1990 and 2005. Four systematic reviews,[13-16] which included 36 unique studies, met these inclusion criteria.[17-52] One reviewer (S.K.G.) screened these studies, and she excluded 25[28-52] for the following reasons: the study was not published in English[52]; the study design was not a prospective cohort or randomized controlled trial[46]; the study did not apply second- or third-generation sealant material[28,30,32-40,42,45,49,50]; subjects were not between 5 and 10 years of age [48]; the study contained insufficient information to estimate both the percentage of sealants that

were retained fully on permanent first molars according to year since placement and the standard errors (SEs) for these estimates[29,41,47,51]; mechanical preparation, such as enameloplasty or fissureotomy, was performed before sealant placement[44]; or lost or fractured sealant material was repaired or reapplied.[31,43]

Data abstraction. The same reviewer (S.K.G.) abstracted the studies meeting the inclusion criteria. The abstraction form included the following factors hypothesized to be associated with sealant retention:

- two- or four-handed delivery;
- years since placement (for example, one, two or three);
- tooth-surface cleaning method (toothbrush or handpiece);
- isolation by cotton rolls or a rubber dam;
- type of suction;
- use of acid-etching and/or a bonding agent;
- type of primary operator (dentist or nondentist);
- income level of the country (high or not high).

We included the last factor to explore the assumption that greater access to and utilization of dental services, as well as differences in dental systems in higher-income countries, would increase the detection of incipient caries in sealed teeth. We contacted the authors of the studies to verify information about the conduct of the study if adequate detail was not provided in published reports.

Quality assessment. Because we selected studies from published systematic reviews that had explicit quality criteria for inclusion, we did not reassess all aspects of individual study quality but did document two selected quality aspects: number of primary operators and whether operators received training before delivering sealants to study subjects. It is important to remember that, to our knowledge, there are no comparative studies of sealant outcomes for two- versus four-handed placement and, thus, some commonly used criteria to determine study quality such as random allocation would not necessarily apply.

Outcome measure and data adjustment. Our outcome measure was retention at each annual follow-up examination of sealants that were placed on occlusal surfaces of first permanent molars. We defined retention as the presence of a sealant that completely covered the pits and fissures of the tooth. We used the following formula to calculate the SE of the retention rate:

$$SE = \sqrt{\frac{\text{retention} \times (1 - \text{retention})}{n}}$$

where "n" represents the number of teeth initially sealed.

Because teeth in the same subject may be correlated with each other, conducting the analysis at the tooth level may have underestimated SEs. If a study provided only site-level retention data (for example, examiners reported multiple sites on individual teeth, such as buccolingual pits and mesiodistal occlusal pits), we used the reported retention rate but calculated the SE using the reported number of teeth instead of tooth sites. This adjustment resulted in higher SEs for studies using tooth sites as the unit of analysis.

Analysis. We calculated the summary-weighted retention rate separately for the studies that used two-and four-handed delivery for each of the three years after sealant placement. We weighted the studies by the reciprocal of their squared SE. To determine whether it was reasonable to pool the studies to attain a summary estimate of retention according to the presence or absence of a second operator for each of the three years, we examined whether the confidence intervals on the forest plots[53] overlapped for studies using two-handed delivery and for those using four-handed delivery.

We used weighted linear regression models to examine the effect of four-handed delivery alone (model 1) and in the presence of other hypothesized factors (model 2) on sealant retention for each year since placement. All explanatory factors were represented in the regression model as dichotomous independent variables, where "1" indicates the presence of the factor and "0" indicates the absence of the factor. We excluded hypothesized factors that were present in only one study, because the variable might have reflected other unique aspects of a single study. We considered explanatory variables to be significant if the *P* value for the coefficient was less than or equal to .05.

Because we had several possible combinations of explanatory variables and a small sample of studies, we constructed a tree diagram to determine for which combinations of variables we had studies. We also compared the explanatory power of model 1 (that is, how much total variation was

TABLE 1

Characteristics of included studies.

CHARACTERISTIC	STUDY AUTHOR, YEAR STUDY BEGAN, SITE					
	McCune and Colleagues[17] 1975 (Medellin, Columbia)	Mertz-Fairhurst and Colleagues[18] 1974 (Augusta, Ga.)	Charbeneau and Dennison[19] 1973 (Chelsea, Mich.)	Erdogan and Alaçam[20] 1982 (Ankara, Turkey)	Houpt and Shey[21] 1976 (Jersey City, N.J.)*	Hunter[22] (Year Not Reported (New Zealand)
Sealant Placement						
Operators trained	NR‡	Yes	NR	NR	NR	Yes
No. of primary operators	Two	Six	Two	One	Two	NR
Isolation	CR¶, low-volume suction	CR, triple air-water syringe or central suction	Teeth isolated with dry-angle absorbent wafer and saliva ejector	CR, suction and low-volume saliva ejector	CR, low-volume suction	Air-water syringe, low-volume suction
Children's Age (Years)**	6-8	6-8	6-8	8-10	6-10	5-8
Follow-up						
No. of children at first follow-up	173	155	126††	59	186	509
No. of teeth at first follow-up	275	239	202	118	186	509
No. of tooth sites at first follow-up	NA	NA	NA	NA	NA	NA
Study weight at first follow-up	3,574	4,679	1,226	668	2,494	2,215

* Fourth-year retention calculated with site data.
† Retention calculated with site data.
‡ NR: Not reported.
§ The authors used findings for second operator only because retention rates for first operator were much lower than those reported in other studies.
¶ CR: Cotton rolls.
# NA: Not applicable.
** Unless otherwise specified.
†† Estimate based on the reported number of tooth pairs per child.
‡‡ Estimate based on the number of tooth pairs per child at the second-year follow-up examination.
§§ The authors assumed one sealed tooth per child.

continued on next page

explained by the model as measured by the adjusted R^2) with that of model 2. We also reran the regression without the weights to determine whether the results still held when we weighted all of the studies equally.

RESULTS

We included 11 studies in the final body of evidence (Table 1). Eight studies used four-handed delivery (representing 1,189 children and 1,944 teeth), while three used two-handed delivery (representing 885 children and 1,000 teeth). In nine studies, the operator performed prophylaxis using a handpiece (with pumice or prophylaxis paste) before placing the sealant. In two studies, the operator cleaned the tooth surfaces with a toothbrush and toothpaste. In six studies, dentists were the primary operators. Seven studies were conducted in high-income countries. Most studies began between 1973 and 1995. Four of the seven studies conducted in high-income countries began between 1973 and 1976. Of the remaining three studies, two likely began in 1977. The four studies published in countries with not-high incomes began between 1975 and 1995.

We found little or no variation for several factors. All studies used cotton rolls and/or high- or low-volume suction to isolate the surface; acid-

TABLE 1 (CONTINUED)

STUDY AUTHOR, YEAR STUDY BEGAN, SITE				
Poulsen and Colleagues[23] 1995 (Damascus, Syria)	**Gibson and Colleagues[24] (Year Not Reported) (Vancouver, British Columbia)**	**Rock and Bradnock[25] (Year Not Reported) (Birmingham, England)**	**Thylstrup and Poulsen[26] 1974 (Hillerod, Denmark)†**	**Vrbic[27] 1979 (Slovenia)**
Yes	NR	NR	NR	NR
Two	One	One§	One	Six
NA#	CR, suction	CR, air-water syringe and high-volume aspirator	CR, low- and high-volume suction	Low-volume suction
7	Second-graders	6-7	7	Kindergarten
121	246‡‡	65	190	244
121§§	393	130	305	373
NA	NA	NR	451	NA
1,696	4,217	686	1,562	5,068

etching before sealant placement; and autopolymerized resin-based sealants applied to the occlusal surfaces of permanent first molars in both arches.

Retention rates. Summary retention rates for one, two and three years after placement were 89.0 percent (range, 73.4 to 94.6 percent), 81.2 percent (range, 59.5 to 88.9 percent) and 73.9 percent (range, 60.1 to 87.5 percent), respectively. Retention appeared to vary significantly according to study for both two- and four-handed studies (Figure). Summary retention rates for studies using four-handed delivery—equaling 89.8 percent after one year, 83.0 percent after two years and 83.0 percent after three years—were higher than summary retention rates for studies using two-handed delivery (equaling 84.8 percent after one year, 72.4 percent after two years and 67.9 percent after three years) (data not shown). For the regression model that included four-handed delivery and the time since sealant placement as explanatory variables (model 1 in Table 2 (page 287); 28 observations), the adjusted R^2 was 42 percent and the coefficient for four-handed delivery approached significance ($P = .055$).

Explanatory variables. Stratifying studies according to four explanatory variables (four-handed delivery, surface cleaning via handpiece prophylaxis, dentist as the primary operator and country income) revealed several combinations of these variables for which there were no studies (Table 3, page 287). The included studies provided data for seven of the 16 possible combinations of explanatory variables. Because there were no studies in lower-income countries that used two-handed delivery and, thus, would add no direct information about the impact of four-handed delivery, we ran the regression model for all of the studies and for studies that were conducted in a high-income country. These seven studies conducted in high-income countries provided 18 observations of sealant retention over three years since placement; three studies used two-handed delivery and four studies used four-handed

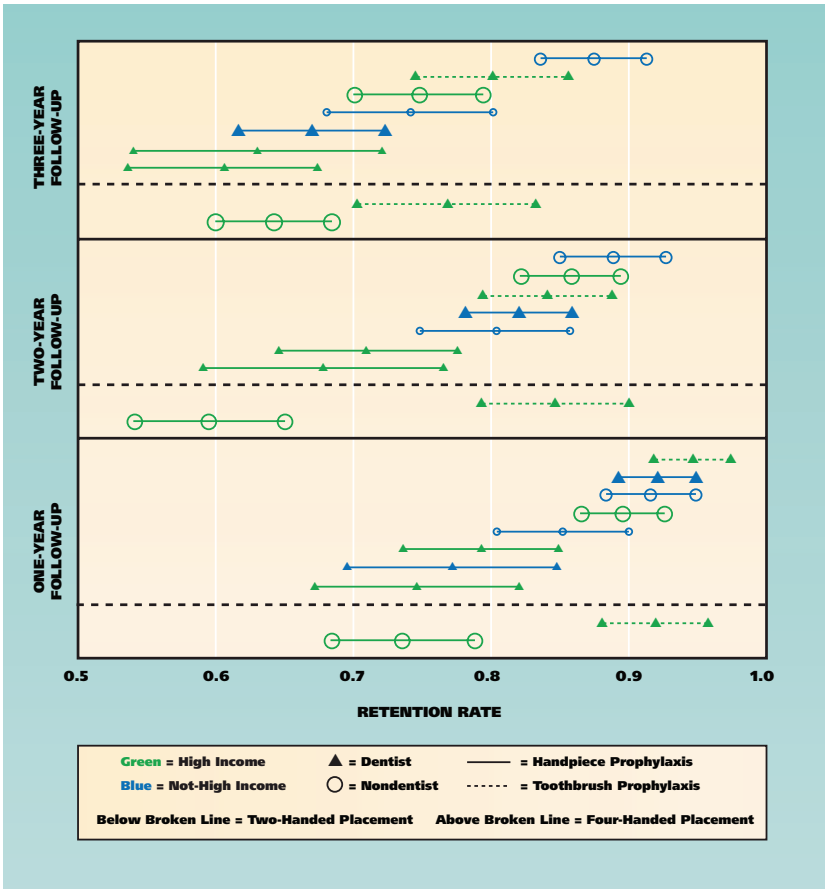


Figure. Forest plots showing sealant retention (95 percent confidence interval) in studies involving two- and four-handed delivery, for each year after placement.

delivery (Table 3). Five of these seven studies used a handpiece prophylaxis, all with prophylaxis paste.

When we included all of the studies, the adjusted R^2 was 0.69, and when we excluded the studies from countries that were not high-income (model 2 in Table 2), the adjusted R^2 was 0.81. Four-handed delivery increased sealant retention by a statistically significant 9 percentage points in model 2. Sealant retention decreased with the following factors: years since placement, study conducted in a high-income country, prophylaxis performed with a handpiece before sealant placement, and having a dentist as the primary operator. Rerunning the regression models without the weights did not change the direction or significance of the association between the factors and sealant retention.

DISCUSSION

The findings of this multivariate analysis indicate that, in comparison with two-handed delivery, four-handed delivery increased sealant retention by about 9 percentage points. It is important to note that we identified this positive association only when the variation in other selected factors (that is, time since sealant placement, provider type and surface cleaning method) was controlled across the studies. In contrast, the simple sealant retention rates in an individual study reflect multiple factors, and, thus, retention rates of more than 90 percent at one year for sealants placed in a study with two-handed delivery[21] or less than 80 percent in a study with four-handed delivery[20,25] can be expected.

The forest plots suggest that significant heterogeneity existed among studies even after we stratified them according to the presence of a second operator. This likely reflects the multiple factors that can affect retention and thus indicated that the multivariate analysis, which controlled for the effects of some of these factors, was the appropriate approach. The high R^2—ranging from 69 to 81 percent—for the final regression models indicates that these models included important variables affecting sealant retention in this group of studies.

The findings for some of the other variables in the model also were consistent with the initial hypotheses. First, sealant retention decreased over time. Three years after placement, about 15 percent of the sealants were completely or partially lost. In addition, sealants were less likely to be retained over time in high-income countries. As described above, greater use of dental services in these countries may have increased the probability of detecting caries in sealed teeth.

Unexpected findings. Certain findings of our analysis were unexpected. We found that handpiece prophylaxis was associated with a reduction in sealant retention of about 20 percentage points when compared with toothbrush prophylaxis. Of the nine studies in the regression analysis that reported the use of a handpiece prophylaxis, five used prophylaxis paste, three used pumice and one did not specify. It is possible that some prophylaxis pastes marketed in the 1970s and 1980s may have contained oils or other substances that

TABLE 2

Coefficients associated with sealant retention ($P < .05$) in fixed-effects weighted least-squares regression models.

VARIABLE	COEFFICIENT (STANDARD ERROR)			
	All Studies		High-Income Studies	
	Model 1	Model 2	Model 1	Model 2
Intercept*	0.83 (0.04)	1.01 (0.05)	0.84 (0.04)	0.98 (0.04)
Two Years Since Placement	–0.08 (0.03)	–0.07 (0.02)	–0.09 (-0.05)	–0.08 (0.03)
Three Years Since Placement	–0.14 (0.04)	–0.14 (0.03)	–0.16 (0.05)	–0.14 (0.03)
Four-Handed Delivery	NA†	0.09 (0.03)	0.04 (0.02)	0.10 (0.03)
High-Income Country	NA	–0.07 (0.03)	NA	NA
Handpiece Prophylaxis	NA	–0.16 (0.03)	NA	–0.20 (0.04)
Dentist Delivered Sealants	NA	–0.07 (0.03)	NA	–0.04 (0.04)
Adjusted R^2	0.42	0.69	0.41	0.81

* One-year retention for studies using two-handed delivery and a toothbrush prophylaxis. None of the included studies had all of the characteristics.
† NA: Not applicable.

TABLE 3

Studies stratified according to four factors hypothesized to be associated with sealant retention.

HIGH-INCOME COUNTRY							
Handpiece Prophylaxis				No Handpiece Prophylaxis			
Dentist operator		Nondentist operator		Dentist operator		Nondentist operator	
Four-Handed	Two-Handed	Four-Handed	Two-Handed	Four-Handed	Two-Handed	Four-Handed	Two-Handed
Charbeneau and Dennison[19]	NA*	Gibson and colleagues[24]	Hunter[22]	Mertz-Fairhurst and colleagues[18]	Houpt and Shey[21]	NA	NA
Rock and Bradnock[25]	NA	NA	Thylstrup and Poulsen[26]	NA	NA	NA	NA
NOT-HIGH-INCOME COUNTRY							
Handpiece Prophylaxis				No Handpiece Prophylaxis			
Dentist operator		Nondentist operator		Dentist operator		Nondentist operator	
Four-Handed	Two-Handed	Four-Handed	Two-Handed	Four-Handed	Two-Handed	Four-Handed	Two-Handed
Erdogan and Alaçam[20]	NA	McCune and colleagues[17]	NA	NA	NA	NA	NA
Vrbic[27]	NA	Poulsen and colleagues[23]	NA	NA	NA	NA	NA

* Not applicable.

interfered with bonding. In addition, prophylaxis paste, along with pumice, may have been difficult to remove completely from the enamel surface before etching. In 1998, a study comparing toothbrush prophylaxis (with no toothpaste) with handpiece prophylaxis (with prophylaxis paste) reported similar rates of sealant retention—all greater than 97 percent—after one year.[54]

Another unexpected finding was the association between having a dentist as the primary

operator and lower sealant retention rates. The prevalence of sealant placement in the United States through the early 1990s, however, was less than 20 percent. This suggests that many operators likely had limited experience with sealant materials and/or placement techniques. The studies in which dentists were the primary operators may have been less likely to provide training in sealant placement than the studies in which the primary operators were nondentists for two possible reasons.

First, the investigators may have assumed that training was unnecessary because dentists generally have exceptional familiarity with restorative materials and techniques; moreover, even as early as the 1970s and 1980s, they were increasingly using resin-based composite materials. During that time, however, placement of resin-based composite materials generally was limited to restorations on smooth surfaces (that is, Class III, IV and V) with prepared margins. In the absence of training, some of the dentist operators and auxiliaries may not have appreciated fully the meticulousness and attention to detail that are required for successful sealant placement on pit-and-fissure surfaces.

Second, the opportunity cost of training time, as measured by foregone wages, would be higher for dentists than for nondentists. We cannot test this hypothesis because only three of the studies in this analysis specifically described the use of training before sealant placement. In the one study in which the dentists were trained, the retention rate was high, ranging from 95 percent at one year to 80 percent at three years after a one-time placement of sealants.[18]

Study limitations. This study and its underlying methodology have limitations. First, our comparison of the subgroups was observational. In the absence of random assignment in studies that were designed to directly compare sealant placement outcomes according to two- and four-handed delivery, the association between retention and an explanatory variable might have been due to another omitted causal variable, commonly known as confounding. Confounding may have been mitigated, however, because we used a multivariate analysis that attempted to control for key factors that are relevant to sealant retention.

Second, we did not have studies for all of the possible combinations of study factors, and there were, at most, two studies for any combination of factors. However, although the findings cannot be considered to be definitive because of potential confounding and the limited number of studies, the R^2 value suggests that, for this group of studies, the factors included in the model had good predictive power.

Third, our findings may be subject to recall bias because we contacted authors to obtain additional information if adequate data were not included in their report. For example, only five of the 11 studies reported the main explanatory variable—number of operators—in the original report.

Finally, our search universe was limited to studies included in systematic reviews of sealant effectiveness, and only one reviewer screened these studies. For this exploratory analysis, we chose a less resource-intensive method to identify and screen potential studies. In the absence of published comparative studies, this approach is attractive because it provides an efficient method of collecting data from well-conducted studies. The studies included in systematic reviews have met rules of study design, conduct and measurement. In addition, we minimized bias in selecting studies for the current analysis, because the universe of studies was determined by authors of the original systematic reviews. Inclusion and exclusion criteria in this analysis were objective and were specified before we screened available studies. Findings may be useful in developing hypotheses and directing resources for further research.

CONCLUSIONS

For this group of 11 studies, four-handed delivery was associated with higher retention of resin-based sealants. Although these descriptive findings cannot be generalized to all settings, they justify allocating resources to studies that directly compare sealant placement outcomes using two- and four-handed delivery. ■

Disclosure: None of the authors reported any disclosures.

The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention, Atlanta.

1. Association of State and Territorial Dental Directors. Best practice approaches for state and community oral health programs. New Bern, N.C.: Association of State and Territorial Dental Directors. "www.webcitation.org/5ToThC99J". Accessed Jan. 24, 2008.
2. Beauchamp J, Caufield PW, Crall JJ, et al. Evidence-based clinical recommendations for the use of pit-and-fissure sealants: a report of the American Dental Association Council on Scientific Affairs. 2008;139(3):257-268.
3. American Dental Association. 2005 survey of dental practice: Employment of dental practice personnel. Chicago: ADA Survey Center.

4. Muller-Bolla M, Lupi-Pégurier L, Tardieu C, Velly AM, Antomarchi C. Retention of resin-based pit and fissure sealants: a systematic review. Community Dent Oral Epidemiol 2006;34(5):321-336.
5. Waggoner WF, Siegal M. Pit and fissure sealant application: updating the technique. JADA 1996;127(3):351-361.
6. Carter N. Seal America: The prevention invention. Second ed. Washington: National Maternal and Child Oral Health Resource Center. "www.webcitation.org/5Rnk5yjJ3". Published 2007. Accessed Jan. 24, 2008.
7. Folke BD, Walton JL, Feigal RJ. Occlusal sealant success over ten years in a private practice: comparing longevity of sealants placed by dentists, hygienist, and assistants. Pediatr Dent 2004;26(5):426-432.
8. Feigal RJ, Donly KJ. The use of pit and fissure sealants. Pediatr Dent 2006;28(2):143-150.
9. Cooper TM. Four-handed dentistry in the team practice of dentistry. Dent Clin North Am 1974;18(4):739-753.
10. Robinson GE, Wuehrmann AH, Sinnett GM, McDevitt EJ. Four-handed dentistry: the whys and wherefores. JADA 1968;77(3):573-579.
11. U.S. Department of Health and Human Services. Oral health in America: A report of the surgeon general. Rockville, Md: U.S. Department of Health and Human Services, National Institute of Dental and Craniofacial Research, National Institutes of Health; 2000.
12. The World Bank. Country classification. Washington: The World Bank. "www.webcitation.org/5RnlSJkfB". Accessed Jan. 24, 2008.
13. Ahovuo-Saloranta A, Hiiri A, Nordblad A, Worthington H, Makela M. Pit and fissure sealants for preventing dental decay in the permanent teeth of children and adolescents. Cochrane Database Syst Rev 2004;(3):CD001830.
14. Llodra JC, Bravo M, Delgado-Rodriguez M, Baca P, Galvez R. Factors influencing the effectiveness of sealants: a meta-analysis. Community Dent Oral Epidemiol 1993;21(5):261-268.
15. Mejáre I, Lingström P, Petersson LG, et al. Caries-preventive effect of fissure sealants: a systematic review. Acta Odontol Scand 2003;61(6):321-330.
16. Truman BI, Gooch BF, Sulemana I, et al. Reviews of evidence on interventions to prevent dental caries, oral and pharyngeal cancers, and sports-related craniofacial injuries. Am J Prev Med 2002;23(1 suppl):21-54.
17. McCune RJ, Bojanini J, Abodeely RA. Effectiveness of a pit and fissure sealant in the prevention of caries: three-year clinical results. JADA 1979;99(4):619-623.
18. Mertz-Fairhurst EJ, Fairhurst CW, Williams JE, Della-Giustina VE, Brooks JD. A comparative clinical study of two pit and fissure sealants: 7-year results in Augusta, Ga. JADA 1984;109(2):252-255.
19. Charbeneau GT, Dennison JB. Clinical success and potential failure after single application of a pit and fissure sealant: a four-year report. JADA 1979;98(4):559-564.
20. Erdogan B, Alaçam T. Evaluation of a chemically polymerized pit and fissure sealant: results after 4.5 years. J Paediatr Dent 1987;3:11-13.
21. Houpt M, Shey Z. The effectiveness of a fissure sealant after six years. Pediatr Dent 1983;5(2):104-106.
22. Hunter PB. A study of pit and fissure sealing in the School Dental Service. N Z Dent J 1988;84(375):10-12.
23. Poulsen S, Beiruti N, Sadat N. A comparison of retention and the effect on caries of fissure sealing with a glass-ionomer and a resin-based sealant. Community Dent Oral Epidemiol 2001;29(4):298-301.
24. Gibson GB, Richardson AS, Patton RE, Waldman R. A clinical evaluation of occlusal composite and amalgam restorations: one- and two-year results. JADA 1982;104(3):335-337.
25. Rock WP, Bradnock G. Effect of operator variability and patient age on the retention of fissure sealant resin: 3-year results. Community Dent Oral Epidemiol 1981;9(5):207-209.
26. Thylstrup A, Poulsen S. Retention and effectiveness of a chemically polymerized pit and fissure sealant after 2 years. Scand J Dent Res 1978;86(1):21-24.
27. Vrbic V. Five-year experience with fissure sealing. Quintessence Int 1986;17(6):371-372.
28. Alvesalo L, Brummer R, Le Bell Y. On the use of fissure sealants in caries prevention: a clinical study. Acta Odontol Scand 1977;35(3):155-159.
29. Arrow P, Riordan PJ. Retention and caries preventive effects of a GIC and a resin-based fissure sealant. Community Dent Oral Epidemiol 1995;23(5):282-285.
30. Bagramian RA, Graves RC, Bhat M. A combined approach to preventing dental caries in schoolchildren: caries reductions after one year. JADA 1976;93(5):1014-1019.
31. Bravo M, Llodra JC, Baca P, Osorio E. Effectiveness of visible light fissure sealant (Delton) versus fluoride varnish (Duraphat): 24 month clinical trial. Community Dent Oral Epidemiol 1996;24(1):42-46.
32. Burt BA, Berman DS, Silverstone LM. Sealant retention and effects on occlusal caries after 2 years in a public program. Community Dent Oral Epidemiol 1977;5(1):15-21.
33. Going RE, Haugh LD, Grainger DA, Conti AJ. Four-year clinical evaluation of a pit and fissure sealant. JADA 1977;95(5):972-981.
34. Gourley JM. A two-year study of a fissure sealant in two Nova Scotia communities. J Public Health Dent 1975;35(2):132-137.
35. Higson JF. Caries prevention in first permanent molars by fissure sealing: a 2-year study in 6-8-year-old children. J Dent 1976;4(5):218-222.
36. Horowitz HS, Heifetz SB, Poulsen S. Adhesive sealant clinical trial: an overview of results after four years in Kalispell, Montana. J Prev Dent 1976;3(3 Pt 2):38-47.
37. Klein SP, Bohannan HM, Bell RM, Disney JA, Foch CB, Graves RC. The cost and effectiveness of school-based preventive dental care. Am J Public Health 1985;75(4):382-391.
38. Leal FR, Forgas-Brockmann L, Simecek J, Cohen ME, Meyer DM. A prospective study of sealant application in Navy recruits. Mil Med 1998;163(2):107-109.
39. Leverett DH, Handelman SL, Brenner CM, Iker HP. Use of sealants in the prevention and early treatment of carious lesions: cost analysis. JADA 1983;106(1):39-42.
40. Meurman JH, Helminen SK. Effectiveness of a fissure sealant 3 years after application. Scand J Dent Res 1976;84(4):218-223.
41. Messer LB, Calache H, Morgan MV. The retention of pit and fissure sealants placed in primary school children by Dental Health Services, Victoria. Aust Dent J 1997;42(4):233-239.
42. Pereira AC, Pardi V, Mialhe FL, Meneghim Mde C, Ambrosano GM. A 3-year clinical evaluation of glass-ionomer cements used as fissure sealants. Am J Dent 2003;16(1):23-27.
43. Poulsen S, Thylstrup A, Christensen PF, Ishoy U. Evaluation of a pit- and fissure- sealing program in a public dental health service after 2 years. Community Dent Oral Epidemiol 1979;7(3):154-157.
44. Raadal M, Laegreid O, Laegreid KV, Hveem H, Dorsgaard EK, Wangen K. Fissure sealing of permanent first molars in children receiving a high standard of prophylactic care. Community Dent Oral Epidemiol 1984;12(2):65-68.
45. Rock WP. Fissure sealants: results of a 3-year clinical trial using an ultra-violet sensitive resin. Br Dent J 1977;142(1):16-18.
46. Selwitz RH, Nowjack-Raymer R, Driscoll WS, Li SH. Evaluation after 4 years of the combined use of fluoride and dental sealants. Community Dent Oral Epidemiol 1995;23(1):30-35.
47. Simonsen RJ, Stallard RE. Fissure sealants: colored sealant retention 3 months post application. Quintessence Int Dent Dig 1977;8(2):81-86.
48. Songpaisan Y, Bratthall D, Phantumvanit P, Somridhivej Y. Effects of glass ionomer cement, resin-based pit and fissure sealant and HF applications on occlusal caries in a developing country field trial. Community Dent Oral Epidemiol 1995;23(1):25-29.
49. Stephen KW, Sutherland DA, Trainer J. Fissure sealing by practitioners: first year retention data in Scottish 6-year-old children. Br Dent J 1976;140(2):45-51.
50. Stephen KW. A four-year fissure sealing study in fluoridated and non-fluoridated Galloway. Health Bull (Edinb) 1978;36(3):138-145.
51. Sterritt GR, Frew RA. Evaluation of a clinic-based sealant program. J Public Health Dent 1988;48(4):220-224.
52. Tanguy R, Casanova F, Barnaud J. Prevention of tooth fissure caries using a sealing resin in the public health service [in French]. Rev Odontostomatol (Paris) 1984;13(2):125-130.
53. Lewis S, Clarke M. Forest plots: trying to see the wood and the trees. BMJ 2001;322(7300):1479-1480.
54. Gillcrist JA, Vaughan MP, Plumlee GN Jr, Wade G. Clinical sealant retention following two different tooth-cleaning techniques. J Public Health Dent 1998;58(3):254-256.

The effect of dental sealants on bacteria levels in caries lesions

A review of the evidence

Ella M. Oong, DMD, MPH; Susan O. Griffin, PhD; William G. Kohn, DDS; Barbara F. Gooch, DMD, MPH; Page W. Caufield, DDS, PhD

ABSTRACT

JADA CE CONTINUING EDUCATION ARTICLE 1

Background. Concern about inadvertently sealing over caries often prevents dentists from providing dental sealants. The objective of the authors' review was to examine the effects of sealants on bacteria levels within caries lesions under dental sealants.

Methods. The authors searched electronic databases for comparative studies examining bacteria levels in sealed permanent teeth. To measure the effect of sealants on bacteria levels, they used the $\log_{10}$ reduction in mean total viable bacteria counts (VBC) between sealed and not-sealed caries and the percentage reduction in the proportion of samples with viable bacteria.

Results. Six studies—three randomized controlled trials, two controlled trials and one before-and-after study—were included in the analysis. Although studies varied considerably, there were no findings of significant increases in bacteria under sealants. Sealing caries was associated with a 100-fold reduction in mean total VBC (four studies, 138 samples). Sealants reduced the probability of viable bacteria by about 50.0 percent (four studies, 117 samples).

Conclusions. The authors found that sealants reduced bacteria in carious lesions, but that in some studies, low levels of bacteria persisted. These findings do not support reported concerns about poorer outcomes associated with inadvertently sealing caries.

Clinical Implications. Practitioners should not be reluctant to provide sealants—an intervention proven to be highly effective in preventing caries—because of concerns about inadvertently sealing over caries.

Key Words. Pit-and-fissure sealants; caries; bacteria.
JADA 2008;139(3):271-278.

Strong evidence shows that sealants are effective in preventing caries in children at varying degrees of risk.[1,2] Despite this evidence of effectiveness, sealant prevalence among lower-income children (who are at higher risk of experiencing dental caries) remains at around 30 percent,[3] well below the Healthy People 2010 objective of 50 percent.[4] Survey data of dentists suggest that one of the major barriers to their providing sealants is concern about inadvertently sealing over caries.[5,6] This concern has become an obstacle to implementation of school-based sealant programs (Association of State and Territorial Dental Directors, unpublished data, 2005). Documenting the effectiveness of placing sealants over existing caries, thus, is important, because such documentation could remove a barrier to providing a proven intervention.

Dental caries is an infectious and transmissible disease, caused by cariogenic bacteria of the oral cavity, specifically those colonizing the surfaces of teeth.[7-10] Caries lesions may be caused by a range of bacteria, but principal among the cariogenic flora are the mutans streptococci and lactobacilli.[7,10] It long has been hypothesized that sealing an existing lesion from contact with the oral fluids should lead to eventual reduction and even death of these organisms and,

Dr. Oong is a dental public health resident, Centers for Disease Control and Prevention/Division of Oral Health/Surveillance, Investigations, and Research Branch, Chamblee, Ga.
Dr. Griffin is a health economist, Centers for Disease Control and Prevention/Division of Oral Health/Surveillance, Investigations, and Research Branch, 4770 Buford Highway, MSF10, Chamblee, Ga. 30341, e-mail "sig1@cdc.gov". Address reprint requests to Dr. Griffin.
Dr. Kohn is the associate director of science, Centers for Disease Control and Prevention/Division of Oral Health/Surveillance, Investigations, and Research Branch, Chamblee, Ga.
Dr. Gooch is a dental officer, Centers for Disease Control and Prevention/Division of Oral Health/Surveillance, Investigations, and Research Branch, Atlanta.
Dr. Caufield is a professor, Cariology and Comprehensive Care, New York University College of Dentistry, New York City.

thereby, should arrest the lesion's progress.[11] Accordingly, the fate of bacteria in caries lesions that are purposely sealed over has been of great interest to researchers and clinicians alike.

Therefore, we undertook a systematic review of the evidence regarding the effectiveness of sealants in stabilizing or reducing bacteria levels in caries lesions. This study is part of a larger systematic review that examined the effectiveness of sealants in managing caries in the pits and fissures of permanent teeth. Another report from this review found that dental sealants reduced the probability of caries progression by more than 70 percent compared with untreated control teeth.[12]

METHODS

Inclusion criteria. This analysis was part of a broader systematic review of sealant effectiveness in known carious lesions in the pits and fissures of permanent teeth. Initially, we included all in vivo studies published in English that compared outcomes, such as caries progression or bacteria levels, in permanent teeth treated with sealants with outcomes in permanent teeth not treated with sealants. Comparisons could involve concurrent randomized controlled trials (RCTs), controlled trials or cohort studies (prospective or retrospective) or studies conducted across time (before-and-after, time series) in the same groups. In this analysis, we included comparative studies that examined bacteria viability in sealed carious lesions. There were no restrictions regarding study populations.

Identification of studies. Details of our search strategy and results have been described elsewhere.[12] Two reviewers (B.G. and S.G.) independently examined the titles and abstracts of the 1,905 unique records identified in our search for primary studies or systematic or narrative reviews of the effectiveness of sealants in preventing or treating caries. Of these records, we ordered 262 articles; from our examination of their references, we ordered an additional 49 articles, for a total of 311.

Study selection. Three reviewers (B.G., S.G. and W.K.) reached a consensus that of these 311 articles, 26 studies should be evaluated further. These three reviewers rejected seven studies for inclusion for the following reasons: they were case studies, lacked appropriate outcomes or did not include both baseline and follow-up examinations. Of the 19 studies included in the larger systematic review, nine included data on bacteria levels under sealed carious lesions; of these nine studies, six had sufficient data from which to calculate outcome measures. The Quality of Reporting of Meta-Analyses Flow Diagram for the original, larger study has been published elsewhere.[12]

Data abstraction and quality assessment. Two reviewers (S.G. and E.O.) abstracted studies by using a modified version of a form developed for the National Institutes of Health Caries Consensus Development Conference in 2001.[12] This form was used in a systematic review of methods to manage caries.[13] We made one notable modification to the form to collect detailed information about bacteria-sampling methodology. The abstractors collected information to document study quality (in terms of such characteristics as study design, dropout rate, examiner blinding and bacteria-sampling methodology).

Outcome measures. We used two outcomes—mean viable bacteria count (VBC) as measured with colony-forming units per milligram (CFU/mg) and percentage of samples with VBC greater than zero—to measure activity for total bacteria, *Streptococcus mutans* and lactobacilli. To evaluate the effect of sealants on mean VBC, we examined the change in $\log_{10}$ mean VBC (= $\log_{10}$ mean VBC$_{\text{SEALED}}$ – $\log_{10}$ mean VBC$_{\text{NOT-SEALED}}$, where a $\log_{10}$ mean VBC value of 6 equals 1×10^6, or 1,000,000 CFU) and whether the difference in mean VBC for sealed and unsealed teeth was significant ($P < .05$). To measure the effect of sealants on the percentage of samples with VBC greater than zero, we used the percentage change in proportion of samples having VBC greater than zero:

$$\left(\frac{\%\ \text{samples VBC} > 0\ \text{SEALED}}{\%\ \text{samples VBC} > 0\ \text{NOT SEALED}} - 1 \right) \times 100$$

Synthesis of findings. We report the overall median and mean effect measures across all studies. We did not calculate confidence intervals for these summary measures because we included multiple observations from the same study, so observations likely were not independent.

ABBREVIATION KEY. CFU: Colony-forming unit. **DEJ:** Dentinoenamel junction. **GIC:** Glass-ionomer cement. **RBS:** Resin-based sealant. **RCT:** Randomized controlled trial. **VBC:** Viable bacteria count.

RESULTS

Description of studies. Of the six studies[14-19] used to calculate outcome measures in this analysis (representing 303 bacteria samples), two studies were RCTs,[17,18] one was a subgroup analysis of an RCT of split-mouth design,[14] two were controlled trials that did not mention randomization[15,16] and one was of a before-and-after design (in which the same tooth was sampled before and after sealant placement)[19] (Table 1).

About 94 percent of sampled lesions were cavitated at baseline (that is, allowed explorer penetration, had visible cavitation or had radiographic evidence of lesion depth ranging from the dentinoenamel junction [DEJ] to the dentin-pulp border but without pulpal involvement). The remaining 6 percent of lesions most likely were noncavitated (that is, they permitted the explorer probe to catch without penetration or sticking). In four studies, unsealed teeth likely had been carious for a shorter time than had sealed teeth.[14-17] Bacterial samples from unsealed teeth were obtained at baseline while samples from sealed teeth were obtained at follow-up[15-17] or, for the one study in which all bacteria samples were obtained at follow-up, unsealed teeth were diagnosed as carious at follow-up while sealed teeth were diagnosed at baseline.[14] Three studies used polymerized, resin-based sealant (RBS),[14,15,17] two used autopolymerized RBS[16,18] and one used both glass-ionomer cement (GIC) and visible-light–polymerized RBS.[19] Study populations included children, adolescents and young adults, ranging in age from 6 to 25 years.

Sealant effectiveness: total bacteria. We used results from four studies (18 observation points across five years representing 254 samples) to examine the effect of sealants on VBC.[14-16,19] There were no findings of significant increases in total bacteria under sealants. The reduction in $\log_{10}$ mean VBC at the last period in each study was approximately three in two studies[15,16] and two in the remaining two studies[14,19] (one of these two studies reported the median not the mean value). The overall median and mean reductions were 3.01 and 2.56 (138 samples), respectively (Table 2, page 275), and appeared to increase as time since sealant placement increased. Mean total VBC was lower for sealed teeth than for unsealed teeth in the three studies that tested for statistical significance.[14-16]

Four studies (nine observations across five years representing 117 samples) reported the proportion of samples with viable bacteria from sealed and unsealed caries lesions.[14,17-19] The reduction in the proportion of samples with viable bacteria attributable to sealants ranged from zero percent to 100.0 percent, with a median value of 50.0 percent and a mean value of 51.6 percent (Table 3, page 276). In all but one study,[17] lesions were sealed with a maximum depth of one-half of the distance from the DEJ to the pulp. In that study, however, the researchers presented findings for both moderate dentinal lesions ranging in depth from the DEJ to one-fourth the distance from the DEJ to the dentin-pulp border and deep dentinal lesions ranging in depth from one-fourth the distance from the DEJ to the pulp to the full distance from the DEJ to the pulp. If we were to exclude the findings for deep dentinal lesions, then the median and mean reduction in percentage of samples having viable bacteria would increase to 87.5 percent and 71.8 percent, respectively.

Sealant effectiveness: *S. mutans* and lactobacilli. Three studies[14,16,19] provided data for mean and median *S. mutans* VBC counts (seven observations representing 130 samples with follow-up times ranging from one day to five years; data not shown). Two of the three studies showed a twofold reduction in the $\log_{10}$ mean *S. mutans* VBC at the last sampling period.[14,16] In one of these two studies, however, the median count was 0 for both sealed and unsealed teeth.[16] The other study, the only one to test for statistical significance, showed that the reduction was indeed significant.[14] In the third study, the reduction in the $\log_{10}$ median *S. mutans* VBC was –0.45; it should be noted that in this study, the mean VBC were very low at baseline ($< 1 \times 10^1$) and at follow-up ($< 6 \times 10^1$), so any difference likely represented normal microbiological sampling variability. Two studies presented data on the percentage of samples with S. *mutans.* In one study,[14] sealants reduced the probability of viable *S. mutans* by 63 percent, and in the study with very low *S. mutans* counts at baseline, sealants increased the probability of viable *S. mutans* by 38 percent.

Two studies[14,19] provided data on lactobacilli counts (two observations across time representing 68 samples; data not shown). The reduction in $\log_{10}$ mean and median VBC was 1.75. The reduction was significant in the one study that tested for statistical significance.[14] In both studies, the

TABLE 1

Description of included studies.

CHARACTERISTIC	STUDY AUTHOR, YEAR, SITE AND DURATION (MONTHS)					
	Going and Colleagues,[14] 1978, United States, 60	**Handelman and Colleagues,[15] 1976, United States, 24**	**Jensen and Handelman,[16] 1980, United States, 12**	**Jeronimus and Colleagues,[17] 1975, United States, 1**	**Mertz-Fairhurst and Colleagues,[18] 1979, United States, 12**	**Weerheijm and Colleagues,[19] 1993, Netherlands, 7**
Subjects' Age (Years) and Background Community Fluoridation Exposure	10 to 14; no fluoridation	12 to 15; study location was fluoridated	8 to 25; study location was fluoridated	6 to 12; not reported (NR)	Children; NR*	7 to 18; NR
Lesion and Sealant Method by which cavitation status was assessed at baseline	Visual-tactile (VT) examination	VT/radiographs	VT/radiographs	VT/radiographs	VT/radiographs	VT
Lesion classification	Enamel (explorer catch) or dentinal (explorer stick/ penetration)	Dentinal: no more than one-half the distance between dentinoenamel junction (DEJ) and pulp	Dentinal: no more than half the distance between DEJ and pulp	Dentinal: from DEJ to pulp	Dentinal: lesion aperture between 1 and 3 mm	Dentinal: visible lesion
Material used†	RB1	RB1	RB2	RB1‡	RB2	GIC/RB3
Retention rate (%)	100§	100	100	100	NR	0/100
Study Design						
No. of subjects at baseline	51	NR	NR	11	4	13
No. of teeth	59	89	97	41	8	17¶
Design	Subgroup of randomized controlled trial (RCT) of split-mouth design (in subgroup analysis, control and treatment teeth not necessarily in same subject)	Non-RCT	Non-RCT	RCT (parallel groups)	RCT (split-mouth design)	Before-after
Dropout (DO) rate for teeth	27% across 5 years	NR	NR	NR	NR	NR
Examiner blinding	Yes#	NR	NR	NR	NR	NR
Laboratory Methods						
No. of samples	70	89	97	41	8	17
Isolation	Rubber dam	Rubber dam	Rubber dam	Rubber dam	Rubber dam	Rubber dam
Site sterilization	Betadine solution followed by 70% isopropyl alcohol	7% tincture of iodine and 70% alcohol	70% ethyl alcohol	7% tincture of metaphen followed by 70% alcohol	Merbromin and 70% alcohol	NR
Sample size	1 mg	1 mg	1 mg**	1 cubic mm	Dentin sample by probe mixed with Todd Hewitt medium and then 0.1 milliliter of mixture plated	0.2 mg
Medium	MM10 sucrose agar, mitis-sucrose-bacitracin (MSB) agar, and Rogosa agar	Baird Parker	Baird Parker and MSB agar	Sterile trypticase soy broth	Todd Hewitt agar	Blood agar, nitrocellulose blood agar, and Rogosa agar
Culture time	3 to 4 days	4 days	4 days	4 days	5 days	4 days
Outcome	CFU/mg (plate)††	CFU/mg (plate)	CFU/mg (plate)	Culture turbidity (yes/no)‡‡	CFU/mg (plate)	CFU/mg (plate)

* The researchers were located in Augusta, Ga., which had a fluoridated water supply at the time the study was conducted.
† RB1: Ultraviolet light–polymerized resin-based sealant. RB2: Autopolymerized resin-based sealant. RB3: Visible light–polymerized resin-based sealant. GIC: Glass ionomer cement sealant.
‡ Findings for Epoxylight 9075 (Lee Pharmaceuticals, South El Monte, Calif.) and 3M Caries Preventive Treatment (3M, now 3M ESPE, St. Paul, Minn.) excluded because two-week retention was less than 50 percent. For 3M product, acid concentration for etching was below recommended norm.
§ Study states that researchers verified integrity of sealant at each examination period (three, six, 12, 24, 36, 48 and 60 months).
¶ Study had 13 subjects and 24 teeth. We excluded findings for seven resealed teeth because the baseline bacteria levels were lower than those in never-sealed teeth.
# All bacteriologic samples were processed and interpreted without knowledge of which treatment group was involved or of the clinical findings.
** The researchers attempted to obtain representative samples for all teeth; thus, for slight caries penetration they sampled almost the entire lesion, and for deep lesions they sampled both superficial and deeper layers.
†† CFU/mg: Colony-forming units per milligram.
‡‡ Cloudiness in liquid culture indicates bacterial activity.

TABLE 2

The effect of sealants on mean total viable bacteria count (MTVBC*) per millligram of carious dentin, by months since placement.

STUDY	MONTHS SINCE SEALANT PLACEMENT	SEALED CARIES		CONTROL		EFFECT		
		No. of Bacterial Samples	MTVBC	No. of Bacterial Samples	MTVBC	Log_{10} Reduction	Mean Difference	*P* Value Mean Difference
Jensen and Handelman[16]	0.03	11	455.6×10^4	9†	925.1×10^4	0.3	469.5×10^4	.398
Jensen and Handelman	0.10	8	320.8×10^4	9	925.1×10^4	0.5	604.3×10^4	.227
Jensen and Handelman	0.23	10	120.6×10^4	9	925.1×10^4	0.9	804.5×10^4	.060
Handelman and Colleagues[15]	0.35	8	5.0×10^4	29‡	115.5×10^4	1.4	110.5×10^4	.048
Jensen and Handelman	0.5	12	35.9×10^4	9	925.1×10^4	1.4	889.2×10^4	.024
Handelman and Colleagues	1	10	4.7×10^4	29	115.5×10^4	1.4	110.8×10^4	.027
Jensen and Handelman	1	12	12.1×10^4	9	925.1×10^4	1.9	913.0×10^4	.020
Handelman and Colleagues	2	10	2.9×10^4	29	115.5×10^4	1.6	112.6×10^4	.025
Jensen and Handelman	2	8	154.5×10^4	9	925.1×10^4	0.8	770.6×10^4	.110
Handelman and Colleagues	4	6	1.0×10^4	29	115.5×10^4	2.1	114.5×10^4	.076
Jensen and Handelman	4	10	6.7×10^4	9	925.1×10^4	2.1	918.4×10^4	.034
Handelman and Colleagues	6	8	0.6×10^4	29	115.5×10^4	2.3	114.9×10^4	.040
Jensen and Handelman	6	8	7.5×10^4	9	925.1×10^4	2.1	917.6×10^4	.058
Weerheijm and Colleagues[19¶]	7	17	1.5×10^3	17	1.0×10^5	1.8	9.9×10^4	NR§
Handelman and Colleagues	12	12	0.1×10^4	29	115.5×10^4	3.0	115.4×10^4	.012
Jensen and Handelman	12	9	0.9×10^4	9	925.1×10^4	3.0	924.2×10^4	.043
Handelman and Colleagues	24	6	0.1×10^4	29	115.5×10^4	3.3	110.5×10^4	.073
Going and Colleagues[14]	60	30	25.6×10^3	21	$32{,}247 \times 10^3$	2.1	$3{,}199.1 \times 10^3$	< .05
Mean (Last Follow-Up)						2.5		
Median (Last Follow-Up)						3.0		

* Power represents inverse of dilution ratio; that is, a power of 4 indicated dilution ratio was 1:4.
† Samples from nine teeth obtained at baseline served as the control group in all follow-up periods.
‡ Twenty-nine samples obtained at baseline served as the control group in all follow-up periods.
§ NR: Not reported.
¶ Median value per 0.2 milligrams of carious dentin.

TABLE 3

Percentage reduction in proportion of samples having viable bacteria for sealed and unsealed caries lesions.

STUDY	MONTHS SINCE PLACEMENT	SEALED LESIONS			UNSEALED LESIONS			% REDUCTION
		No.	With > 0 CFUs*		No.	With > 0 CFUs		
			No.	%		No.	%	
Jeronimus and Colleagues[17] (I†)	0.5	6	1	17	6‡	4	67	75.0
Jeronimus and Colleagues (I)	0.75	6	0	0	6	4	67	100.0
Jeronimus and Colleagues (I)	1	6	0	0	6	4	67	100.0
Weerheijm and Colleagues[19]	7	17	16	94	17§	17	100	5.9
Mertz-Fairhurst and Colleagues[18]	12	4	0	0	4	4	100	100.0
Going and Colleagues[14]¶	60	30	15	50	21	21	100	50.0
Jeronimus and Colleagues (MD#)	0.5	5	5	100	5**	5	100	0.0
Jeronimus and Colleagues (MD)	0.75	4	4	100	5	5	100	0.0
Jeronimus and Colleagues (MD)	1	3	2	67	5	5	100	33.3
Median (All Studies, All Observations)				50			100	
Mean				47			89	
Median (All Studies, Excluding Jeronimus MD)				8			83	
Mean				27			83	
Median (All Studies, All Observations)								50.0
Mean								51.6
Median (All Studies, Excluding Jeronimus MD)								87.5
Mean								71.8

* CFUs: Colony-forming units.
† I: Incipient dentinal caries, no more than one-quarter of the distance between the dentinoenamel junction and pulp.
‡ Samples obtained from six teeth at baseline served as controls in all follow-up periods.
§ Bacterial samples obtained before sealant placement served as the control group; bacterial samples obtained from the same teeth seven months after sealant placement served as the treatment group.
¶ Minimum level of detection in study was 50 organisms per sample.
# MD: moderate-to-deep dentinal caries, more than one-half the distance between the dentinoenamel junction and the pulp.
** Samples obtained from five teeth at baseline served as controls in all follow-up periods.

percentage of samples with lactobacilli was lower for sealed teeth than for unsealed teeth. The percentage reduction in probability of viable lactobacilli was 37 percent.

DISCUSSION

Sealants were effective in reducing total bacteria counts in caries lesions. The reduction increased with time since sealant placement. At the last follow-up, there was a 100-fold decrease in mean bacteria counts in two studies[14,19] and a 1,000-fold decrease in the remaining two studies.[15,16] Sealants also reduced bacterial cultivability. On average, 47 percent of sealed lesions had viable bacteria (median = 50 percent) compared with 89 percent of unsealed lesions (median = 100 percent). When we excluded deep dentinal lesions, these values decreased to 27 percent for sealed lesions (median = 8 percent) and 83 percent in unsealed lesions (median = 83 percent) (Table 3).

These data suggest that a limited number of cultivable organisms may persist in some lesions but that their numbers are small. The effect of sealants on levels of *S. mutans* and lactobacilli, which have been suggested as primary cariogens in pit-and-fissure caries, also was strong in two of the three studies that examined this outcome.[14,16] These results provide more specific information about the preventive effects of sealants at the surface level.

Bacterial activity, as measured by a reduction in $\log_{10}$ mean VBC or the percentage of cultivable samples, decreased with time in all studies that had multiple follow-up periods.[15-17] Results of one study showed a linear decrease in mean $\log_{10}$ VBC across time.[16] Since bacteria decreased across time, the findings of this review suggest that retained sealants deprive bacteria of access to nutrients in the substrate. Furthermore, it appears that bacteria that persist under sealants cannot produce acid when isolated from the carbohydrate substrate and, thus, adequately sealed lesions are unlikely to progress. Another analysis of studies included in the larger systematic review that supported this report on bacteria levels under sealants found that sealing noncavitated lesions reduced the probability of lesion progression by more than 70 percent.[12]

The importance of adequately sealing a carious lesion is further supported by the finding that retained sealants regardless of material were effective. Studies included in this review used a variety of sealant materials: RBS polymerized by visible or ultraviolet light, autopolymerized RBS and GIC. Of the six studies that used RBS,[14-19] five reported retention rates,[14-17,19] and in these studies, retention was 100 percent. For the one study that also used GIC, full retention was 0 percent, but in all lesions, the opening remained sealed at follow-up.[19] Because the opening remained sealed, we cannot determine if the effectiveness of GIC was attributable to the isolation of bacteria from nutrients in the substrate, the release of fluoride into the dentin or a combination of both factors. It is hypothesized that release of fluoride from GIC contributes to primary caries prevention.[20] However, the clinical effect of fluoride release from GIC is not well-established; a systematic review showed insufficient evidence to recommend GIC for the primary prevention of dental caries.[2] Interestingly, one study reported that fissures with caries retained sealants better than did apparently intact fissures.[14]

The larger systematic review found two additional studies providing evidence that sealants are effective in reducing bacteria viability. The first study,[21] which was published in 1943, examined bacteria levels in caries sealed with baseplate gutta-percha packed down tightly and then in turn covered by zinc oxyphosphate cement. Results from this study showed that lactobacilli died out in all cases between two and 10 months after sealing and that streptococcus test results remained positive in more than one-third of the teeth studied after having been sealed for more than one year. Another study, an RCT, compared sealing bacteria in carious dentin with GIC restorative material with sealing bacteria with amalgam.[22] This study found that at six months, both materials inhibited caries progression as measured by total counts of bacteria, *S. mutans* and lactobacilli but that a larger decrease in *S. mutans* and lactobacilli resulted from GIC use.

Other studies document that at least two other species of bacteria can persist even when deprived of nutrients.[23,24] These species enter a starvation state, which allows bacterial long-term persistence in a nongrowing but cultivable state for at least two months. Further research is needed to determine how long cariogenic bacteria can persist when isolated from nutrients. The longest period for studies included in this review was five years; however, current data suggest that a sizable number of sealants are retained for almost twice that time.[25] One additional argument for the effectiveness of sealants in reducing bacterial activity is the fact that fissures in sound teeth harbor cariogenic bacteria and that, because these sealed teeth remain caries-free in most instances, these sealed-over bacteria either perish or are no longer metabolically active. Study results indicate that some teeth still have a considerable number of bacteria remaining even after acid etching.[14,17]

One limitation of this review was that all included studies were conducted before 2000. The sole criterion for bacterial viability in these studies was cultivability. Since that time, microbiological quantification and characterization have become DNA-based, obviating the need for cultivation, which captures only the cultivable minority of microorganisms present.[26] Another limitation was that one outcome measure reported in four studies, mean VBC, is sensitive to outlying values.[14-16,19] As a result, mean VBC typically are transformed to $\log_{10}$ values, and the

mean then is calculated for these transformed values. However, investigators in two of the three studies that found that mean VBC were lower in sealed teeth performed their statistical testing on transformed values.[15,17] Further research is needed with studies that meet current standards in design and conduct.

Our findings do not support reported concerns about poorer outcomes associated with inadvertently sealing caries and should lessen practitioners' reluctance to provide sealants—an intervention proven to be highly effective in preventing caries. Indeed, although study conduct varied considerably, there were no findings of significant increases in bacteria under sealants.

CONCLUSION

We found that sealants significantly reduced bacteria levels in cavitated lesions, but that in some studies, low levels of bacteria persisted. These findings support those of a recent meta-analysis that sealants prevented caries progression.[12] In combination, these two sets of findings suggest that when sealants are retained, and thus access to fermentable substrates is blocked, bacteria do not appear capable of exerting their cariogenic potential. ■

Disclosure: None of the authors reported any disclosures.

The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the U.S. Centers for Disease Control and Prevention, Atlanta.

The authors gratefully acknowledge the generous contribution of time and expertise by the U.S. Centers for Disease Control and Prevention's Dental Sealant Systematic Review Work Group: James D. Bader, DDS, MPH; Jan Clarkson, BSc, BDS, PhD, FDSRCS(Paed); Margherita Fontana, DDS, PhD; Daniel M. Meyer, DDS; R. Gary Rozier, DDS, MPH; Jane A. Weintraub, DDS, MPH; and Domenick T. Zero, DDS, MS.

1. Truman BI, Gooch BF, Sulemana I, et al. Reviews of evidence on interventions to prevent dental caries, oral and pharyngeal cancers, and sports-related craniofacial injuries. Am J Prev Med 2002;23(1 suppl):21-54.
2. Ahovou-Saloranta A, Hiiri A, Nordblad A, Worthington H, Makela M. Pit and fissure sealants for preventing dental decay in the permanent teeth of children and adolescents. Cochrane Database Syst Rev 2004;(3):CD001830.
3. Dye BA, Tan S, Smith V, et al. Trends in oral health status: United States, 1988-1994 and 1999-2004. Vital Health Stat April 11 2007;(248):1-92.
4. U.S. Department of Health and Human Services. Healthy People 2010: Understanding and improving health. 2nd ed. Washington: U.S. Department of Health and Human Services; 2000.
5. Chapko MK. A study of the intentional use of pit and fissure sealants over carious lesions. J Public Health Dent 1987;47(3):139-142.
6. Primosch RE, Barr ES. Sealant use and placement techniques among pediatric dentists. JADA 2001;132(10):1442-1451.
7. Loesche WJ. Role of Streptococcus mutans in human dental decay. Microbiol Rev 1986;50(4):353-380.
8. Caufield PW. Dental caries: a transmissible and infectious disease revisited—a position paper. Pediatr Dent 1997;19(8):491-498.
9. Gibbons RJ, van Houte J. Dental caries. Annu Rev Med 1975;26:121-136.
10. Tanzer JM, Livingston J, Thompson AM. The microbiology of primary dental caries in humans. J Dent Educ 2001;65(10):1028-1037.
11. Kidd EA, Fejerskov O. What constitutes dental caries? Histopathology of carious enamel and dentin related to the action of cariogenic biofilms. J Dent Res 2004;83 Spec No C:C35-C38.
12. Griffin SO, Oong E, Kohn W, et al. The effectiveness of sealants in managing carious lesions. J Dent Res 2008;87(2):169-174.
13. Bader JD, Shugars DA, Bonito AJ. Systematic reviews of selected dental caries diagnostic and management methods. J Dent Educ 2001; 65(10):960-968.
14. Going RE, Loesche WJ, Grainger DA, Syed SA. The viability of microorganisms in carious lesions five years after covering with a fissure sealant. JADA 1978;97(3):455-462.
15. Handelman SL, Washburn F, Wopperer P. Two-year report of sealant effect on bacteria in dental caries. JADA 1976;93(5):967-970.
16. Jensen OE, Handelman SL. Effect of an autopolymerizing sealant on viability of microflora in occlusal dental caries. Scand J Dent Res 1980;88(5):382-388.
17. Jeronimus DJ Jr, Till MJ, Sveen OB. Reduced viability of microorganisms under dental sealants. ASDC J Dent Child 1975;42(4):275-280.
18. Mertz-Fairhurst EJ, Schuster GS, Williams JE, Fairhurst CW. Clinical progress of sealed and unsealed caries, part I: depth changes and bacterial counts. J Prosthet Dent 1979;42(5):521-526.
19. Weerheijm KL, de Soet JJ, van Amerongen WE, de Graff J. The effect of glass-ionomer cement on carious dentine: an in vivo study. Caries Res 1993;27(5):417-423.
20. Beiruti N, Frencken JE, van't Hof MA, van Palenstein Helderman WH. Caries-preventive effect of resin-based and glass ionomer sealants over time: a systematic review. Community Dent Oral Epidemiol 2006;34(6):403-409.
21. Besic FC. The fate of bacteria sealed in dental cavities. J Dent Res 1943;22(5):349-354.
22. Kreulen CM, de Soet JJ, Weerheijm K, van Amerongen WE. In vivo cariostatic effect of resin modified glass ionomer and amalgam on dentin. Caries Res 1997;31(5):384-389.
23. Heim S, Lleo MM, Bonato B, Guzman CA, Canepari P. The viable but nonculturable state and starvation are different stress responses of *Enterococcus faecalis,* as determined by proteome analysis. J Bacteriol 2002;184(23):6739-6745.
24. Lleo MM, Tafi MC, Canepari P. Nonculturable *Enterococcus faecalis* cells are metabolically active and capable of resuming active growth. Syst Appl Microbiol 1998;21(3):333-339.
25. Ripa LW. Sealants revisited: an update of the effectiveness of pit-and-fissure sealants. Caries Res 1993;27(suppl 1):77-82.
26. Kurath G, Morita Y. Starvation-survival physiological studies of a marine *Pseudomonas* sp. Appl Environ Microbiol 1983;45(4):1206-1211.

A comparison of the effects of toothbrushing and handpiece prophylaxis on retention of sealants

Shellie Kolavic Gray, DMD, MPH; Susan O. Griffin, PhD; Dolores M. Malvitz, DrPH; Barbara F. Gooch, DMD, MPH

ABSTRACT

Background. Tooth surface cleaning before acid etching is considered to be an important step in the retention of resin-based pit-and-fissure sealants.

Methods. The authors reviewed and summarized instructions for cleaning tooth surfaces from five manufacturers of 10 unfilled resin-based sealants marketed in the United States. The authors also searched electronic databases for studies that directly compared the effects of different surface-cleaning methods on sealant retention and for systematic reviews of the effectiveness of sealants. They explored the association between surface-cleaning methods and sealant retention in the studies included in the systematic reviews. They calculated the summary weighted retention rates for studies that used either a handpiece or toothbrush prophylaxis.

Results. All of the sealant manufacturers' instructions for use (IFU) recommended cleaning the tooth before acid etching. None of the IFU directly stated that a handpiece was required to perform the cleaning, but five IFU implied the use of handpiece prophylaxis. None of the IFU recommended surface-altering procedures in caries-free teeth. Direct evidence from two clinical trials showed no difference in complete sealant retention between surfaces cleaned mechanically with pumice or prophylaxis paste and those cleaned with air-water syringe or dry toothbrushing. Indirect evidence from 10 studies found that weighted summary retention by year after sealant placement in studies that used toothbrush prophylaxis was greater than or equivalent to values for studies that used handpiece prophylaxis.

Conclusions. Levels of sealant retention after surface cleaning with toothbrush prophylaxis were at least as high as those associated with handpiece prophylaxis.

Clinical Implications. This finding may translate into lower resource costs for sealant placement.

Key Words. Dental sealants; pit-and-fissure sealants; acid etching; dental prophylaxis; toothbrush cleaning; dental cleaning.

JADA 2009;140(1):38-46.

In the placement of pit-and-fissure sealants, a clean tooth surface facilitates direct contact between acid etchant and enamel. The etched enamel, in turn, provides microporosities into which resin-based material flows to form a mechanical bond that retains the sealant against the tooth surface.[1] Pumice prophylaxis by means of a rubber cup or rotary brush on a slow-speed handpiece has been a method commonly used for surface cleaning before acid etching.[2] Other methods, however, have been used in clinical care settings and school programs. For example, in 2001, 45 and 15 percent of pediatric dentists reported using pumice or paste and a rotary cup or brush, respectively, for surface cleaning teeth during sealant placement.[3] Thirteen percent reported using a toothbrush, and 11 percent reported using nothing, which we presume was with the use of the air-water syringe. Toothbrush prophylaxis commonly is used in school-based dental sealant (SBDS) programs to clean the tooth before etching the enamel surface.[4-8]

Recent evidence-based clinical recommendations for use of pit-and-fissure sealants did not specifically address surface-cleaning methods,

Dr. Kolavic Gray is a dental epidemiologist, Public Health Division, Northrop Grumman, Atlanta.
Dr. Griffin is a health economist, Surveillance, Investigations, and Research Branch, Division of Oral Health, Centers for Disease Control and Prevention, Chamblee, Ga.
Dr. Malvitz is a public health consultant, Palladian Partners, Silver Spring, Md.
Dr. Gooch is a dental officer, Surveillance, Investigations, and Research Branch, Division of Oral Health, Centers for Disease Control and Prevention, 4770 Buford Highway, Mailstop F10, Chamblee, Ga. 30341, e-mail "bfg1@cdc.gov". Address reprint requests to Dr. Gooch.

although supporting information acknowledged that manufacturers' sealant placement instructions should be consulted and that a surface-cleaning step typically is included in these instructions.[9] Concurrent with the development of clinical recommendations by the American Dental Association, the Centers for Disease Control and Prevention (CDC) convened a work group of experts to examine the available information and update recommendations related to specific practices in SBDS programs. SBDS programs typically are found in schools that serve children from low-income families, and they focus primarily on sealing occlusal surfaces of permanent molars—the teeth that are most susceptible to dental caries.[10,11] As part of the CDC's review, the work group considered the effectiveness of placement techniques, such as surface-cleaning methods and manufacturers' instructions for use (IFU).

In this article, we describe surface-cleaning methods recommended by manufacturers for unfilled resin-based sealants before acid etching, as well as the findings of clinical studies that compared sealant retention by surface-cleaning methods. Because there are few clinical studies that directly compare surface-cleaning methods and sealant outcomes, we also examined studies included in systematic reviews of sealant effectiveness. These studies typically contain detailed descriptions of surface-cleaning and placement procedures and provide indirect evidence about the association between cleaning methods and sealant outcomes.

METHODS

We reviewed and summarized surface-cleaning methods detailed in IFU for unfilled sealant materials marketed in the United States by five manufacturers. We focused our review of IFU on unfilled sealants because they do not require occlusal adjustment and, thus, are used most commonly in school programs.

We searched electronic databases for clinical studies published in English during the period of 1966 through 2006 that directly compared results for the retention or effectiveness of resin-based sealants after different surface-cleaning procedures. For our search of the PubMed database, we used the following search strategy: "Pit and Fissure Sealants"[Mesh] AND (cleaning[Text Word] OR prophylaxis[Text Word]) AND ("humans"[MeSH Terms] AND English[lang] AND (Clinical Trial[ptyp] OR Randomized Controlled Trial[ptyp])). We used similar parameters when we searched The Cochrane Library database. The searches yielded 25 articles representing 21 unique studies. Two of the authors (S.K.G. and S.O.G.) screened titles and abstracts and excluded 19 of the 21 studies because they were not about resin-based sealants or did not directly compare the cleaning methods used before placement.[12-30] One author (S.K.G.) abstracted the two remaining studies.[5,31]

Because our literature review yielded only two comparative clinical studies, we also searched the literature for systematic reviews of the effectiveness of sealants. From the studies included in these reviews, we documented surface-cleaning methods and sealant outcomes and, thus, generated indirect evidence about the relationship between surface-cleaning methods and sealant retention. We searched PubMed and The Cochrane Library for reviews that were published in English between 1990 and 2006. We identified four systematic reviews, which included 35 unique studies.[32-35] One author (S.K.G.) screened these studies and excluded 24 of the 35 studies for the following reasons: was not published in English,[36] had no concurrent comparison group,[37] involved the use of ultraviolet light–polymerized resin-based sealant material (that is, first-generation material),[13,38-50] contained insufficient information to estimate both the percentage of sealants that were fully retained on permanent first molars by year since placement and the standard errors (SE) of those estimates,[51-54] involved the use of mechanical preparation such as enameloplasty or fissureotomy before sealant placement,[55] or involved the repair or reapplication of lost or fractured sealant material.[56-58]

For 11 of the 35 studies that met our inclusion criteria,[6,7,59-67] one author (S.K.G.) documented the study designs, methods of cleaning and preparing the surface, retention of the sealant over time and other descriptive data. If adequate detail about surface-cleaning methods was not provided, we contacted the study's authors to verify information about how they conducted the study.

The main outcome measure in our analysis of indirect evidence was the percentage of sealants fully retained on the occlusal pits and fissures of

ABBREVIATION KEY. CDC: Centers for Disease Control and Prevention. **IFU:** Instructions for use. **M1:** Permanent first molar. **NR:** Not reported. **SBDS:** School-based dental sealant.

first permanent molars at annual follow-up examinations. We chose retention instead of effectiveness as the outcome because retention would be less affected by potential confounders such as differences in caries risk among the sample populations of multiple studies. We assumed a binomial distribution in calculating the SE of the retention rate:

$$SE = \sqrt{\frac{\text{retention} \times (1 - \text{retention})}{n}}$$

For each of the five years after sealant placement, we calculated a summary retention rate separately for the studies that used the same type of surface-cleaning method (for example, handpiece or toothbrush prophylaxis). We weighted the studies by the reciprocal of their squared SE. We deemed summary retention rates by cleaning method significantly different if the 95 percent confidence intervals (rounded up to two decimal points) did not overlap.

RESULTS

Manufacturers' IFU. We identified 10 unfilled sealant products from five manufacturers. The IFU for all 10 products directed the operator to clean the tooth surface before acid etching (Table 1). In Table 1, each manufacturer is designated by a letter, and the unfilled sealant products manufactured by the same company are numbered. For example, A-1, A-2 and A-3 are three unfilled sealants from the same manufacturer. None of the IFU directly stated that a handpiece was required to perform the cleaning. However, the use of pumice, prophylaxis paste or prophylaxis brush was included in the IFU for five products, implying handpiece use. Language in the IFU for the other five products was nonspecific. The IFU for seven products indicated that use of fluoride-containing or oil-containing pastes be avoided. None of the IFU specifically directed the operator to perform enameloplasty, fissureotomy, air abrasion or air polishing to clean the tooth surface before placing the sealant. The IFU for one product, however, directed the operator to remove minimal caries with a small round bur in a slow-speed handpiece after surface cleaning.

Direct evidence. From the literature search, we identified two clinical trials that directly compared surface-cleaning methods.[5,31] Investigators in these studies found no difference in complete retention of sealants between surfaces that were cleaned mechanically with pumice and those that were cleaned by means of an air-water spray and running a sharp probe along the fissures. Both studies reported retention rates greater than 96 percent at one year after placement for all surface-cleaning methods (Table 2, page 42).

Indirect evidence. Eleven of 35 studies from four systematic reviews of the effectiveness of sealants met our initial criteria.[6,7,59-67] We were unable to determine definitively the surface-cleaning method used in one study[66] and excluded the study from our analysis. Handpiece prophylaxis with a rubber cup or rotary brush was used in eight studies, and toothbrush prophylaxis was used in two studies (Table 3, page 43). Of those studies using handpiece prophylaxis, four used pumice and four used prophylaxis paste. Of the latter four studies, three specifically stated that the paste did not contain fluoride, and one did not specify if the paste contained fluoride. Only one of the four studies using prophylaxis paste indicated that the paste was oil-free.[61] No studies stated if there was fluoride or oil in the pumice. Of the two studies using toothbrush prophylaxis, patients (under the supervision of an operator) brushed their own teeth—in one study with fluoride-containing toothpaste, and in the other with a dentifrice without fluoride. We observed no difference in reported retention of sealants between these two studies (Table 4, page 44).

From the 10 selected studies, we generated weighted summary measures of complete retention (percentage) for sealants (Table 4). Because of notably low retention rates for one operator in a study that used handpiece prophylaxis,[65] we excluded that operator's results. By not including the findings from this operator, our findings were biased toward handpiece prophylaxis' being more effective. Weighted summary retention by year after sealant placement for studies that used toothbrush prophylaxis was either greater than or equivalent to values for studies that used handpiece prophylaxis (Table 4). The summary retention rate for studies using toothbrush prophylaxis was higher at year one compared with studies using handpiece prophylaxis, and we observed no differences in summary retention between the two cleaning methods at years two through five (Table 4).

DISCUSSION

We found that the five manufacturers of the unfilled resin-based sealants marketed in the United States that we included in our review

instructed the operator to clean the surface before performing acid etching and placing the sealant material. IFU for five of the products included in our limited review did not specify a particular cleaning method, thus allowing operators to use their professional judgment. Some IFU stated that additives, such as fluoride or oil, should be avoided. In 1982, Gwinnett[68] noted that there were no studies that contraindicated the use of fluoride-containing prophylaxis paste for cleaning the tooth surface before etching. Recommendations in sealants' IFU to avoid fluoride might be based on older in vitro or laboratory studies that found exposure of enamel to topical fluorides inhibited acid etching and reduced the bond strength of early sealant products.[69-71] More recent clinical[72,73] and in vitro[74-78] studies suggest that exposure of teeth to various topical fluoride treatments or fluoride-containing prophylaxis paste before sealant placement does not decrease retention or bond strength. Similarly, we found no difference in sealant retention between two studies that used toothpaste with and without fluoride before sealant placement.[6,7]

TABLE 1

Sealant manufacturers' instructions for surface preparation.

MANUFACTURER-PRODUCT	CLEANING IMPLEMENT	CLEANING MATERIAL	CLEANING METHOD
A-1	Prophylaxis brush	Pumice and water, no commercial prophylaxis pastes (fluoride or oil additives interfere with etching)	Handpiece not specifically stated in IFU* but implied through recommended use of prophylaxis brush
A-2	Prophylaxis brush	Pumice and water, no commercial prophylaxis pastes (fluoride or oil additives interfere with etching)	Handpiece not specifically stated in IFU but implied through recommended use of prophylaxis brush
A-3	Not stated	Not stated	Nonspecific; IFU do not state or imply use of handpiece or prophylaxis paste
B-1	Not stated	Prophylaxis paste (nonfluoride, oil-free) or pumice and water	Handpiece not specifically stated in IFU but implied through recommended use of prophylaxis and prophylaxis paste
B-2	Not stated	Prophylaxis paste (nonfluoride, oil-free) or pumice and water	Handpiece not specifically stated in IFU but implied through recommended use of prophylaxis and prophylaxis paste
C-1	Not stated	Paste (nonfluoride, oil-free)	Nonspecific; IFU do not state or imply use of handpiece and description of paste is nonspecific
C-2	Not stated	Paste (nonfluoride oil-free)	Nonspecific; IFU do not state or imply use of handpiece and description of paste is nonspecific
D-1	Not stated	Not stated	Nonspecific; IFU do not state or imply use of handpiece or prophylaxis paste.
D-2	Not stated	Not stated	Nonspecific; IFU do not state or imply use of handpiece or prophylaxis paste
E-1	Not stated	Prophylaxis paste (nonfluoride oil-free)	Handpiece not specifically stated in IFU but implied through recommended use of prophylaxis paste; minimal caries removed with small round bur in slow speed handpiece

* Instructions for use.

In our literature search, we found only two published clinical studies that directly compared sealant retention by surface-cleaning methods,[5,31] but our findings are consistent with those of a recent systematic review of retention of resin-based sealants,[79] which was published after we began our analysis. The systematic review also reported no difference for the study by Donnan and Ball,[31] which compared handpiece cleaning to no cleaning beyond an air-water spray and running a sharp probe along the fissures, and for the study by Gillcrist and colleagues,[5] which compared handpiece cleaning (with fluoride-containing paste) to dry toothbrush cleaning provided by the operator.

Although the studies that we evaluated from systematic reviews did not directly compare surface-cleaning methods, they provided suffi-

TABLE 2

Sealant retention rate, by clinical studies that compared surface-cleaning methods.

STUDY	SURFACE-CLEANING METHOD	RETENTION RATE (%)	
		Six Months	12 months
Gillcrist and Colleagues[5]	Handpiece, prophylaxis brush, fluoride prophylaxis paste	NR*	97.6
	Dry toothbrushing by operator	NR	99.2
Donnan and Ball[31]	Handpiece, prophylaxis brush, pumice	98.3	96.6
	Sharp probe along fissures, forceful water spray	98.3	97.3

* NR: Not reported.

ciently detailed information about cleaning methods and retention to allow us to conduct a weighted bivariate analysis. Based on the summary retention data we examined, it appears that sealant retention was the same or higher when teeth were cleaned with a toothbrush rather than with a handpiece. For this group of studies that we included in our review, we found that sealant retention was higher in studies using toothbrush prophylaxis at one year. In years two through five, however, toothbrush and handpiece cleaning had similar percentages of sealant retention. We excluded one study[66] from our analysis because the surface-cleaning method was not specifically described. The article stated that tooth surfaces "received careful mechanical cleaning," a phrase that may suggest the use of a handpiece. When we included the findings from this study in our analysis along with the other studies using handpiece prophylaxis, we found that the summary retention was higher in studies using toothbrush prophylaxis at both year one and year two. Retention data for the excluded study were not reported after two years; therefore, our summary retention did not change for years three through five.

Toothbrushing differs from other cleaning methods—such as handpiece prophylaxis, air-polishing or use of an explorer—because either the patient or the provider can do it. In our literature review, we did not identify any studies that compared sealant retention when the operator brushed the patient's teeth versus when the patient brushed his or her own teeth. In both studies that we included in our indirect analysis to generate summary retention findings, a toothbrush was used to clean the surface. Patients (that is, children) brushed their teeth with a dentifrice while supervised by an operator. Summary retention data reported in our study for both handpiece and toothbrush cleaning (for example, 85 percent or higher at one year) are consistent with estimates of sealant retention reported in comprehensive reviews of the literature.[32,80] In addition, toothbrushing can be performed with or without toothpaste or other dentifrice. Retention data at one year for toothbrushing with toothpaste was similar to reported retention for dry toothbrushing in the clinical study by Gillcrist and colleagues[5]; summary retention was higher than 94 percent for both methods.

The surface-cleaning method also was included in a recent multivariate analysis exploring four-handed delivery and retention of resin-based sealants.[81] In that analysis, Griffin and colleagues[81] found that retention was lower when surfaces were cleaned with a handpiece before placement. It is possible that some prophylaxis pastes marketed in the 1970s and 1980s contained oils or other substances that interfered with bonding. It also is possible that residual paste or pumice within pits and fissures after prophylaxis and etching could reduce retention of sealants.

Consistent with general manufacturers' IFU, all studies included in our analyses cleaned the tooth surface before acid etching, either with a handpiece, toothbrush or air-water spray. In the earliest sealant studies, Buonocore and colleagues[82-84] and Cueto and Buonocore[85] used a pumice handpiece prophylaxis to provide a clean enamel surface for etching. Donnan and Ball[31] suggested that the scientific justification for the handpiece prophylaxis before acid etching may rest on a study by Miura and colleagues.[86] The latter study reported that pumice prophylaxis improved bond strength for orthodontic brackets on smooth surfaces of premolars that were subsequently extracted and evaluated via scanning electron microscope. The authors concluded that the "greatest adhesion was achieved when both polishing and acid etching were carried out."[86] The relevance of these findings to application of sealants to occlusal pits and fissures is unclear, however, because the materials and methods used in that study—use of 70 percent ethyl alcohol before and after prophylaxis, application of a

TABLE 3

Cleaning method descriptions and summary measures of resin-based sealant retention, by study.

STUDY	YEAR STUDY BEGAN	AGE OF SUBJECTS (YEARS)*	DESIGN	TOOTH	PAIRS OF TEETH OR SITES (NO.)	FOLLOW-UP (NO. OF MONTHS)	COMPLETE RETENTION (%)	MATERIAL	SURFACE PREPARATION
Charbeneau and Dennison[59]	1975	5-8	Half-mouth	M1†	229 202 186 193 185	0 12 24 36 48	100 79 71 61 52	Autocure	Handpiece, rubber cup, prophylaxis paste without fluoride
Erdogan and Alaçam[60]	1982	8-10	Half-mouth	M1	170 118 102 96	0 12 18 54	100 77 73 74	Autocure	Handpiece, prophylaxis brush, pumice
Gibson and Colleagues[61]	1975	6-10	Half-mouth	M1	425 393 352 337 330 331	0 12 24 36 48 60	100 89 86 75 68 67	Autocure	Handpiece, rubber cup, prophylaxis paste without fluoride
Houpt and Shey[6]	1976	6-10	Half-mouth	M1	205 186 175 164 162 125	0 12 24 36 48 60	100 94 88 83 73 67	Autocure	Toothbrush—child brushed with fluoride-containing toothpaste under supervision of dentist
Hunter[62]	NR‡	5-8	Half-mouth	M1	575 509	0 36	100 73	Autocure	Handpiece, rubber cup, prophylaxis paste without fluoride
McCune and Colleagues[63]	1975	6-9	Half-mouth	M1	318 275 252 272	0 12 24 36	100 92 89 87	Autocure	Handpiece, prophylaxis brush, pumice
Mertz-Fairhurst and Colleagues[7]	1975	6-8	Half-mouth§	M1	NR 239 233 201 168	0 12 24 36 54	100 94 84 80 71	Autocure	Toothbrush—child brushed own teeth with dentifrice without fluoride under supervision of dentist
Poulsen and Colleagues[64]	1995	7	Comparison	M1	NR NR NR 206	0 12 24 36	100 85 80 74	Autocure	Handpiece, prophylaxis brush, pumice
Rock and Bradnock[65] (Operafor 2)	1974	6-7	Half-mouth	M1	NR 130 109 111	0 12 24 36	100 68 63	Autocure	Handpiece, rotary brush, prophylaxis paste (fluoride status unknown)
Vrbič[67]	1979	6.8	Half-mouth	M1	413 373 293	0 24 60	100 86 52	Autocure	Handpiece, prophylaxis brush, pumice

* Studies may have included other age groups, but we limited our review to 5- to 10-year-olds.
† M1: Permanent first molars. Studies may have examined primary teeth or other permanent teeth, but we limited our analysis to permanent first molars.
‡ NR: Not reported.
§ First-generation sealant on one side of mouth and second-generation sealant on the other one-half. Values for first-generation sealant not included in table.

silane coupling agent and placement of sealant material on smooth surfaces—are not common elements of pit-and-fissure sealant placement.

Our study had some limitations. In our review of the literature, we found only two direct comparative studies of surface cleaning methods. In our analysis of studies included in systematic reviews of effectiveness, we found only two

TABLE 4

Percentage of sealants completely retained, by year since placement and cleaning method.

STUDY	COMPLETE RETENTION (% [95% CONFIDENCE INTERVAL])				
	Year One	Year Two	Year Three	Year Four	Year Five
Toothbrush Prophylaxis					
Houpt and Shey[6]	94 (91-97)	88 (84-92)	83 (78-88) (33 months)	73 (67-79)	67 (60-74)
Mertz-Fairhurst and colleagues[7]	95 (92-97)	84 (79-89)	80 (76-84)	NR*	71 (65-78) (54 months)
SUMMARY RETENTION	**94 (92-96)**	**86 (83-89)**	**82 (78-85)**	**73 (67-79)**	**69 (64-74)**
Handpiece Prophylaxis					
Charbeneau and Dennison[59]	79 (74-85)	71 (64-77)	61 (54-68)	52 (45-60)	NR
Erdogan and Alaçam[60]	77 (70-85)	74 (65-82)	NR	NR	74 (65-83) (54 months)
Gibson and colleagues[61]	90 (87-93)	86 (82-89)	75 (70-79)	68 (63-73)	67 (62-72)
Hunter[62]	NR	NR	73 (69-77)	NR	NR
McCune and colleagues[63]	92 (88-95)	89 (85-93)	88 (84-91)	NR	NR
Poulsen and colleagues[64]	NR	NR	74 (68-80)	NR	NR
Rock and Bradnock[65] (Operator 2†)	75 (67-82)	68 (59-77)	63 (54-72)	NR	NR
Vrbič[67]	NR	86 (82-90)	NR	NR	(46-58)
SUMMARY RETENTION	**87 (85-89)**	**84 (82-86)**	**76 (74-78)**	**63 (59-67)**	**63 (59-66)**

* NR: Not reported.
† Results from operator 1 excluded, owing to notably low results.

studies that used toothbrush prophylaxis. Our analysis of studies from systematic reviews was observational and limited to bivariate analysis. Our findings may be subject to recall bias because we contacted authors to obtain additional information if adequate data were not included in their studies. Because the studies in the systematic reviews were not designed to compare sealant outcomes by surface-cleaning method directly, the association between retention and an explanatory variable might have been due to another variable that was omitted. Although the possibility of confounding remains, a recent multivariate analysis found that toothbrush prophylaxis was associated with higher sealant retention than was handpiece prophylaxis.[81]

We limited our search for indirect evidence to studies in the existing systematic reviews of sealant effectiveness.[32-35] These studies already had met specific rules for study design, conduct and measurement established for each systematic review. In the absence of published comparative studies, our less resource-intensive method to identify and screen potential studies is attractive because it is an efficient method of collecting data from well-conducted studies. We minimized bias because the authors of the original systematic reviews determined the universe of studies. Although only one author screened these studies for our review, the inclusion and exclusion criteria in our analysis were objective and were specified before we screened available studies.

CONCLUSIONS

The results of our comparative tooth cleaning analysis indicate that retention of sealants after a supervised toothbrush cleaning by the patient was at least as high as those associated with a traditional handpiece prophylaxis. Our findings may translate into lower costs for materials, equipment and personnel. ■

Disclosure. None of the authors reported any disclosures.

The findings and conclusions of this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

1. Retief DH. The mechanical bond. Int Dent J 1978;28(1):18-27.
2. National Institutes of Health. Consensus development conference statement on dental sealants in the prevention of tooth decay. JADA 1984;108(2):233-236.
3. Primosch RE, Barr ES. Sealant use and placement techniques among pediatric dentists. JADA 2001;132(10):1442-151.
4. Carter N. Seal America: The Prevention Invention. 2nd ed. Washington: National Maternal and Child Oral Health Resource Center; 2007. "www.webcitation.org/5Rnk5yjJ3". Accessed Oct. 24, 2008.

5. Gillcrist JA, Vaughan MP, Plumlee GN Jr, Wade G. Clinical sealant retention following two different tooth-cleaning techniques. J Public Health Dent 1998;58(3):254-256.
6. Houpt M, Shey Z. The effectiveness of a fissure sealant after six years. Pediatr Dent 1983;5(2):104-106.
7. Mertz-Fairhurst EJ, Fairhurst CW, Williams JE, Della-Giustina VE, Brooks JD. A comparative clinical study of two pit and fissure sealants: 7-year results in Augusta, GA. JADA 1984;109(2):252-255.
8. Siegal MD, Lalumandier JA, Farquhar CL, Bouchard JM. School-based and school-linked public health dental sealant programs in the United States, 1992-93. Columbus, Ohio: Association of State and Territorial Dental Directors; 1997.
9. Beauchamp J, Caufield PW, Crall JJ, et al.; American Dental Association Council on Scientific Affairs. Evidence-based clinical recommendations for the use of pit-and-fissure sealants: a report of the American Dental Association Council on Scientific Affairs. JADA 2008;139(3):257-268.
10. Association of State and Territorial Dental Directors. Best Practice Approaches for State and Community Health Programs. School-based Dental Sealant Programs; 2003. "www.astdd.org/docs/BPASchoolSealantPrograms.pdf". Accessed Oct. 21, 2008.
11. Macek MD, Beltrán-Aguilar ED, Lockwood SA, Malvitz DM. Updated comparison of the caries susceptibility of various morphological types of permanent teeth. J Public Health Dent 2003;63(3):174-182.
12. Arrow P. Control of occlusal caries in the first permanent molars by oral hygiene. Community Dent Oral Epidemiol 1997;25(4):278-283.
13. Bagramian RA, Graves RC, Bhat M. A combined approach to preventing dental caries in schoolchildren: caries reductions after one year. JADA 1976;93(5):1014-1019.
14. Brocklehurst PR, Joshi RI, Northeast SE. The effect of air-polishing occlusal surfaces on the penetration of fissures by a sealant. Int J Paediatr Dent 1992;2(3):157-162.
15. Chevitarese AB, Chevitarese O, de Souza IP, Vianna RB. Influence of prophylaxis on the microleakage of sealants: in vitro study. J Clin Pediatr Dent 2002;26(4):371-375.
16. Courson F, Renda AM, Attal JP, Bouter D, Ruse D, Degrange M. In vitro evaluation of different techniques of enamel preparation for pit and fissure sealing. J Adhes Dent 2003;5(4):313-321.
17. Flório FM, Pereira AC, Meneghim Mde C, Ramacciato JC. Evaluation of non-invasive treatment applied to occlusal surfaces. ASDC J Dent Child 2001;68(5-6):326-331, 301.
18. Futatsuki M, Kubota K, Yeh YC, Park K, Moss SJ. Early loss of pit and fissure sealant: a clinical and SEM study. J Clin Pediatr Dent 1995;19(2):99-104.
19. Ganesh M, Tandon S. Clinical evaluation of FUJI VII sealant material. J Clin Pediatr Dent 2006;31(1):52-57.
20. Güngör HC, Turgut MD, Attar N, Altay N. Microleakage evaluation of a flowable polyacid-modified resin composite used as fissure sealant on air-abraded permanent teeth. Oper Dent 2003;28(3):267-273.
21. Haytac MC, Dogan MC, Antmen B. The results of a preventive dental program for pediatric patients with hematologic malignancies. Oral Health Prev Dent 2004;2(1):59-65.
22. Joharji RM, Adenubi JO. Prevention of pit and fissure caries using an antimicrobial varnish: 9 month clinical evaluation. J Dent 2001;29(4):247-254.
23. Kervanto-Seppälä S, Lavonius E, Kerosuo E, Pietilä I. Can glass ionomer sealants be cost-effective? J Clin Dent 2000;11(1):1-3.
24. Lupi-Pégurier L, Muller-Bolla M, Bertrand MF, Fradet T, Bolla M. Microleakage of a pit-and-fissure sealant: effect of air-abrasion compared with classical enamel preparations. J Adhes Dent 2004;6(1):43-48.
25. Lygidakis NA, Oulis KI, Christodoulidis A. Evaluation of fissure sealants retention following four different isolation and surface preparation techniques: four years clinical trial. J Clin Pediatr Dent 1994;19(1):23-25.
26. Ovrebö RC, Raadal M. Microleakage in fissures sealed with resin or glass ionomer cement. Scand J Dent Res 1990;98(1):66-69.
27. Percinoto C, Cunha RF, Delbem AC, Aragones A. Penetration of a light-cured glass ionomer and a resin sealant into occlusal fissures and etched enamel. Am J Dent 1995;8(1):20-22.
28. Rix AM, Sams DR, Dickinson GL, Adair SM, Russell CM, Hoyle SL. Pit and fissure sealant application using a drying agent. Am J Dent 1994;7(3):131-133.
29. Rahimtoola S, van Amerongen E. Comparison of two tooth-saving preparation techniques for one-surface cavities. ASDC J Dent Child 2002;69(1):16-26.
30. Srinivasan V, Deery C, Nugent Z. In-vitro microleakage of repaired fissure sealants: a randomized, controlled trial. Int J Paediatr Dent 2005;15(1):51-60.
31. Donnan MF, Ball IA. A double-blind clinical trial to determine the importance of pumice prophylaxis on fissure sealant retention. Br Dent J 1988;165(8):283-286.
32. Ahovuo-Saloranta A, Hiiri A, Nordblad A, Worthington H, Mäkelä M. Pit and fissure sealants for preventing dental decay in the permanent teeth of children and adolescents. Cochrane Database Syst Rev 2004;(3):CD001830.
33. Llodra JC, Bravo M, Delgado-Rodriguez M, Baca P, Galvez R. Factors influencing the effectiveness of sealants: a meta-analysis. Community Dent Oral Epidemiol 1993;21(5):261-268.
34. Mejàre I, Lingström P, Petersson LG, et al. Caries-preventive effect of fissure sealants: a systematic review. Acta Odontol Scand 2003;61(6):321-330.
35. Truman BI, Gooch BF, Sulemana I, et al. Reviews of evidence on interventions to prevent dental caries, oral and pharyngeal cancers, and sports-related craniofacial injuries. Am J Prev Med 2002;23(1 suppl):21-54.
36. Tanguy R, Casanova F, Barnaud J. Prevention of tooth fissure caries using a sealing resin in the public health service [in French]. Rev Odontostomatol (Paris) 1984;13(2):125-130.
37. Selwitz RH, Nowjack-Raymer R, Driscoll WS, Li SH. Evaluation after 4 years of the combined use of fluoride and dental sealants. Community Dent Oral Epidemiol 1995;23(1):30-35.
38. Alvesalo L, Brummer R, Le Bell Y. On the use of fissure sealants in caries prevention: a clinical study. Acta Odontol Scand 1977;35(3):155-159.
39. Burt BA, Berman DS, Silverstone LM. Sealant retention and effects on occlusal caries after 2 years in a public program. Community Dent Oral Epidemiol 1977;5(1):15-21.
40. Going RE, Haugh LD, Grainger DA, Conti AJ. Four-year clinical evaluation of a pit and fissure sealant. JADA 1977;95(5):972-981.
41. Gourley JM. A two-year study of a fissure sealant in two Nova Scotia communities. J Public Health Dent 1975;35(2):132-137.
42. Higson JF. Caries prevention in first permanent molars by fissure sealing: a 2-year study in 6-8-year-old children. J Dent 1976;4(5):218-222.
43. Horowitz HS, Heifetz SB, Poulsen S. Adhesive sealant clinical trial: an overview of results after four years in Kalispell, Montana. J Prev Dent 1976;3(3 Pt 2):38-39, 44, 46-47.
44. Klein SP, Bohannan HM, Bell RM, Disney JA, Foch CB, Graves RC. The cost and effectiveness of school-based preventive dental care. Am J Public Health 1985;75(4):382-391.
45. Leal FR, Forgas-Brockmann L, Simecek J, Cohen ME, Meyer DM. A prospective study of sealant application in navy recruits. Mil Med 1998;163(2):107-109.
46. Leverett DH, Handelman SL, Brenner CM, Iker HP. Use of sealants in the prevention and early treatment of carious lesions: cost analysis. JADA 1983;106(1):39-42.
47. Meurman JH, Helminen SK. Effectiveness of fissure sealant 3 years after application. Scand J Dent Res 1976;84(4):218-223.
48. Pereira AC, Pardi V, Mialhe FL, Meneghim Mde C, Ambrosano GM. A 3-year clinical evaluation of glass-ionomer cements used as fissure sealants. Am J Dent 2003;16(1):23-27.
49. Rock WP. Fissure sealants. Results of a 3-year clinical trial using an ultra-violet sensitive resin. Br Dent J 1977;142(1):16-18.
50. Stephen KW. A four-year fissure sealing study in fluoridated and non-fluoridated Galloway. Health Bull (Edinb) 1978;36(3):138-145.
51. Arrow P, Riordan PJ. Retention and caries preventive effects of a GIC and a resin-based fissure sealant. Community Dent Oral Epidemiol 1995;23(5):282-285.
52. Messer LB, Calache H, Morgan MV. The retention of pit and fissure sealants placed in primary school children by Dental Health Services, Victoria. Aust Dent J 1997;42(4):233-239.
53. Simonsen RJ, Stallard RE. Fissure sealants: colored sealant retention 3 months post application. Quintessence Int Dent Dig 1977;8(2):81-86.
54. Sterritt GR, Frew RA, Rozier RG, Brunelle JA. Evaluation of a school-based fluoride mouthrinsing and clinic-based sealant program on a non-fluoridated island. Community Dent Oral Epidemiol 1990;18(6):288-293.
55. Raadal M, Laegreid O, Laegreid KV, Hveem H, Korsgaard EK, Wangen K. Fissure sealing of permanent first molars in children receiving a high standard of prophylactic care. Community Dent Oral Epidemiol 1984;12(2):65-68.
56. Bravo M, Baca P, Llodra JC, Osorio E. A 24-month study comparing sealant and fluoride varnish in caries reduction on different permanent first molar surfaces. J Public Health Dent 1997;57(3):184-186.

57. Poulsen S, Thylstrup A, Christensen PF, Ishøy U. Evaluation of a pit-and fissure-sealing program in a public dental health service after 2 years. Community Dent Oral Epidemiol 1979;7(3):154-157.
58. Songpaisan Y, Bratthall D, Phantumvanit P, Somridhivej Y. Effects of glass ionomer cement, resin-based pit and fissure sealant and HF applications on occlusal caries in a developing country field trial. Community Dent Oral Epidemiol 1995;23(1):25-29.
59. Charbeneau GT, Dennison JB. Clinical success and potential failure after single application of a pit and fissure sealant: a four-year report. JADA 1979;98(4):559-564.
60. Erdogan B, Alaçam T. Evaluation of a chemically polymerized pit and fissure sealant: results after 4.5 years. J Paediatr Dent 1987; 3:11-13.
61. Gibson GB, Richardson AS, Waldman R. The effectiveness of a chemically polymerized sealant in preventing occlusal caries: five-year results. Pediatr Dent 1982;4(4):309-310.
62. Hunter PB. A study of pit and fissure sealing in the School Dental Service. N Z Dent J 1988;84(375):10-12.
63. McCune RJ, Bojanini J, Abodeely RA. Effectiveness of a pit and fissure sealant in the prevention of caries: three-year clinical results. JADA 1979;99(4):619-623.
64. Poulsen S, Beiruti N, Sadat N. A comparison of retention and the effect on caries of fissure sealing with a glass-ionomer and a resin-based sealant. Community Dent Oral Epidemiol 2001;29(4):298-301.
65. Rock WP, Bradnock G. Effect of operator variability and patient age on the retention of fissure sealant resin: 3-year results. Community Dent Oral Epidemiol 1981;9(5):207-209.
66. Thylstrup A, Poulsen S. Retention and effectiveness of a chemically polymerized pit and fissure sealant after 2 years. Scand J Dent Res 1978;86(1):21-24.
67. Vrbič V. Five-year experience with fissure sealing. Quintessence International. 1986;17(6):371-372.
68. Gwinnett AJ. Pit-and-fissure sealants: an overview of research. J Public Health Dent 1982;42(4):298-304.
69. Kochavi D, Gedalia I, Anaise J. Effect of conditioning with fluoride and phosphoric acid on enamel surfaces as evaluated by scanning electron microscopy and fluoride incorporation. J Dent Res 1975;54(2): 304-309.
70. Lee H, Stoffey D, Orlowski J, Swartz ML, Ocumpaugh D, Neville K. Sealing of developmental pits and fissures, 3: effects of fluoride on adhesion of rigid and flexible sealers. J Dent Res 1972;51(1):191-201.
71. Low T, Von Fraunhofer JA, Winter GB. The bonding of a polymeric fissure sealant to topical fluoride-treated teeth. J Oral Rehabil 1975;2(3):303-307.
72. El-Housseiny AA, Sharaf AA. Evaluation of fissure sealant applied to topical fluoride treated teeth. J Clin Pediatr Dent 2005;29(3):215-219.
73. Warren DP, Infante NB, Rice HC, Turner SD, Chan JT. Effect of topical fluoride on retention of pit and fissure sealants. J Dent Hyg 2001;75(1):21-24.
74. Aboush YE, Tareen A, Elderton RJ. Resin-to-enamel bonds: effect of cleaning the enamel surface with prophylaxis pastes containing fluoride or oil. Br Dent J 1991;171(7):201-209.
75. Bogert TR, Garcia-Godoy F. Effect of prophylaxis agents on the shear bond strength of a fissure sealant. Pediatr Dent 1992;14(1):50-51.
76. Garcia-Godoy F, Perez R, Hubbard GW. Effect of prophylaxis pastes on shear bond strength. J Clin Orthod 1991;25(9):571-573.
77. Koh SH, Chan JT, You C. Effects of topical fluoride treatment on tensile bond strength of pit and fissure sealants. Gen Dent 1998;46(3): 278-280.
78. Sol E, Espasa E, Boj JR, Canalda C. Effect of different prophylaxis methods on sealant adhesion. J Clin Pediatr Dent 2000;24(3): 211-214.
79. Muller-Bolla M, Lupi-Pégurier L, Tardieu C, Velly AM, Antomarchi C. Retention of resin-based pit and fissure sealants: a systematic review. Community Dent Oral Epidemiol 2006;34(5):321-336.
80. U.S. Department of Health and Human Services. Office of the Surgeon General. Oral Health in America: A Report of the Surgeon General. Rockville, Md.: U.S. Department of Health and Human Services, National Institute of Dental and Craniofacial Research, National Institutes of Health; 2000:166-169.
81. Griffin SO, Jones K, Gray SK, Malvitz DM, Gooch BF. Exploring four-handed delivery and retention of resin-based sealants. JADA 2008;139(3):281-289.
82. Buonocore MG. A simple method of increasing the adhesion of acrylic filling materials to enamel surfaces. J Dent Res 1955;34(6): 849-853.
83. Buonocore MG, Matsui A, Gwinnett AJ. Penetration of resin dental materials into enamel surfaces with reference to bonding. Arch Oral Biol 1968;13(1):61-70.
84. Buonocore M. Adhesive sealing of pits and fissures for caries prevention, with use of ultraviolet light. JADA 1970;80(2):324-330.
85. Cueto EI, Buonocore MG. Sealing of pits and fissures with an adhesive resin: its use in caries prevention. JADA 1967;75(1):121-128.
86. Miura F, Nakagawa K, Ishizaki A. Scanning electron microscopic studies on the direct bonding system. Bull Tokyo Med Dent Univ 1973; 20(3):245-260.

Caries risk in formerly sealed teeth

Susan O. Griffin, PhD; Shellie Kolavic Gray, DMD; Dolores M. Malvitz, DrPH; Barbara F. Gooch, DMD, MPH

ABSTRACT

JADA CE CONTINUING EDUCATION ARTICLE 1

Background. The authors examined the risk of caries development in teeth with partially or fully lost sealant (formerly sealed [FS] teeth) relative to the risk in teeth that never have received sealants (never-sealed [NS] teeth).

Methods. The authors searched the population of studies used in five reviews of sealant effectiveness as established in split-mouth design studies involving resin-based sealants with no reapplication of lost sealant. They required included studies to contain sufficient data to estimate the risk of caries in FS teeth relative to that in NS teeth (relative risk [RR] = $\frac{\%\text{ FS developing caries}}{\%\text{ NS developing caries}}$) and its 95 percent confidence interval (CI). To estimate the mean RR by year since sealant placement, they used a weighted bivariate model and tested for heterogeneity using the quantity I^2.

Results. The weighted mean RR was 0.998 (95 percent CI, 0.817-1.220) one year after placement (four studies, 345 tooth pairs) and 0.936 (95 percent CI, 0.896-0.978) at four years (five studies, 1,423 tooth pairs).

Conclusions. Teeth with fully or partially lost sealant were not at a higher risk of developing caries than were teeth that had never been sealed.

Clinical Implications. Inability to provide a retention-check examination to all children participating in school sealant programs because of loss to follow-up should not disqualify a child from receiving sealants.

Key Words. Dental sealants; pit-and-fissure sealants; retention; caries.
JADA 2009;140(4):415-423.

Almost 70 percent of youth have experienced dental caries by late adolescence.[1] Available data show that children and youth from low-income families (those with an income of less than 200 percent of the federal poverty guidelines) are more than twice as likely to have untreated caries in their permanent teeth as are their higher-income counterparts.[1] Overall, about 90 percent of carious lesions are found in the pits and fissures of permanent posterior teeth,[2] with molars being the most susceptible to caries in comparison with other tooth types.[3]

Researchers have shown that dental sealants delivered in clinical or school settings are highly effective in preventing dental caries, reducing caries in the pits and fissures by 60 percent from two to five years after placement.[4] Sealant effectiveness is linked to sealant retention, and a retained sealant has been shown to be 100 percent effective.[5] Although systematic reviews[4,6] have demonstrated the effectiveness of dental sealants, recent national data indicate that sealant prevalence among children and youth—30 percent[1]—is well below the national Healthy People

Dr. Griffin is a health economist, Office of the Director, Division of Oral Health, Centers for Disease Control and Prevention, 4770 Buford Highway, Mailstop F10, Chamblee, Ga. 30341, e-mail "sig1@cdc.gov". Address reprint requests to Dr. Griffin.
Dr. Gray is a dental epidemiologist, Public Health Division, Northrop Grumman, Atlanta.
Dr. Malvitz is a public health consultant, Palladian Partners, Silver Spring, Md.
Dr. Gooch is a dental officer, Surveillance, Investigations, and Research Team, Division of Oral Health, Centers for Disease Control and Prevention, Chamblee, Ga.

TABLE 1

Description of studies used to determine risk of caries in formerly sealed teeth.

STUDY CHARACTERISTIC	STUDY AUTHOR, YEAR STUDY PUBLISHED, SITE		
	McCune and Colleagues,[13] 1979, Colombia	Mertz-Fairhurst and Colleagues,[14] 1984, United States	Charbeneau and Colleagues,[15] 1977, United States
Subjects			
Age range (years)	6-9	6-8	5-8
Background prevention exposure	CWF*	CWF	NR†
Caries severity threshold	One or more lesions§	One or more lesions	NR
Sealants			
Material¶	RB2	RB1# and RB2	RB2
Tooth type sealed**	M	M	M
Criteria for partial loss	Present on at least one occlusal region	Present on at least one occlusal region	NR
Criteria for full loss	Sealant not present on any occlusal region	Sealant not present on any occlusal region	NR
Complete retention rate (%)††	Y1 = 92, Y2 = 89, Y3 = 88	**RB1:** Y1 = 84, Y2 = 58, Y3 = 60, Y4.5 = 35 **RB2:** Y1 = 95, Y2 = 84, Y3 = 80, Y4.5 = 72	Y1.5 = 74, Y4 = 52
Study Quality			
Number of subjects at baseline‡‡	200	382	143
Teeth	636	1,202	458
Sites	NA§§	NA	NR
Dropout rate (%)	Y1 = 14, Y2 = 21, Y3 = 15	Y1 = 21, Y2 = 19, Y3 = 34, Y4 = 42	Y1.5 = 16¶¶, Y4 = 19
Method of measurement of caries progression	VT##	VT	VT
Caries criteria	NR	Catch/softness and evidence of decalcification	Explorer catch and evidence of decalcification
Examiner agreement	Consensus	92%	Consensus

* CWF: Community water fluoridation.
† NR: Not reported.
‡ FMR: Fluoride mouthrinse delivered fortnightly.
§ Lesion: Untreated or treated caries.
¶ RB1: Ultraviolet light–polymerized resin-based sealant. RB2: Autopolymerized resin-based sealant.
# Assumed ultraviolet light–polymerized resin-based sealant (RB1) because majority of lost sealants were RB1.
** M: Permanent molar. PM: Permanent premolar.
†† Y1: Year 1. Y1.5: Year 1.5. Y2: Year 2. Y3: Year 3. Y4: Year 4. Y4.5: Year 4.5.
‡‡ Note that these numbers are for all subjects.
§§ NA: Not applicable—for example, analysis was done at the tooth level so site-level data are not applicable.
¶¶ Estimated for teeth versus subjects.
VT: Visual/tactile.

(continued on next page)

2010[7] target of 50 percent. Disparities exist according to income, with children from lower-income families about one-half as likely to have received a sealant as their counterparts from higher-income families.[1]

School programs providing dental sealants are an important intervention to increase children's receipt of sealants. On the basis of strong evidence of effectiveness, the independent, nongovernmental Task Force on Community Preventive Services[8]—a volunteer body of public health

ABBREVIATION KEY. **CDC:** Centers for Disease Control and Prevention. **CWF:** Community water fluoridation. **FMR:** Fluoride mouthrinse. **FS:** Formerly sealed. **M:** Permanent molar. **NA:** Not applicable. **NR:** Not reported. **NS:** Never sealed. **PM:** Permanent premolar. **RB1:** Ultraviolet light–polymerized resin-based sealant. **RB2:** Autopolymerized resin-based sealant. **VT:** Visual/tactile. **Y1**: Year 1. **Y1.5**: Year 1.5. **Y2:** Year 2. **Y3:** Year 3. **Y4:** Year 4. **Y4.5:** Year 4.5.

STUDY AUTHOR, YEAR STUDY PUBLISHED, SITE			
Going and Colleagues,[29] 1977, United States	**Horowitz and Colleagues,[32] 1976, United States**	**Leake and Martinello,[49] 1976, Canada**	**Thylstrup and Poulsen,[22] 1976, Denmark**
10-14	5-14	5-7	7
None	None	NR	FMR‡
NR	NR	NR	NR
RB1	RB1	RB1	RB2
M and PM	M	M	M
Slight to severe loss of material	Part but not all of pit or fissure was not covered with sealant	Sealant can be demonstrated as present on some occlusal grooves and fissures	Part but not all of pit or fissure was not covered with sealant
Total loss of material	Entirely missing	Sealant cannot be demonstrated over any of the occlusal grooves and fissures	Entirely missing
Y1 = 81,Y2 = 69, Y3 = 56, Y4 = 50	Y4 = 50	Y4 = 20	Y1 = 73, Y2 = 60
84	429	518	217
479	NR	2,072	NR
NA	NR	NA	NR
Y1 = 5, Y2 = 16, Y3 = 18, Y4 = 18	Y4 = 37.5	Y4 = 19	Y1 = 12, Y2 = 12.0
VT	VT	VT and radiographic	VT
Explorer catch/penetration or visually evident lesion	Explorer catch and evidence of decalcification	Fissure definitely resists the withdrawal or supports the point of explorer	Definite pull required to remove explorer
Consensus	NR	One examiner	One examiner

and prevention experts whose members are appointed by the director of the Centers for Disease Control and Prevention (CDC), Atlanta—issued a strong recommendation that school-based sealant programs be part of a comprehensive community strategy to prevent dental caries. The task force also acknowledged that these programs typically deliver services to children unlikely to receive them otherwise (such as children from lower-income families). School-based sealant programs also have the potential to link students with treatment services in the community.

One potential barrier to delivering sealants is the concern that a tooth with a partially lost sealant may be at a higher risk of developing caries than it would be if it never had been sealed. The theoretical rationale is that food particles could become trapped under a partially retained sealant, thus increasing the availability of nutrients for cariogenic bacteria. Because

school-based programs typically deliver sealants to children who are more likely to move during or between school years than are higher-income children,[9] follow-up examinations for all children receiving sealants may not be possible. This concern about risks associated with sealant loss led a CDC-sponsored Expert Work Group that was developing guidelines for school-based sealant programs to request an analysis of relevant clinical studies. We were charged with carrying out this analysis. Therefore, the objective of our research was to determine if the risk of developing caries in a formerly sealed (FS) tooth with fully or partially lost sealant exceeds the risk in a never-sealed (NS) tooth.

MATERIALS AND METHODS

Inclusion criteria and identification and selection of studies. We searched MEDLINE and the Cochrane Library for systematic reviews of sealant effectiveness that were published in English from 1990 through 2005. Five systematic reviews,[4,6,10-12] which included 37 unique studies,[13-49] met these inclusion criteria. Two reviewers (S.K.G. and S.O.G.) screened these studies. They excluded 30 of the studies for the following reasons: publication in language other than English,[47] adult rather than child or youth subjects,[34] absence of concurrent comparison group that had not received sealants,[19,25,37,40,42,43,46] intervention not involving placement of resin-based sealants on permanent posterior teeth with no reapplication,[26,27,35,38,39,44,48] absence of description of caries status by retention status[17,18,20,21,23,28,30,31,33,41] and absence of a split-mouth design.[16,24,36,45]

Data abstraction and quality assessment. The same two reviewers independently abstracted data from the included studies. If there was disagreement on a specific item on the abstraction form, both reviewers re-examined the relevant portion of the study and reached consensus on the appropriate value. Because included studies were randomized controlled split-mouth trials and selected from among published systematic reviews that included explicit quality criteria for inclusion, we did not assign a quality score. However, we collected information on selected aspects of study quality (Table 1, page 416), including loss to follow-up and validity (caries assessment method) and reliability (examiner agreement) of caries status determination. Because studies involved randomized controlled trials with a split-mouth design, we determined it to be unlikely that initial assembly and maintenance of comparable groups was an issue. We also should note that it is difficult to blind examiners as to whether a sealant was placed or not placed unless the sealant was removed before follow-up, a scenario that is not typical in most sealant studies.

Outcome and risk measures. Our outcome measure was whether a tooth, when assessed at each annual follow-up examination, had developed caries. We compared the risk of developing caries in an FS tooth relative to that in an NS tooth, where relative risk (RR) = $\frac{\%\text{ FS developing caries}}{\%\text{ NS developing caries}}$. FS teeth included teeth that had fully or partially lost sealant material. We also estimated the 95 percent confidence interval (CI) for the RR reported in each study by assuming that paired teeth were independent (further information about estimation of the variance is available as supplemental data to the online version of this article, found at "http://jada.ada.org"). We also collected data on the percentage of FS teeth on which the sealants were partially lost.

Our outcome measure was whether a tooth, when assessed at each annual follow-up examination, had developed caries.

Synthesis of findings. To estimate the mean RR, we used a weighted bivariate model in which we weighted each study by the reciprocal of its squared standard error. We also calculated the median RR across studies. To determine if the weighted bivariate analysis was heterogeneous, we calculated the quantity I^2.[50]

RESULTS

Characteristics of studies. We included seven studies in the final body of evidence (Table 1). The publication date of the last report from each study ranged from 1976 to 1984.[13-15,22,29,32,49] Three studies involved the use of ultraviolet light–polymerized resin-based sealant, which we designated "RB1" [29, 32,49]; three involved the use of autopolymerized resin-based sealant, which we designated "RB2" [13,15,22]; and one involved the use of both RB1 and RB2.[14] RB1 sealants have lower retention rates than do RB2 sealants, as evidenced by results from the latter study,[14] in which about 70 percent of teeth classified as FS had received RB1 at the first two follow-up examinations. Researchers in all but one study[29]

reported data for permanent molars only.

Subjects' ages ranged from 5 through 14 years. In three studies, investigators reported that subjects were exposed to fluoride via community water systems or mouthrinse program participation,[13,14,22] two studies reported no fluoride exposure[29,32] and two studies did not report background fluoride exposure.[15,49] Caries incidence among NS teeth at the first-year follow-up examination ranged from 24 to 47 percent. Researchers in all studies used visual or tactile methods or both to assess caries; however, those in one study also used radiographs.[49] For studies with more than one examiner, reported agreement among examiners (one study did not report agreement[32]) was greater than 90 percent. Loss to follow-up ranged from 5 to 21 percent for the five studies in which researchers conducted their first follow-up examination one to 1.5 years after placement[13-15,22, 29] and from 19 to 37.5 percent for the two studies in which investigators conducted their follow-up examinations four years after placement.[32,49]

Our findings suggest that heightened concern about partially lost sealants trapping food and thus increasing the risk of caries development may be unfounded.

For studies in which researchers reported sealant loss at the tooth level versus the site level,[13-15,29,49] the mean percentage of FS teeth accounted for by partially lost sealants was at least 60 percent, up to and including three years after placement (Table 2). The mean percentage of FS teeth accounted for by partially lost sealants declined over time, and there did not appear to be a difference according to generation of sealant material. Two studies reported retention at the site level (pit and fissure; data not shown)[22,32]; in one of them,[22] the proportion of FS teeth accounted for by partially lost sealants was 27 percent one year after placement and 32 percent two years after placement, and in the other study,[32] it was 32 percent four years after placement.

The RR one year after placement (four studies,[14,15,22,29] 345 tooth pairs) ranged from 0.828 to 1.118 (Table 3, page 421). The weighted mean RR was 0.998 (95 percent CI, 0.817-1.220) and the median value was 0.941 (data not shown). For later years, the RR ranged from 0.467 to 1.186 with a weighted mean of 0.912 (95 percent CI, 0.793-1.048) at two years (four studies,[13,14,22,29] 481 tooth pairs), from 0.761 to 1.111 with a weighted mean of 0.901 (95 percent CI, 0.789-1.029) at three years (three studies,[13,14,29] 332 tooth pairs) and from 0.693 to 1.083 with a weighted mean of 0.936 (95 percent CI, 0.896-0.978) at four years (five studies,[14,15,29,32,49] 1,423 tooth pairs) (Table 3). The median RR was less than 1 for all years since sealant placement. In year 1, the I^2 statistic was negative, indicating that heterogeneity was not present. The I^2 statistic was always higher than 66 percent for later years, indicating that there were systematic differences among studies.

DISCUSSION

Our findings indicate that individual teeth with partial or complete loss of sealant are not at a higher risk of developing caries than they would be if they never had received sealants. The caries rate in FS teeth is less than or equal to the rate in NS teeth. The weighted mean RR was less than 1 for all four years after sealant placement, and the median RR also was less than 1 for all years after placement. Additionally, partially retained sealants accounted for the majority of FS teeth in most studies in which investigators collected data at the tooth level. In all but one study,[49] the RR of caries for FS teeth with partially lost sealants versus NS teeth was lower than the RR of caries for FS teeth with either partially or fully lost sealants versus NS teeth. In the remaining study, by Leake and Martinello,[49] the RR of caries for FS teeth with partially lost sealants was the same as the RR of caries for FS teeth with either partially or fully lost sealants in comparison with teeth that never had received sealants. These findings suggest that heightened concern about partially lost sealants trapping food and thus increasing the risk of caries development may be unfounded.

Theoretically, it is possible that partially retained sealants may offer some protection,[51] especially if a specific tooth site remains sealed. Indeed, in one study included in our analysis, Horowitz and colleagues[32] found that sealant effectiveness increased with the extent of retention. One possible explanation as to why our review did not find an association is that the unit of observation (tooth) used in most studies was not sufficiently sensitive to detect a difference. For example, let us assume that all teeth without sealants develop caries and that 10 teeth, each

TABLE 2

Formerly sealed teeth: percentage partially retained, according to sealant material and interval since placement.*

STUDY	SEALANT MATERIAL,† BY INTERVAL SINCE PLACEMENT	SEALANTS PARTIALLY RETAINED (%)
One Year		
Going and colleagues[29]	RB1	87
Mertz-Fairhurst and colleagues[14]	RB1	64
MEAN	NA‡	**76**
Mertz-Fairhurst and colleagues[14]	RB2	46
McCune and colleagues[13]	RB2	70
Charbeneau and colleagues[15]	RB2	74
MEAN	NA	**63**
Two Years		
Mertz-Fairhurst and colleagues[14]	RB1	57
Going and colleagues[29]	RB1	73
MEAN	NA	**65**
McCune and colleagues[13]	RB2	64
Mertz-Fairhurst and colleagues[14]	RB2	65
Charbeneau and colleagues[15]	RB2	61
MEAN	NA	**60**
Three Years		
Mertz-Fairhurst and colleagues[14]	RB1	52
Going and colleagues[29]	RB1	70
MEAN	NA	**61**
McCune and colleagues[13]	RB2	68
Mertz-Fairhurst and colleagues[14]	RB2	53
Charbeneau and colleagues[15]	RB2	59
MEAN	NA	**60**
Four Years		
Mertz-Fairhurst and colleagues[14]	RB1	33
Going and colleagues[29]	RB1	56
Leake and Martinello[49]§	RB1	2
MEAN	NA	**30**
Mertz-Fairhurst and colleagues[14]	RB2	49
Charbeneau and colleagues[15]	RB2	53
MEAN	NA	**51**

* Thylstrup and Poulsen[22] and Horowitz and colleagues[32] not included because these studies collected retention data at the site level versus the tooth level. Percentage of formerly sealed teeth accounted for by partially retained sealant was 32 percent and 27 percent for years 1 and 2, respectively, in Thylstrup and 32 percent in Horowitz.
† RB1: Ultraviolet (UV) light–polymerized resin-based sealant. RB2: Autopolymerized resin-based sealant.
‡ NA: Not applicable.
§ Sealant loss rate is higher than in the other studies. Clinicians reported difficulty in adapting to field equipment. Variation in the intensity of the UV light from the polymerization unit also was reported. This unit was one of the first manufactured to meet Canadian electrical standards; the investigators tried to compensate by increasing sealant exposure to UV light from 30 to 45 seconds.

with two sites, are sealed while their contralateral teeth remain unsealed. If one site on each tooth lost its sealant while the other site remained sealed, then the RR calculated at the tooth level would be 100 percent/100 percent = 1, while the RR at the site level would be 50 percent/100 percent = 0.5. In the two studies that used site as the unit of measurement, both[22,32] had an RR of less than 1. However, only one study[22] did not include 1 in the 95 percent CI.

We compared the caries in FS teeth with that in NS teeth at the individual tooth level. It is important to note, however, that at the community level, the relevant question is not a direct comparison of caries rates in FS and NS teeth but rather a comparison of the caries rate in the group with sealed teeth (FS teeth plus fully retained sealants) versus the caries rate in the group with NS teeth. It must be remembered that the caries rate in the group with sealed teeth is based on the sealant loss rate and the caries rate in teeth that lost sealants (that is, FS teeth).

TABLE 3

Risk of caries development in formerly sealed (FS) teeth and never-sealed (NS) teeth for each interval since sealant placement.

STUDY, ACCORDING TO INTERVAL SINCE SEALANT PLACEMENT	NO. OF TOOTH PAIRS	CARIOUS FS TEETH	CARIOUS NS TEETH	RR*	95% CI†
One Year					
Mertz-Fairhurst and colleagues[14]	50	12	14	0.857	0.441-1.666
Charbeneau and colleagues[15‡]	88	42	41	1.024	0.749-1.401
Going and colleagues[29§]	87	38	34	1.118	0.784-1.401
Thylstrup and Poulsen[22¶]	120	24	29	0.828	0.513-1.335
WEIGHTED MEAN	**345**	Not applicable (NA)	NA	**0.998**	**0.817-1.220**
Two Years					
McCune and colleagues[13#]	28	7	15	0.467	0.225-0.967
Mertz-Fairhurst and colleagues[14]	146	74	63	1.186	0.928-1.516
Going and colleagues[29]	124	62	75	0.827	0.659-1.037
Thylstrup and Poulsen[22]	183	61	73	0.836	0.637-1.096
WEIGHTED MEAN	**481**	NA	NA	**0.912**	**0.793-1.048**
Three Years					
McCune and colleagues[13]	34	21	22	0.955	0.664-1.372
Mertz-Fairhurst and colleagues[14]	122	66	73	1.111	0.893-1.382
Going and colleagues[29]	176	86	113	0.761	0.631-0.918
WEIGHTED MEAN	**332**	NA	NA	**0.901**	**0.789-1.029**
Four Years					
Mertz-Fairhurst and colleagues[14**]	162	117	126	1.083	0.955-1.229
Charbeneau and colleagues[15]	190	135	139	0.971	0.857-1.101
Going and colleagues[29]	195	106	130	0.815	0.893-0.959
Horowitz and colleagues[32††]	205	97	140	0.693	0.583-0.823
Leake and Martinello[49‡‡]	671	514	543	0.947	0.895-1.001
WEIGHTED MEAN	**1,423**	NA	NA	**0.936**	**0.896-0.978**

* RR: Relative risk.
† CI: Confidence interval.
‡ Actual period was 1.5 years.
§ RR for partially lost sealants was 1.06, 0.78, 0.75 and 0.72 for one, two, three and four years after placement, respectively.
¶ RR for partially lost sealants was 0.2 and 0.5 for one and two years after placement, respectively.
# RR for partially lost sealants was 0 and 0.71 for two and three years after placement, respectively.
** Actual period was 4.5 years.
†† RR for partially lost sealants was 0.1.
‡‡ RR for partially lost sealants was 1.0.

Researchers conducting a systematic review that included only studies in which lost sealants were not reapplied found that sealants reduced caries by more than 70 percent.[10] This finding indicates that the sealant loss rate multiplied by the caries rate in the group with FS teeth is less than the caries rate in the group with NS teeth or, equivalently, that the benefits of delivering sealants to children for whom follow-up cannot be ensured exceed the potential risks. Additionally, the findings of our study indicate that at the individual tooth level, the risk of caries development in FS teeth does not exceed that in NS teeth.

Because current guidance recommends sealant placement only when there is a risk of caries development[52] and because sealant effectiveness is linked directly to retention,[5] the maximum protection against caries can be achieved when a sealant is fully retained. Our findings do not suggest that practitioners can be any less careful in their sealant-application technique or in the evaluation or maintenance of sealants after placement in clinical practice. Our findings, however, do suggest that a child should not be deprived of the benefits of a sealant even when follow-up care cannot be ensured.

If we consider Cochrane inclusion/exclusion criteria for study design[6] as the gold standard, then the overall quality of studies included in this review was good. Of the four studies included in this review that were not in the Cochrane review,[6] three[22,29,49] were randomized controlled

trials and had dropout rates meeting the Cochrane criteria. Of these three studies, two were excluded from the Cochrane review because they did not meet the intervention criteria of RB2 sealant material,[29,49] and one was excluded because the children in the study participated in a biweekly mouthrinse program.[22] One additional study had a four-year dropout rate of 37.5 percent.[32] The Cochrane review excluded studies with three-year dropout rates exceeding 30 percent and did not specify a threshold for four years after sealant placement.

One limitation of this analysis was the finding of heterogeneity for pooled results two to four years after sealant placement. The presence of heterogeneity suggests that there were significant differences between studies. These differences may not be as important in this study, in which our primary purpose was to determine if the preponderance of evidence indicated that FS teeth were at greater risk of developing caries than were NS teeth. We were not trying to obtain a precise point estimate of effect. For four[13, 22,32,49] of the seven studies included in this review, the point estimate of the RR for each year since sealant placement was always less than 1. In only one[14] of the remaining three studies was the RR consistently above 1, and in that study the highest point estimate of the RR was 1.186.

Finally, we limited our search to studies included in systematic reviews of sealant effectiveness. For this analysis, we chose a less resource-intensive method to identify and screen potential studies. This approach is attractive because it provides an efficient method of collecting data from well-conducted studies. The studies included in systematic reviews have met rules of study design, conduct and measurement. In addition, we minimized bias in selecting studies for this analysis because the authors of the original systematic reviews determined the universe of studies. Inclusion and exclusion criteria in this analysis were explicit, and we specified them before screening available studies.

All but one[14] of the studies included in this analysis were published in the 1970s, when flouride exposure was lower. Furthermore, in some of the studies we included,[14,29,32,49] researchers used a generation of sealant material (RB1) that no longer is commercially available in the United States. It is unlikely, however, that these factors influenced our findings. Among this group of studies, the RR did not appear to vary according to background fluoride exposure or generation of sealant material.

CONCLUSION

The values for both the weighted mean and the median RR suggest that FS teeth with fully or partially lost sealant were not at a higher risk of developing caries than were NS teeth. Thus, the inability to provide a retention examination to all children participating in school-based sealant programs because of potential loss to follow-up should not exclude any child from having access to the well-documented caries-preventive benefit of a retained sealant. ■

Disclosures. Dr. Malvitz and Dr. Gray work for the Centers for Disease Control and Prevention under contracts with Palladian Partners, Silver Spring, Md., and Northrop Grumman, Atlanta, respectively. None of the other authors reported any disclosures.

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the U.S. Centers for Disease Control and Prevention.

1. 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;248:1-92.
2. U.S. Centers for Disease Control and Prevention, National Center for Health Statistics. National Health and Nutrition Examination Surveys 1999-2004. "www.cdc.gov/nchs/nhanes.htm". Accessed Oct. 2, 2007.
3. Macek MD, Beltrán-Aguilar ED, Lockwood SA, Malvitz DM. Updated comparison of the caries susceptibility of various morphological types of permanent teeth. J Public Health Dent 2003;63(3):174-182.
4. Truman BI, Gooch BF, Sulemana I, et al. Reviews of evidence on interventions to prevent dental caries, oral and pharyngeal cancers, and sports-related craniofacial injuries. Am J Prev Med 2002;23(1 suppl):21-54. "www.thecommunityguide.org/oral/oral-ajpm-ev-rev.pdf". Accessed Feb. 10, 2009.
5. National Institutes of Health. Consensus development conference statement: dental sealants in the prevention of tooth decay. J Dent Educ 1984;48(2 suppl):126-131.
6. Ahovuo-Saloranta A, Hiiri A, Nordblad A, Worthington H, Makela M. Pit and fissure sealants for preventing dental decay in the permanent teeth of children and adolescents (published update in: Cochrane Database Syst Rev 2008;[4]:CD001830). Cochrane Database Syst Rev 2004;(3):CD001830.
7. U.S. Department of Health and Human Services. Healthy people 2010. 2nd ed. Washington: U.S. Department of Health and Human Services; 2000.
8. Task Force on Community Prevention Services. Recommendations on selected interventions to prevent dental caries, oral and pharyngeal cancers and sports-related craniofacial injuries. Am J Prev Med 2002; 23(1 suppl):16-20.
9. Koball H, Douglas-Hall A. Where do children in low-income families live? National Center for Children in Poverty, Mailman School of Public Health, Columbia University. November 2003. "www.nccp.org/publications/pdf/text_573.pdf". Accessed Feb. 10, 2009.
10. Llodra JC, Bravo M, Delgado-Rodriguez M, Baca P, Galvez R. Factors influencing the effectiveness of sealants: a meta-analysis. Community Dent Oral Epidemiol 1993;21(5):261-268.
11. Mejare I, Lingstrom P, Petersson LG, et al. Caries-preventive effect of fissure sealants: a systematic review. Acta Odontol Scand 2003;61(6):321-330.
12. Rozier RG. Effectiveness of methods used by dental professionals for the primary prevention of dental caries. J Dent Educ 2001;65(10): 1063-1072.
13. McCune RJ, Bojanini J, Abodeely RA. Effectiveness of a pit and fissure sealant in the prevention of caries: three-year clinical results. JADA 1979;99(4):619-623.
14. Mertz-Fairhurst EJ, Fairhurst CW, Williams JE, Della-Giustina VE, Brooks JD. A comparative clinical study of two pit and fissure

sealants: 7-year results in Augusta, Ga. JADA 1984;109(2):252-255.
15. Charbeneau GT, Dennison JB, Ryge G. A filled pit and fissure sealant: 18-month results. JADA 1977;95(2):299-306.
16. Erdogan B, Alaçam T. Evaluation of a chemically polymerized pit and fissure sealant: results after 4.5 years. J Paediatr Dent 1987;3: 11-13.
17. Houpt M, Sheykholeslam Z. The clinical effectiveness of Delton fissure sealant after one year. ASDC J Dent Child 1978;45(2):130-132.
18. Hunter PB. A study of pit and fissure sealing in the School Dental Service. N Z Dent J 1988;84(375):10-12.
19. Poulsen S, Beiruti N, Sadat N. A comparison of retention and the effect on caries of fissure sealing with a glass-ionomer and a resin-based sealant. Community Dent Oral Epidemiol 2001;29(4):298-301.
20. Richardson AS, Waldman R, Gibson GB, Vancouver BC. The effectiveness of a chemically polymerized sealant in preventing occlusal caries: two year results. Dent J 1978;44(6):269-272.
21. Rock WP, Bradnock G. Effect of operator variability and patient age on the retention of fissure sealant resin: 3-year results. Community Dent Oral Epidemiol 1981;9(5):207-209.
22. Thylstrup A, Poulsen S. Retention and effectiveness of a chemically polymerized pit and fissure sealant after 12 months. Community Dent Oral Epidemiol 1976;4(5):200-204.
23. Vrbic V. Retention of fissure sealant and caries reduction. Quintessence Int 1983;15(4):421-424.
24. Alvesalo L, Brummer R, Le Bell Y. On the use of fissure sealants in caries prevention: a clinical study. Acta Odontol Scand 1977;35(3): 155-159.
25. Arrow P, Riordan PJ. Retention and caries preventive effects of a GIC and a resin-based fissure sealant. Community Dent Oral Epidemiol 1995;23(5):282-285.
26. Bagramian RA, Graves RC, Bhat M. A combined approach to preventing dental caries in schoolchildren: caries reductions after one year. JADA 1976;93(5):1014-1019.
27. Bravo M, Llodra JC, Baca P, Osorio E. Effectiveness of visible light fissure sealant (Delton) versus fluoride varnish (Duraphat): 24-month clinical trial. Community Dent Oral Epidemiol 1996;24(1):42-46.
28. Burt BA, Berman DS, Silverstone LM. Sealant retention and effects on occlusal caries after 2 years in a public program. Community Dent Oral Epidemiol 1977;5(1):15-21.
29. Going RE, Haugh LD, Grainger DA, Conti AJ. Four-year clinical evaluation of a pit and fissure sealant. JADA 1977;95(5):972-981.
30. Gourley JM. A two-year study of a fissure sealant in two Nova Scotia communities. J Public Health Dent 1975;35(2):132-137.
31. Higson JF. Caries prevention in first permanent molars by fissure sealing: a 2-year study in 6-8-year-old children. J Dent 1976;4(5): 218-222.
32. Horowitz HS, Heifetz SB, Poulsen S. Adhesive sealant clinical trial: an overview of results after four years in Kalispell, Montana. J Prev Dent 1976;3(3 pt 2):38-39, 44, 46-47.
33. Klein SP, Bohannan HM, Bell RM, Disney JA, Foch CB, Graves RC. The cost and effectiveness of school-based preventive dental care. Am J Public Health 1985;75(4):382-391.
34. Leal FR, Forgas-Brockmann L, Simecek J, Cohen ME, Meyer DM. A prospective study of sealant application in Navy recruits. Mil Med 1998;163(2):107-109.
35. Leverett DH, Handelman SL, Brenner CM, Iker HP. Use of sealants in the prevention and early treatment of carious lesions: cost analysis. JADA 1983;106(1):39-42.
36. Meurman JH, Helminen SK. Effectiveness of fissure sealant 3 years after application. Scand J Dent Res 1976;86(4):153-156.
37. Messer LB, Calache H, Morgan MV. The retention of pit and fissure sealants placed in primary school children by Dental Health Services, Victoria. Aust Dent J 1997;42(4):233-239.
38. Pereira AC, Pardi V, Mialhe FL, Meneghim Mde C, Ambrosano GM. A 3-year clinical evaluation of glass-ionomer cements used as fissure sealants. Am J Dent 2003;16(1):23-27.
39. Poulsen S, Thylstrup A, Christensen PF, Ishøy T. Evaluation of a pit- and fissure-sealing program in a public dental health service after 2 years. Community Dent Oral Epidemiol 1979;7(3):154-157.
40. Raadal M, Laegreid O, Laegreid KV, Hveem H, Korsgaard EK, Wangen K. Fissure sealing of permanent first molars in children receiving a high standard of prophylactic care. Community Dent Oral Epidemiol 1984;12(2):65-68.
41. Rock WP. Fissure sealants: results of a 3-year clinical trial using an ultra-violet sensitive resin. Br Dent J 1977;142(1):16-18.
42. Selwitz RH, Nowjack-Raymer R, Driscoll WS, Li SH. Evaluation after 4 years of the combined use of fluoride and dental sealants. Community Dent Oral Epidemiol 1995;23(1):30-35.
43. Simonsen RJ, Stallard RE. Fissure sealants: colored sealant retention 3 months post application. Quintessence Int Dent Dig 1977; 8(2):81-86.
44. Songpaisan Y, Bratthall D, Phantumvanit P, Somridhivej Y. Effects of glass ionomer cement, resin-based pit and fissure sealant and HF applications on occlusal caries in a developing country field trial. Community Dent Oral Epidemiol 1995;23(1):25-29.
45. Stephen KW. A four-year fissure sealing study in fluoridated and non-fluoridated Galloway. Health Bull (Edinb) 1978;36(3):138-145.
46. Sterritt GR, Frew RA. Evaluation of a clinic-based sealant program. J Public Health Dent 1988;48(4):220-224.
47. Tanguy R, Casanova F, Barnaud J. Prevention of tooth fissure caries using a sealing resin in the public health service [in French]. Rev Odontostomatol (Paris) 1984;13(2):125-130.
48. Heller KE, Reed SG, Bruner FW, Eklund SA, Burt BA. Longitudinal evaluation of sealing molars with and without incipient dental caries in a public health program. J Public Health Dent 1995;55(3): 148-153.
49. Leake JL, Martinello BP. A four year evaluation of a fissure sealant in public health setting. Dent J 1976;42(8):409-415.
50. Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. BMJ 2003;327(7414):557-560.
51. Simonsen RJ. Pit and fissure sealant: review of the literature. Pediatr Dent 2002;24(5):393-414.
52. Beauchamp J, Caufield PW, Crall JJ, et al. Evidence-based clinical recommendations for use of pit-and-fissure sealants: a report of the American Dental Association Council on Scientific Affairs. JADA 2008;139(3):257-267.

RESEARCH REPORTS
Clinical

S.O. Griffin[1]*, E. Oong[1], W. Kohn[1], B. Vidakovic[2], B.F. Gooch[1], and CDC Dental Sealant Systematic Review Work Group: J. Bader[3], J. Clarkson[4], M.R. Fontana[5], D.M. Meyer[6], R.G. Rozier[7], J.A. Weintraub[8], and D.T. Zero[5]

[1]Centers for Disease Control and Prevention/Division of Oral Health/Surveillance, Investigations, and Research Branch, 4770 Buford Highway, MSF10, Chamblee, GA 30341, USA; [2]Wallace H. Coulter School of Biomedical Engineering, 2101 Whitaker Building, 313 Ferst Dr., Georgia Tech, Atlanta, GA 30332-0535, USA; [3]School of Dentistry, University of North Carolina, Chapel Hill, NC 27599-7450, USA; [4]Dental Health Services Research Unit, Dundee DD24BF, Scotland, UK; [5]Oral Health Research Institute, Indiana University School of Dentistry, 415 Lansing Street, Indianapolis, IN 46202, USA; [6]American Dental Association, 211 E. Chicago Ave., Chicago, IL 60611, USA; [7]Department of Health Policy and Administration, The University of North Carolina at Chapel Hill, 1105F McGavran-Greenberg Hall, CB#7411, Chapel Hill, NC 27599-7411, USA; and [8]Center to Address Disparities in Children's Oral Health, University of California. San Francisco School of Dentistry, 3333 California Street, Suite 495, San Francisco, CA 94143-1361, USA; *corresponding author, sig1@cdc.gov

J Dent Res 87(2):169-174, 2008

The Effectiveness of Sealants in Managing Caries Lesions

ABSTRACT

A barrier to providing sealants is concern about inadvertently sealing over caries. This meta-analysis examined the effectiveness of sealants in preventing caries progression. We searched electronic databases for comparative studies examining caries progression in sealed permanent teeth. We used a random-effects model to estimate percentage reduction in the probability of caries progression in sealed *vs*. unsealed carious teeth. Six studies, including 4 randomized-controlled trials (RCT) judged to be of fair quality, were included in the analysis (384 persons, 840 teeth, and 1090 surfaces). The median annual percentage of non-cavitated lesions progressing was 2.6% for sealed and 12.6% for unsealed carious teeth. The summary prevented fraction for RCT was 71.3% (95%CI: 52.8%-82.5, no heterogeneity) up to 5 years after placement. Despite variation among studies in design and conduct, sensitivity analysis found the effect to be consistent in size and direction. Sealing non-cavitated caries in permanent teeth is effective in reducing caries progression.

KEY WORDS: pit and fissure sealants, caries.

Received February 15, 2007; Last revision July 3, 2007; Accepted October 30, 2007

A supplemental appendix to this article is published electronically only at http://jdr.iadrjournals.org/cgi/content/full/87/2/169/DC1.

INTRODUCTION

There is strong evidence that sealants are effective in both clinical and school settings for preventing caries in children at various levels of risk (Truman *et al.*, 2002; Ahovuo-Saloranta *et al.*, 2004). The evidence for sealant effectiveness in the management of dental caries is limited, however. One review that examined the effectiveness of interventions to manage caries for the National Institutes of Health (NIH) Caries Consensus Development Conference included only 1 study on sealants (Bader *et al.*, 2001). Despite the strong evidence of primary effectiveness, sealant prevalence among lower-income children (who are at higher risk for dental caries) is about 30% (Dye *et al.*, 2007), well below the Healthy People 2010 objective of 50%.

Analysis of survey data from dentists suggests that one barrier to providing sealants is concern about inadvertently sealing over caries (Chapko, 1987; Primosch and Barr, 2001). This concern has also been a barrier to implementing school-based sealant programs (Association of State and Territorial Dental Directors, unpublished data, 2005).

Documenting the effectiveness of sealants in the management of existing caries is therefore important, and such documentation could potentially remove barriers to the provision of a proven intervention. The purpose of this meta-analysis is to examine the effectiveness of dental sealants in preventing the progression of caries lesions in the pits and fissures of permanent teeth.

METHODS

Inclusion Criteria

This analysis was part of a broader systematic review of sealant effectiveness in the management of caries in the permanent dentition. Initially, we included all *in vivo* studies published in English that compared caries progression or bacteria levels in permanent teeth that did and did not receive sealants. Comparisons could be concurrent or measured over time (time-series or before-after) in the same groups. In the current meta-analysis, study designs were limited to randomized and non-randomized controlled trials and cohort studies that provided concurrent comparisons of % of lesions progressing. There were no restrictions on study populations.

Identification of Studies

In our search of MEDLINE (1966 to June, 2005), using a modified version of the strategy used by the NIH Caries Consensus Development Conference (University of Michigan, 2003), we identified 1872 records. The MEDLINE search strategy was adapted to search EMBASE (1980 to June, 2005), which identified 71 records, and the Cochrane Central Register of Controlled Trials (accessed the first week of September, 2005), which identified 79 records. In total, there were 1905 unique records. Two reviewers independently examined the titles and abstracts of these records for systematic or narrative reviews of the effectiveness of sealants in preventing or managing caries and primary studies on managing caries. We accessed 262 articles. From our examination of their

Table 1. Description of Studies Whose Data Were Used to Calculate Summary Measures

Study[a]	Subjects[b]	Sealants[c]	Study Quality[d]
Flório *et al.*, 2001; Brazil; 12	6-year-olds; prophylaxis every 3 mos; NC[e]	Resin-modified GIC; No; 65.5%	23; 72; NA[f]; RCT[g] (parallel groups); 1 yr DO = 9%; Direct digital radiography; NR[h]; NR
Frencken *et al.*, 1998; Zimbabwe; 36	Secondary school students (mean age = 13.9 yrs); NR; NC	GIC; No; 20.4%	NR; at follow-up 368; NA; Prospective cohort (parallel groups); 3-year DO for sealed group = 39%; VT[i]; Yes; NR
Gibson ; and Richardson, 1980 Canada; 30	2nd graders; NR; NC	RB2[j]; NR; NR (1-yr retention = 89.6% for entire study)	NR; at follow-up -79; 111; Subgroup of RCT (originally designed as split-mouth design, but in this analysis, control and treatment teeth not necessarily in same child); For entire RCT, and 2-year DO = 8 and 17%, respectively; VT examination and radiograph; NA; NR
Going *et al.*, 1976[k]; 1976; United States; 12	10- to 14-year-olds; no fluoridation; NC/C	RB1; Yes[l]; NR (1-yr retention = 81% for entire study)	NR; 85 (first follow-up); NA; Subgroup of RCT (originally designed as split-mouth design, but in this analysis, control and treatment teeth not necessarily in same child); 1-year DO for entire RCT = 6%; VT; NR; Yes
Heller *et al.*, 1995; United States; 60	1st graders; fluoridation; NC	RB3; Yes; NR	71; NR; 436 surfaces (approximately 2 surfaces *per* tooth); NA; Retrospective cohort (parallel groups); NR; VT; NA; No
Mertz-Fairhurst *et al.*, 1986; United States; 12	9 to 19 yrs; NR: C	RB2; NR; NR	20; 40; NA; RCT (split-mouth design); 1-yr DO = 30%; Bodecker device; NR; Yes

[a] First author; year published; country where conducted; duration (mos).
[b] Age range; background prevention exposure; baseline caries severity.
[c] Material; sealants maintained/repaired; retention rate.
[d] Number of subjects at baseline; number of teeth; number of sites; design; drop-out rate for teeth (DO); how caries progression measured; examiner calibration; examiner blinding.
[e] NC = non-cavitated and C = cavitated.
[f] NA = not applicable.
[g] RCT = randomized controlled trial.
[h] NR = not reported.
[i] VT = visual-tactile examination.
[j] RB1, Resin-based-UV light polymerized; RB2, Resin-based-autopolymerized; RB3, Resin-based-light polymerized.
[k] This was the only study that reported effectiveness for multiple follow-ups. We used the first-year results because Going *et al.* used NuvaSeal, which may have lower retention rates than currently used sealant materials.
[l] For sealed teeth, year 1 findings reported for teeth retaining their sealant.

references, we accessed an additional 49 articles, for a total of 311.

Study Selection

One investigator (SG) screened all articles and identified 31 potential qualifying studies. After review by three investigators (BG, SG, and WK), consensus was reached that 26 studies should be evaluated further. Of the 19 studies included in the larger systematic review, 10 had information on % of lesions progressing. Of these 10 studies, 6 had a concurrent control group (see QUOROM flow diagram in APPENDIX).

Data Abstraction and Quality Assessment

Two reviewers (SG and EO) abstracted studies using a slightly modified version of a form developed for the NIH Caries Consensus Conference. The abstraction forms were jointly reviewed by three investigators (BG, SG, and EO) to assess study quality using criteria established by the third US Preventive Services Task Force (USPSTF; Harris *et al.*, 2001). These criteria are further described in the APPENDIX.

Outcome and Effect Measures

Our outcome measure was the percentage of caries lesions progressing, where progression was defined as demineralization or loss of tooth structure. In 4 studies, restorations were placed after study examiners determined that caries progression had exceeded given thresholds. For 2 studies, where children had access to outside care, placement of a restoration indicated caries progression. To measure effectiveness, we calculated the relative risk ratio (RR)

$$R = \frac{\%\ \text{lesions progressing}_{\text{SEALED}}}{\%\ \text{lesions progressing}_{\text{NOT SEALED}}}$$

and its 95% confidence interval (CI). One can obtain the prevented fraction by subtracting the RR from 1, and the upper/lower 95%CI by subtracting the lower/higher 95%CI of the RR ratio from 1.

Synthesis of Findings

We calculated the median percentage of lesions progressing in

sealed and unsealed surfaces, as well as the median prevented fraction, for all studies and for subgroups of studies with selected characteristics. We classified baseline caries as non-cavitated if the study described caries as incipient or restricted to the enamel, or if there were no apparent defects in the enamel, or the lesion did not permit explorer penetration. We classified caries as cavitated if the study stated that cavitation was visually detectible, or the lesion allowed for explorer penetration.

In adjusting the data for differences in study design, multiple observations *per* subject, and 100% or 0% progression rates (LaPlace adjustment), we made conservative assumptions that would bias the results toward finding no statistical significance (APPENDIX). We used the Der Simonian and Laird (DSL) random-effects model (Stijnen, 1999) to obtain the summary RR and its 95% confidence interval. We tested for homogeneity of effect size using the quantity I^2 (Higgins *et al.*, 2003). Finally, we conducted sensitivity analysis to determine how robust our findings were to excluding cohort studies and assuming higher values of intra-oral correlation (APPENDIX).

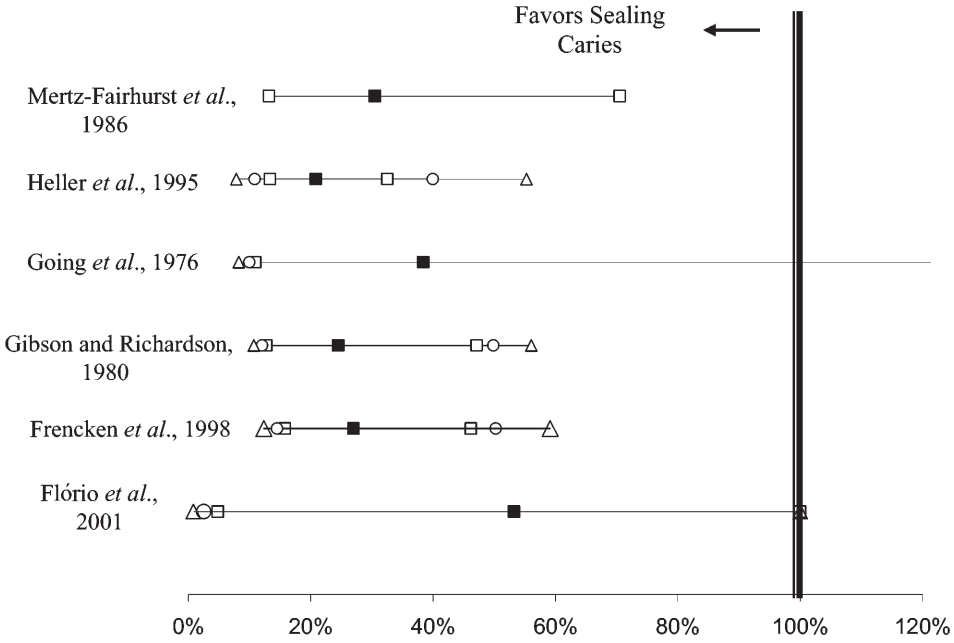


Figure. Adjusted relative risk ratios and 95% confidence interval, assuming 0, 30%, and 100% correlation among teeth. Progression rates of 0% or 100% adjusted according to the LaPlace procedure, described in the text.

■ Relative risk ratio.
□ 95% confidence interval assuming no correlation (rho = 0.0).
○ 95% confidence interval assuming rho = 0.3.
Δ 95% confidence interval assuming rho = 1.0.

RESULTS

Characteristics of Studies

The 6 studies included in this analysis (representing an estimated 384 persons, 840 teeth, and 1090 surfaces) varied in design (4 RCTs), baseline caries classifications, and types of sealant material (Table 1). Four studies primarily sealed non-cavitated lesions, 1 exclusively sealed cavitated lesions, and 1 sealed both cavitated and non-cavitated lesions. Three studies used 2nd- or 3rd-generation resin-based sealants, 2 used glass-ionomer cement (GIC), and 1 used 1st-generation resin-based sealants. Study populations included children, adolescents, and young adults ranging in age from 6 to 19 yrs.

Quality of Studies

All the studies were rated as "fair" quality (Table 2). It is likely that comparable groups were assembled in 5 studies—4 RCTs and 1 cohort study where baseline sealant prevalence and DFS did not differ between the sealed and not-sealed groups. All studies clearly defined the intervention. The 2 cohort studies did not report drop-out rates, and 1 RCT of split-mouth design reported a one-year drop-out rate of 30%. In the 3 remaining RCTs, however, the one-year drop-out rate was less than 10% (this included the 2 larger studies that supported subgroup analyses of sealed caries lesions).

In the absence of sealant removal prior to follow-up examination, we assumed that outcome assessment was not blinded. In only 1 RCT, however, were sealants removed prior to the follow-up examination, with teeth assessed by an examiner who did not know the initial group assignment. In 2 of the remaining 5 studies (1 RCT and 1 cohort study), however, either the examiner used new record forms at each follow-up examination (and thus was unaware of the child's previous findings), or there was an independent outside examiner. In the remaining 3 studies (2 RCTs and 1 cohort study), either the same examiner conducted both the baseline and follow-up examinations, or blinding was not described.

Effects of Sealants

The median annualized progression rates for sealed and unsealed lesions were, respectively, 5.0% and 16.1% (Table 3). If we classified all teeth in the study by Going *et al.* (1976) as cavitated, then, the annualized progression rates for cavitated lesions would be 19.4% (sealed) and 59.3% (not-sealed). The percentage of non-cavitated lesions progressing would be 2.6% (sealed) and 12.6% (not-sealed). Alternatively, if we classified all teeth in the Going study as non-cavitated, then the median annualized progression rates for non-cavitated lesions would be 2.9% (sealed) and 13.6% (not-sealed), respectively.

For the individual studies, the prevented fraction ranged from 61.6% to 100.0%, with a median of 74.2% (Table 3). The median prevented fraction did not vary greatly by grouping—the median value always exceeded 50% (Table 3).

The RR for the studies ranged from 0 to 38.4%, but after the LaPlace adjustment, it ranged from 20.8% to 53.2% (Fig.). The CI for each study widened as we made more conservative assumptions about correlation among teeth (Fig.), but changing the assumptions about correlation did not result in rejecting findings of

Table 2. Quality Assessment of 6 Studies with Concurrent Controls

Criteria	Study					
	Flório *et al.*, 2001	Frencken *et al.*, 1998	Gibson and Richardson, 1980	Going *et al.*, 1976	Heller *et al.*, 1995	Mertz-Fairhurst *et al.*, 1986
Initial assembly of comparable groups	Good—RCT[a] employing parallel group design, where children were randomly assigned to treatment group.	Fair—assignment based on returned permission slip.	Good—RCT with split-mouth design, where treatment teeth determined by dice.	Good—RCT with split-mouth design, where side of mouth receiving treatment was randomly selected.	Good— although assignment based on returned permission slip, study showed that baseline DFS did not differ between control and treatment groups.	Good—RCT with split-mouth design, where treatment tooth decided *via* randomized treatment assignment sheet.
Clear definition of intervention	Good—GIC sealants on NC lesions.	Good—GIC sealants on NC lesions.	Good—RB sealants on NC lesions.	Good—RB sealants on NC lesions.	Good—RB sealants on NC lesions.	Good—RB sealants on NC lesions.
Reliability and validity of measure of outcome	Fair—blinding not specified and whether same examiner interpreted digital radiographs at BL and FU indeterminant.	Fair—VT[b] and sealants not removed at FU[c]; outside examiner.	Fair—no blinding and same examiner conducted VT BL[d] examination and read radiographs at FU; 71% of lesion progression due to restorations.	Fair—although examiners blinded as to previous caries score, caries score determined by VT and sealants not removed at FU, although new record forms were used at each examination.	Fair—no blinding, same examiner (not a primary investigator) at BL and FU, and VT where sealants not removed at FU, although subjects received regular clinical care (59% of sites progressing due to restorations).	Good—removed sealant, and blinded examiners assessed lesion progression.
No differential loss to FU or overall high loss to FU	Good—drop-out rate was 9%.	Fair—number of controls not reported.	Fair—drop-out rates not reported for subgroup; For entire study, 1- and 2-year drop-out rates for tooth pairs were 8 and 17%, respectively.	Fair—drop-out rates not reported for subgroup; For entire study, 1-year drop-out rate for subjects was 6%.	Fair—retrospective cohort study, so drop-out rate not reported.	Fair—1-year drop-out rate was 30%.
Other threats to validity:	Fair—small sample size.	None apparent	None . apparent.	None apparent.	None apparent.	Fair—small sample size.
Quality score	Fair	Fair	Fair	Fair	Fair	Fair

a RCT = randomized controlled trial.
b VT = visual tactile examination.
c FU = follow-up examination.
d BL = baseline examination.

statistical significance for any of the 4 studies whose initial 95%CI did not achieve 100%.

The summary prevented fraction ranged from 73.2% (95%CI: 59.8%-82.2%), assuming perfect correlation among teeth (adjusted n = 398), to 75.0% (95%CI: 67.1%-81.1%), assuming no correlation (adjusted n = 946), and equaled 74.1% (95%CI: 63.8%-81.4%), assuming 30% correlation (adjusted n = 638). When we restricted the analysis to the 4 randomized trials, the summary prevented fraction ranged from 71.2% (95%CI: 50.3%-83.3%), assuming perfect correlation (adjusted n = 154), to 71.3% (95%CI: 54.1%-82.0%), assuming no correlation (adjusted n = 254), and equaled 71.3% (95%CI: 52.8%-82.5%), assuming 30% correlation (adjusted n = 207). The quantity I^2 was 0 regardless of our assumptions about correlation among teeth or whether to include

only randomized trials, which indicated no observed heterogeneity.

DISCUSSION

We found that sealing caries lesions reduced the probability of lesion progression. The summary prevented fraction was more than 70%, and in the sensitivity analyses, the lower bound of the 95%CI always exceeded 50%. The consistency in size and direction across included studies and under a range of conservative assumptions indicates that the findings are robust.

Because non-cavitated lesions accounted for almost 90% of teeth in this study, the evidence supporting the sealing of non-cavitated lesions (NC) was stronger than that for the sealing of cavitated (C) lesions. The median annualized probability of progression for NC lesions was very low (2.6%). This finding does not support reported concerns about poorer outcomes associated with the inadvertent sealing of caries and should lessen the reluctance of practitioners to provide sealants—an intervention proven to be highly effective in preventing caries. The annualized probability reflects progression in lesions recognized as "early or incipient" and suggests that the probability of progression for pit-and-fissure surfaces with caries considered "questionable" could be even lower. These findings not only support the placement of sealants to manage and arrest lesions determined to be in the early carious stages, but also, just as importantly, support their placement for surfaces where caries status is uncertain.

Table 3. Percentages of Sealed and Unsealed Caries Lesions Progressing and Prevented Fraction for Different Subgroups

	No. Teeth	No. Persons	No. Studies	Sealed Caries Lesions (%)		Unsealed Caries Lesions (%)		Prevented Fraction (%)	
				Median[a]	Range	Median	Range	Median	Range
All	840	384	6	9.6	0-28.6	41.4	6.1-100	74.2	61.6-100
RCT[b]	254	140	4	13.1	0-28.6	48.0	6.1-100	73.5	61.6-100
< = 12 mos	175	91	3	7.1	0-28.6	18.6	6.1-100	71.4	61.6-100
30-36 mos	447	222	2	13.7	8.4-19.0	54.2	31.1-77.4	74.2	73.0-75.5
60 mos	218	71	1	10.8	—	51.8	—	79.2	—
GIC[c]	430	193	2	4.2	0-8.4	18.6	6.1-31.1	86.5	73.0-100
RB1[d]	85	57	1	7.1	—	18.6	—	61.6	—
RB2[e] & RB3[f]	225	134	3	19.0	10.8-28.6	77.4	51.8-100	75.5	71.4-79.2
Non-cavitated	727	313	4	9.6	0-19.0	41.4	6.1-51.8	77.3	73.0-100
Cavitated[g]	113	71	2	17.9	7.1-28.6	59.3	18.6-100	66.5	61.6-71.4
Annualized[h]									
All	840	384	6	5.0	0-31.7	16.1	6.1-100	78.7	68.3-100
RCT	254	140	4	7.6	0-31.7	31.7	6.1-100	75.2	68.3-100
GIC	430	193	2	1.4	0-2.9	8.9	6.1-11.7	87.7	75.3-100
RBI	85	57	1	7.1	—	18.6	—	61.6	—
RB2 & RB3	225	134	3	8.1	2.3-31.7	44.8	13.6-100	82.0	68.3-83.4
Non-cavitated	727	313	4	2.6	0-8.1	12.6	6.1-44.8	82.7	75.3-100
Cavitated[g]	113	71	2	19.4	7.1-31.7	59.3	18.6-100	65.0	61.6-68.3

[a] In most cases, mean was fairly close to median value.
[b] Randomized controlled trial.
[c] Glass-ionomer cement sealants.
[d] 1st-generation resin-based sealants (UV light-polymerizing).
[e] 2nd-generation resin-based sealants (auto-polymerizing).
[f] 3rd-generation resin-based sealants (light-polymerizing).
[g] Assumes that study by Going *et al.* exclusively sealed cavitated lesions.
[h] Reported values annualized assuming a constant progression rate (PR).
Annualized % progressing = $1 - [1 - (PR)^{1/n}]$, where n represents years since placement.

Another notable finding of this review was the low annualized probability of progression (12.6%) for not-sealed, non-cavitated lesions. This finding suggests that immediate surgical treatment of such lesions may not be necessary. Thus, practitioners can consider sealing these surfaces or can simply wait and monitor them for signs of active progression. Approaches focusing on prevention and management (*e.g.*, sealants) are particularly attractive, since they could potentially preserve tooth structure and lower the likelihood of future complex restorations.

There were variations among the studies included in this analysis. Sealant material included both resin-based and GIC sealants. Among the 4 studies that used resin-based sealants, 3 used 2nd- or 3rd-generation sealants, which have similar retention rates (Muller-Bolla *et al.*, 2006). The one-year retention rate of 81% for the 1 study using 1st-generation sealant material included in this meta-analysis was within the range of retention for auto-polymerized sealants reported in a meta-analysis on the primary effectiveness of sealants (Ahovuo-Saloranta *et al.*, 2004). Although this same review found limited evidence to support the effectiveness of GIC sealant material as a primary preventive measure, 1 longitudinal study that sampled 24 teeth found no difference in bacteria levels between dentinal lesions sealed with resin-based and GIC sealants 7 mos after placement (Weerheijm *et al.*, 1993).

The studies also varied by how they assessed caries progression. Three studies assessed progression solely with a visual-tactile examination. In the absence of sealant loss or a restoration on a previously sealed caries lesion, visual-tactile assessment of caries under sealants is limited. In 1 of the 3 studies included in our meta-analysis, however, children received regular restorative care, and thus it is likely that sealed teeth were periodically assessed radiographically and restored if necessary.

All RCTs (4 studies) included in this review received a "fair" quality rating, primarily due to failure to blind outcome assessment (3 studies) and high loss to follow-up (1 study). It should be noted, however, that comparative studies examining the effectiveness of sealants for primary prevention typically do not remove sealants at follow-up. For example, none of the studies included in a recent systematic review of sealants removed sealant at the final follow-up examination (Ahovuo-Saloranta *et al.*, 2004).

While limitations of this analysis have been carefully described, the strengths of these studies, and of the meta-analysis as well, should be clearly noted. First, we conducted a sensitivity analysis that adjusted for correlation among multiple observations

per person to determine the most conservative (widest) confidence interval for the summary prevented fraction. Other systematic reviews of sealant effectiveness have included studies with multiple observations *per* person, and this systematic review is likely the first study that adjusted data for this limitation. In addition, the consistency of the effect measure across studies also lends support for the quality of the 6 studies; it is very unlikely that such consistency among estimates based on studies with noted variations occurred by chance alone.

There is additional evidence for sealant effectiveness in the management of caries. Two other studies identified in the larger systematic review also examined the impact of sealants on caries progression, but did not report % of lesions progressing. One study found that caries lesions measured by radiographic assessment were more likely to regress under intact sealants than under defective sealants (Handelman *et al.*, 1986). Another RCT found that the mean depth change in caries lesions was significantly lower in the sealed group than in the not-sealed group (49 μm *vs.* 614 μm depth change; Mertz-Fairhurst *et al.*, 1979). In addition, several studies have found that sealing caries reduces bacteria levels (Jeronimus *et al.*, 1975; Jensen and Handelman, 1980).

This review also supports the need for further studies that meet current standards of quality in design, conduct, and reporting, to continue to build the evidence related to sealant effectiveness in preventing caries progression, especially in cavitated lesions, which represented, at most, 14% of carious teeth in this analysis. Uniform criteria to assess progression from early demineralization to frank cavitation, as well as standardized methodologies to measure progression, are needed. This review would have been strengthened if all studies had used examiners calibrated to the same criteria and the same method to assess caries progression (*i.e.*, visual-tactile examination with removal of sealants).

In conclusion, the evidence supports the placement of sealants over non-cavitated caries lesions in the pits and fissures of permanent teeth in children, adolescents, and young adults. Despite variations in study design and conduct, subgroup and sensitivity analyses found the effect to be consistent in size and direction.

ACKNOWLEDGMENTS

This research was funded by the Centers for Disease Control and Prevention. We also thank Sylvia Bickley, Trials Service Coordinator, Cochrane Group, for her assistance.

REFERENCES

Ahovuo-Saloranta A, Hiiri A, Nordblad A, Worthington H, Makela M (2004). Pit and fissure sealants for preventing dental decay in the permanent teeth of children and adolescents. *Cochrane Database Syst Rev* 3:CD001830.

Bader JD, Shugars DA, Bonito AJ (2001). Systematic reviews of selected dental caries diagnostic and management methods. *J Dent Educ* 65:960-968.

Chapko MK (1987). A study of the intentional use of pit and fissure sealants over carious lesions. *J Public Health Dent* 47:139-142.

Dye BA, Tan S, Smith V, Lewis BG, Barker LK, Thornton-Evans G, et al. (2007). Trends in oral health status: United States, 1988-1994 and 1999-2004. National Center for Health Statistics. *Vital Health Stat* 11:1-92.

Flório FM, Pereira AC, Meneghim MC, Ramacciato JC (2001). Evaluation of non-invasive treatment applied to occlusal surfaces. *ASDC J Dent Child* 68:326-331.

Frencken JE, Makoni F, Sithole WD, Hackenitz E (1998). Three-year survival of one-surface ART restorations and glass-ionomer sealants in a school oral health programme in Zimbabwe. *Caries Res* 32:119-126.

Gibson GB, Richardson AS (1980). Sticky fissure management. 30-month report. *J Can Dent Assoc* 46:255-258.

Going RE, Conti AJ, Haugh LD, Grainger DA (1976). Two-year clinical evaluation of a pit and fissure sealant. Part II. Caries initiation and progression. *J Am Dent Assoc* 92:578-585.

Handelman SL, Leverett DH, Espeland MA, Curzon JA (1986). Clinical radiographic evaluation of sealed carious and sound tooth surfaces. *J Am Dent Assoc* 113:751-754.

Harris RP, Helfand M, Woolf SH, Lohr KN, Mulrow CD, Teutsch SM, et al. (2001). Current methods of the U.S. Preventive Services Task Force—a review of the process. *Am J Prev Med* 20(3 Suppl):21-35.

Heller KE, Reed SG, Bruner FW, Eklund SA, Burt BA (1995). Longitudinal evaluation of sealing molars with and without incipient dental caries in a public health program. *J Public Health Dent* 55:148-153.

Higgins JP, Thompson SG, Deeks JJ, Altman DG (2003). Measuring inconsistency in meta-analyses. *BMJ* 327:557-560.

Jensen OE, Handelman SL (1980). Effect of an autopolymerizing sealant on viability of microflora in occlusal dental caries. *Scand J Dent Res* 88:382-388.

Jeronimus DJ Jr, Till MJ, Sveen OB (1975). Reduced viability of microorganisms under dental sealants. *ASDC J Dent Child* 42:275-280.

Mertz-Fairhurst EJ, Schuster GS, Williams JE, Fairhurst CW (1979). Clinical progress of sealed and unsealed caries. Part I: Depth changes and bacterial counts. *J Prosthet Dent* 42:521-526.

Mertz-Fairhurst EJ, Schuster GS, Fairhurst CW (1986). Arresting caries by sealants: results of a clinical study. *J Am Dent Assoc* 112:194-197.

Muller-Bolla M, Lupi-Pégurier L, Tardieu C, Velly AM, Antomarchi C (2006). Retention of resin-based pit and fissure sealants: a systematic review. *Community Dent Oral Epidemiol* 34:321-336.

Primosch RE, Barr ES (2001). Sealant use and placement techniques among pediatric dentists. *J Am Dent Assoc* 132:1442-1451.

Stijnen T (1999). Tutorial in biostatistics meta-analysis: formulating, evaluating, combining, and reporting. *Stat Med* 18:321-359.

Truman BI, Gooch BF, Sulemana IS, Gift HC, Horowitz AM, Evans CA, et al. (2002). The Task Force on Community Preventive Services reviews of evidence on interventions to prevent dental caries, oral and pharyngeal cancers, and sports-related craniofacial injury. *Am J Prev Med* 23(1 Suppl):21-54.

University of Michigan (2003). Dentistry library. NIH CDC on caries, last revised 8/29/03: http://www.lib.umich.edu/dentlib/nihcdc/hedges/#caries (accessed December 2007).

Weerheijm KL, de Soet JJ, van Amerongen WE, de Graaff J (1993). The effect of glass-ionomer cement on carious dentine: an in vivo study. *Caries Res* 27:417-423.

Guiding Principles of Infection Control:

PRINCIPLE 1. TAKE ACTION TO STAY HEALTHY

PRINCIPLE 2. AVOID CONTACT WITH BLOOD AND OTHER POTENTIALLY INFECTIOUS BODY SUBSTANCES

PRINCIPLE 3. MAKE PATIENT CARE ITEMS (instruments, devices, equipment) SAFE FOR USE

PRINCIPLE 4. LIMIT THE SPREAD OF BLOOD AND OTHER INFECTIOUS BODY SUBSTANCES

Levels of Anticipated Contact between the dental health care professional (DHCP) or volunteer and the patient's mucous membranes, blood or saliva visibly contaminated with blood to determine the suggested elements for the infection control program. This checklist is designed to provide information for 3 levels of programs:

I. **Anticipated contact with the patient's mucous membranes, blood or saliva visibly contaminated with blood.**

II. **Anticipated contact with the patient's mucous membranes but not with blood or saliva visibly contaminated with blood.**

III. **No anticipated contact with the patient's mucous membranes, blood, or saliva visibly contaminated with blood.**

P.O. Box 6297 Annapolis, MD 21401
P: 410-571-0003
F: 410-571-0028
office@OSAP.org **www.OSAP.org**

OSAP.org
Because Safety Matters

ALL PROGRAMS SHOULD MEET THE MINIMUM REQUIREMENTS BASED ON THE CENTERS FOR DISEASE CONTROL AND PREVENTION'S (CDC) GUIDING PRINCIPLES OF INFECTION CONTROL

Level I	Level II	Level III	INFECTION CONTROL PRACTICE	Yes	No	Comments
X	**X**	**X**	**Infection Control Program Operating Procedures**			
			Is there a written infection control program?			
			Is there a designated person(s) responsible for program oversight?			
			Are there methods for monitoring and evaluating the program?			
			Is there a training program for dental health-care personnel (DHCP) (initial and ongoing) in infection control policies and practices?			
X	**X**	**X**	**Immunizations**			
			Are DHCP adequately immunized against vaccine-preventable diseases? Immunizations should meet or exceed federal, state and local guidelines. (May not be necessary for screenings)			
			Hepatitis B			
			Annual Influenza			
			Additional immunizations needed for program:			
X	**X**	**X**	**Hand Hygiene**			
			Are sinks available close to the area where care is provided?			
			If not, are alcohol-based hand sanitizers available?			
			Is staff properly trained in the use of alcohol handrub products?			
X	**X**		**Personal Protective Equipment (PPE) (e.g., gloves, masks, protective eyewear, protective clothing)**			
			Is there a protocol that outlines what PPE are worn for which procedures?			
			Is PPE storage available and close to care?			
			Are facilities available to disinfect PPE (DHCP evewear, patient eyewear, heavy duty utility gloves)?			

P.O. Box 6297 Annapolis, MD 21401
P: 410-571-0003
F: 410-571-0028
office@OSAP.org **www.OSAP.org**

Level I	Level II	Level III	INFECTION CONTROL PRACTICE	Yes	No	Comments
X	**X**	**As necessary**	**Environmental Surfaces: Clinical Contact Surfaces (e.g., light handles and countertops)**			
			Is there a list of what surfaces will be cleaned, disinfected or barrier protected and the process and products to be used?			
			If chemical disinfectants are used, is there a protocol for how they are managed, stored and disposed?			
X	**X**		**Housekeeping Surfaces (e.g., floors, walls)**			
			Is there a list of which housekeeping surfaces will need to be cleaned and disinfected and how often?			
X	**X**		**Safe Handling of Sharp Instruments and Devices**			
			Are DHCP trained in the safe handling and management of sharps?			
			Are sharps containers safely located as close as possible to the user?			
			Is there a written protocol for transporting and disposing of sharps and sharps containers?			
X	**X**		**Management and Follow-Up of Occupational Exposures**			
			Is there a written procedures manual for post-exposure management?			
			Is there a designated person responsible for post-exposure management?			
			Is there a mechanism to document the exposure incident?			
			Where is the closest medical facility for wound care and post-exposure management?			
			Is there a mechanism to refer the source and DHCP for testing and follow-up?			
			Is there a mechanism for expert consultation by phone?			
			Are post-exposure prophylaxis medications readily available onsite, at an emergent care facility or nearby pharmacy?			
			Who is the responsible party for post-exposure care costs?			
			Does Workers' Compensation apply?			
			Have DHCP been trained in post-exposure management procedures?			

Level I	Level II	Level III	INFECTION CONTROL PRACTICE	Yes	No	Comments
X	**X**	If used	**Reusable Patient Items**			
			Are reusable patient items processed onsite?			
			IF YES:			
			Is there a protocol for how and where contaminated instruments are cleaned and processed?			
X	**X**	If used	**Reusable Patient Items, continued**			
			Is there adequate space for the processing area to be divided into clean and dirty areas?			
			Has the person who is performing the processing been adequately trained?			
			Is the sterilizer(s) spore tested at least weekly?			
			Are protocols in place to handle positive tests?			
			Can dental equipment and patient items be safely stored and secured if left on site?			
			IF NO:			
			Is there an adequate inventory of instruments for the number of patients to be treated?			
			Are containers for holding or transporting contaminated instruments puncture-proof, secured, & labeled as a biohazard?			
X	**X**	**X**	**Single-Use (Disposable) Items and Devices**			
			Is there a protocol for which single-use, disposable items will be used and how they will be disposed? e.g., gloves, tongue depressors			
			Are disposable items unit-dosed for each patient?			
			Are syringes that deliver sealant and composite material barrier-protected if they aren't single-use, disposable syringes?			
X	**X**	**X**	**Management of Dental Unit Water Quality**			
			Is there a protocol for how dental unit water quality will be maintained and monitored?			

Level I	Level II	Level III	INFECTION CONTROL PRACTICE	Yes	No	Comments
X	**X**	**X**	**Management of Regulated and Non-Regulated Medical Waste**			
			Is there a protocol and designated person responsible for proper disposal of regulated waste (e.g., sharps containers, extracted teeth) and non-regulated waste (regular trash)?			

Best Practice Approaches
for State and Community Oral Health Programs

A Best Practice Approach Report describes a public health strategy, assesses the strength of evidence on the effectiveness of the strategy, and uses practice examples to illustrate successful/innovative implementation.

Date of Initial Report: June 16, 2003
Updated – August 2014

Best Practice Approach
School-based Dental Sealant Programs

Summary of Evidence Supporting School-based Dental Sealant Programs

Research	+++
Expert Opinion	+++
Field Lessons	++
Theoretical Rationale	+++

See **Attachment A** for details.

I. Description

A. Dental Sealants

Dental sealants are clear or opaque plastic materials applied to the occlusal pit-and-fissure (biting) surfaces of teeth to prevent tooth decay (dental caries).Sealants prevent initiation and arrest progression of tooth decay by providing a physical barrier against microorganisms and food particles that collect in pits and fissures.(1) About 90 percent of decay occurs in the pits and fissures of permanent posterior teeth (2) with the molars being at highest risk.(3) National data show that children from low-income families have a significantly higher proportion of untreated caries compared to children from high-income families. Only 25% of 6–9 year olds from low-income families had sealants compared to 34% of children from high-income families (25.5%).(4)

The Surgeon General's Report *Oral Health in America: A Report of the Surgeon General* noted that sealants are an efficient use of resources when used in populations with higher-than-average disease incidence rates and when sealants are placed on teeth at highest risk for caries.(5)

Based on recommendations and reviews by a panel of experts supporting the Task Force on Community Preventive Services, the *Guide to Community Preventive Services* (The Community Guide) strongly recommends school-based and school-linked dental sealant delivery programs for preventing or reducing occlusal caries on posterior teeth of children.(6)

B. Dental Sealant Programs

Dental sealant programs generally are targeted to vulnerable populations less likely to receive dental care that could benefit from sealants, such as children eligible for free or reduced-cost meal

programs.(5) Schools are an ideal place to reach children. School-based sealant programs have been associated with reducing the incidence of tooth decay by 40 to 60 percent.(6, 7)

There are variations in how dental sealant programs are designed:

- **School-based programs** are conducted completely within the school setting, with teams of dental health professionals such as dentists or dental hygienists utilizing portable equipment or in a fixed clinical facility within the school setting or in a mobile dental van parked on school property.

- **School-linked programs** are connected with schools, but deliver the sealants at a site other than the school (e.g., a clinic or private dental office). School-linked programs may present information, distribute consent forms and conduct dental screening at schools.

- **Hybrid programs** incorporate school-based and school-linked services.

School-based and school-linked dental sealant programs have the potential to link students with treatment and ongoing care in a dental home in the community where dental care should be comprehensive, continuously accessible, coordinated, and family-centered. (8) Community-based sealant programs are not meant to be a replacement for a dental home.

Over the past four years the Synopses of State Dental Public Health programs has shown that more than 50% of the states/DC have programs for dental sealants (in one or more of the program design variations described previously). In FY 2011-2012, 68.6% of states/DC reported having a dental sealant program.(9)

In 2010 and 2011, the Pew Children's Dental Campaign assessed and graded 50 states/DC on eight policy benchmarks that ensure dental health and access to care for disadvantaged children.(10, 11) Two of these eight policy benchmarks focused on dental sealants (Table 1). The first benchmark was selected because children from low-income families are at higher risk for tooth decay and less likely to have received dental sealants compared to their higher-income counterparts.(4) Thus it is important to know the distribution of sealant programs in high-need schools that serve at risk children. The second benchmark addresses State Dental Practice Acts as research shows that sealant programs in states with less restrictive practice acts are more cost effective.(12)

Table 1: Pew Center on the States Sealant Policy Benchmarks 2010, 2011 (10, 11)

Policy Benchmark 1: Percentage of High-Need Schools with Sealant Programs

Percentage of high-need schools with sealant programs	Number of States 2010	2011
• 75-100%	3	2
• 50-74%	7	7
• 25-49%	7	12
• 1-24%	23	23
• None	11	7

Policy Benchmark 2: Rules Restricting Hygienists

State allows hygienists to provide sealants without a prior dentist's exam*	Number of States 2010	2011
• Yes	30	*
• No	21	*
• Yes (Exam never required)	*	16
• Yes (Exam sometimes required – some classifications of hygienists can place sealants without a prior exam)	*	13
• No (Exam always required)	*	12
• No (Exam and dentist's direct or indirect supervision required)	*	10

***response categories changed in 2010**

In 2013, Pew Children's Dental Campaign graded 50 States/DC on four benchmarks focusing on prevention and improving access to sealants among children.(7)

Table 2: Pew Center on the States Sealant Policy Benchmarks 2013 (7)	
Benchmark 1: Percentage of High-Need Schools with Sealant Programs	
Categories	**# of States**
• Programs reaching 75% or more of high-need schools	5
• Programs reaching 50-74% of high-need schools	10
• Programs reaching 25-49% of high-need schools	16
• Programs reaching less than 25% of high-need schools	15 + DC
• No programs	4
Benchmark 2: Rules Restricting Hygienists	
Categories	**# of States**
• A dentist's exam is not required prior to a hygienist placing a sealant in a school	15
• A dentist's exam is sometimes required in a school (e.g., certain classifications of dental hygienist, such as public health hygienists, can place sealants without a dentist's prior exam)	16
• A dentist's exam is always required in a school	
• A dentist's exam and indirect or direct supervision are required in a school	11 8 + DC
Benchmark 3: Collecting and Submitting Data to the National Oral Health Surveillance System	
Categories	**# of States**
• Submitted data within the past five years	31
• Participated, but no recent data	12
• Never participated	7 + DC
Benchmark 4: Meeting Healthy People 2010 Sealant Goal	
Categories	**# of States**
• Met the Sealant goal	10
• Did not meet the Sealant goal	40 + DC
Overall State Grades	
Categories	**# of States**
• **A (10-11 points)**	5
• **B (8-9 points)**	8
• **C (6-7 points)**	17
• **D (3-5 points)**	15
• **F (0-2 points)**	5 + DC

C. School-Based Dental Sealant Programs

Health care professionals often provide prevention services in schools to protect and promote the health of students. A school oral health promotion/disease prevention program may incorporate several elements, such as oral health education, dental screenings, topical fluoride and/or sealant applications, and referral for dental treatment. Primary dental care programs in school settings may also include sealants as part of basic restorative and preventive dental treatment. This Best Practice Report will, however, focus only on school-based sealant programs.

School-based dental sealant programs seek to ensure that children receive a highly effective dental prevention service through a proven community-based approach. Tooth decay disproportionately affects low-income children and children from racial and ethnic minority groups.(13) School-based sealant programs generally are designed to maximize effectiveness by targeting schools with high-risk children (those vulnerable populations less likely to receive dental care) such as children eligible for free and reduced-cost meal programs.

Children and their parents/guardians are made aware of the value and the availability of dental sealants through the school program. Once signed consent forms have been returned, children are evaluated for their sealant needs and dental professionals place the sealants. School-based sealant programs address the unmet needs of the children by placing sealants, facilitating referral and ensuring quality and continuity of care through retention checks, replacement of lost sealant material, and follow-up on any untreated dental disease.(14)
A state oral health program's role in school sealant programs may take the form of:
(a) providing direct service delivery,
(b) funding grants or contracts for sealant programs,
(c) managing a state-level program that provides vouchers for services in the community instead of direct services at the school,
(d) assisting with establishment of a "dental home,"
(e) setting standards for local direct service sealant programs, and/or
(f) facilitating and promoting private-public sealant program partnerships (e.g., schools and dental societies).

The following description of a school-based dental sealant program shows the attributes of a direct service delivery program, whether operated by a state or local agency or an organization:

1. **Deliver sealants to large numbers of high-risk children with susceptible permanent molar teeth.**

    - The program should serve a geographic area that has a critical mass of children who meet its eligibility criteria. Such areas could include urban neighborhoods or rural counties.

    - The goal of the program is to reach children who would be considered high-risk based on their socioeconomic status. Generally, eligibility for the free or reduced cost school meal program from the U.S. Department of Agriculture's National School Lunch Program has been used as a proxy for income and increased risk of untreated decay. Children from low-income families have been shown to be less likely to receive dental care than are children whose families do not meet the meal program criteria. Local standards will determine the acceptability of targeting children rather than schools.

    - In many locales, offering a sealant program only to children on the meal program may be viewed as stigmatizing and, therefore, unacceptable. Targeting schools based on the proportion of free or reduced cost meal program-eligible children, however, is generally acceptable. A minimum of 50 percent of the student enrollment eligible for the free and reduced meals is a common benchmark for school eligibility.

    - Generally, sealant programs target children in the second grade (for sealing the first permanent molars that typically erupt at ages 6 to 7) and sixth grade (for sealing the second permanent molars that typically erupt between 11 and 13 years of age). Targeting these grades maximizes the availability of susceptible molar teeth. Although some sixth graders may not have erupted second molars, this grade was chosen because program participation typically drops off for higher grades.

    - Obtaining signed parental consent forms is a critical component of successful school-based sealant programs. In general, signed consent form return rates are between 40 to 60%. Some of the reasons why parents may not sign consent forms are: a) failure of the child to bring the consent form home or give it to the parents, b) parent's lack of knowledge about the benefits of dental sealants, c) other health, social, cultural or family factors. To develop an effective program, the program administrators should try to reduce barriers and develop strategies to gain parental consent for students to receive dental sealants.

2. **Maximize program efficiency.**

   - The program staff, in conjunction with school staff, establishes an adequate flow of available children into the sealant placement area. School-based programs minimize the amount of time children are away from class and tend to maximize participation by increasing parent willingness to enroll children in the program.

   - The program operates in the least expensive and most productive manner possible, while maintaining quality standards. Sealant delivery with a two-person team using a four handed technique is more effective than using a single operator.(15)

   - On average, efficient school-based programs using four-handed technique can place dental sealants on 15-16 children per team per school day (typical school day is about 6.7 hours).(12) Programs must comply with state laws regarding delegable procedures and whether dentists need to conduct an initial exam to determine which teeth are to be sealed. However, significant cost savings may result from reducing the required level of supervision by a dentist.(12) Efficient use of resources generally directs a program to hire the least expensive qualified personnel permitted to perform the preventive procedures under state law. The program must provide adequate training and quality assurance.

   - For any program, choosing the right sealant material is important. The placement of sealant material demands meticulous application techniques and following the manufacturer's instructions.(6) Several sealant materials are available but the most commonly used are resin-based sealants and glass ionomer cements. When selecting the dental sealant material for use in a school-based dental sealant program, the main considerations should include cost-effectiveness of materials that: 1) have prolonged retention properties; 2) have low solubility in the oral environment; and 3) are simple to apply.(14)

3. **Maintain a quality assurance system.**

   - Patient/family procedures. A quality sealant program ensures confidentiality and treats children and families respectfully. A quality program should have direct communication with the parent/guardian of the child. Sealants will not be placed without written permission and a completed medical form. The program will provide the family with documentation of services provided.

   - Clinical procedures. A quality program will follow Centers for Disease Control and Prevention (CDC) infection control guidelines and the Occupational Safety and Health Administration (OSHA) guidelines and standards to promote worker safety and health with written policies and protocols in place. The program will stay abreast of the latest evidence-based studies focused on dental sealants, sealant material, and application techniques.

   - Family Educational Right and Privacy Act/Health Insurance Portability and Accountability Act (FERPA/HIPAA). Programs will be in compliance with laws that are in place to protect the privacy of student information. For more information: National Assn. of School Nurses: HIPAA & FERPA.

   - Quality Assurance. Technical quality generally refers to a high rate of retention for sealants (one-year retention rates of well-applied sealants usually averages between 80 to 90%). Sealant quality can be assessed by checking short-term retention rates or one -year retention rates or both on a sample of students who received dental sealants from the SBSP. Short term retention checks are done within one to two months of sealant placement and are helpful to evaluate staff performance, to identify needed protocol changes, and to determine the adequacy of material and equipment used. (14) Yearly retention checks are generally done during the next school year. If resources allow then retention checks should be completed on as many students as possible.

- Ensuring Appropriateness of the Program. Appropriateness can be evaluated by analyzing program participation to ensure children and schools in the program meet its eligibility criteria. Additionally, programs should ensure compliance with applicable state laws and professional standards and guidelines, including infection control.

4. Identify children with treatment needs and ensure that they receive appropriate dental care.

- When assessing the need for sealants, programs typically also identify children with treatment needs such as untreated decay and notify parents/guardians and school nurses. Ensuring that children receive appropriate dental care often is the most difficult aspect of a school-based sealant program. Ideally treatment needs will be met through linking a child to a dental home, which could include a broad base of locations, such as private dental providers, local health departments, non-profit public clinics, and community health centers.

- School-based dental professionals and community health workers can play an important role in helping to coordinate needed dental care and address potential barriers that interfere with parents pursuing care, finding dentists who will provide care to their children and assuring that children receive the recommended care.

5. Re-screen children within one year of initial sealant placement.

- Sealant retention and integrity can be checked and newly erupted teeth can be sealed during the following school year if the child has not moved and if consent is received Typically, children who received sealants in second grade are re-screened in third grade. Best practices guidelines recommend sealant retention checks to be performed within one year of sealant placement.

- The timing of sealant retention evaluation can depend on several factors such as local program objectives; changes in dental materials, techniques or personnel; and student movement in and out of the school and school district.(8)

- Evaluating sealants after placement is very important but may not be feasible for all programs. However, even if the follow-up cannot be ensured, high-risk children should still receive sealants.(6)

6. Maintain descriptive program data.

Program data should reflect the program's ability to reach its goals and objectives. Baseline data should be established to track progress towards program goals.

Descriptive program data may include:

- An estimate of the percentage of eligible schools (e.g., schools with 50 percent or more of the students eligible for the free and reduced lunch program) in the state served by sealant programs (generally each state's Department of Education website has the list of public schools with percentage of children on free and reduced lunch program). National statistics on distribution of public schools by free and reduced lunch program can be found on the National Center for Education Statistics website.

- An estimate of the number and percentage of all high-risk children in the state who receive sealants through the program.

- Number of consent forms returned.

- Rates of participation. Number of children screened and number of children who received sealants.

- Calculating and comparing caries incidence (new areas of tooth decay) in children who participated in the sealant program and received sealants. For example, comparing cohort data from 2012 to 2013.

- An estimate of the cost per child screened (including costs of referrals for care) and cost per child who receives sealants. These will provide suitable benchmarks for program efficiency.(16, 17) Methods used by states to estimate cost per child or per sealant are not standardized (e.g., cost of equipment, sealant supplies and materials, travel and/or administrative time may or may not be included in estimating cost). Note that depending on the tooth selection criteria, assessment of the number of teeth sealed or the cost per tooth sealed should identify if low-risk teeth, such as premolars, routinely were also sealed.

One option for maintaining sealant program data is SEALS (Sealant Efficiency Assessment for Locals and States), a software program developed by the Centers for Disease Control and Prevention (CDC) that aids in the evaluation of sealant program effectiveness and efficiency. This Excel-based software automates the capture, storage, and analysis of oral health status of participants, the type and number of delivered services, and event costs and logistics. SEALS generate summaries and performance measures such as cost per child receiving sealants, sealant retention, averted caries, and children sealed per chair-hour. Companion software, SEALS_Admin, uses data from individual local sealant programs to calculate statewide values of the summary and performance measures and ranks individual programs on 15 performance measures. SEALS data can be used to estimate the cost and impact of a sealant program. Data also can be used to compare school sealant events by need, cost and efficiency, enabling programs to allocate resources more efficiently. The software can help programs identify areas where they are less efficient and then set goals for improvement.

7. Sustainability.

The program's sustainability can be demonstrated by having an ongoing plan for covering program expenses. This may include a recurring line item in the state or municipal budget, a mechanism for collecting Medicaid reimbursements, or recurring grant funding. Some state agencies may enter into creative partnerships with community groups or funders to sustain the program.

II. Objectives, Guidelines & Recommendations from Authoritative Sources

Objectives.

Table 3: Healthy People 2020 Oral Health Objective
OH-12: Increase the proportion of children and adolescents who have received dental sealants on their molar teeth. (18)

Objective	Baseline*	Target
12.1: Increase the proportion of children aged 3-5 years who have received dental sealants on one or more of their primary molar teeth	1.4 % of children aged 3-5 years received dental sealants on one or more of their primary molars in 1999–2004	**1.5%**
12.2: Increase the proportion of children aged 6-9 years who have received dental sealants on one or more of their permanent first molar teeth	25.5 % of children aged 6-9 years received dental sealants on one or more of their first permanent molars in 1999–2004	**28.1%**
12.3: Increase the proportion of adolescents aged 13-15 years who have received dental sealants on one or more of their permanent molar teeth	19.9 % of adolescents aged 13-15 years received dental sealants on one or more of their first permanent molars and one or more second permanent molars in 1999–2004	**21.9 %**
***Data Source:** National Health and Nutrition Examination Survey (NHANES), CDC, NCHS **(13)**		

Sealant programs focus on permanent molars because caries risk on other teeth with pits and fissures is considerably lower.(3) Although sealants can be placed on the pits and fissures of children's premolars, maxillary incisors and primary molars, the situations in which such use would be appropriate may be limited.

Guidelines and Recommendations: In 2009, CDC and a workgroup of recognized experts in sealant research, practice, and policy, and experts in caries assessment, prevention, and treatment published guidelines for sealant use in school-based programs.(8) These guidelines are based on current scientific evidence and provide guidance in planning, implementing and evaluating school-based sealant programs (Table 4).

Table 4: Recommendations for School-based Sealant Programs

Topic	Recommendation
Indications for sealant placement	Seal sound and non-cavitated pit and fissure surfaces of posterior teeth, with first and second permanent molars receiving highest priority.
Tooth surface assessment	Differentiate cavitated and non-cavitated lesions. ○ Unaided visual assessment is appropriate and adequate. ○ Dry teeth prior to assessment with cotton rolls, gauze, or, when available, compressed air. ○ An explorer may be used to "gently" confirm cavitation (i.e., breaks in the continuity of the surface); do not use a sharp explorer under force. ○ Radiographs are unnecessary solely for sealant placement. ○ Other diagnostic technologies are not required.
Sealant placement and evaluation	Clean the tooth surface. ○ Toothbrush prophylaxis can be used. ○ Additional surface preparation methods, such as air abrasion or enameloplasty, are not recommended. ○ Use a four-handed technique, when resources allow. ○ Seal teeth of children even if follow-up cannot be ensured. ○ Evaluate sealant retention within one year.

III. Research Evidence

The Community Preventive Services Task Force recommends school-based dental sealant programs based on strong evidence of effectiveness in preventing caries in children.(6) A 2013 Cochrane Collaboration review of sealant studies found that sealant placement on the occlusal surfaces of the permanent molars in children and adolescents reduces caries by 81% when compared to no sealant when followed up to two years.(6, 19)

The Community Guide (2013) found that the adjusted median decrease in caries on the occlusal surfaces of posterior teeth in children due to sealant placement was 40%. School-based sealant programs become more cost-effective as the caries risk of the targeted students increases. (20-22) For programs targeting high-risk schools, sealing all children offers higher cost-savings than trying to identify and seal only high-risk children.(23) In schools where as few as 20% of students are high-risk, delivering sealants to all children improves oral health outcomes at a small cost (8 cents per cavity-free month per tooth).(24) School-based sealant programs can also reduce racial, ethnic and economic disparities in the prevalence of dental sealants.(8, 25)

IV. Best Practice Criteria

For the best practice approach of **School-based Dental Sealant Programs**, the ASTDD Best Practices Committee has proposed the following **initial review standards** for five best practice criteria:

1. **Impact/Effectiveness:**
    - The program delivers services to large numbers of high-risk children with susceptible permanent molar teeth.
    - The program maintains a quality assurance system that includes technical quality (the sealants placed have a high rate of retention) and appropriateness (the children receiving sealants are at high caries risk).
2. **Efficiency:**
    - The program uses the least expensive personnel permitted by state laws to screen children and deliver dental sealants with adequate training and quality assurance.
3. **Demonstrated Sustainability:**
    - The program demonstrates sustainability by establishing a track record or a reasonable plan for covering program expenses.
4. **Collaboration/Integration:**
    - Collaborative partnerships are established to administer and sustain the program.
5. **Objectives/Rationale:**
    - The program's goals and objectives are linked to the state and/or national oral health goals and objectives.

V. State Practice Examples

During the first phase of the ASTDD Best Practices Project, states submitted descriptions of their successful practices to share their experiences and implementation strategies. The following practice examples illustrate various elements or dimensions of the best practice approach for **School-based Dental Sealant Programs**. These reported success stories should be viewed in the context of the individual state and program environment, infrastructure and resources. End-users are encouraged to review the practice descriptions (click on the links of the practice names) and adapt ideas for a better fit to their states and programs.

A. Summary Listing of Practice Examples

In FY 2013-2014, five states updated practice descriptions of their **school-based dental sealant programs** to the ASTDD Best Practices Committee and six states provided new submissions. These programs illustrate substantial elements of the model school-based sealant program described in Section I-C. See **Figure 1**. Each practice name is linked to a detailed description report.

Figure 1.

State Practice Examples of School-based Dental Sealant Programs

Item	Practice Name	State	Practice #
1	Arizona Dental Sealant Program	AZ	04006
2	Cost Study of Colorado School-based Dental Sealant Programs	CO	07005
3	Georgia's State School-based Dental Sealant Program	GA	12006
4	Illinois Dental Sealant Grant Program	IL	16004
5	Kansas School Oral Health Programs	KS	19014
6	SEAL! Michigan School-based Dental Sealant Program	MI	25007
7	Southern Nevada Dental Initiative-Future Smiles School-based Prevention Program	NV	31008
8	New Mexico School-linked Dental Sealant Program	NM	34001
9	The Ohio Department of Health Dental School-based Sealant Program	OH	38002
10	Oregon School-based Dental Sealant Program	OR	40007
11	Wisconsin Seal-A-Smile	WI	56004

B. Highlights of Practice Examples

AZ Arizona Dental Sealant Program (Practice #04006)
The Arizona Department of Health, Bureau of Women's and Children's Health, Office of Oral Health has administered the Arizona Dental Sealant Program since 1987. This school-based dental sealant program targets children in 2nd and 6th grades attending eligible schools in Arizona. Eligible schools are public and charter schools with a high proportion of students participating in the National School Lunch Program (free and reduced lunch program). All children in 2nd and 6th grade attending eligible schools are entitled to receive a dental screening; those who are uninsured, Medicaid and SCHIP beneficiaries, covered by Indian Health Services or by a state-funded primary care health care program and do not have private dental insurance also qualify for dental sealants. Counties and individual providers are contracted by the state Office of Oral Health to implement the program.

CO Cost Study of Colorado School-based Dental Sealant Programs (Practice #07005)
The Cost Study of Colorado School-based Sealant Programs (SBSP) was designed to analyze existing SBSP utilization data, recorded in the using the Sealant Efficiency Assessment for Locals

and States (SEALS) software, collect and analyze SBSP cost information, and use the SEALS and cost data to develop an economic model to estimate potential cost savings associated with SBSP implementation during the 2010-2011 academic year. Researchers from the Colorado School of Public Health at the University of Colorado Denver conducted the work. The project totaled $97,855 and the work was conducted over a 20.5 month period (4/15/2010 - 12/31/2011). The funding included indirect costs billed as part of the university contract.

GA Georgia's State School-based Dental Sealant Program (Practice #12006)
The Georgia dental sealant program is a school-based program designed to provide eligible students with dental sealants on their first and second permanent molars to prevent tooth decay. The Georgia Third Grade Oral Health BSS, in 2011, found 52% of 3rd grade children in Georgia have a history of tooth decay; 19% have untreated tooth decay; only 37% of 3rd grade children in GA have protective sealants on their 1st permanent molars.
The Georgia Oral Health Prevention Program (GOHPP) provides funds to support the School-Based Sealant Program (S-BSP) targeting high-risk schools, those with large proportions of students from families with low-income. In 2009, 45 of the state's sealant programs were funded by the GOHPP and approximately 3000 sealants were placed on schoolchildren. The GOHPP funds originated from the Maternal and Child Health Block (MCHB) grant as well as state general funds.

IL Illinois Dental Sealant Grant Program (Practice #16004)
The **Dental Sealant Grant Program** (DSGP) assists Illinois schoolchildren who are most at risk for dental caries by providing granting funds, technical assistance and training to public health departments and to other service providers to develop and to implement community-based oral health programs. This school-based/linked program includes: preventive oral health care, oral health education and case management to dental homes. It has been the catalyst for expanding community-based oral health programs throughout the state. It is an essential component to a continuum of oral health care focusing on children and their families who are at the most risk for dental disease. In FY 13, the DSGP currently exists in 72 of the 102 counties in the state and serves approximately 180,000 children placing over 400,000 sealants annually. Since the program's inception in 1986, there more than 1 million children have been seen and more than 2 million sealants placed.

KS Kansas School Oral Health Programs (Kansas School Screening Program and Kansas School Sealant Program) (Practice #19014)
Kansas has two school oral health programs, the Kansas School Screening Program and the Kansas School Sealant Program, that are administered by the Bureau of Oral Health (BOH). The state has a law that requires each child to have an annual "dental inspection." In 2007 the Bureau of Oral Health received a state foundation grant to create a standardized screening protocol and an online data collection system. The protocol mimics the Basic Screening Survey and uses volunteer dental professional screeners to collect and input the screening data. The Screening Program provides the Bureau with school, county and statewide data on children K-12. In the 2011-2012 school year the Screening Program was in 46% of all Kansas public schools. A searchable database of the oral health data is publically available at the Bureau's website.

MI SEAL! Michigan School-Based Dental Sealant Program (Practice #25007)
The Michigan Department of Community Health's SEAL! Michigan dental sealant program works to prevent dental disease through prevention. SEAL! Michigan provides dental sealants, fluoride varnish, and oral health education to students in Michigan in their school settings. By utilizing Registered Dental Hygienists who travel to schools to provide prevention services onsite, cost saving is realized. The SEAL! Michigan program delivers dental sealants, fluoride varnish, and oral health education to children for less than $100 per student. Since the inception of the dental sealant program in 2007, thousands of children have received dental sealants. For the 2009-2010 school year, the program served 85 schools, screened 3,029 students and 214 students with special needs, and provided 11,426 sealants to 1,853 students. Surveys in 2006 and 2010 showed an increased in percentage of 3rd grade children with dental sealants, from 23.3% to 26.4%, closer to reaching the Healthy People 2020 target of 28.1%.

NV Southern Nevada Dental Initiative – Future Smiles School-based Prevention Program (Practice #31008)
Future Smiles is a Nevada non-profit, 501(c) (3) IRS status, school-based prevention program that provides services to children who attend higher-risk schools with greater than 50% free and reduced meal program enrollment (FRL). Children served by the program are from families living well below the federal poverty guidelines (FPL), Medicaid/CHIP enrollees as well as children who are uninsured/underinsured living in Southern Nevada. All at-risk children enrolled at the schools are eligible for services.

NM School Based Dental Sealant Program (Practice #34001)
The New Mexico Department of Health (DOH), Office of Oral Health (OOH) administers a school-based dental sealant program that provides oral health education, dental screenings, and dental sealant applications on first and second molars. The dental sealant program was developed to provide preventive services for school children to reduce tooth decay, since many low-income children have limited or no access to preventive dental care. In rural areas, all elementary school children are eligible to participate in the dental sealant program. In urban areas, the services are limited to the first, second and third grade students. The program is supported by state staff and by contracted private dental providers. Program services are offered at no cost to the parents or guardians and to participating schools. Elementary schools qualify for the program if they have at least 50% or more of its student population on the free and reduced school lunch program. FY 12 the State of New Mexico allocated an estimated $681,499.00 general fund for the state dental sealant program. For the 2012 school year: 6,254 students participated in the program with a total of 19,075 molars being sealed.

OH The Ohio Department of Health Dental School-Based Sealant Program (Practice #38002)
The Ohio Department of Health's (ODH) School-based Oral Health Program provides grants to support school-based sealant programs (SBSPs) targeting higher-risk schools, those with large proportions of students from families with low-incomes. In 2012, 18 of the state's 21 SBSPs were funded by ODH and provided sealants to 25,321 schoolchildren. The ODH grant funds originate from Ohio's Federal Maternal and Child Health (MCH) Block Grant. In 2010, a HRSA Oral Health Workforce grant supported the expansion of SBSPs. Grantee agencies include: local health departments, school systems, private not-for-profit agencies, and hospitals. Findings from the ODH's 2009-10 oral health survey of schoolchildren indicate that SBSPs, targeted to groups at higher- risk for dental caries and least likely to receive regular dental care have substantially increased sealant prevalence and reduced disparity in schools reached by the program. The prevalence of sealants among third grade students in schools with dental sealant programs is approximately 1.5 times greater than for students in schools without sealant programs. Just over 50 percent of all Ohio third graders have at least one or more sealants on their permanent molar teeth, meeting the HP2010 objective regardless of racial group or income. In 2013, the ODH began implementing a pilot collaboration between two safety net dental care programs and SBSPs in Northeast Ohio to provide follow-up care to students identified as needing dental treatment. As part of the ODH Quality Assurance Plan, the ODH initiated formalized biennial "check-in" calls to discuss with SBSPs their progress toward meeting ODH benchmarks and their sealant targets for the year.

OR Oregon School-based Dental Sealant Program (Practice #40007)
The **Oregon Health Authority's (OHA's) Dental Sealant Program (DSP)** targets schools where at least 50% of the students are eligible for the Federal Free-and-Reduced Lunch Program. In the participating schools, all 1st and 2nd graders with parental permission receive a screening, and sealants are placed when appropriate (1st-5th graders in very small schools). Children with immediate dental needs are referred for care through coordination with the school nurse. Local resources such as Coordinated Care Organizations (Oregon's Medicaid program), Dental Care Organizations, and community health clinics that offer dental services are utilized.

WI Wisconsin Seal-A-Smile (Practice #56004)

The Wisconsin Seal-A-Smile (SAS) school-based dental sealant program began providing dental sealants to low-income children across the state of Wisconsin in 1999. The Wisconsin Department of Health Services (DHS) has provided ongoing funding for the SAS program since its inception. DHS, in collaboration with Children's Health Alliance of Wisconsin (Alliance), provides program support and monitors all aspects of the school-based dental sealant program. Local programs apply annually for mini-grants to support their dental sealant programs. Local public health departments, community health centers, hospitals, school districts, dental and dental hygiene schools, independent dental hygienists and dental clinics are the recipients of these grants ranging in size from $1,000 to $75,000.

VI. Acknowledgements

This updated report is the result of efforts by ASTDD to identify and provide information on developing successful practices that address the oral health care needs of infants, toddlers and preschool children.

The ASTDD Best Practices Committee extends a special thank you to Dr. Shillpa Naavaal, BDS, MPH, MS, Dental Public Health Resident at CDC (2012-2013), for her help in preparation of this report.

This publication was supported by Cooperative Agreement 1U58DP004919-01 from CDC, Division of Oral Health.

Suggested citation: Association of State and Territorial Dental Directors (ASTDD) Best Practices Committee. Best practice approach: school-based dental sealant programs [monograph on the Internet]. Reno, NV: Association of State and Territorial Dental Directors; 2014 August 18.16p. Available from: http://www.astdd.org.

VII. Attachment

Strength of Evidence Supporting Best Practice Approaches

The ASTDD Best Practices Committee takes a broad view of evidence to support best practice approaches for building effective state and community oral health programs. The Committee evaluated evidence in four categories: research, expert opinion, field lessons and theoretical rationale. Although all best practice approaches reported have a strong theoretical rationale, the strength of evidence from research, expert opinion and field lessons fall within a spectrum. On one end of the spectrum are promising best practice approaches, which may be supported by little research, a beginning of agreement in expert opinion, and very few field lessons evaluating effectiveness. On the other end of the spectrum are proven best practice approaches, ones that are supported by strong research, extensive expert opinion from multiple authoritative sources, and solid field lessons evaluating effectiveness.

Promising Best Practice Approaches			**Proven Best Practice Approaches**	
Research	+	⇨ ⇨	Research	+++
Expert Opinion	+		Expert Opinion	+++
Field Lessons	+		Field Lessons	+++
Theoretical Rationale	+++		Theoretical Rationale	+++

Research

- \+ A few studies in dental public health or other disciplines reporting effectiveness.
- ++ Descriptive review of scientific literature supporting effectiveness.
- +++ Systematic review of scientific literature supporting effectiveness.

Expert Opinion

- \+ An expert group or general professional opinion supporting the practice.
- ++ One authoritative source (such as a national organization or agency) supporting the practice.
- +++ Multiple authoritative sources (including national organizations, agencies or initiatives) supporting the practice.

Field Lessons

- \+ Successes in state practices reported without evaluation documenting effectiveness.
- ++ Evaluation by a few states separately documenting effectiveness.
- +++ Cluster evaluation of several states (group evaluation) documenting effectiveness.

Theoretical Rationale

- +++ Only practices which are linked by strong causal reasoning to the desired outcome of improving oral health and total well-being of priority populations will be reported on this website.

VIII. Resources

1) Seal America
2) CDC School-Based Dental Sealant Programs
3) NIDCR- Sealants
4) Arkansas PANDA Program
5) Maryland - Guidelines & Operations Manual
6) Ohio – School-Based Dental Sealant Program Manual
7) OSAP- Portable and Mobile Oral Health Settings References and Resources
8) Confidentiality in School-Based Health Services: Understanding HIPAA & FERPA
9) DHHS & Dept. of Education: FERPA & HIPAA
10) ADA- Pit-and-Fissure Sealants
11) CDHP- Dental Sealants: Proven to Prevent Tooth Decay

IX. References

1. Beauchamp J, Caufield PW, Crall JJ, Donly K, Feigal R, Gooch B, et al. Evidence-based clinical recommendations for the use of pit-and-fissure sealants: a report of the American Dental Association Council on Scientific Affairs. J Am Dent Assoc. 2008 03/;139(3):257-68.
2. Kaste LM, Selwitz RH, Oldakowski RJ, Brunelle JA, Winn DM, Brown LJ. Coronal caries in the primary and permanent dentition of children and adolescents 1-17 years of age: United States, 1988-1991. J Dent Res. 1996 Feb;75 Spec No:631-41. PubMed PMID: 8594087.
3. Macek MD, Beltran-Aguilar ED, Lockwood SA, Malvitz DM. Updated comparison of the caries susceptibility of various morphological types of permanent teeth. J Public Health Dent. 2003 /;63(3):174-82.
4. Dye BA, Li X, Thornton-Evans G. Oral Health Disparities as Determined by Selected Healthy People 2020 Oral Health Objectives for the United States, 2009-2010: National Center for Health Statistics; 2012.
5. US Department of Health and Human Services. Oral health in America: A report of the Surgeon General. US Department of Health and Human Services, National Institutes of Health, National Institute of Dental and Craniofacial Research Rockville, MD; 2000.
6. Guide to Community Preventive Services. Preventing dental caries: school-based dental sealant delivery programs 2013.
7. PEW Center on the States. Falling Short Most States Lag on Dental Sealants. The Pew Charitable Trusts; 2013.
8. Gooch BF, Griffin SO, Gray SK, Kohn WG, Rozier RG, Siegal M, et al. Preventing dental caries through school-based sealant programs: updated recommendations and reviews of evidence. J Am Dent Assoc. 2009 11/;140(11):1356-65.
9. Association of State and Territorial Dental Directors. Synopses of State Dental Public Health Programs. Data for FY 2011-2012. 2013.
10. PEW Center on the States. The Cost of Delay State Dental Policies Fail One in Five Children. The Pew Charitable Trusts; 2010.
11. PEW Center on the States. The State of Children's Dental Health: Making Coverage Matter. The Pew Charitable Trusts; 2011.

12. Scherrer CR, Griffin PM, Swann JL. Public health sealant delivery programs: optimal delivery and the cost of practice acts. Medical decision making : an international journal of the Society for Medical Decision Making. 2007 Nov-Dec;27(6):762-71. PubMed PMID: 17585006.
13. Dye BA, Tan S, Smith V, Lewis BG, Barker LK, Thornton-Evans G, et al. Trends in oral health status: United States, 1988-1994 and 1999-2004. Vital Health Stat 11. 2007 04/(248):1-92.
14. Carter NL, with the American Association for Community Dental Programs and the National Maternal and Child Oral Health Resource Center. Seal America: The Prevention Invention (2nd ed., rev.). Washington, DC: National Maternal and Child Oral Health Resource Center, 2011.
15. Griffin SO, Jones K, Gray SK, Malvitz DM, Gooch BF. Exploring four-handed delivery and retention of resin-based sealants. J Am Dent Assoc. 2008 Mar;139(3):281-9; quiz 358. PubMed PMID: 18310732.
16. Task Force on Community Preventive S. Recommendations on selected interventions to prevent dental caries, oral and pharyngeal cancers, and sports-related craniofacial injuries. Am J Prev Med. 2002 Jul;23(1 Suppl):16-20. PubMed PMID: 12091092.
17. Ohio Department of Health. School-based Dental Sealant Program Manual. Bureau of Community Health Services and Patient-Centered Primary Care; 2012.
18. U.S. Department of Health and Human Services. Healthy People 2020. Washington, DC. : Office of Disease Prevention and Health Promotion. . Available from: http://www.healthypeople.gov/2020/topicsobjectives2020/objectiveslist.aspx?topicId=32.
19. Ahovuo-Saloranta A, Forss H, Walsh T, Hiiri A, Nordblad A, Makela M, et al. Sealants for preventing dental decay in the permanent teeth. Cochrane database of systematic reviews. 2013;3:CD001830. PubMed PMID: 23543512.
20. Siegal MD, Detty AM. Do school-based dental sealant programs reach higher risk children? J Public Health Dent. 2010 Summer;70(3):181-7. PubMed PMID: 20149063.
21. Siegal MD, Detty AM. Targeting school-based dental sealant programs: who is at "higher risk"? J Public Health Dent. 2010 Spring;70(2):140-7. PubMed PMID: 20050991.
22. Truman BI, Gooch BF, Sulemana I, Gift HC, Horowitz AM, Evans CA, et al. Reviews of evidence on interventions to prevent dental caries, oral and pharyngeal cancers, and sports-related craniofacial injuries. Am J Prev Med. 2002 Jul;23(1 Suppl):21-54. PubMed PMID: 12091093.
23. Griffin SO, Griffin PM, Gooch BF, Barker LK. Comparing the costs of three sealant delivery strategies. J Dent Res. 2002 09/;81(9):641-5.
24. Quinonez RB, Downs SM, Shugars D, Christensen J, Vann WF. Assessing cost-effectiveness of sealant placement in children. J Public Health Dent. 2005 /;65(2):82-9.
25. Centers for Disease Control and Prevention. Impact of Targeted, School-Based Dental Sealant Programs in Reducing Racial and Economic Disparities in Sealant Prevalence Among Schoolchildren: Ohio, 1998--1999. MMWR, Morbidity and Mortality weekly report. 2001;50(34):736-8.

Dental Sealants and Bisphenol A (BPA) Policy Statement
Association of State and Territorial Dental Directors (ASTDD)
Adopted: February 3, 2011

Problem

Pit-and-fissure sealants have been used effectively as part of a comprehensive approach to caries prevention for children and adults on an individual basis or as a public health measure for at-risk populations.[1] Bisphenol A (BPA), a chemical used to manufacture polycarbonate plastics and found in many food and drink containers as well as dental sealant and composite resin materials, may cause some adverse health effects such as problems with reproduction and development.[2] A recent systematic review examining the existence of BPA in dental materials and its relationship to any potential health risks recommends continued use of these dental products for children, with firm adherence to precautionary application techniques.[3] However, the same systematic review, advises pregnant women to defer elective dental treatment with composite and sealants. The American Dental Association (ADA) and experts from the American Academy of Pediatric Dentistry (AAPD) reviewed the evidence and concluded that dental sealants should still be recommended for all populations because the purported risks were minimal and could be controlled by routine operative procedures.

Methods

Placement of resin-based sealants on the permanent molars of children is effective for caries reduction.[4] Sealants can be used in primary prevention[5] or secondary prevention of dental caries.[6] Working with partners at local and state levels, school-based sealant programs help students with limited access to dental care receive dental services. Those programs are recommended on the basis of strong evidence of effectiveness in reducing caries on occlusal surfaces of posterior teeth among children.[1]

Resins in sealants and composites are composed primarily of BPA derivatives rather than pure BPA.[3] BPA may be released from dental resins in sealants and composites through salivary enzymatic hydrolysis of BPA derivatives, and BPA is detectable in small amounts in saliva for up to three hours after resin placement.[3] However, this finding was not consistent among all studies; other in-vitro studies failed to detect any traces of BPA derivatives over a period of ten days.[7,8,9] The quantity and duration of systemic BPA absorption from dental resins is not clear from the available data.[3] However, the amount of the dental sealant material usually used in children does not influence the serum concentration levels of BPA.[10]

Dental sealant and composite product selection is important since dental resin materials contain different molecular formulations that determine the release of BPA. Dental products containing the bisphenol A derivative glycidyl dimethacrylate (bis-GMA) are less likely to be hydrolyzed to BPA so there is less risk of BPA absorption and subsequent possible adverse health effects than those containing bisphenol A

dimethacrylate (bis-DMA).[3] Studies have consistently shown that bis-DMA hydrolyzes to BPA on contact with salivary esterases.[11,12] This process does not occur with bis-GMA making bis-GMA based resins preferable in terms of adverse health effects rather than bis-DMA based products.[11,12,13]

Bis-GMA-based resins seem to be used most commonly in the U.S. market according to a listing of products with the greatest market share[14] and the monomer compositions listed on current material safety data sheets (MSDSs).[3] Most other BPA derivatives used in dental materials have not been evaluated for adverse health effects.

The literature suggests the following simple precautionary application techniques that can be used to considerably reduce BPA exposure:

- Adequate light curing[15] that incorporates a longer curing time with lower intensity lights results in less cytotoxicity and less release of the unpolymerized components,[16,17]
- Rinsing the mouth for about 30 seconds following application of a dental sealant with water or saline solution or rubbing the sealant using a mild abrasive such as pumice, either on a cotton applicator or a prophy cup is suggested to be effective in minimizing the monomers release,[18] and,
- Further, temporarily blocking off the sealed area with a rubber dental dam also helps in minimizing the leach of the monomers to the saliva.

The ADA and key government agencies concur that there is a lack of evidence and toxicological information demonstrating that the low-level of BPA exposure that may result from dental sealants and composites poses any known health threat.[19] The Department of Health and Human and Services considers population exposure to BPA from dental sealants low and infrequent.[20] In addition, the Food and Drug Administration (FDA) asserts that FDA-regulated products on the market that contain BPA are safe.[21]

Policy Statement

The Association of State and Territorial Dental Directors supports and recommends the continued use of composites and dental sealants for all populations.

---

[1] Task Force on Community Preventive Services. Recommendations on selected interventions to prevent dental caries, oral and pharyngeal cancers, and sports-related craniofacial injuries. *Am J Prev Med*. 2002;23(1S):16-20. http://www.community guide.org/oral/ajpm-recs.pdf. Accessed September 23, 2010.

[2] Bisphenol A (BPA) Fact Sheet. Centers for Disease Control and Prevention Web site. http://www.cdc.gov/exposurereport/BisphenolA_FactSheet.html. Published January 2010. Accessed September 22, 2010.

[3] Fleisch AF, Sheffield PE, Chinn C, Edelstein BL, Landrigan PJ. Bisphenol A and related compounds in dental materials. *Pediatrics*. 2010;126(4):760-768.

[4] Llodra JC, Bravo M, Delgado-Rodriguez M, Baca P, Galvez R. Factors influencing the effectiveness of sealants--a meta-analysis. *Community Dent Oral Epidemiol*. 1993;21(5):261-268.

[5] Griffin SO, Oong E, Kohn W, Vidakovic B, Gooch BF. CDC Dental Sealant Systematic Review Work Group, Bader J, Clarkson J, Fontana MR, et al. The effectiveness of sealants in managing carious lesions. *J Dent Res*. 2008;87(2):169-174.

[6] Oong EM, Griffin SO, Kohn W, Gooch BF, Caufield PW. The effect of dental sealants on bacteria levels in caries lesions: a review of the evidence. *J Am Dent Assoc.* 2008;139(3):271-278.
[7] Geurtsen W, Spahl W, Leyhausen G. Variability of cytotoxicity and leaching of substances from four light-curing pit and fissure sealants. *J Biomed Mater Res*. 1999;44(1):73-77.
[8] Hamid A, Hume WR. A study of component release from resin pit and fissure sealants in vitro. *Dent Mater*. 1997;13(2):98-102.
[9] Lewis JB, Rueggeberg FA, Lapp CA, Ergle JW, Schuster GS. Identification and characterization of estrogen-like components in commercial resin-based dental restorative materials. *Clin Oral Investig*. 1999;3(3):107-113.
[10] Zimmerman-Downs JM, Shuman D, Stull SC, Ratzlaff RE. Bisphenol a blood and saliva levels prior to and after dental sealant placement in adults. *J Dent Hyg*. 2010;84(3):145-150.
[11] Schmalz G, Priess A, Arenholt-Bindslev D. Bisphenol-A content of resin monomers and related degradation products. *Clin Oral Investig*. 1999;3(3):114-119.
[12] Arenholt-Bindslev D, Breinholt V, Preiss A, Schmalz G. Time-related bisphenol-A content and estrogenic activity in saliva samples collected in relation to placement of fissure sealants. *Clin Oral Investig.* 1999; 3(3):120-125.
[13] Tarumi H, Imazato S, Narimatsu M, Matsuo M, Ebisu S. Estrogenicity of fissure sealants and adhesive resins determined by reporter gene assay. *J Dent Res*. 2000;79(11):1838-1843.
[14] Strategic Dental Marketing Inc. 2008. Cited by: Fleisch AF, Sheffield PE, Chinn C, Edelstein BL, Landrigan PJ. Bisphenol A and related compounds in dental materials. *Pediatrics*. 2010;126(4):760-768.
[15] Aranha AM, Giro EM, Souza PP, Hebling J, de Souza Costa CA. Effect of curing regime on the cytotoxicity of resin-modified glass-ionomer lining cements applied to an odontoblast-cell line. *Dent Mater.* 2006;22(9):864-869.
[16] Brackett MG, Bouillaguet S, Lockwood PE, et al. In vitro cytotoxicity of dental composites based on new and traditional polymerization chemistries. *J Biomed Mater Res B Appl Biomater*. 2007;81(2):397-402
[17] Knezevic A, Zeljezic D, Kopjar N, Tarle Z. Cytotoxicity of composite materials polymerized with LED curing units. *Oper Dent* 2008;33(1):23-30
[18] Azarpazhooh A, Main PA. Is there a risk of harm or toxicity in the placement of pit and fissure sealant materials? A systematic review. *J Can Dent Assoc*. 2008; 74(2):179-183.
[19] Council on Scientific Affairs Statement. Bisphenol A and dental materials. American Dental Association Web site. http://www.ada.org/1766.aspx. Published July 2010. Accessed November 17, 2010.
[20] Center for the Evaluation of Risks to Human Reproduction. Research Triangle Park, NC: National Toxicology Program, National Institutes of Health. *NTP-CERHR monograph on the potential human reproductive and development effects of Bisphenol A.* NIH Publication No. 08-5994. http://cerhr.niehs.nih.gov/evals/bisphenol/bisphenol.pdf. Published September 2008. Accessed November 17, 2010.
[21] U.S. Food and Drug Administration. Update on Bisphenol A for Use in Food Contact Applications: January 2010. U.S. Food and Drug Administration Web site. http://www.fda.gov/NewsEvents/PublicHealthFocus/ucm197739.htm#current. Updated March 22, 2010. Accessed September 23, 2010.

Program Implementation and Outreach Protocol

All school-based sealant program staff should use the following steps to implement the I-Smile™ @ School program in new schools. These steps will ensure a uniform process of school outreach and program execution.

Step 1. Contact Superintendent

Once the targeted school(s) for the I-Smile™ @ School program has been identified, send the following information to the school district superintendent to describe the program and its intent:

- Introductory letter
- I-Smile™ @ School Fact Sheet
- I-Smile™ @ School Questions and Answers for School Staff

A Sample Letter to Superintendents template may be found on page 905.1.

Approximately 10 days after the letter is sent, provide a follow-up call to the superintendent to confirm their support.

Step 2. Contact Principal

Once a superintendent has agreed to participate in the I-Smile™ @ School program, contact the school principal to provide the following program information:

- Introductory letter (with "carbon copy" to the school nurse)
- I-Smile™ @ School Fact Sheet
- I-Smile™ @ School Questions and Answers for School Staff
- Blank consent form

A Sample Letter to Principals template may be found on page 906.1. The I-Smile™ @ School Fact Sheets may be found on pages 902.1 and 903.1. The I-Smile™ @ School Questions and Answers for School Staff form may be found on page 904.1.

Approximately 10 days after the letter is sent, provide a follow-up call to the principal to confirm the letter was received and confirm school contact information and dates. Class lists of targeted grades should be requested at this time, which should include teacher names.

Step 3. Contact School Nurse to schedule

Schedule a date for the program as far in advance as possible to allow for sufficient time to distribute and collect consent forms, educate school staff, and prepare materials. Check with the principal, school nurse, teachers, and/or secretary to ensure there are no field trips, special testing, special guests, parties, etc., scheduled for the classes and/or children being served.

Step 4. Provide Teacher information

At least one month prior to the start of the I-Smile™ @ School program, provide the following information to all teachers whose classrooms are participating:

- Introductory letter
- I-Smile™ @ School Fact Sheet
- I-Smile™ @ School Questions and Answers for School Staff
- Consent packets

The Sample Letter to Teachers template may be found on page 907.1.

Refer to Steps 6 and 7 below for consent packet distribution and collection. An emphasis should be placed on collecting all consents, whether or not the student participates in the program. Incentives, such as stickers, pencils and other low-cost items, are encouraged to be used when collecting consent forms.

Step 5. Contact Community Dentists
Notify all dentists in the community to make them aware of the I-Smile™ @ School program and the services it provides. It is crucial to maintain positive working relationships.

The Sample Letter to Dentists template may be found on page 908.1.

Step 6. Consent packet distribution
At least one month prior to the I-Smile™ @ School program start date, remind teachers that consent packets should be sent home to parents. Consent packets should include:

- Introductory letter
- Consent form
- I-Smile™ @ School Fact Sheet

The Sample Letter to Parents template may be found on page 909.1.

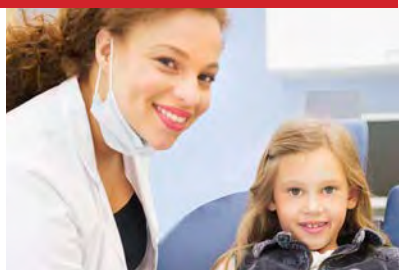
Step 7. Collection of consent forms
At least two weeks before the program is scheduled to begin, collect all consent forms. This will allow adequate time to review all forms for completion. Program staff should ensure all pertinent information is present and all parent/guardian signatures are completed in ink.

Step 8. Preparation for sealant clinic
Ensure all schedules, class lists, and consent forms are organized and ready when the program begins. I-Smile™ @ School staff are expected to follow the school's 'Visitor' rules, which often includes wearing a visible name tag and signing in and out of the school. School staff should be notified of the I-Smile™ @ School staff estimated arrival and departure times for the duration of the program.

I-Smile™ @ School staff should also be familiar with the school's emergency response plan to ensure the safety of themselves and the students.

For Parents & Caregivers

I-Smile @ School



THE FACTS ABOUT I-Smile™ @ School

What is I-Smile™ @ School?

I-Smile™ @ School is a preventive dental program that provides no-cost dental screenings, dental sealants, fluoride varnish, and oral health education for students. These services are provided by Iowa licensed dentists and dental hygienists. This preventive dental program takes place during the school day, but students miss very little class time.

Why is oral health care so important?

Tooth decay (also called cavities) is the most common chronic childhood disease. It is five times more common than asthma and seven times more common than hay fever. Students miss an estimated 51 million hours of school time each year due to dental-related illness.[1] Decay damages teeth and can impact a student's ability to learn, eat and speak properly, sleep, and build self-confidence. Dental sealants and fluoride varnish help protect the teeth and prevent decay. They save time, money and the discomfort often associated with tooth decay.

What is a dental screening?

A dental screening is a simple look in the mouth to check the condition of the teeth and determine if dental sealants or fluoride varnish are needed. No x-rays are taken, and a dental screening does not take the place of a dental checkup at a dental office.

What is fluoride varnish?

Fluoride varnish is a sticky liquid that is quickly and easily applied to teeth to strengthen them and prevent tooth decay. It is safe and tastes good. Fluoride varnish is highly effective at reducing a child's risk of decay.

What are dental sealants?

A dental sealant is a tooth-colored material that is applied to the chewing surfaces of back teeth. Sealants protect teeth from germs and food that can cause cavities. They are very effective at preventing cavities and are recommended by the American Dental Association.

How are dental sealants applied?

Applying sealants is simple and painless. The teeth are cleaned and the sealant liquid is painted in the grooves of the chewing surfaces with a small brush. The sealant bonds directly to the tooth in about 30 seconds with the use of a special light.

How long do dental sealants last?

Sealants can last for many years if your child takes good care of his or her teeth. Sealants should be checked at each dental visit and reapplied if necessary.

When should a child's teeth be sealed?

A child's permanent molars should be sealed as soon as they erupt. These teeth usually come in around the ages of 6 and 12 years. Permanent premolars and primary (baby) molars may also be sealed to protect those teeth from tooth decay.

How much do these services cost?

All I-Smile™ @ School program services are provided at no cost.

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

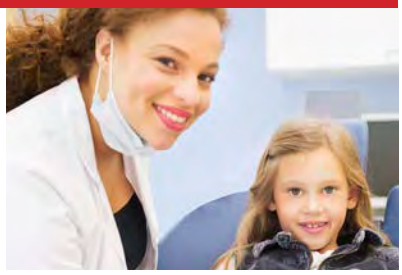
IDPH Iowa Department of Public Health

Contact information

Bureau of Oral & Health Delivery Systems
Iowa Department of Public Health
1-866-528-4020

Para los padres y cuidadores

I-Smile @ School



HOJA INFORMATIVA DE I-Smile™ @ School

¿Qué es I-Smile™ @ School?

I-Smile™ @ School (Sonrío en la escuela) es un programa dental preventiva que ofrece evaluaciones dentales, selladores dentales, barniz de flúor, y educación sobre salud bucal sin costo a los estudiantes. Estos servicios son proporcionados por dentistas e higienistas dentales licenciados de Iowa. Este programa dental preventivo se lleva a cabo durante la jornada escolar pero los estudiantes pierden muy poco tiempo de clase.

¿Por qué es tan importante la salud bucal?

Las caries son la enfermedad crónica más común en la infancia. Es cinco veces más común que el asma y siete veces más común que la fiebre del heno. Los alumnos pierden un estimado de 51 millones horas de tiempo de la escuela cada año debido a la enfermedad dental relacionada.[1] Las caries dañan los dientes y pueden afectar la capacidad de un estudiante para aprender, comer bien, dormir y generar confianza en sí mismo. Los selladores dentales y el barniz de flúor ayudan a proteger los dientes y a evitar las caries. Ahorran tiempo, dinero y las molestias que suelen asociarse con las caries.

¿Qué es una evaluación dental?

Una evaluación dental es una simple revisión de la boca para ver en qué estado están los dientes y determinar si se necesitan selladores dentales o barniz de flúor. No se toman radiografías; una evaluación dental no sustituye a las revisiones dentales periódicas en el consultorio de un dentista.

¿Qué es barniz de flúor?

El barniz de flúor es un líquido pegajoso que se aplica fácilmente sobre los dientes para fortalecerlos y evitar las caries. Es seguro y tiene buen sabor. El barniz de flúor es muy eficaz en la reducción del riesgo de formación de caries en los niños.

¿Qué son los selladores dentales?

Un sellador dental es un material de color similar al de los dientes que se aplica sobre la superficie de masticación de las muelas. Los selladores protegen los dientes contra los gérmenes y la comida que pueden causar caries. Son muy eficaces para evitar las caries y están recomendados por la Asociación Dental Estadounidense.

¿Cómo se aplican los selladores dentales?

La aplicación de los selladores es simple e indolora. Se limpian los dientes y se pasa el sellador líquido con un pincel pequeño en las hendiduras de las superficies de masticación. El sellador se pega directamente al diente en unos 30 segundos mediante el uso de una luz especial.

¿Cuánto tiempo duran los selladores?

Si su hijo se cuida bien los dientes, los selladores pueden durar muchos años. Los selladores deben revisarse en cada consulta dental y volver a aplicarse si fuera necesario.

¿Cuándo deben sellarse los dientes de un niño?

Los molares permanentes de un niño deben sellarse ni bien erupcionan. Estos dientes suelen salir entre los 6 y los 12 años de edad. También se pueden sellar los premolares permanentes y de leche, para protegerlos contra las caries.

¿Cuánto cuestan estos servicios?

Todos los servicios de I-Smile™ @ School se proporcionan sin costo para usted.

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

IDPH Iowa Department of Public Health

Información de contacto

Oficina de Salud Oral y Sistema de Entrega de Servicios
Departamento de Salud Pública de Iowa
1-866-528-4020

I-Smile™ @ School

QUESTIONS AND ANSWERS FOR SCHOOL STAFF

What is the I-Smile™ @ School Program?

I-Smile™ @ School is a preventive dental program that focuses on improving the oral health of Iowa's students. The program provides dental screenings, dental sealants, fluoride varnish, and age-appropriate oral health education. Iowa licensed dental hygienists and/or dentists provide all I-Smile™ @ School services.

The Iowa Department of Public Health has provided oversight for school-based oral health programs for more than 15 years. There are I-Smile™ @ School programs in most of Iowa's 99 counties. All I-Smile™ @ School programs are held to high standards as determined by peer-reviewed research and Centers for Disease Control and Prevention (CDC) recommendations.

How are schools selected for the program?

The program targets schools with a higher percentage of students eligible for free and reduced-price lunch, generally those schools with rates greater than 40 percent. This allows the program to target schools with students who may have more difficulty affording routine dental care.

Why provide dental services in a school?

It is the goal of every school to promote academic success and well-being for each student. The I-Smile™ @ School program is a win-win for the school and families by providing onsite preventive services that can improve a student's oral health and overall health and success. The program reduces access to care barriers such as lack of transportation, parents needing to take time off work, and lack of insurance. It also reduces stigmas because services are offered to all students, regardless of their risk or ability to otherwise receive preventive dental care.

School-based programs are recommended by the Centers for Disease Control and Prevention and the American Dental Association as a cost-effective and convenient way to prevent tooth decay in children.

What does a student need to participate in the program?

Students must have active consent from a parent/guardian to participate in the I-Smile™ @ School program. Consent forms are provided by the program and gathered by the school. Medicaid dental insurance information is collected, if applicable. There is no cost for the services, so no payment is collected.

How long are students absent from the classroom?

The amount of time a student is away from the class will vary depending on the services provided. Each "appointment" is long enough to provide quality and compassionate dental care, individualized for each child. Since the services are provided within the school, each "appointment" takes much less time than traveling to a dental appointment outside of the school.

A student receiving dental services may be absent from the classroom for 15-30 minutes. I-Smile™ @ School recognizes that this may affect some students differently than others and will work with school staff to ensure students miss the least amount of time in the most appropriate part of the school day.

How is follow-up care provided?

All I-Smile™ @ School programs will encounter children with dental needs. Program staff provide referrals for all children and will work with school staff, families, and local dental providers to ensure treatment needs are met. The goal is that all children will have access to a regular source of dental care.

Where will the services be provided in the school?

I-Smile™ @ School staff will set up mobile equipment wherever there is a private, convenient room or space that can be disinfected and is near an electrical outlet. Empty classrooms, stages, lunchrooms or other areas are most commonly used. Each I-Smile™ @ School program provides their own equipment, but may ask to use school items such as tables or chairs.

How long will program staff be at the school?

The length of time program staff will be at a school will depend on the number of students with positive consent to be served. Most programs will be completed within one to two weeks, depending on the length of the school week and other school activities. I-Smile™ @ School equipment is generally taken down and removed from the school at the completion of the program. If needed, the equipment can be moved to accommodate special school events or if there is a lapse of time between services provided.

Contact information

Bureau of Oral and Health Delivery Systems
Iowa Department of Public Health
1-866-528-4020

Sample Letter to Superintendents

I-Smile @ School Logo

{Date}

Dear Superintendent,

{Name of School} has been selected to participate in the I-Smile™ @ School program – an exciting opportunity for students and staff!

I-Smile™ @ School is a program that focuses on preventing tooth decay and improving oral health for students. The program provides **FREE** dental screenings, fluoride varnish, dental sealants and age-appropriate oral health education. School-based programs are effective and have been recommended by the Centers for Disease Control and Prevention (CDC), American Dental Association and the Community Preventive Services Task Force. Iowa licensed dental hygienists and/or dentists provide all of the services.

Tooth decay is a silent epidemic that is very common and largely preventable. According to the CDC, 60 percent of children under age 15 have experienced tooth decay, which causes an estimated 51.7 million lost hours of school time each year nationally.[1]

It is the goal of every school to promote academic success and well-being for each student. Participation in the I-Smile™ @ School program is a win-win for the school and families – it is a community partnership that will allow the school to offer preventive care for students and promote health and success.

Please see the attached *I-Smile™ @ School Fact Sheet* and *I-Smile™ @ School Questions and Answers for School Staff* for more details about the program.

I will follow-up with you in the next week to answer any questions you might have and to confirm that {school name} will participate in the program. We look forward to partnering with your school staff to promote health, well-being, and academic success for all students!

Sincerely,

{Sealant Program Coordinator}
{Contact Information}

Enclosures:
I-Smile™ @ School Fact Sheet
I-Smile™ @ School Questions and Answers for School Staff

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

I-Smile @ School Logo

{Date}

Dear Principal,

The I-Smile™ @ School program is pleased that {Name of school} will participate in our preventive dental service program. This letter and the enclosed documents will provide you with a better understanding of our program and how it might work in your school.

I-Smile™ @ School is a program that focuses on preventing tooth decay and improving oral health for children. The program provides **FREE** dental screenings, fluoride varnish, dental sealants and age-appropriate oral health education. School-based programs are effective and have been recommended by the Centers for Disease Control and Prevention (CDC), American Dental Association and the Community Preventive Services Task Force. Iowa licensed dental hygienists and/or dentists provide all of the services.

Tooth decay is a silent epidemic that is very common and largely preventable. According to the CDC, 60 percent of children under age 15 have experienced tooth decay, which causes an estimated 51.7 million lost hours of school time each year nationally.[1]

It is the goal of every school to promote academic success and well-being for each student. Participation in the I-Smile™ @ School program is a win-win for the school and families – it is a community partnership that will allow the school to offer preventive care for students and promote health and success.

Please see the attached *I-Smile™ @ School Fact Sheet* and *I-Smile™ @ School Questions and Answers for School Staff* for more details about the program.

I will follow-up with you in the next week to answer any questions you might have and to find out who the school contact person will be.

We look forward to partnering with you and your staff to promote health, well-being, and academic success for all students!

Sincerely,

{Sealant Program Coordinator}
{Contact Information}

Enclosures:
I-Smile™ @ School Fact Sheet
I-Smile™ @ School Questions and Answers for School Staff

Cc: School nurse

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

Sample Letter to Teachers

I-Smile @ School Logo

{Date}

Dear Teachers,

Success in the classroom is often impacted by oral health. Tooth decay is the single most common chronic childhood disease—five times more common than asthma,[1] four times more common than early childhood obesity, and 20 times more common than diabetes.[2] Poor oral health impacts a child's ability to eat, thrive, and grow; to concentrate and learn new skills; to speak properly; and to have self-confidence.

The I-Smile™ @ School program will be at {school name} to provide preventive dental services to all students in the {list} grades. Please see the attached *I-Smile™ @ School Questions and Answers for School Staff* for details about the I-Smile™ @ School program.

The I-Smile™ @ School services are **FREE** to the student and the school. The only requirement is that students must provide a signed consent from their parent or guardian to participate. To ensure full student participation, your help with consent distribution and collection is crucial and very much appreciated. Please distribute the consent forms no later than **{date}.**

I have provided the school with {items} as an incentive to distribute to each student who returns a consent form. Please periodically remind your students to return the consent forms so that they can receive the incentive and participate in this program to improve their health! Please collect all consent forms by **{date}**.

Thank you in advance for your support of the I-Smile™ @ School program. These preventive services are critical for oral health and overall health and will have an impact for many years, providing all students with the opportunity to learn and succeed.

The attached *I-Smile™ @ School Fact Sheet* and *I-Smile™ @ School Questions and Answers for School Staff* should answer many, if not all, of your questions. If you have additional questions, please do not hesitate to contact me.

Sincerely,

{Sealant Program Coordinator}
{Contact information}

Enclosures:
I-Smile™ @ School Fact Sheet
I-Smile™ @ School Questions and Answers for School Staff

[1] US Department of Health and Human Services. *Oral Health in America: A Report of the Surgeon General--Executive Summary*. Rockville, MD: US Department of Health and Human Services, National Institute of Dental and Craniofacial Research, National Institutes of Health, 2000.
[2] http://www.mychildrensteeth.org/assets/2/7/ECCstats.pdf

Sample letter to Dentists

Agency logo

{Date}

Dear Dentist,

I am writing to share that I-Smile™ @ School, a school-based oral health program, will soon be providing preventive dental services at a school in your community.

As you know, dental caries remains the most common chronic childhood illness. According to the most recent (2011-2012) National Health and Nutrition Examination Survey (NHANES), 56 percent of children ages 6 to 8 have experienced dental caries in their primary teeth,[1] and more than 28 percent of children ages 9 to 11 experienced tooth decay in a permanent tooth.[2] Caries prevalence remains higher in children from lower-socioeconomic and minority families, as they face the most challenges in receiving dental care with barriers such as transportation, cost, and lack of oral health awareness.

The I-Smile™ @ School program aims to eliminate some of these barriers by providing no-cost services at schools with children at higher-risk of decay. These services include dental screenings, fluoride varnish applications, dental sealants and oral health education. By providing school-based services at no cost, the program is able to eliminate a parent's struggle to take time off work to take a child to an appointment, to find transportation, or to afford preventive care. In addition, classroom and parent education helps to increase awareness of the importance of oral health and regular dental care.

I-Smile™ @ School is not in every county, town or school in Iowa. In fact, schools selected for the program generally have a 40 percent or higher free and reduced lunch program rate. By selecting schools with a higher percentage of low-income students, we are better able to reach those children needing our services the most.

Every child who participates in the I-Smile™ @ School program is referred to a dentist for treatment and regular care. For those children without a regular dentist, the program provides care coordination to help families find a dentist and assist with transportation and insurance or payment issues.

Please feel free to contact me with any questions. The I-Smile™ @ School program looks forward to partnering with you to improve the health of our children!

Sincerely,

{Sealant Program Coordinator}
{Contact Information}

[1,2] 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: National Center for Health Statistics. 2015., Figure 1-2.

Sample Letter to Parents

I-Smile @ School logo

{Date}

Dear Parent/Guardian:

The {agency} I-Smile™ @ School program is offering **no-cost** dental services on {date} for children in the {insert number} grade{s} at {school name}.

The following services may be provided by dentists and/or dental hygienists:

- Dental Screening – a simple look in the mouth to check for cavities.
- Fluoride Varnish – a sticky liquid that coats all teeth to help make them stronger and prevent tooth decay.
- Dental Sealants – a tooth-colored coating that is painted on the back teeth to protect them from food, germs, and acid that cause tooth decay.
- Oral Health Education – lessons to help students learn about healthy teeth and mouths.

After the services are provided to your child, a letter will be sent to you with the results. Please note that dental screenings do not replace regular dental check-ups. Your child should visit the dentist at least once a year for a complete exam.

A consent form is attached and must be completed and signed by a parent/guardian. **It is very important that the consent form is returned to the school no later than {due date} to ensure that your child is able to participate.**

Please see the attached *I-Smile™ @ School Fact Sheet* for additional information. You may contact me with any questions at the phone number listed below.

Sincerely,

{Sealant Program Coordinator name}
{Contact information}

Enclosures:
Consent
I-Smile™ @ School Fact Sheet

Oral Health Education Curriculum

Classroom education should be provided within all schools participating in the I-Smile™ @ School Program. To standardize lesson plans and ensure consistent information is provided, the following American Dental Association (ADA) programs have been selected for use by program staff (with permission from the ADA). This information is age specific and will provide comprehensive oral health education, activities and demonstrations.

2nd and 3rd Grade: *A Lifetime of Healthy Smiles!*
- Tiny Teeth Do Big Jobs
- Plaque Attack
- You Have Power

4th through 6th Grade: *Teeth to Treasure!*
- Protect your Prized Possession
- Extra Protection for Terrific Teeth

7th and 8th Grade: *Watch Your Mouth!*
- Be Smart About Your Smile
- Going the Extra Smile

You may also access the curriculum at: http://www.mouthhealthykids.org/en/educators/smile-smarts-dental-health-curriculum/#lifetime.

Module 1: "Tiny Teeth Do Big Jobs!" 10-15 minutes

Key Message
Teeth are important for eating, talking and having a nice smile.

Student goals
Upon completing this module students will better understand:

- Why people have teeth.
- How we use our teeth.
- How many sets of teeth people get.

Module Topics (with discussion points and questions)

1. *Why we need teeth.* Who can name something that we do with our teeth? [Discuss children's suggestions, which may include talking, eating or chewing, smiling, singing. Have children talk, chew, and smile and frown at each other.] Today we are going to talk about a very important part of our bodies — our teeth. Teeth help us do many things.

2. *How teeth help us do things better.* We have had some good suggestions. But how do our teeth help us do these things? How do our teeth help us eat? [We can chew our food into little pieces. This keeps us from choking or getting a stomach ache.]

ACTIVITY #1: What about talking? Is it easy to talk without using your teeth? Let's try it. Say "thirty-three thirsty thieves" without letting your tongue touch your teeth… That was very hard to do! Our teeth have the important job of helping our lips and tongue make sounds properly. I have another question. Do you think you need your teeth to frown? Let's test it out. Turn to your neighbor and give a great big smile... Good. Now, give your neighbor a very unhappy frown... H-m-m-m. I guess you don't need teeth to frown! But since most of you laugh and smile a lot, your teeth are very important!

So now we know that:

Our teeth are important because they help us talk properly, chew our food and give us beautiful smiles!

3. *Characteristics of teeth.* What are your teeth like? Are they soft or hard? Do they have sharp edges or are they round like a ball? Are they strong or do they break easily? [Discuss answers.] So, our teeth are hard, have some sharp or cutting edges, and are strong. What would happen if our teeth were soft and weak? [Couldn't chew; they might break; it would be hard to talk.]

4. *The number and purpose of baby (primary) teeth.* When did you get your teeth? [When you were a baby.] Why do babies need teeth? [To learn how to talk and so that they can eat solid food.] Now I have a really hard question. How many baby teeth do children get? Any guesses?

ACTIVITY #2: *Primary Tooth Development.* Here is a picture that shows all the teeth in the top of your mouth and in the bottom. Let's count them together out loud… Twenty teeth! That's a lot. By the time children are three or four years old, they have 20 teeth.

Children get 20 teeth by the time they are 3 or 4 years old.

5. *Sets of teeth in a lifetime.* Will you have these 20 teeth your whole life? [No.] What happens to your teeth when you get to be 5, 6 or 7 years old? [Your teeth start to come out.] Yes, your baby teeth start to come out. Why do you lose your baby teeth? [As children get bigger they need bigger, stronger teeth.] (First grade teachers may want to discuss losing primary teeth and getting permanent teeth in more detail. Visit www.adacatalog.org for supplemental materials.)

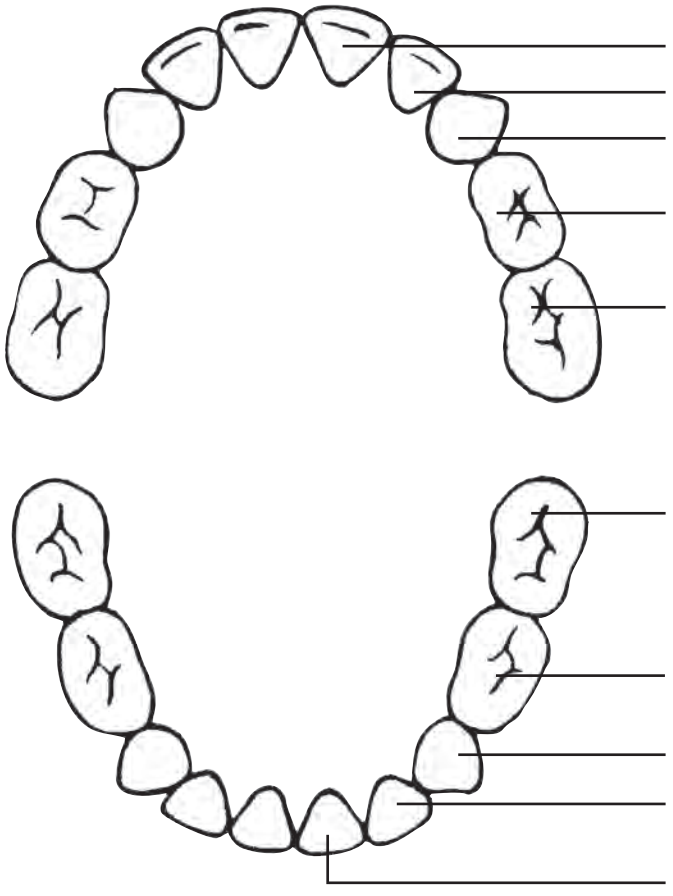
ACTIVITY #3: Look at the size and number of teeth in the photo of the smiling adult and baby. Ask children to imagine all those big teeth in the baby's little mouth. (Use to illustrate why we need baby teeth.) Talk about things that babies cannot do because they don't have many teeth.

6. *Permanent teeth.* When you get older, your 20 baby teeth will be replaced by 32 permanent teeth. Your permanent teeth are bigger and stronger than your baby teeth. After all, they are made to last the rest of your life!

People get two sets of teeth during their life: baby teeth (or primary teeth) and adult teeth (or permanent teeth).

Summary: *Teeth are a special part of our body and do several very important jobs throughout our lives.*

Primary Tooth Development



Upper Teeth	Erupt	Shed
Central incisor	8-12 mos.	6-7 yrs.
Lateral incisor	9-13 mos.	7-8 yrs.
Canine (cuspid)	16-22 mos.	10-12 yrs.
First molar	13-19 mos.	9-11 yrs.
Second molar	25-33 mos.	10-12 yrs.

Lower Teeth	Erupt	Shed
Second molar	23-31 mos.	10-12 yrs.
First molar	14-18 mos.	9-11 yrs.
Canine (cuspid)	17-23 mos.	9-12 yrs.
Lateral incisor	10-16 mos.	7-8 yrs.
Central incisor	6-10 mos.	6-7 yrs.

Module 2: "Plaque Attack!" approximate time: 7 minutes

Key Message
Plaque can hurt teeth by making acids that cause cavities.

Student goals
Upon completing this module students should know:
- What plaque is.
- How plaque can harm teeth.
- What a cavity is.

Module Topics (with discussion points and questions)

1. *Healthy teeth.* Do everyone's teeth always stay strong and healthy? [Solicit a few stories].

2. *Things that prevent teeth from staying healthy.* What can happen to teeth that keeps them from staying healthy? [They get cavities, they can get broken or knocked out.]

3. *What a cavity is.* Let's talk about cavities and what causes them. What is a cavity? [A little hole in your tooth.]

A cavity is a small hole in a tooth.

4. *What plaque is.* Does anyone know what causes cavities? [You may get a variety of answers, but they may not include plaque.] Those are all interesting answers, but there is one thing that plays a big part in causing decay, or cavities, in your teeth. It is called "plaque." [Write "plaque" on chalkboard.] Has anyone heard that word before? If you do not brush your teeth before you go to bed at night, how does your mouth feel when you wake up in the morning? [Tastes bad, smells bad, teeth feel sticky or "fuzzy."] That is because plaque has been forming in your mouth all night. Plaque is a sticky, clear film that is forming on your teeth all the time.

Plaque is a sticky, clear film that is constantly forming on your teeth.

5. *How plaque contributes to decay.* Plaque is bad for your teeth because it contains germs. When a person eats or drinks sugary or starchy foods, the sugars and plaque mix together to make an acid. Does anyone know what acid does? [It makes holes in things.] The acids in your mouth attack your teeth and can make cavities.

The sugars and the germs in plaque mix together to make acid.
The acids in your mouth attack your teeth and
can make cavities.

6. *Repeated acid attacks make cavities grow.* Every time a person eats or drinks, plaque and sugar mix together to make acid. Each acid attack can last 20 minutes, and make a cavity get bigger and bigger. Let's do a demonstration to help us understand how a cavity grows.

Repeated acid attacks make cavities grow bigger.

ACTIVITY #2: *How a Cavity Grows.* Draw a large tooth on a paper towel with a crayon or permanent marker. Using a black watercolor marker, make a heavy dot on the tooth to represent a cavity. Add a drop of water to the cavity to represent another acid attack. After a few minutes look at the tooth and see how the "cavity" has spread.

7. *Repairing cavities.* What happens when someone gets a cavity? Does it heal itself like a scrape or cut on your knee? [No. You have to go to the dentist to get it fixed.] That's right; only your dentist can fix a cavity, by removing the decay and putting a special filling material in the hole.

Cavities cannot go away by themselves.
They must be fixed by a dentist.

Summary: *Plaque and acid can hurt your teeth, making holes that are called cavities.*

Module 3: "YOU have the Power!"

approximate time: 15 minutes

Key Message

A healthy mouth and teeth are important parts of a healthy body. There are many things that children can do to keep their teeth clean, strong and healthy.

Student goals

Upon completing this module students should be aware of four steps for good oral health:

- Brush with fluoride toothpaste twice each day. Spit out all the toothpaste!
- Floss once a day with a grown-up's help.
- Eat and drink nutritious foods and beverages and limit snacks.
- Visit their dentist regularly.

Module Topics (with discussion points and questions)

1. *Feeling healthy.* How do you feel when you are healthy? [List things: feel strong, have lots of energy, feel happy, etc.] Can someone really be healthy if their mouth and teeth are not healthy? [No.] Why not? [Because a clean mouth feels nicer, your breath smells nice, etc.]

Healthy teeth and mouth are part of a healthy body.

2. *Keeping teeth healthy.* What can you do to fight plaque and help keep your teeth healthy? [List answers, which may include brushing, visiting the dentist, good food and drink choices and flossing.] Let's talk about some of these.

3. *Proper brushing.* How many of you brush your teeth? Great! How often should you brush your teeth? [Twice a day.] What do you put on your toothbrush? Yes, toothpaste. Why do you use toothpaste? [Cleans better than water, gets the food and plaque off your teeth, makes your breath smell good, makes your mouth taste good.] Those are all good answers. There is also something very important in most toothpastes that helps strengthen your teeth. Does anyone know what it is called? It's "fluoride." [Write "fluoride" on chalkboard.] Fluoride prevents cavities by strengthening and protecting the teeth from acid. By the way, after you've brushed your teeth, spit out all the toothpaste! Don't swallow it. Toothpaste is for cleaning your teeth, not your stomach!

Brush twice a day with a fluoride toothpaste.
Fluoride prevents cavities by strengthening and protecting tooth enamel.
Always spit out all the toothpaste!

Did your dentist, or the hygienist in your dentist's office, show you how to brush your teeth? Move the brush back and forth gently in short strokes. Brush the top, front, and back sides of each tooth.

[NOTE: Ideally, an adult will brush and floss a child's teeth until he or she is at least 6 years old. By age 6 or 7, children should be able to brush their own teeth twice a day – with supervision until about age 10 or 11 — to make sure they are doing a thorough job. Since adults at home do not always supervise tooth brushing, you might want to suggest to your class that they ask a grown-up to watch them brush, so they can show how well they do it! Flossing demands more manual dexterity than very young children have, and children are not usually able to floss well until they are age 10 or 11, and even then they should be supervised.]

ACTIVITY #3: Here is a picture of one good way to brush your teeth. It says... (Show *How to Brush* and read instructions. Ask for questions and comments.)

Move the brush back and forth gently in short strokes.
Brush the top, front and back sides of each tooth.

4. *Toothbrushes.* What kind of toothbrush do you use? [Get several answers.] I'm going to ask you a question and give you four answers. You tell me which answer you think is the right one. (Pass around a couple of toothbrushes in adult and child sizes, or show *Adult and Child-size Toothbrushes.)* Here's the question:

   What kind of toothbrush would be easiest for you use?
   a) The biggest one you can find
   b) One with a fancy handle
   c) A child-size toothbrush that is easy to hold
   d) A purple one

   You're so smart! You should use a child-size toothbrush that is easy to hold.

Use a toothbrush that has soft bristles and is comfortable to use.

ACTIVITY #4: (Show *Old and New Toothbrushes* and discuss when to get a new toothbrush.) Here are two toothbrushes. Which one looks new? How can you tell if you need a new toothbrush? [If the bristles are bent or broken.] Yes, you should get a new toothbrush when the bristles are bent and worn out.

Replace your toothbrush when the bristles are bent and worn out.

5. *Flossing.* Is there anything else we can do to clean our teeth? [Use floss.] Who knows what dental floss is? [Looks like string or thread.] Dental floss is a special kind of string for cleaning between your teeth. How many of you floss your teeth? Cleaning between your teeth is just as important as brushing. Do you know WHY? [Flossing helps remove bits of food and plaque from between the teeth where your toothbrush can't reach. It helps keep your teeth and gums healthy.] Flossing is not as easy for children to do as brushing, so you should ask your parents or another grown-up to help you floss. You should floss your teeth very gently, once a day.

Floss your teeth very gently, once a day, with a grown-up's help.

ACTIVITY #5: Show floss and explain the technique used in *How to Floss.* Ask for a student volunteer, and demonstrate the following flossing technique using yarn: The child holds hands together with fingers straight up and tight against each other. These are the teeth. Use the yarn to floss between the student's fingers. Arrange students in pairs, give each pair a length of yarn, and allow them time to practice "flossing" each other's fingers. (One variation of this is to smear tempera paint between the fingers of the child representing the teeth, and then use the yarn to "floss." In this way, the children will actually see the "floss" cleaning between the teeth.)

5. *Good nutrition.* Brushing and flossing are very important ways to keep teeth clean and healthy, but there are a few more things that each of us can do. Any ideas? I'll give you two hints: It has to do with plaque and germs and ACID. It also has to do with keeping the rest of your body healthy. Yes. The foods we eat and the beverages we drink are very important for keeping our teeth healthy. So let's talk about food.

ACTIVITY #8: *Nutritious Foods.* Does anyone know (remember) the food groups? [List on board.] Eating a mix of foods from these groups for breakfast, lunch and dinner is the best way to keep your teeth and whole body in good shape. [Discuss healthy eating for a few minutes.] (Visit www.mypyramid.gov for resources.)

But what about snacks, soda pop, and sweets? [Get opinions.] Who remembers what happens in our mouths after we eat? Yes, plaque and sugar mix to form acid. Then the acid attacks our teeth. The more often we eat snacks and drink sugary liquids, the more acid attacks we have. But that doesn't mean that all snacks are bad for you. Sometimes growing children need to eat between meals. If you are hungry and need a snack, choose nutritious foods like fruit, low-fat cheese, low-fat yogurt or raw vegetables. Save the sweets to eat and drink with your meals. A full meal produces lots of saliva in your mouth that helps wash away the acids from your teeth.

Eating a nutritious mix of foods from the food groups is the best way to keep your teeth and body healthy.
If you have sweets, eat or drink them with your meals.
If you snack, eat nutritious foods.

What about chewing gum? [Get opinions.] Chewing gum immediately after a meal or snack is okay as long as the gum is sugarless. In fact, sugar-free gum makes your mouth produce more water, called saliva, which can help rinse the acid off your teeth. Of course, if your parents don't like you chewing gum, then you shouldn't, and we never chew gum in school. And — don't forget — throw your gum away in a trash can when you are finished!

Chewing sugarless gum increases saliva and helps wash out food and acid.

6. *Protect your teeth!* Another way to keep your teeth in good shape is NOT to chew on hard things — like ice cubes, pencils, or hard candy. Your teeth are strong, but it is possible to crack or chip them. It's a good habit to keep things out of your mouth that don't belong there!

Don't chew on hard objects like pencils, ice cubes or hard candy.

7. *Dental visits.* So now we know four important ways to take care of our teeth — brushing, flossing, eating nutritious foods and not chewing on hard objects. There is one more very important thing we should all do to keep our teeth healthy. Who can tell me what it is? Yes! Visit your dentist regularly. Your dentist will tell you when your next visit should be. What are some of the ways the dentist helps you take care of your teeth? [Checks your teeth to see if they are healthy. Tells you how to take good care of your teeth. Fixes cavities and repairs teeth.] Great! [If time allows, discuss the children's experiences at the dentist's office.]

Visit your dentist regularly.

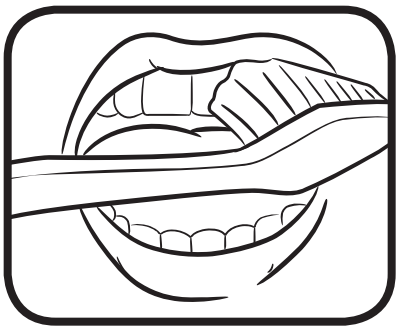
We have learned a lot about our teeth today and how to take good care of them.

1. Our teeth are important.
2. Healthy teeth are part of a healthy body.
3. Taking good care of our teeth is something that each of us can do.

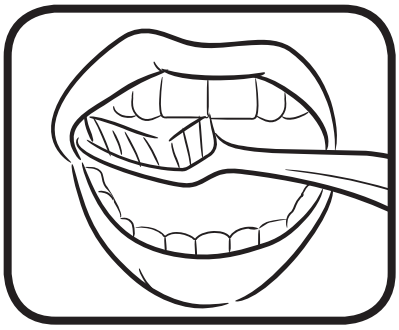
Summary: *Healthy teeth can last a lifetime if they are cared for properly.*

ACTIVITY #9: Have students work individually or in pairs to complete the activity sheets *A-MAZE-ing Message* and *Something's Missing.*

How to Brush

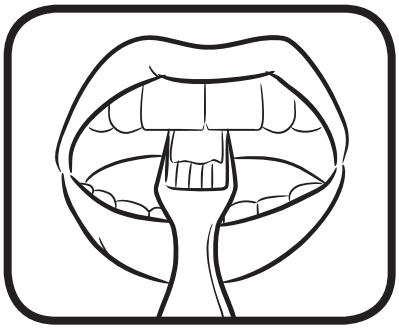


- Place the toothbrush at a 45-degree angle to the gums.

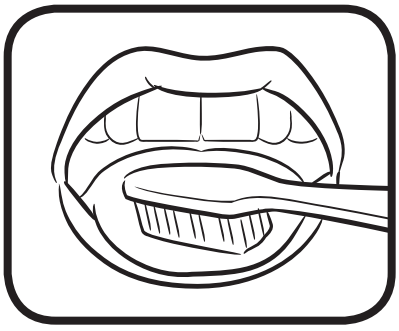


- Move the brush back and forth gently in short strokes.

- Brush the outer surfaces, the inside surfaces and the chewing surfaces of all teeth.



- To clean the inside surface of the front teeth, tilt the brush vertically and make several up-and-down strokes.

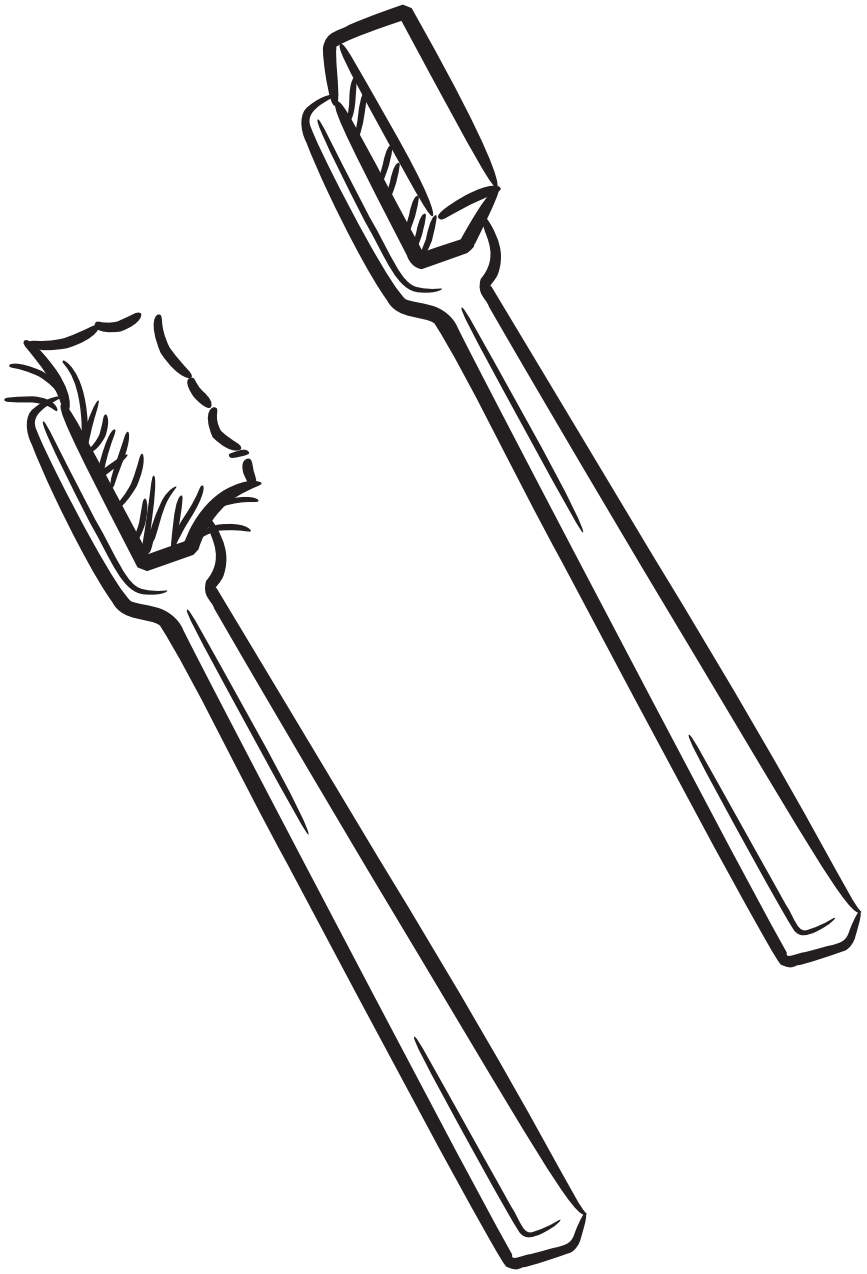


- Brush your tongue to remove bacteria and keep your breath fresh.

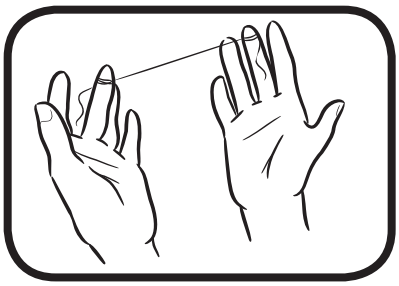
Adult and Child-Size Toothbrushes

Which one would be easiest for him to use?

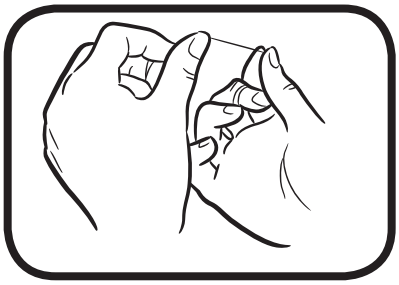
Old & New Toothbrushes



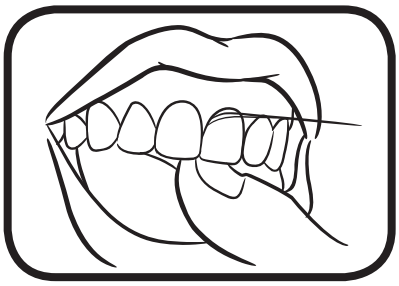
How to Floss



- Use about 18 inches of floss wound around one of your middle fingers, with the rest wound around the opposite middle finger.

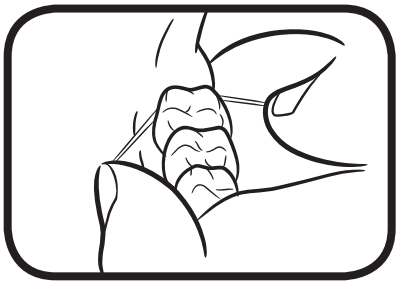


- Hold the floss tightly between the thumbs and forefingers and gently insert it between the teeth.



- Curve the floss into a "C" shape against the side of the tooth.

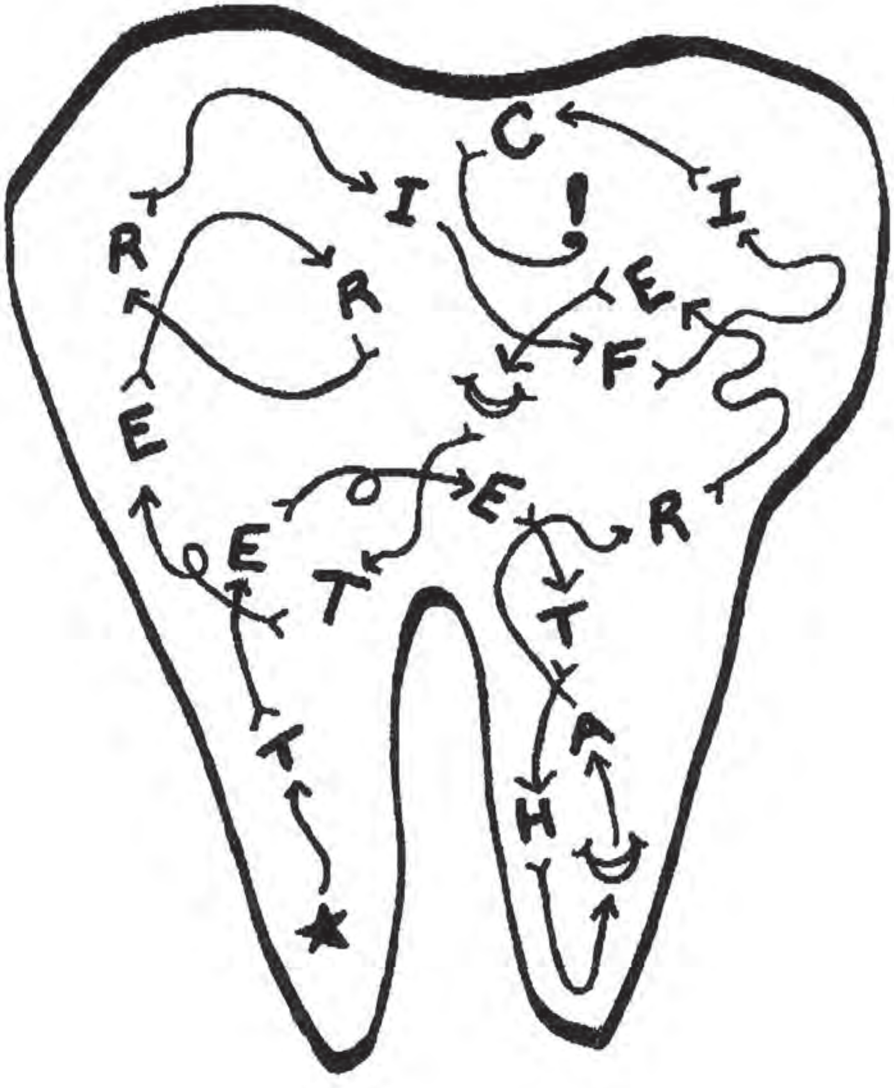
- Rub the floss gently up and down, keeping it pressed against the tooth. Don't jerk or snap the floss.



- Floss all your teeth. Don't forget to floss behind your back teeth.

A-MAZE-ing Message

There is a message hidden in the tooth. Start at the star and follow the arrows.
Write down the letters on the spaces below as you come to them.
A smile means the end of a word. The next letter starts a new word.



_ _ _ _ _   _ _ _   _ _ _ _ _ _ _ _ !

Something's Missing

All the vowels (a, e, i, o, u) are missing from these dental words.
How many can you complete in two minutes?
(The answers are at the bottom of the page.)

b r _ s h	j _ w s
c _ v _ t y	m _ _ t h
c h _ w	m _ _ t h g _ _ r d
c l _ _ n	n _ t r _ t _ _ n
d _ c _ y	p l _ q _ _
d _ n t _ s t	t _ _ t h b r _ s h
f l _ s s	s m _ l _
f l _ _ r _ d _	t _ _ t h
f _ _ d	t _ _ t h p _ s t _
g _ m s	X - r _ y

Answers: brush, cavity, chew, clean, decay, dentist, floss, fluoride, food, gums, jaws, mouth, mouthguard, nutrition, plaque, toothbrush, smile, tooth, toothpaste, X-ray

Module 1: "Protect Your Prized Possession!"

20 - 40 minutes

Key Message

Healthy teeth and mouth are important parts of a healthy body. Taking proper care of teeth now helps them last a lifetime.

Student goals

Upon completing this module students should be aware of the three basic steps to good oral health:

- Brush with fluoride toothpaste twice each day, and floss once each day.
- Eat nutritious foods and limit snacks.
- Visit your dentist regularly.

Module Topics (with discussion points and questions)

1. *Value*. Discuss what makes something valuable. [Write down all answers that apply to teeth: can't be replaced, good quality, lasts a long time, looks nice.] What about your teeth? Are they valuable? [Get opinions.] What do your teeth help you do?

Our teeth help us talk, eat and give us beautiful smiles!

2. *Primary and permanent teeth.* How many sets of teeth do people get in a lifetime? [Two.] What were your first teeth called? [Baby or primary teeth.] When you were little you got 20 baby teeth. Why did they fall out? [As children grow they need bigger, stronger teeth.] That's right, as you get older you need bigger, stronger teeth. By the time people are about 18 they have all 32 adult, or permanent teeth. (Show *Permanent Tooth Development*.) How long do permanent teeth last? [Your whole lifetime — more than 60 years with proper care.] If you lose a permanent tooth, will another one grow in? [No.]

We lose our 20 baby teeth and grow adult teeth because we need bigger, stronger teeth to last the rest of our lives. People get 32 permanent teeth, which can last a lifetime with proper care.

ACTIVITY #1: *Challenge Question: Are teeth a good quality product?* (Give the calculator to a volunteer.) Here's the question: If you have your adult teeth for 60 years, and you eat three meals a day, how many times in your life will you use your teeth to chew food? [60 years x 365 days a year x 3 times a day = 65,700.] 65,700 chewing workouts — and that's if you don't eat snacks between meals! Now, just for fun, let's say that it takes ten minutes to eat a meal, and that you chew your food fifty times a minute. Can you figure out how many times your teeth would chew during those 65,700 workouts? [10 minutes x 50 chews/minute x 65,700 meals = 32,850,000 chews.] 32,850,000 chews! That's almost 33 million times for each tooth! Do you think your teeth are a good quality product? You bet!

Permanent teeth can last more than 60 years!

3. *What happens if we don't take care of our teeth?* So taking care of your teeth sounds like a smart idea. What happens to your teeth if you don't take care of them? [Wait until someone mentions "cavities."]

4. *What a cavity is.* Let's talk about cavities and what causes them. What is a cavity? [A little hole in your tooth.] Right. A cavity is another name for tooth decay. What happens when something decays? [Gets rotten, falls apart, loses strength.] It's no different with your teeth. When your teeth decay, they lose their strength. The decay can also spread throughout your tooth.

A cavity is a small hole in a tooth, also known as tooth decay.

5. *What plaque is.* Does anyone know what causes cavities? [You may get a variety of answers, but they may not include plaque.] Those are all interesting answers, but there is one thing that plays a big part in causing decay, or cavities, in your teeth. It is called "plaque." [Write "plaque" on chalkboard.] Sound familiar? If you don't brush your teeth before you go to bed at night, how does your mouth feel when you wake up in the morning? [Tastes bad, smells bad, teeth feel sticky.] That is because plaque has been forming in your mouth all night. Plaque is a sticky, clear film that is forming on your teeth all the time.

Plaque is a sticky, clear film that is constantly forming on your teeth.

6. *How plaque contributes to decay.* Plaque is bad for your teeth because it contains germs. When you eat or drink sugary or starchy foods, the sugars and plaque mix together to make an acid. The acids in your mouth attack your tooth enamel — the hard outer layer of each tooth — and can cause decay. Each acid attack can last 20 minutes, making cavities bigger and bigger. Let's do a demonstration to help us understand how acid works on teeth.

ACTIVITY #2: *Acid Attack.* Place a Tums® tablet in each of two paper cups. Cover one tablet with vinegar; cover the other with water. Wait five minutes and empty the liquid out of the cups. What has happened to the tablets? The one in the vinegar has dissolved much faster than the one in plain water because vinegar is an acid. Both the Tums® tablet and a tooth contain calcium, and calcium dissolves more readily in acid than in water. [You may need to divide the class into 2 groups so that all the children can see. If possible, recruit another adult to assist with the demonstrations.]

The sugars and germs in plaque mix together to make acid.
The acids in your mouth attack your teeth and can make cavities.
Repeated acid attacks make cavities grow bigger.

7. *Repairing cavities.* What happens when someone gets a cavity in their tooth? Does it heal itself? [No. You have to go to the dentist to get it fixed.] That's right. Only your dentist can fix a cavity, by removing the decay and putting a special filling material in the hole.

Cavities cannot go away by themselves.
They must be repaired by a dentist.

8. *Keeping teeth and gums healthy.* So what can we do to get rid of the acid? How can you fight plaque and acid and keep those valuable permanent teeth healthy ? [List answers which may include brushing, flossing, visiting the dentist, good food and beverage choices.] Let's talk about some of these.

9. *Proper brushing.* Let's list all the good things that happen when we brush our teeth. [Brushing cleans food and plaque off your teeth, fights acid, makes your breath smell good, makes your mouth taste good.] Good answers. How often should you brush your teeth? [Twice a day.] There is a very important ingredient in most toothpastes that helps your teeth. Does anyone know what it is? [Fluoride.] Who knows what fluoride does? [Fluoride prevents cavities by strengthening and protecting the tooth enamel from acid.]

Brush twice a day with a fluoride toothpaste.
Fluoride toothpaste helps prevent cavities by strengthening and protecting tooth enamel.

Move the brush back and forth gently in short strokes. Brush the top, front, and back sides of each tooth. You should also brush your tongue — *very gently!* Really! Your tongue has lots of germs on it that can cause your breath to smell bad.

ACTIVITY #3: Here is a picture of one good way to brush your teeth. It says... (Show *How to Brush* and read instructions. Ask for questions and comments.)

Move the brush back and forth gently in short strokes.
Brush the top, front and back sides of each tooth.
Brush your tongue gently, too.

10. *Toothbrushes.* What kind of toothbrush is best for your teeth? Should it be large or small? [Get several answers.] You're right! You should use a toothbrush is easy to hold and helps you reach all your teeth.

Use a toothbrush that is easy to hold and
helps you reach all your teeth.

ACTIVITY #4: (Show *Old and New Toothbrushes* and discuss when to get a new toothbrush.) Here are two toothbrushes. How can you tell if you need a new toothbrush? [If the bristles are bent or broken.] Yes, you should get a new toothbrush when the bristles are bent and worn out. A worn out toothbrush can't clean the plaque off your teeth very well.

11. *Flossing.* Who remembers what dental floss is? [A special kind of string for cleaning between your teeth.] How many of you floss? How many of you floss once a day? Cleaning between your teeth with floss is just as important as brushing. Do you know why? [Flossing cleans between the teeth, where your toothbrush can't reach.] Flossing helps keep your teeth AND gums healthy! Flossing is not as easy to do as brushing, so you might have to ask your dentist, parents or another adult to show you how to do it properly. You should floss your teeth very gently, once a day.

Floss your teeth gently, once a day.

ACTIVITY #5: Show floss and explain the technique used in *How to Floss.*

12. *Good nutrition.* How does what we eat or drink affect our teeth? [Get a few comments.] What we eat can affect how much acid is made by the plaque in our mouths. Who remembers the food groups? [Make list on board.] Eating a mix of foods from these groups for breakfast, lunch and dinner is the best way to keep your teeth and whole body in good shape. (Visit www.mypyramid.gov for more information.) Let's see how good you are at making up some healthy meals.

ACTIVITY #6 (if time allows): Divide the class into teams of four students. See which group can make a menu of three balanced meals first. Discuss the choices, and how nutritious foods benefit your teeth as well as your total health.

Eating a nutritious mix of foods is the best way to keep your teeth and body healthy.

Good job! But what about snacks, sweets and soda pop? [Get opinions.] Eating sweets all day or drinking lots of soda pop is not good for our bodies, and it can cause cavities, too. Who remembers what happens in our mouths after we eat? Yes, plaque and sugar mix to form acid. Then the acid attacks our teeth. The more often we eat snacks, the more acid attacks we have. But that doesn't mean that all snacks are bad for you. Sometimes growing children and teens need to eat between meals. If you are hungry and need a snack, choose nutritious foods like fruit, low-fat cheese, low-fat yogurt or raw vegetables. If you are thirsty, have a glass of water or low-fat milk. Save the sweets to eat and drink with your meals. A full meal produces lots of saliva in your mouth that helps wash away the acids from your teeth.

If you have sweets, eat or drink them with your meals. If you need a snack, choose nutritious foods.

What about chewing gum? [Get opinions.] Chewing gum for about 20 minutes immediately after a meal or snack is okay as long as the gum is sugarless. In fact, sugar-free gum makes your mouth produce more saliva that can help rinse the acid off your teeth. When you are finished chewing, be sure to throw it away in a trash can.

Chewing sugarless gum increases saliva and helps wash out food and acid.

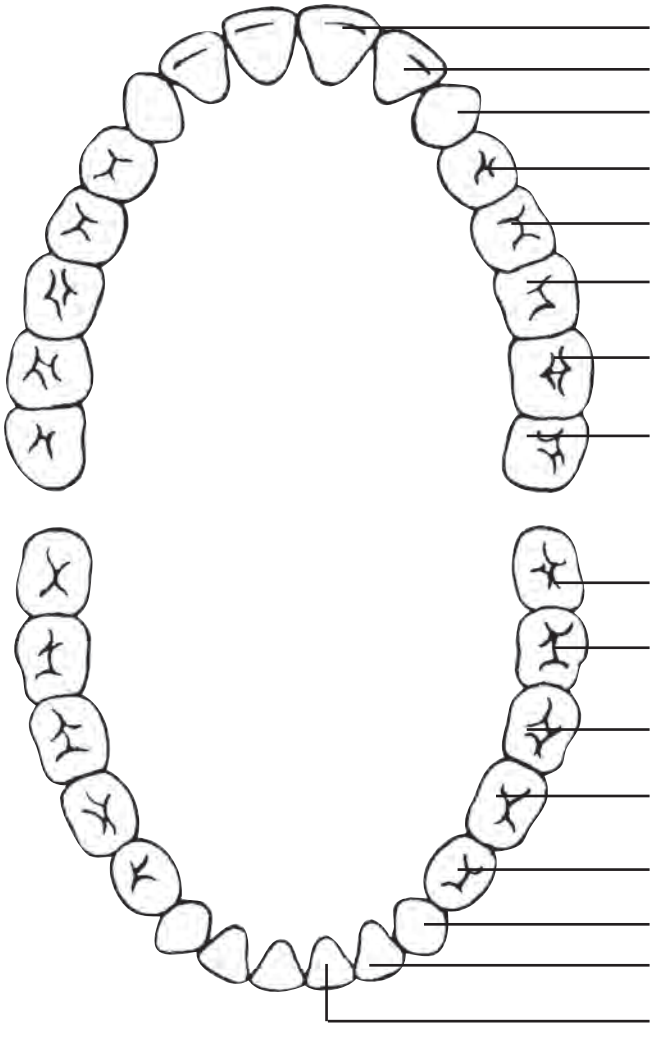
13. *Dental visits.* So far we have talked about three important ways you can care for your teeth — brushing, flossing and eating nutritious foods. There is one more very important thing we should all do to keep our teeth and gums healthy. Who can tell me what it is? Yes! Visit your dentist regularly. What does your dentist do? [Examines your teeth and mouth to see if they are healthy. Tells you how to take good care of your teeth. Fixes cavities and repairs teeth.] What else happens when you go to the dentist? [Get your teeth cleaned, have X-rays to see the insides of teeth to check for cavities and other problems, may get fluoride treatments.] Your dentist will tell you when your next visit should be.

Visit your dentist regularly.

Let's review what we know:

Summary: *Kids in 4th, 5th and 6th grades can do a lot to help keep their teeth and gums in great shape! Brush twice a day with fluoride toothpaste, floss once a day, eat nutritious foods and limit snacks and visit your dentist regularly.*

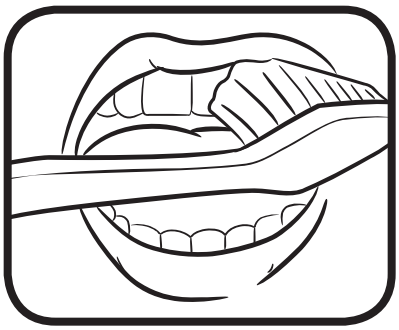
Permanent Tooth Development



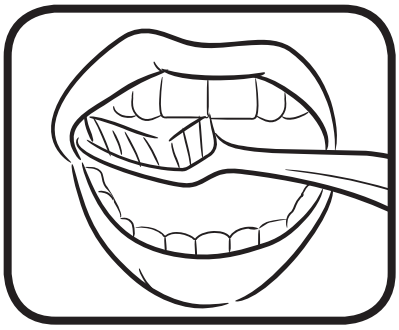
Upper Teeth	Erupt
Central incisor	7–8 yrs.
Lateral incisor	8–9 yrs.
Canine (cuspid)	11–12 yrs.
First premolar (first bicuspid)	10–11 yrs.
Second premolar (second bicuspid)	10–12 yrs.
First molar	6–7 yrs.
Second molar	12–13 yrs.
Third molar (wisdom tooth)	17–21 yrs.

Lower Teeth	Erupt
Third molar (wisdom tooth)	17–21 yrs.
Second molar	11–13 yrs.
First molar	6–7 yrs.
Second premolar (second bicuspid)	11–12 yrs.
First premolar (first bicuspid)	10–12 yrs.
Canine (cuspid)	9–10 yrs.
Lateral incisor	7–8 yrs.
Central incisor	6–7 yrs.

How to Brush

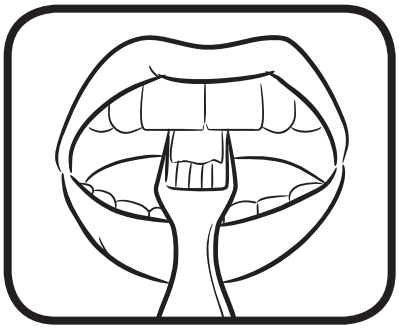


- Place the toothbrush at a 45-degree angle to the gums.

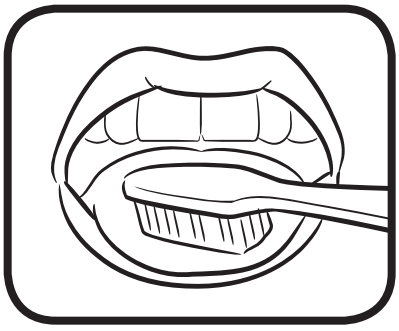


- Move the brush back and forth gently in short strokes.

- Brush the outer surfaces, the inside surfaces and the chewing surfaces of all teeth.

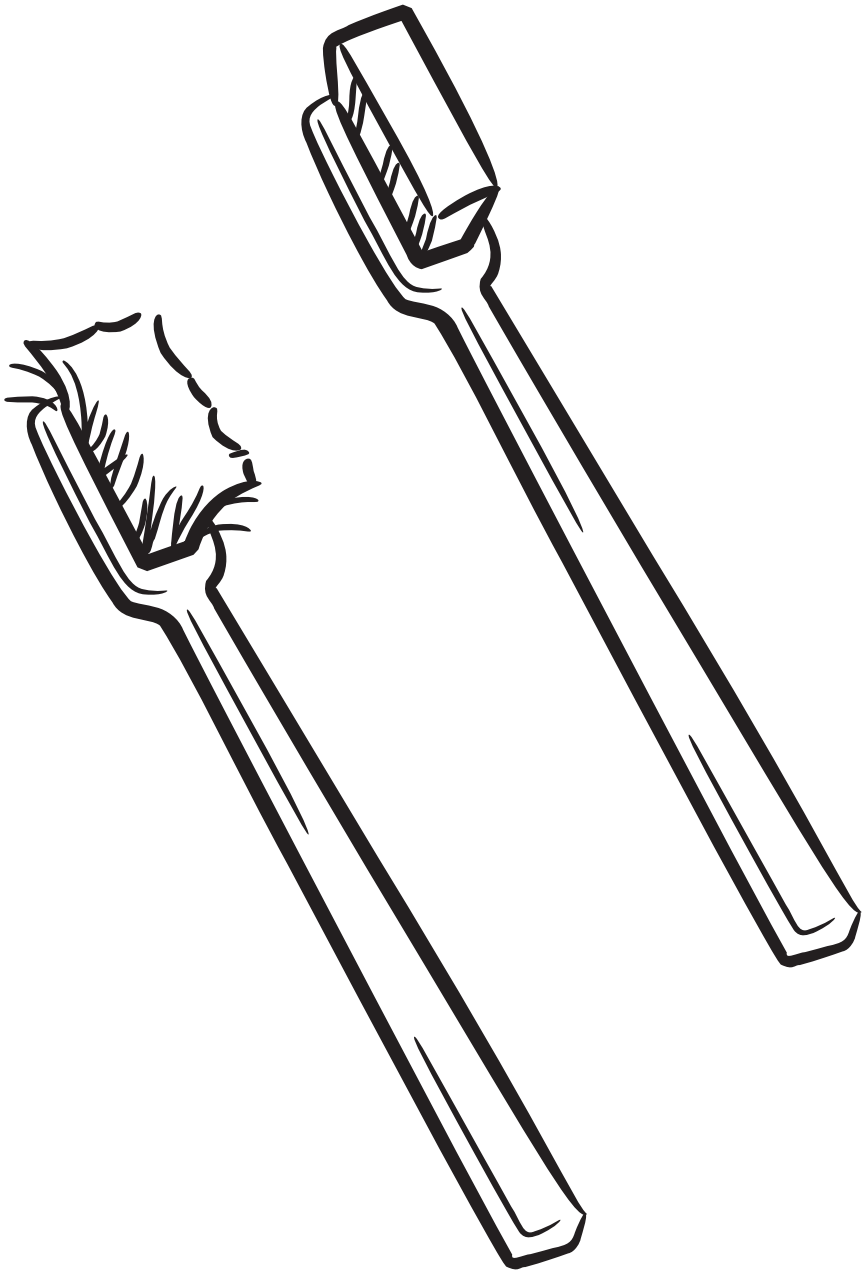


- To clean the inside surface of the front teeth, tilt the brush vertically and make several up-and-down strokes.

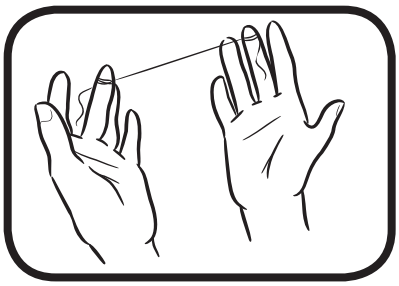


- Brush your tongue to remove bacteria and keep your breath fresh.

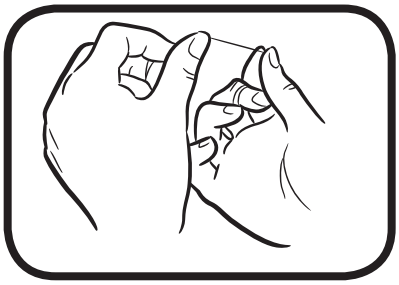
Old & New Toothbrushes



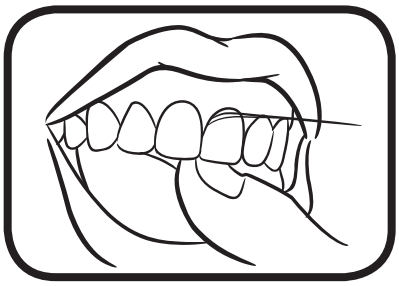
How to Floss



- Use about 18 inches of floss wound around one of your middle fingers, with the rest wound around the opposite middle finger.

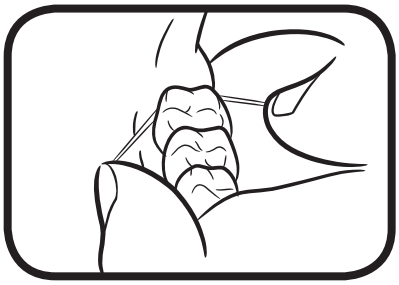


- Hold the floss tightly between the thumbs and forefingers and gently insert it between the teeth.



- Curve the floss into a "C" shape against the side of the tooth.

- Rub the floss gently up and down, keeping it pressed against the tooth. Don't jerk or snap the floss.



- Floss all your teeth. Don't forget to floss behind your back teeth.

Module 2: "Extra Protection for Terrific Teeth"

approximate time: 10 minutes

Key Message

In addition to good oral hygiene and regular dental visits, sealants, mouthguards and good health habits can help teeth last a lifetime.

Student goals

Upon completing this module students should be aware of additional ways that teeth can be protected and kept healthy:

- What dental sealants are, and how they protect teeth from cavities.
- Why wearing mouthguards during active sports is important.
- Recognizing and eliminating behaviors that can harm their teeth.

Module Topics (with discussion points and questions)

1. *Dental sealants.* In addition to keeping your teeth clean, eating nutritious foods and visiting your dentist regularly, there are several other ways you can help your teeth last a lifetime. Does anyone know what dental sealants are? [Some children may have already had sealants applied to their teeth and may be able to explain the process to the class.] After your permanent molars have come in — the large adult teeth toward the back of your mouth — your dentist can coat them with a special dental plastic that seals out decay. Applying sealants is quick, easy and painless. Sealants can last for several years. How many of you have had sealants applied to your permanent teeth? Sealants are additional protection from decay that many of your parents didn't have. When your parents were children, getting cavities was much more common than it is today. This doesn't mean that you can stop caring for your teeth. You still need to brush and floss every day! Sealants are added protection.

ACTIVITY #7: *Sealant Application.* Here is a picture of a dental sealant being applied to a tooth. [If time permits, discuss students' experiences with sealants.]

Dental sealants are a special plastic coating that protect teeth from decay.

ACTIVITY #8: Let's do another experiment, this time to see if a plastic coating can protect our pretend tooth from the acid in vinegar. (Repeat Tums® acid test, this time to show the effectiveness of sealants. Wrap one Tums® in plastic wrap and seal with transparent tape, leaving the other unwrapped. Place each in the bottom of a paper cup. Cover both with vinegar. Wait five minutes and pour off the liquid. Unwrap the plastic from the Tums® tablet. The plastic has protected the "tooth" from the acid.) [You may need to divide your class into 2 groups so that all the children can see. If possible, recruit another adult to assist with the demonstrations.]

2. *Mouthguards.* There is something else you can do to protect your teeth, but this is used to help protect your teeth from getting broken or knocked out. Does anyone know what I'm thinking of? I'll give you a hint. You use it for active sports. [Mouthguard.] That's right! A mouthguard. How many of you have ever worn a mouthguard? A mouthguard is a piece of soft, molded plastic that covers your upper teeth. Your dentist can make one that fits your teeth exactly, or you can buy an unshaped mouthguard at the store that can be softened in boiling water and then shaped to fit over your teeth.

ACTIVITY #9: *Mouthguard.* Here is a picture of a mouthguard. Can someone explain to the class how it fits on the teeth?

Why is it so important to use a mouthguard? [Because if you lose your permanent teeth, new ones will not grow in to replace them.] Do you know anyone who has had teeth knocked out during sports? Will those teeth ever grow back? Wearing a mouthguard is smart even if you don't really want to wear it.

Let's list all the sports and activities that we can think of where your teeth and mouth might be injured. (Remember to include non-team sports such as skateboarding, gymnastics, and rollerblading.)

Mouthguards protect teeth from injury and should be used during all active sports.

Your dentist can make a custom mouthguard, or a self-fitted mouthguard can be purchased at a store.

3. *Behaviors that can hurt teeth.* Is there anything else you can do to protect those priceless treasures in your mouth? Sometimes NOT doing certain things is just as important as the positive things you do. Avoiding bad habits and unhealthy activities is important too. Can anyone name something you might do that would injure your teeth or the health of your mouth? [Write suggestions on chalkboard.]

4. *Chewing on hard objects.* What about chewing on hard objects? Chewing on ice cubes, pencils and pens, or even hard candy can chip or crack your teeth. Even though your teeth are made to last a lifetime, they are made for chewing food only!

Don't chew on hard objects like pencils, ice cubes or hard candy.

5. *Tobacco.* There is another bad habit that is very dangerous, not only for your teeth, but for your mouth and entire body: using tobacco products. Tobacco is bad for your total health. All tobacco — not just cigarettes and cigars. Smokeless tobacco, also called chew, can cause mouth, tongue and lip cancer, and is sometimes more addictive than cigarettes. Tobacco products also stain your teeth and cause gum disease and tooth loss. AND – tobacco products cost a lot of money! Bottom line: There is nothing good to say about tobacco products. Never starting is your best defense against all the health problems related to tobacco.

Tobacco products can cause gum disease, tooth loss and cancer. BE SMART; DON'T START! AND SAVE MONEY, TOO!

We have learned a lot about our teeth today and how to take good care of them.

1. Taking good care of our teeth is something that each of us can do.
2. Your permanent teeth are meant to last a lifetime.
3. Special activities and conditions require extra "tooth attention."

Summary: *Kids, parents and their dentist can work together to provide extra protection for precious teeth.*

ACTIVITY #10: Have students work individually or in pairs to complete the activity sheet *Teeth to Treasure! Word Search* or *Teeth to Treasure! Word Search Challenge* (based on students' ability levels or time allowed). [You may wish to have copies of *Permanent Tooth Development* and *Tooth Anatomy* available as a reference.]

Sealant Application

Mouthguard

Teeth to Treasure! Word Search

See how many words you can find in 20 minutes!
Words go across, up, down, and diagonal.

D C V M S S R J E G S D K F S
C S X O S M R Y T F V L R S T
Q B T O N G UA E S G I U E O E
H R C X I P L G A M I L B U S
R S P T A J I I P T B A Q L L
F L U O R I D E H A C A S O M
T P F R G D G F T C L A E Y S
L H Q T B K E E O P Y X A F T
K E C H T H G N O K W S L L A
K W M J X E T H T O O T A O E
E D H A V I T O Z I D C N S M
B J X D N P U S O X S A T S E
S G M C M E S G N T W T I R E
D R A U G H T U O M L I Y L T
Y T I V A C U H F S Z X E O Y

CAVITY	FLOSS	GUMS	PLAQUE	TOOTH
DAILY	FLUORIDE	MEAT	SEALANT	TOOTHBRUSH
DENTIST	FRUIT	MILK	TOBACCO	TOOTHPASTE
ENAMEL	GRAINS	MOUTHGUARD	TONGUE	VEGETABLES

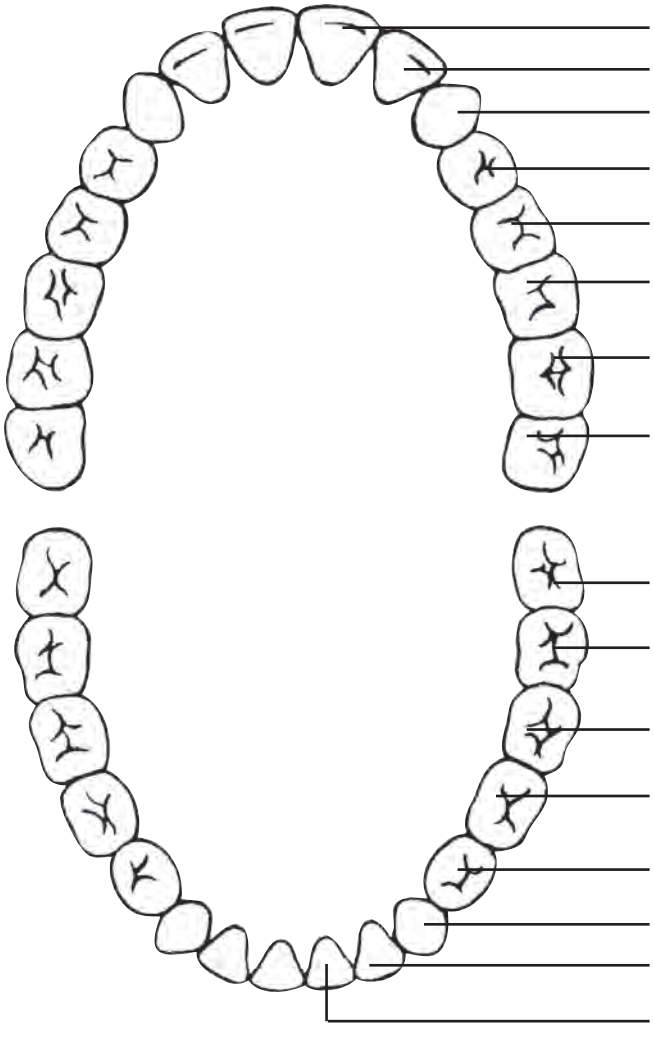
Teeth to Treasure! Word Search Challenge

See how many words you can find in 20 minutes!
Words go across, up, down, and diagonal.

K E F Q J S P M O D K R D G C Q T M T E
M Z K L D W E B O T P O H R K S E O C U
X D G M O F C L S U C O B T I W O R E Q
D A I L Y S W N B A T T D T J T S L D A
A S G L E B S O V A J H N B H W P P I L
H C E K I L C I F S T E G B E N I R R P
E T S A P H T O O T D E R U J J L E O G
P J U V L Y M F C S L U G A A N N V U J
T D L E M A N E U Z S E O E Y R E E L U
O E O O X B N G O H Y V F R V M D N F F
B F V Q A E A T K X V L J T A P K T A U
A S U N U R Y P X P K L A D F L E I K P
C L N G W Q H T O O T E H N R Q T O V H
C S N I H V L G K Z M W A J U B P N A X
O O M I A N X G I X A N A F I X P Z R H
T F I U A R V U C Z K H Z U T Z B A L D
U I U Y G C G C P P B V X K P J Y S R Z
P R I M A R Y Z A T E K Y L V P I R F J
I I U J M I L K I K M O G N T L Z I L B
B Q L X O I W D L A E H V L E U Z L I E

CAVITY	FRUIT	MILK	ROOT	TOOTHBRUSH
DAILY	GRAINS	MOUTHGUARD	SEALANT	TOOTHPASTE
DENTIST	GUMS	ORAL	SUGAR	VEGETABLES
ENAMEL	JAW	PLAQUE	TOBACCO	XRAY
FLOSS	LIPS	PREVENTION	TONGUE	
FLUORIDE	MEAT	PRIMARY	TOOTH	

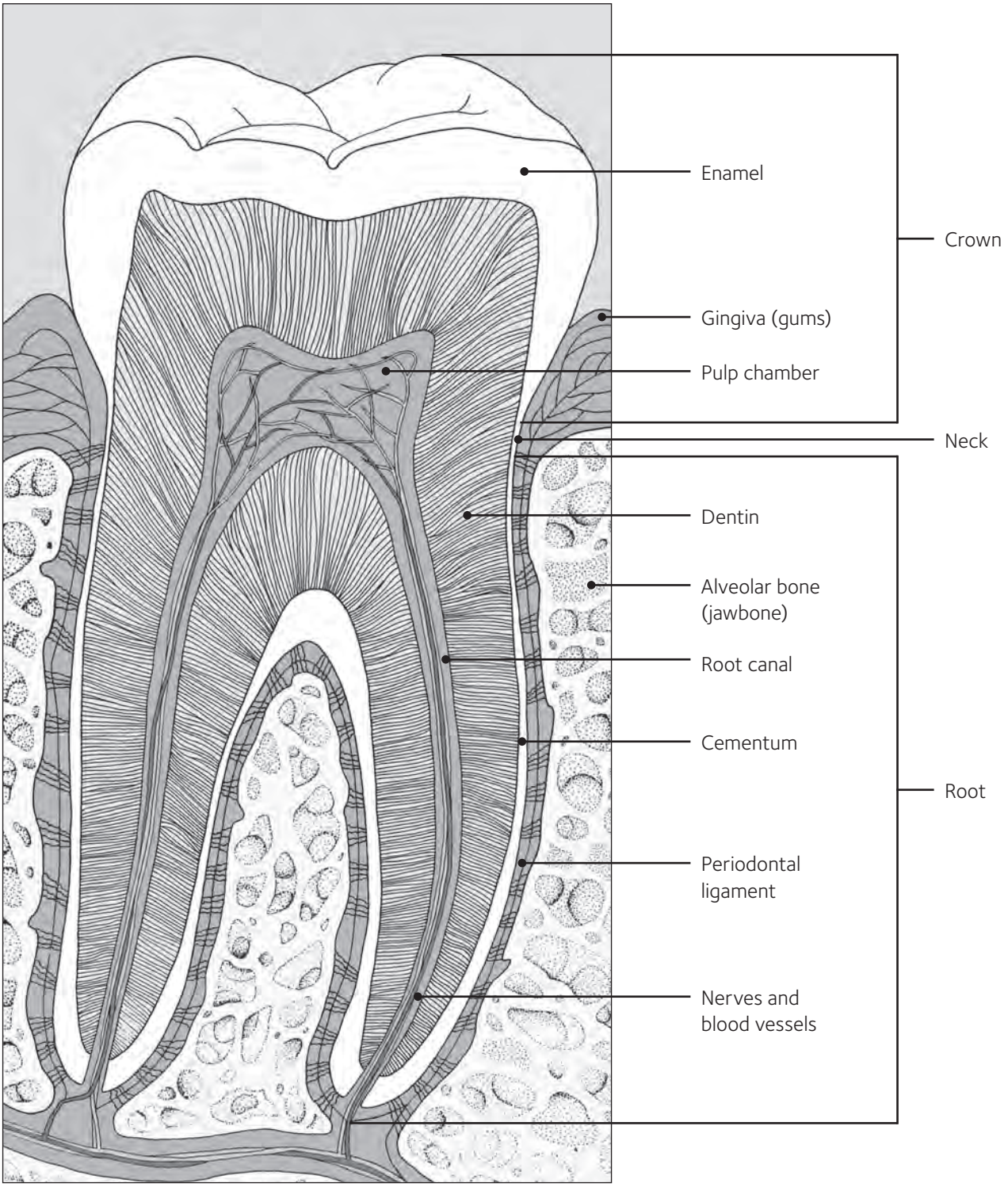
Permanent Tooth Development



Upper Teeth	Erupt
Central incisor	7–8 yrs.
Lateral incisor	8–9 yrs.
Canine (cuspid)	11–12 yrs.
First premolar (first bicuspid)	10–11 yrs.
Second premolar (second bicuspid)	10–12 yrs.
First molar	6–7 yrs.
Second molar	12–13 yrs.
Third molar (wisdom tooth)	17–21 yrs.

Lower Teeth	Erupt
Third molar (wisdom tooth)	17–21 yrs.
Second molar	11–13 yrs.
First molar	6–7 yrs.
Second premolar (second bicuspid)	11–12 yrs.
First premolar (first bicuspid)	10–12 yrs.
Canine (cuspid)	9–10 yrs.
Lateral incisor	7–8 yrs.
Central incisor	6–7 yrs.

Tooth Anatomy



Module 1: "Be Smart about Your Smile!"

15 -30 minutes

Key Message

Taking proper care of your teeth enhances your total health and gives you a more attractive appearance.

Student goals

Upon completing this module students should be aware that good oral health habits:

- Help keep their whole body healthy and fit.
- Can help them do their best at school and in sports (because they will feel better, both physically and psychologically).
- Have cosmetic benefits, including a nicer looking smile, fresh breath, and social confidence.

Module Topics (with discussion points and questions)

1. *Personal appearance.* Let's make a list of things that help a person be more attractive. I don't mean good looking or popular; I'm looking for ideas about what makes people of any age attractive. [List on chalkboard: Personality attributes like friendliness, intelligence, confidence; Physical attributes like their smile, cleanliness, being physically fit, having good health.]

2. *The benefits of a nice smile.* Since we are going to be talking about teeth and good oral health in a few minutes, let's talk a little more about having an attractive smile. What does it take to get and keep a nice smile? [Keep teeth clean by brushing and flossing, visit your dentist, eat nutritious foods, don't smoke.] Yes, all those things affect your smile, your teeth, your health and your appearance.

Good oral health habits play a big part in having a nice smile, speaking well, being able to eat properly and having confidence.

3. *What happens if teeth are not cared for?* So taking care of your teeth sounds like a smart idea. What happens to your teeth if you don't take care of them? [Bad breath, stains, cavities, swollen gums, maybe tooth loss.]

4. *What a cavity is.* None of those things sound very appealing. Let's talk about cavities and what causes them. What is a cavity? [A little hole in your tooth.] Right. A cavity is another name for tooth decay. What happens when something decays? [Gets rotten, falls apart, loses strength.] It's no different with your teeth. When your teeth decay, they lose their strength. The decay can spread throughout your tooth.

A cavity is a small hole in a tooth,
also known as tooth decay.

5. *What plaque is.* Does anyone remember what causes cavities? [You may get a variety of answers, but they may not include plaque.] Those are all interesting answers, but there is one thing that plays a big part in causing decay, or cavities, in your teeth. It is called "plaque." Sound familiar? If you don't brush your teeth before going to bed at night, how does your mouth feel when you wake up in the morning? [Tastes bad, smells bad, teeth feel sticky.] That is because plaque has been forming in your mouth all night. Plaque is a sticky, clear film that is forming on your teeth 24 hours a day.

Plaque is a sticky, clear film that is constantly
forming on your teeth.

6. *How plaque contributes to decay.* When you eat or drink foods containing sugars and starches, the bacteria (germs) in plaque produce acids that attack tooth enamel. The stickiness of the plaque keeps the harmful acids against the teeth. After many such attacks, the tooth enamel — the hard outer layer of each tooth — breaks down and a cavity forms. Each acid attack can last as long as 20 minutes, making cavities bigger and bigger. So, do any of you think you have plaque on your teeth right now?

7. *Plaque and gum disease.* If the plaque is not removed effectively with daily brushing and cleaning between teeth with floss, it eventually hardens into *calculus* or *tartar.* Tartar must be removed, because it makes your teeth more difficult to clean. If tartar is not removed, it can lead to gingivitis, an early form of gum disease in which your gums become irritated and can bleed easily. [*Gingiva* = gums; *-itis* = inflammation] That's why it is important to brush your teeth twice a day, floss daily and have your teeth professionally cleaned at the dental office.

The sugars in food and germs in plaque mix together
to make acid. The acids in your mouth attack your teeth
and can make cavities. Repeated acid attacks make
cavities grow bigger.

Twice-daily brushing and once-daily flossing help remove
bits of food and plaque from the mouth and are *essential*
in preventing both tooth decay and gum disease.

7. *Repairing cavities.* What happens when someone gets a cavity in their tooth? Does it heal itself? [No. You have to go to the dentist to get it repaired.] That's right. Only your dentist can repair a cavity, by removing the decay and putting a special filling material in the hole.

Cavities cannot go away by themselves.
They must be treated by a dentist.

8. *Three ways to keep teeth their best.* Let's talk about the three main ways we can keep those "pearly whites" in smiling condition: proper brushing and flossing, eating nutritious foods, and regular dental visits.

9. *Proper brushing.* Let's start with brushing, and list all the good things that happen when we brush our teeth. [Brushing cleans food and plaque off teeth, fights acid, makes your breath smell good, makes your mouth taste good.] Good answers. How often should you brush your teeth? [Twice a day.] There is an important ingredient in most toothpaste that helps your teeth. Does anyone know what it is? [Fluoride.] What does fluoride do? [Fluoride prevents cavities by strengthening and protecting the tooth enamel from acid.]

Brush twice a day with a fluoride toothpaste.
Fluoride toothpaste helps prevent cavities by
protecting tooth enamel.

Move the brush back and forth gently in short strokes. Brush the top, front, and back sides of each tooth. If you are wearing braces, you should ask your general dentist or orthodontist about the best way to brush and keep your teeth clean.

You should also *gently* brush your tongue. Really! Your tongue has lots of germs on it that can cause your breath to smell bad. And by the way, toothbrushes don't last forever. If your toothbrush looks like this (hold up *Old and New Toothbrushes*), with bent or broken bristles, it's time to toss it and get a new one! You should use a toothbrush that is comfortable to hold and easily reaches all tooth surfaces.

ACTIVITY #1: **Here is a picture of one way to brush your teeth. It says...**
(Show *How to Brush* and read instructions. Ask for questions and comments.)

Move the brush back and forth gently in short strokes.
Brush the top, front and back sides of each tooth.
Brush your tongue gently, too.

Use a toothbrush that easily reaches all tooth surfaces
and is comfortable to hold.

10. *Flossing.* How many of you floss your teeth each day? Flossing cleans between your teeth, which is just as important as brushing them. There are lots of types of floss you can choose from — waxed, unwaxed, flavored, string or flat tape. Flossing is not as easy to do as brushing, so if you don't remember how, ask your dentist, then practice.

You should floss once a day. Why is flossing important? [Helps remove bits of food and plaque from between teeth, where your toothbrush can't reach. Helps keep your gums healthy.] Your permanent teeth are much closer together than your baby teeth were, and flossing those choppers is essential for healthy teeth and gums — and fresh breath, too! But floss gently. It doesn't take a lot of muscle to remove the plaque and debris from between your teeth — just determination.

Floss your teeth gently, once a day.

ACTIVITY #2: Show floss and explain the technique used in *How to Floss.*

11. *Good nutrition.* How does what we eat and drink affect our teeth? [Get a few comments.] What we eat and drink, and how often, affect how much acid is made by the plaque in our mouths.

What we eat and drink, and how often, affect how much acid is produced in our mouths.

Who remembers the food groups? [List on board.] Eating a mix of foods from these groups for breakfast, lunch and dinner is the best way to keep your teeth and whole body in good shape. You know how important it is to eat right when you are in sports or dance. Well, your teeth are just as affected by what you put in your mouth. Did you know that Olympic athletes have their own dentist? That's because athletes cannot reach peak performance if their mouths are sore or if their teeth ache. Eating a nutritious mix of foods also helps you stay at your proper weight, helps keep your skin clear and makes your hair shiny! (Visit www.mypyramid.gov for more information.) So let's see how good you are at making up some healthy meals.

ACTIVITY #3: Divide the class into teams of four students. See which can be the first group to make up a menu of three balanced meals and two healthy snacks. Discuss the choices, and how nutritious foods benefit your teeth as well as your total health.

Eating a nutritious mix of foods from the food groups is the best way to keep your teeth and body healthy.

Those are very creative meal ideas! But what about sweets? Do you have to give up ALL sweets to have a healthy body and teeth? [Get opinions.] Munching on snacks all day and drinking lots of soda pop is not good for your body. It can cause an unhealthy

weight gain and cavities, too! Who remembers what happens in our mouths after we eat? Yes, plaque and sugar mix to form acid. Then the acid attacks our teeth. The more often we eat snacks, the more acid attacks we have. Don't eat too many sweets or drink a lot of soda pop. But if you have sweets, eat or drink them with your meals, because your saliva helps wash the acid off your teeth. If you need a snack between meals, choose nutritious foods like fruit, low-fat cheese, low-fat yogurt, or raw vegetables. If you are thirsty, have a glass of water or low-fat milk.

If you want sweets, eat or drink them with your meals.
If you snack, eat nutritious foods.

What about chewing gum? [Get opinions.] Chewing gum for about 20 minutes immediately after a meal or snack is okay as long as the gum is sugarless. In fact, sugar-free gum makes your mouth produce more saliva, which helps rinse the acid off your teeth to prevent tooth decay.

Chewing sugarless gum increases saliva and helps wash out food and acid.

12. *Dental visits.* So far we have talked about three important ways you can care for your teeth — brushing, flossing and eating nutritious foods. There is one more very important thing we should all do to keep our teeth healthy — visit our dentist regularly. What does your dentist do? Let's list some of the things that can happen during a routine dental visit. [Examines your teeth, gums and the rest of your mouth to see if they are healthy; tells you how to take good care of your teeth; fixes cavities and repairs teeth; checks your mouth for sores and signs of cancer; sometimes takes X-rays to see the insides of teeth and jawbone; gives you a fluoride treatment.]

    What else? [You have your teeth professionally cleaned.] Why is that important? [Even when you brush well, some plaque stays on your teeth and, over time, hardens into tartar. Tartar can only be removed by a professional cleaning.] Who remembers what we said earlier about why tartar must be removed from teeth? [Tartar must be removed because it makes your teeth more difficult to clean. If tartar is not removed, it can lead to *gingivitis,* an early form of gum disease in which your gums become irritated and can bleed easily.]

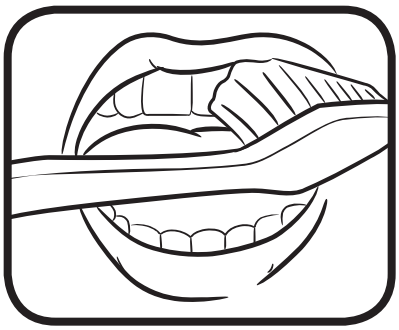
    Ask your dentist when your next visit should be!

Visit your dentist regularly.
A routine dental visit includes an examination of your teeth and mouth, professional cleaning, and may include X-rays, repair of damaged teeth and a fluoride treatment.

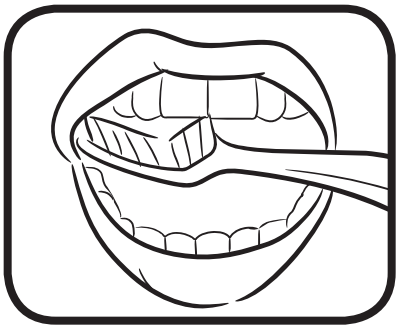
Summary: *Good oral health care provides many benefits that go beyond cavity prevention.*

- *It helps keep your whole body healthy and fit.*
- *It can help you do your best at school and in sports, because you will feel better, both physically and mentally.*
- *It has cosmetic benefits, including a nicer looking smile, fresh breath, and social confidence.*

How to Brush

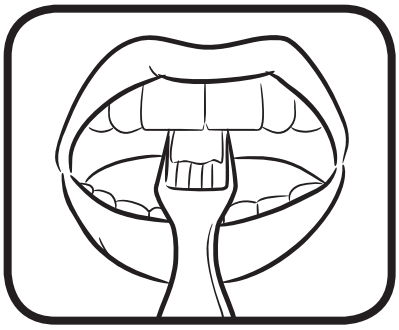


- Place the toothbrush at a 45-degree angle to the gums.

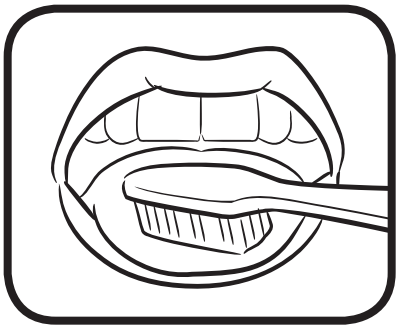


- Move the brush back and forth gently in short strokes.

- Brush the outer surfaces, the inside surfaces and the chewing surfaces of all teeth.

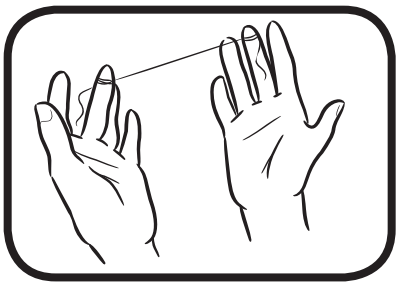


- To clean the inside surface of the front teeth, tilt the brush vertically and make several up-and-down strokes.

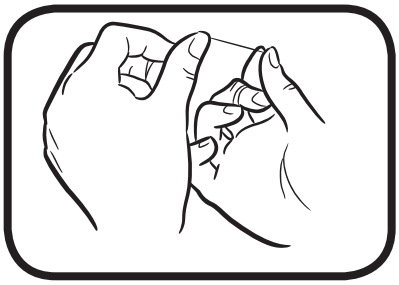


- Brush your tongue to remove bacteria and keep your breath fresh.

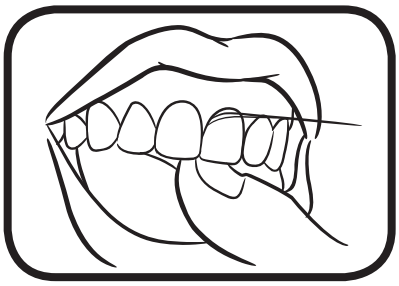
How to Floss



- Use about 18 inches of floss wound around one of your middle fingers, with the rest wound around the opposite middle finger.

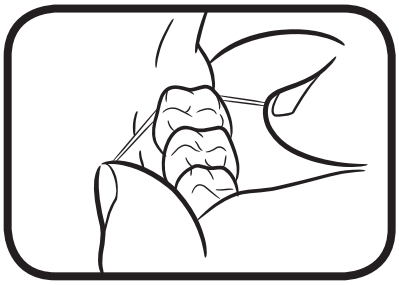


- Hold the floss tightly between the thumbs and forefingers and gently insert it between the teeth.



- Curve the floss into a "C" shape against the side of the tooth.

- Rub the floss gently up and down, keeping it pressed against the tooth. Don't jerk or snap the floss.



- Floss all your teeth. Don't forget to floss behind your back teeth.

Module 2: "Going the Extra Mile for Tooth Protection" approximate time: 15 minutes

Key Message
In addition to daily dental health care, there are many ways that teens can protect their smiles.

Student goals
Upon completing this module students should be aware of additional ways that teeth can be protected and kept healthy:
- Recognizing and eliminating behaviors that can harm teeth, such as mouth piercing and tobacco use.
- Wearing mouthguards during active sports is important to protect teeth, mouth and face.

Module Topics (with discussion points and questions)

1. *Popular behaviors and bad habits that can damage teeth and health.* One of the toughest parts about being a teen is that you have to make choices that can affect your health, your appearance and your future. Some are just little things, like how you wear your hair, but some are decisions that can have a lasting effect on your life. We are going to talk about a few that are directly related to the health of your teeth and mouth.

2. *Trends and peer pressure.* Why is it so hard sometimes to make smart choices? [Comments may include: developing bad habits; the difficulty of going against trends or peer pressure; not knowing what the smart choice is; sometimes bad choices are more fun than good choices.] What are some choices that you may have to make — either now or as you get older — that can affect your teeth and mouth? [mouth piercing/mouth jewelry; smoking; chewing tobacco; eating too much junk food and drinking too much soda pop; not visiting the dentist; not using a mouthguard]

3. *Bad habits.* Let's talk first about getting rid of a bad habit that many of us have — chewing on hard objects. Do you ever find yourself chewing on ice cubes, pencils and pens? Chewing on hard objects — even hard candy — can chip or crack your teeth. Your teeth are made to last a lifetime, but they are made for chewing food only! How can you break a bad habit like chewing on hard objects? [Put notes reminding yourself not to chew on things around your house and desk; ask friends to remind you if they see you chewing on stuff; chew more sugarless gum.] It's hard to break bad habits, but you can do it! Recognizing that you have a bad habit is the first step.

Don't chew on hard objects like pencils,
ice cubes or hard candy.
Ask friends and family to help you break bad habits.

4. *Tobacco.* There is another bad habit that is very dangerous, not only for your teeth, but for your mouth and entire body: using tobacco products. ALL tobacco is bad for your health, not just cigarettes and cigars. Smokeless tobacco, also called chew, snuff, dip or spitting tobacco, has become a very serious health problem for teens and young adults today. You know that smoking cigarettes can eventually kill you. You may not know that smokeless tobacco can cause mouth, tongue and lip cancer, and can be more addictive than cigarettes. Tobacco products also stain your teeth and cause gum disease and tooth loss. That certainly won't help your appearance any! Listen to these statistics: 1.) Approximately 28,000 people were diagnosed as having oral (mouth) cancer last year. Many of them probably thought they were safe because they used smokeless tobacco. Wrong! 2.) About 7,200 people will die from mouth cancer this year. AND – tobacco products cost a lot of money! Bottom line: There is nothing good to say about tobacco products. Never starting is your best defense against all the health problems related to tobacco.

Tobacco products are expensive and cause gum disease, tooth loss and cancer. BE SMART; DON'T START! AND SAVE MONEY, TOO!

ACTIVITY #4: Working in pairs, have the students write anti-tobacco-use slogans. Choose a class favorite and write it on a large piece of poster board to hang in your classroom.

5. *Mouth jewelry.* Let's talk about mouth jewelry. You might think pierced lips and tongues are attractive, or you might not, but you probably don't know just how dangerous these piercings can be. What do you think can happen to your teeth and mouth from piercings? [List on chalkboard: mouth sores and infections; chipped or cracked teeth; you can choke.] That's a good start, but it gets worse! Your mouth contains millions of bacteria, and infection and pain often occur with mouth piercing. Your mouth and tongue can swell up large enough to close off your airway. Piercing can also cause nerve damage and uncontrollable bleeding. You can choke on parts that come off in your mouth, and you can crack your teeth if you bite down on the jewelry. Mouth piercing is a decision that goes way past looking fashionable — it can have a big effect on your health!

Mouth piercing can result in infection, swelling, pain, choking, uncontrolled bleeding and cracked or chipped teeth.

6. *Mouthguards.* There is a good habit you can get into that will help protect your teeth from getting broken or knocked out. Does anyone know what I'm thinking of? I'll give you a hint. You use it for active sports. [Mouthguard.] That's right! A mouthguard. How many of you have ever worn a mouthguard? A mouthguard is a piece of soft, molded plastic that covers your upper teeth. Your dentist can make one that fits your teeth exactly, or you can buy an unshaped mouthguard that can be softened in boiling water and then shaped to fit over your teeth.

ACTIVITY #5: *Mouthguard.* Here is a picture of a mouthguard. Can someone explain to the class how it fits on the teeth?

Why is it so important to use a mouthguard? [Because if you lose your permanent teeth, new ones will not grow in to replace them.] Do you know anyone who has had teeth knocked out during sports? Will those teeth ever grow back? Mouthguards also help prevent injuries to your lips, face and jaw. Wearing a mouthguard is very smart even if you don't think it's a great fashion statement!

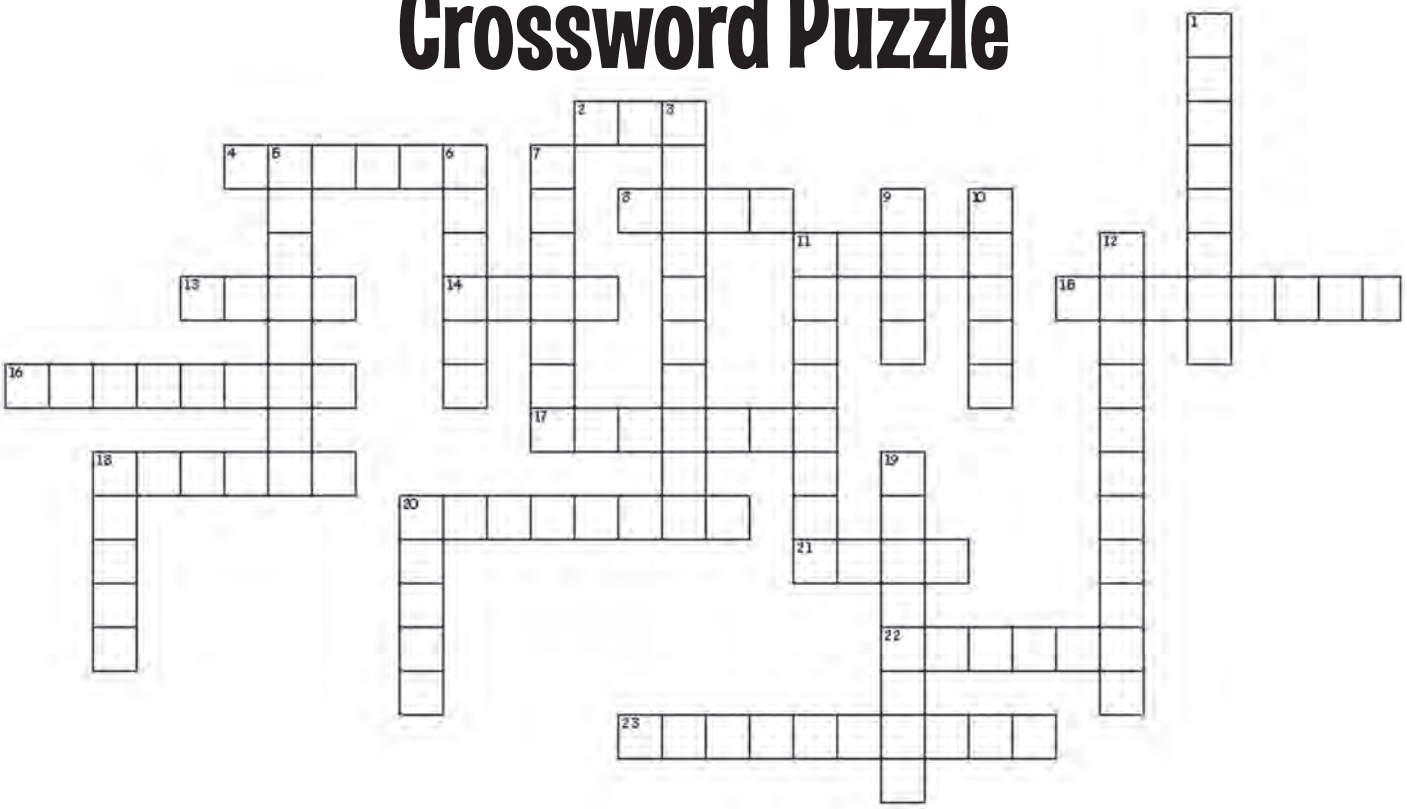
ACTIVITY #6: Let's make a list of all the sports and activities that we can think of in which your teeth and mouth might be injured. (Remember to include non-team sports such as skateboarding, gymnastics and rollerblading.)

Mouthguards protect teeth from injury and should be used during all active sports.
Your dentist can make a custom mouthguard, or a self-fitted mouthguard can be purchased at a store.

Summary: *In addition to the basics of good oral hygiene, smart teens avoid behaviors that can damage their health and appearance, and protect their teeth during active sports by wearing mouthguards.*

ACTIVITY #7: Have students work individually or in pairs to complete the activity sheet *Watch Your Mouth! Crossword Puzzle.* [You may wish to have copies of *Permanent Tooth Development* and *Tooth Anatomy* available as a reference.]

Watch Your Mouth! Crossword Puzzle



Across

2. A food, deep yellow inside, belonging to the vegetables group
4. A primary cause of cavities and gingivitis
8. The innermost tissue of a tooth
11. With good personal and professional care, you should keep your teeth as long as you are _____ .
13. The unit you are studying is about ____ health.
14. A liquid containing calcium
15. The thin, hard covering of the root of a tooth
16. Most dentists recommend a tooth brush with soft _____ .
17. A dangerous product that is bad for your total health
18. A food with a white inside, belonging to the vegetables group
20. A natural substance which can help prevent cavities
21. A member of the grains group, frequently eaten in Asian countries
22. A watery secretion that bathes teeth and promotes digestion
23. Used to remove plaque

Down

1. The most common dental disease among young people
3. Protects teeth during sports
5. The periodontal _____ holds the tooth in its bony socket.
6. The hard outer covering of a tooth
7. Coating that protects teeth from decay
9. The part of the mouth just outside the teeth
10. A good substitute for meat
11. The type of bone in which teeth are embedded
12. _____ disease can result in destruction of tissues surrounding the tooth.
18. A fuzzy-skinned member of the fruits group
19. The front teeth
20. Cleans between teeth