Letter from the Editor - David C. Sarrett, DMD

Among the many risks that dentists must manage are percutaneous injuries—those occupational risks presented by sharps, needles and burs. The Needlestick Safety and Prevention Act, signed into law in 2000, directed OSHA to revise its Bloodborne Pathogens Standard, which applies to all employers who have employees with reasonably anticipated occupational exposure to blood or other potentially infectious materials. The revised standard requires documenting the annual consideration and implementation of appropriate engineering controls, and soliciting non-managerial healthcare workers in evaluating and choosing devices.

Needlestick injuries are only a small part of all percutaneous injuries in dental practice. Some bur injuries occur when a handpiece, resting in its holder, has an exposed bur pointing toward the dentist who accidentally scrapes a hand or arm against it. In this issue, the article, “Safe Injection Practices: Protecting Dentists, Their Staff and Their Patients,” takes a look at preventing percutaneous injuries along with examples of products and resources currently available for that purpose. I think you’ll find the data on percutaneous injuries, which was collected over the past two decades at the ADA’s Health Screening Program, very interesting.

Also in this issue is an evaluation of vinyl polysiloxane (VPS) occlusal registration materials. The ADA Laboratory purchased and evaluated eight products that were suggested by the ADA Clinical Evaluators (ACE) Panel. The laboratory tested several characteristics of the products: consistency, contact angle, strain in compression, elastic recovery, detail reproduction, gypsum compatibility, and dimensional stability before and after disinfection.

This is our third online-only issue of the ADA Professional Product Review. I’d like to hear from you. What products would you like to see evaluated? What products have been troublesome in your practice and why? Drop me a line at pprclinical@ada.org.

All the best to you, your staff and family as we approach the holiday season.
Proper use and selection of occlusal registration materials for interocclusal records is a necessary part of a restorative dental practice, particularly when the vertical dimension of occlusion or the jaw relationship is altered. In a review article by Murray et. al., the authors state that use of an occlusal registration material is appropriate under the following circumstances:

• the gypsum casts do not provide sufficient contact to establish the occlusal relationship (i.e., the position to be recorded is unstable);
• the occlusal relationship (either horizontal or vertical) needs alteration;
• adjustable or semi-adjustable articulators are to be used.¹

The commonly used occlusal registration materials are dental waxes (e.g., 28-gauge casting wax sheets or hard baseplate wax), metal oxide pastes (e.g., zinc oxide pastes), acrylic resins, and elastomeric materials, such as polyethers and additional silicones.¹,⁹,¹² This article focuses on addition silicones, which are also known as vinyl polysiloxanes (VPS) or polyvinyl siloxanes (PVS). The ADA Laboratories tested several characteristics of VPS occlusal registration materials: Consistency, contact angle, strain in compression, elastic recovery, detail reproduction, gypsum compatibility, and dimensional stability before and after disinfection.

The ADA Laboratory purchased and evaluated eight VPS occlusal registration materials based on survey responses from the ADA Clinical Evaluators (ACE) Panel:

• Blu-Mousse Dental Impression/Bite Registration Material Super-Fast (Parkell, Inc., Edgewood, NY)
• Correct Plus Hydrophilic Vinyl Polysiloxane Impression Material Superfast (Pentron Clinical, Orange, CA)
• Exabite II NDS Vinyl Polysiloxane Bite Registration Crème (GC America, Inc., Alsip, IL)
• Futar D Bite Registration Material Vinyl Polysiloxane (Roydent Dental Products, Johnson City, TN)

Table 1. Summary of Product Features

<table>
<thead>
<tr>
<th>OCCLUSAL (BITE) REGISTRATION MATERIAL</th>
<th>Manufacturer</th>
<th>Intraoral setting time</th>
<th>Intended Clinical Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exabite II NDS</td>
<td>GC America</td>
<td>45 seconds</td>
<td>Checking occlusal registration</td>
</tr>
<tr>
<td>Imprint Bite</td>
<td>3M ESPE</td>
<td>40 seconds</td>
<td>Bite registration</td>
</tr>
<tr>
<td>JET BLUE BITE Super Fast</td>
<td>Coltène/Whaledent</td>
<td>30 seconds</td>
<td>Bite registration and/or registration of centric occlusion</td>
</tr>
<tr>
<td>Take 1 Advanced Bite Registration</td>
<td>Kerr Corporation</td>
<td>60 seconds</td>
<td>Bite registration</td>
</tr>
<tr>
<td>Blu-Mousse Super-Fast</td>
<td>Parkell</td>
<td>30 seconds</td>
<td>Bite registration; Primary impression for two-stage technique, impression for temporary prosthesis; Stent fabrication</td>
</tr>
<tr>
<td>Correct Plus Bite Superfast</td>
<td>Pentron Clinical</td>
<td>30 seconds</td>
<td>Bite registration</td>
</tr>
<tr>
<td>Futar D</td>
<td>Roydent Dental Products</td>
<td>120 seconds from start of mix</td>
<td>Centric occlusion; Material for coating bite registration forks; Locating material, such as for Gothic arch tracings; Fabricating model segments for fitting down porcelain and composite inlays as well as cast inlays and onlays, etc.</td>
</tr>
<tr>
<td>Regisil Rigid Superfast</td>
<td>DENTSPLY Caulk</td>
<td>60 seconds</td>
<td>Intraoral recording of occlusal and centric relationships; Registrations between complete or partially edentulous occlusion rims; Pre-operative quadrant matrix impression for use in the direct fabrication of provisional (temporary) crowns, short-span bridges, inlays and onlays</td>
</tr>
</tbody>
</table>

"An Evaluation of Eight Elastomeric Occlusal Registration Materials"

Spiro Megremis, PhD, Amer Tiba, PhD, Kristy Vogt, BS
· Imprint Bite (3M ESPE, St. Paul, MN)
· JET BLUE BITE Superfast (Coltène/Whaledent, Cuyahoga Falls, OH) Regisil Rigid Vinyl Polysiloxane Bite Registration Material Super Fast Set (DENTSPLY Caulk, Milford, DE)
· Take 1 Advanced Bite Registration Material (Kerr Corp., Romulus, MI)

The setting speed formulation of most materials was “super fast,” as these materials are typically used for occlusal registration. However, a regular set formulation is available for all eight brands.

**Summary of Tests**

**Consistency**

*Clinical Significance:* The tests, performed in accordance with ANSI/ADA Standard No. 19, “Dental Elastomeric Impression Materials”, are meant to provide a measure of an elastomers ability to flow.² While bite registration materials are not identified by a consistency classification system like elastomeric impression materials, good “flow characteristics” and “limited initial resistance to closure” are named as desirable properties for bite registration materials prior to set.¹,³ As noted by Chai et al.,⁵ “one of the ideal properties of registration materials is to offer no resistance to the jaws during closure to the established vertical dimension,” since a material with “significant resistance” can cause a deviation of the mandible in three-dimensional space from its “normal” intercuspal position. However, in certain clinical situations, such as natural teeth opposing an edentulous arch, too much flow may be detrimental due to the space that the material is expected to fill. In such instances, the ability to “layer” the material from the same mix may be required to achieve adequate thickness for clinical success.

Standard No. 19 defines consistency as the “degree of firmness with which particles of a material, prepared for use, cohere so as to allow the material to flow, or resist flow, as required to achieve the purpose for which it is intended.”² Therefore, the consistency test, as defined in the Standard, is meant to provide a measure of an impression material’s ability to flow, and it is used for the same purpose for the bite registration materials evaluated in this study.

*Methods:* Three specimens of each bite registration material were tested similarly to the method outlined in Standard No. 19, with the exception that the load was applied 15 seconds after the completion of mixing instead of 25 seconds. This modification was made so that the load was applied at the same time for all materials, as some bite registration materials have a working time less than 25 seconds. In the method, 0.5 ml of material is placed between two glass plates with a constant force of 14.7 N (about 3.3 lbs) applied 15 seconds after completion of mixing. After 5 seconds, the load was released and 15 minutes later, the disc diameter was measured in two places on each specimen and the average reported in Table 2.

*Results:* The results of the consistency test are presented in Table 2. The greater the average diameter of the disc, the greater is the relative flow of the material. To put Table 2 values in perspective, according to Standard No. 19, the maximum disc diameter for putty and heavy-bodied consistency elastomeric impression materials is 35 mm, the range for medium-bodied materials is between 31 mm (minimum) and 41 mm (maximum), and the minimum for light-bodied is 36 mm (with no maximum).

<table>
<thead>
<tr>
<th>Occlusal Registration Material</th>
<th>Disc Diameter (mm) (n=3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blu-Mousse</td>
<td>25</td>
</tr>
<tr>
<td>Correct Plus Bite</td>
<td>20</td>
</tr>
<tr>
<td>Exabite I NDS</td>
<td>30</td>
</tr>
<tr>
<td>Futar D</td>
<td>36</td>
</tr>
<tr>
<td>Imprint Bite</td>
<td>25</td>
</tr>
<tr>
<td>JET BLUE BITE</td>
<td>34</td>
</tr>
<tr>
<td>Regisil Rigid</td>
<td>35</td>
</tr>
<tr>
<td>Take 1 Advanced Bite</td>
<td>22</td>
</tr>
</tbody>
</table>

Note: Test method limited reporting test data to whole numbers. The standard deviation for these values is zero because reporting of test data was limited to whole numbers and the consistency of the values from specimen to specimen within each product effectively had no variation.
Contact Angle

Clinical Significance: This test provides a measure of the hydrophilicity/hydrophobicity of a thin film of bite registration material spread onto an optically flat glass disc by recording the contact angle with time of a drop of water placed on the surface of the material. The greater the contact angle the more hydrophobic the material. Conversely, the more the drop spreads on the surface, resulting in a low contact angle, the greater the hydrophilicity. In general for detail reproduction, a low contact angle is desirable because it indicates the material is capable of achieving intimate contact with tooth surfaces, which is considered a desirable property for elastomeric impression materials. However, for occlusal registration materials, a relatively large contact angle (greater than 90 degrees) may be considered desirable since the argument can be made that the hydrophobic nature of these materials can displace any residual water.

Methods: Five specimens of each bite registration material were analyzed at room temperature using the Drop Shape Analysis System, FM 40 Easy Drop (KrÜss GmbH, Hamburg, Germany). For each test, a thin film of registration material was spread onto an optically flat glass disc, and then 15 seconds after the start of the mix, a 5µl water droplet was applied to the surface of the unset material. Contact angle was measured beginning one second after contact between the water droplet and the material and continuously measured over 30 seconds. The average contact angle over the 30 seconds was recorded, and for each material, the average of the 5 tests was reported.

Results: The average contact angle measurements for the products tested are shown in Figure 1. For all of the products, the contact angle measurements are greater than 90 degrees, which means the bite registration materials are relatively hydrophobic. Therefore, care should be taken to make sure that the tooth surface contacting the material is dry, since moisture could prevent intimate contact between the material and the tooth.

Strain in Compression

Clinical Significance: The strain-in-compression test is taken from ANSI/ADA Standard No. 19 and provides a method for measuring the relative flexibility/stiffness of elastomeric impression materials. For these materials, it is important that a set material be both flexible enough to be “removed from the mouth without injury to impressed oral tissues” and stiff enough “in the more flexible portions of impressions, to resist deformation when model-forming products are poured against them.” For bite registration materials, the stiffness of the set material is the more important consideration, since the material will not typically cover soft tissue or have gypsum products poured against them. Both Chai et al. and Murray et al. state that an important characteristic of a bite registration material is that it be stiff enough (or appropriately rigid) “when used to relate the dental casts so the weight of the cast and the articulator do not deform the record.” Chai et al. also note that some of the earliest available elastomeric materials that were used for bite registration materials had the principle drawback that their “lack of rigidity made the accurate location of casts difficult”; however, Michalakis et al. noted that some elastomeric impression materials that are used as bite registration materials have been modified with some additives to make them more suitable for this application. This test provides a relative measure of the stiffness of these materials when subjected to a specific load after setting.

Methods: Strain-in-compression was performed on five specimens of each material according to ANSI/ADA Standard No. 19.

Results: Figure 2 shows the results of the strain-in-compression tests. A higher strain-in-compression value indicates greater relative flexibility, whereas a lower value signifies a relatively stiffer material. For perspective, Standard No. 19 requires a minimum and maximum strain-in-compression of 0.8% and 20%, respectively, for both putty and heavy-bodied consistency elastomeric impression materials. It can be seen that the bite registration materials are near the minimum value of 0.8%, which is desirable for this application. Note that the necessity for a specific minimum value for elastomeric impression materials is because a set impression material requires a minimum amount of flexibility to be removed from the mouth, especially for clinical situations with severe undercuts. However, the fact that the mean value for one of the bite registration materials falls below the 0.8% minimum value is not necessarily a cause for concern, since typically the set material does not need to require a significant amount of flexibility clinically.
Contact Angle of Bite Registration Materials Measured 15 Seconds After Start of Mix

Figure 1. Mean contact angle values measured over 30 seconds beginning 15 seconds after start of mix. The vertical "I" bars within the mean value bars represent standard deviations. The horizontal bars indicate values that are not statistically different (n=5, One-Way ANOVA, p<0.05).

Strain in Compression

Figure 2. Mean strain-in-compression values for occlusal registration materials tested according to ANSI/ADA Standard No. 19. The horizontal "I" bars within the mean value bars represent standard deviations. Vertical bars represent values that are not statistically different (n=5, One-Way ANOVA, p<0.05).
Elastic Recovery

**Clinical Significance:** The elastic recovery test is taken from ANSI/ADA Standard No. 19. This test is clinically important because it provides a measure of the ability of a bite registration material to elastically recover after being removed from the mouth. This is done by deforming the material a specific, clinically relevant distance after it has set and then removing the deforming force and measuring the ability of the material to recover to its original dimensions. When assessing the results generated by this test, it should be taken into consideration that occlusal registration materials will typically not be exposed to the same degree of deformation during removal from the mouth as impression materials.

**Methods:** Five cylindrical specimens were made for each registration material with a height of 20 mm. After setting, each specimen was deformed 6 mm (30% of the original specimen height) within one second. The height of each specimen was measured before and after deformation, and the elastic recovery was calculated as the difference between the two heights divided by the initial height and reported as percent recovery of the initial height of the specimen.

**Results:** All of the bite registration materials tested in this study recovered from 98 to 100 percent of their original height. For reference, ANSI/ADA Standard No. 19 requires that an elastomeric impression material recover at least 96.5 percent of its original height.

Detail Reproduction

**Clinical Significance:** The detail reproduction test is also taken from ANSI/ADA Standard No. 19. This test is meant to indicate the ability of an elastomeric impression material to provide a detailed negative copy of the surface being impressed. For these materials, the clinical significance of this test has been questioned in that the detail obtained by in-vitro reproductions is not always reproducible at the same level in the mouth, as a result of the hydrophobicity (see Contact Angle section) of some of the elastomeric impression materials. However, for the different bite registration materials tested in this study, this method provides information on their relative ability to reproduce surface detail on the same test block and under the same conditions, which is relevant when comparing products.

**Methods:** We evaluated detail reproduction according to ANSI/ADA Standard No. 19. Three specimens of each bite registration material were tested using a stainless steel test block with three V-shaped grooves, 25 mm long and having varying widths of 20, 50, and 75 microns at the top of the groove and depths half the value of the width.

**Results:** All bite registration materials were able to completely reproduce the 20 micron wide line over the entire length of the detail reproduction test block, demonstrating their ability to reproduce fine detail to the same degree as required for medium and light bodied impression materials.

Gypsum Compatibility

**Clinical Significance:** The gypsum compatibility test, which is taken from ANSI/ADA Standard No. 19, is designed to evaluate how accurately the detailed lines in an impression material can be reproduced in a gypsum cast. Although bite registration materials typically do not come into contact with setting gypsum, it is feasible that dentists may use these materials for purposes other than their intended clinical applications. Therefore, we evaluated how accurately the detailed lines created in the bite registration materials are reproduced in gypsum casts in a similar manner to the evaluation for elastomeric impression materials.

**Methods:** Each detail reproduction specimen (see Detail Reproduction section) was used to pour a gypsum cast. CoeCal (GC America), a Type III dental model stone, and Die Keen Green (Modern Materials), a Type V, high-strength gypsum stone, were used. The gypsum materials passed tests for setting time and linear expansion according to ANSI/ADA Standard No. 25. Specimens were viewed under an optical microscope at 30X using low-angle illumination from an external light source.

**Results:** Table 3 shows the results of the gypsum compatibility tests. The results show that outgassing is clearly a problem for most of the bite registration materials, and that only two of the products were able to reproduce the detailed lines in gypsum casts. Since many bite registration products do not include pouring of a gypsum cast as an indicated use, this serves as a caution to use these materials only as indicated, even though their handling properties might make it tempting to use them for other applications.

Dimensional Stability Before and After Disinfection

**Clinical Significance:** A bite registration material’s dimensional stability with time is an important factor in its clinical success if the material is expected to provide accurate occlusal registration when used at a later time. The dimensional stability of the bite registration materials in
this study was evaluated based on the dimensional stability test specified in ANSI/ADA Standard No. 19 for elastomeric impression materials. This test evaluates how well a material maintains its dimensions after removal from a test block or form, followed by storage for approximately 24 hours. One important factor that affects the dimensional stability of an elastomeric impression material after it is removed from the mouth, which may also affect occlusal registration materials, is the coefficient of thermal expansion of the material; this is the amount that the material contracts when cooling from the temperature of the material in the mouth to room temperature. Since the mold and the material are initially at 35°C, the linear dimensional change test is designed to measure the effect of this factor on the dimensional stability of the tested material.

Methods: While ANSI/ADA Standard No. 19 requires that linear dimensional change be measured at a maximum of 24 hours after specimen fabrication; the standard does not address the effect of disinfectants. In this study, six specimens of each registration material were made from the same test block used for the detail reproduction tests. Three specimens were measured after 24 hours and then again after 7 days and 14 days storage in a temperature/humidity chamber at 23°C and 50% humidity, without disinfection. The Centers for Disease Control and Prevention’s “Guidelines for Infection Control in Dental Health Care Settings (2003)” recommend that items used in the fabrication of dental prostheses and appliances be cleaned and disinfected either at the clinic or once they reach the dental laboratory. Therefore, since the disinfection medium can be a possible factor in dimensional stability of the registration materials, the remaining three specimens for each material were soaked in disinfectant, rinsed, dried, and measured after 24 hours and then again after 7 days and 14 days storage in a temperature/humidity chamber at 23°C and 50% humidity. DisCide ULTRA (Palmero Health Care) was used as the disinfection medium for all eight registration materials. DisCide ULTRA, a quaternary ammonium compound, was evaluated in the ADA Professional Product Review’s evaluation of surface disinfectants.

Results: All of the bite registration materials that we evaluated exhibited a linear dimensional change of less than or equal to 0.5% over 14 days, even with disinfection, as shown in Table 4. To put these values in perspective, ANSI/ADA Standard No. 19 requires a maximum linear dimensional change of no greater than 1.5% for all consistencies of elastomeric impression materials. Since only three specimens of each material were tested per condition (i.e., disinfected and non-disinfected), statistical analysis was not performed on the results. When the materials were disinfected, it can be seen that for 7 of the 8 materials tested the dimensional stability stayed the same or slightly increased (never more than 0.1%) from 24 hours out to 14 days. For the Regisil Rigid Superfast, the

<table>
<thead>
<tr>
<th>Occlusal Registration Material</th>
<th>Gypsum Compatibility with CoeCal (Type 3)</th>
<th>Gypsum Compatibility with Die Keen Green (Type 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blu-Mousse SuperFast</td>
<td>Reproduced 20µm line</td>
<td>Reproduced 20 µm line</td>
</tr>
<tr>
<td>Correct Plus Bite Superfast</td>
<td>Excessive outgassing; all lines obliterated</td>
<td>Excessive outgassing; all lines obliterated</td>
</tr>
<tr>
<td>Exabite II NDS</td>
<td>Excessive outgassing; all lines obliterated</td>
<td>Excessive outgassing; all lines obliterated</td>
</tr>
<tr>
<td>Futar D</td>
<td>Reproduced 20 µm line</td>
<td>Reproduced 20 µm line</td>
</tr>
<tr>
<td>Imprint Bite</td>
<td>Excessive outgassing; all lines obliterated</td>
<td>Excessive outgassing; all lines obliterated</td>
</tr>
<tr>
<td>JET BLUE BITE superfast</td>
<td>Excessive outgassing; all lines obliterated</td>
<td>Excessive outgassing; all lines obliterated</td>
</tr>
<tr>
<td>Regisil Rigid Superfast</td>
<td>Excessive outgassing; all lines obliterated</td>
<td>Excessive outgassing; all lines obliterated</td>
</tr>
<tr>
<td>Take 1 Advanced Bite</td>
<td>Excessive outgassing; all lines obliterated</td>
<td>Excessive outgassing; all lines obliterated</td>
</tr>
</tbody>
</table>

Three gypsum compatibility tests were performed for each bite registration material.
percent change went from 0.3% at 7 days to 0.2% at 14 days. Considering the small sample size (n=3) and small magnitude of the percent change (less than or equal to 0.1%), this difference is probably not significant. Similarly, for the non-disinfected materials, it can be seen that for 6 of the 8 materials tested the dimensional stability stayed the same or slightly increased (never more than 0.1%) from 24 hours out to 14 days. Again, the Regisil Rigid Superfast showed a slight decrease in percent linear dimensional change from 7 days to 14 days, and, additionally, the Blu-Mousse Superfast also exhibited a slight decrease over the same time period. However, as noted for the disinfected samples, this change is probably not significant.

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Dr. Amer Tiba is a research associate, ADA Laboratories.
Ms. Kristy Vogt is team Leader, laboratory evaluations, ADA Laboratories.

Disclosure: None of the authors reported any disclosures.

Table 4. Dimensional Stability of Occlusal Registration Materials Before and After Disinfection

<table>
<thead>
<tr>
<th>Occlusal Registration Material</th>
<th>24 hours, no disinfection</th>
<th>24 hours, disinfected</th>
<th>7 days, no disinfection</th>
<th>7 days, disinfected</th>
<th>14 days, no disinfection</th>
<th>14 days, disinfected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blu-Mousse Superfast</td>
<td>0.1</td>
<td>0.0</td>
<td>0.2</td>
<td>0.1</td>
<td>0.4</td>
<td>0.1</td>
</tr>
<tr>
<td>Correct Plus Bite Superfast</td>
<td>0.1</td>
<td>0.0</td>
<td>0.2</td>
<td>0.0</td>
<td>0.1</td>
<td>0.0</td>
</tr>
<tr>
<td>Exabite II NDS</td>
<td>0.3</td>
<td>0.0</td>
<td>0.3</td>
<td>0.0</td>
<td>0.3</td>
<td>0.0</td>
</tr>
<tr>
<td>Futar D</td>
<td>0.2</td>
<td>0.1</td>
<td>0.2</td>
<td>0.1</td>
<td>0.2</td>
<td>0.0</td>
</tr>
<tr>
<td>Imprint Bite</td>
<td>0.2</td>
<td>0.1</td>
<td>0.3</td>
<td>0.0</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>JET BLUE BITE superfast</td>
<td>0.2</td>
<td>0.0</td>
<td>0.2</td>
<td>0.0</td>
<td>0.3</td>
<td>0.0</td>
</tr>
<tr>
<td>Regisil Rigid Superfast</td>
<td>0.4</td>
<td>0.0</td>
<td>0.1</td>
<td>0.1</td>
<td>0.5</td>
<td>0.1</td>
</tr>
<tr>
<td>Take 1 Advanced</td>
<td>0.2</td>
<td>0.0</td>
<td>0.2</td>
<td>0.1</td>
<td>0.2</td>
<td>0.0</td>
</tr>
</tbody>
</table>
In 2012, the Colorado Department of Public Health sent letters to 8,000 patients of a dentist who had been suspended for reusing syringes and needles over a 12-year period. In a statement, the department said that the reused needles and syringes were used in several patients’ intravenous lines, in violation of standard medical protocol. As a result, patients were urged to seek tests for HIV and hepatitis infections. This is a very unusual case, and not one that is a common problem in dentistry.

Although there have been no recent confirmed transmissions of infection in dentistry resulting from unsafe injection practices, the U.S. Centers for Disease Control and Prevention (CDC) reports that numerous outbreaks have been reported in other healthcare settings.1

The CDC issued the 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Dental Health-Care Settings, which includes standard precautions for safe injection practices,2 and the CDC’s Guidelines for Infection Control in Dental Health-Care Settings, 2003.3

The agency also urges all healthcare providers, including dentists, to review their infection control practices and the practices of all staff under their supervision.4 CDC reminds dental practitioners of the following practices that are critical for patient safety:1

- Never administer medications from the same syringe to more than one patient, even if the needle is changed or if you are injecting through an intervening length of intravenous (IV) tubing.
- After a syringe or needle has been used to enter or connect to a patient’s IV, it is contaminated and should not be used on another patient or to enter a medication vial.
- Never enter a medication vial, bag, or bottle with a used syringe or needle.
- When possible, use single-dose vials instead of multiple-dose vials, particularly when medications will be administered to multiple patients.2
- Never use medications packaged as single-dose or single-use for more than one patient—this includes ampoules, cartridges, and bags or bottles of intravenous solutions.
- Assign medications packaged as multi-dose vials to a single patient whenever possible.

- Never use bags or bottles of intravenous solution as a common source of supply for more than one patient.
- Follow proper infection control practices during the preparation and administration of injected medications.
- Never combine the leftover contents of a syringe or single-use vials for later use.

Patient safety requires strict adherence to safe injection practices. Unsafe injection practices during patient care can have serious consequences,4 such as:

- Possible exposure to and transmission of bloodborne pathogens
- Requirements for patient notification and recommendation that they be tested for Hepatitis C, Hepatitis B, and HIV
- Patients filing malpractice suits
- Disciplinary action by licensing boards

Preventing Needlestick and Puncture Injuries in the Dental Office

Dentists and their staff must also protect themselves from potential needlestick injuries and other injuries from burs and sharps. The Needlestick Safety and Prevention Act was signed into law on November 6, 2000.5 The Act directed the Occupational Safety and Health Administration (OSHA) to revise its Bloodborne Pathogens Standard, which applies to all employers who have employees with reasonably anticipated occupational exposure to blood or other potentially infectious materials.6,7 Following this legislation there was a 38% drop in percutaneous injuries among full time hospital employees.8

Many dentists may not be aware that OSHA requires them to annually review devices and engineering controls to prevent needlesticks.5,6

The revised standard requires documentation of: 1) annual consideration and implementation of appropriate engineering controls, and (2) solicitation of non-managerial healthcare workers in evaluating and choosing devices. The plan must be reviewed and updated at least annually.

Engineering controls are defined as “controls (e.g., sharps disposal containers, self-sheathing needles, safer medical devices, such as sharps with engineered sharps injury protections and needleless systems) that isolate or remove the bloodborne pathogens hazard from the workplace.”
A sampling of products currently available are listed in links that follow as guidance. The CDC also provides sample forms for dentists and their staff to use in the hands-on evaluation of these devices. See: www.cdc.gov/OralHealth/infectioncontrol/forms.htm.

In addition, the Food and Drug Administration (FDA), the CDC, the National Institute for Occupational Safety and Health (NIOSH), and OSHA issued a Joint Safety Communication on May 30, 2012 that strongly encourages healthcare professionals to use blunt-tip suture needles as an alternative to standard suture needles when suturing fascia and muscle to decrease the risk of needlestick injury. The pathogens of primary concern are the human immunodeficiency virus (HIV), hepatitis B virus (HBV), and hepatitis C virus (HCV). Workers and employers are urged to take advantage of available engineering controls and work practices to prevent exposure to blood and other body fluids.

Background
The most efficient mode of patient-to-provider transmission for bloodborne pathogens is through percutaneous injuries (e.g., needlesticks and injuries from other sharp devices).

The CDC recently surveyed dentists’ compliance with the use of safety sharps. The agency surveyed a random sample of 6,825 U.S. dentists in 2008. The response rate was 49 percent. The survey recorded attitudes towards trying or using safer syringes and scalpels. Approximately 21 percent of responding dentists reported having used a safer syringe or scalpel in the preceding 12 months; 16.9 percent used a safer syringe, and 11.7 percent used a safer scalpel, suggesting that at least 7.6 percent had used both. About 41 percent reported having used a needle recapping device in their practice.

In the same study, the CDC found 6 percent of responding dentists reported having experienced one or more percutaneous injuries in the previous 12 months and 14.4 percent reported such injuries among staff members. Overall, 50.9 percent of responding dentists and their staff members with percutaneous injuries reportedly were referred for medical follow-up and the injuries of 73.4 percent of those were documented; fewer than one-half (48.4 percent) were referred medically and underwent documentation of their injuries. An estimated 83.4 percent of respondents reported always documenting percutaneous injuries experienced by themselves and their staff.

Furthermore, data collected from the ADA Health Screening Program annually tracked the reported numbers of all percutaneous injuries (PI), including needlesticks, among participating U.S. dentists. In the period 1993-97 the average yearly number of reported percutaneous injuries was 2.40 per participating dentist and by 2007-11 that number had dropped to 1.14 percutaneous injuries per year.

Frequency of Percutaneous Injuries/Year
All U.S. Dentists

While these data are somewhat encouraging and may suggest that current regulatory policies and recommendations for preventing percutaneous injuries are effective, they only tell part of the story. Getting a better understanding of why percutaneous injuries continue to occur at any level requires sorting these data into one group of dentists reporting no percutaneous injuries and one group reporting any percutaneous injuries and comparing them.

Practicing U.S. Dentists Reporting Percutaneous Injuries in the Past 30 Days

If dentists reporting no percutaneous injuries are removed from the dataset of all dentists, then the average numbers of percutaneous injuries per dentist increases about 7 times over all dentists in 1993 and increases even higher in 2006.
These data indicate that today over 91 percent of practicing dentists in the ADA’s Health Screening Program report no percutaneous injuries, but the much smaller proportion that do report injuries shows that the frequency of percutaneous injuries from 1993 to 2006 has remained very high. This would indicate that any additional efforts to further reduce percutaneous injuries should be focused upon that group that experiences any percutaneous injuries.

Among those practicing dentists reporting any percutaneous injuries, significant contributing factors were:

- Female gender (compared to males)
- Being right handed (compared to left handed) as dominant hand
- Being under 50 (compared to those 50 or older) after controlling for whether they were currently practicing dentistry
- Being under 65 (compared to those 65 or older) after controlling for whether they were currently practicing dentistry

Figure 4. Percutaneous Injuries in Last 30 Days by Gender: Practicing U.S. Dentists Participating in the ADA Health Screening Program (HSP)

Figure 3. Extrapolated Percutaneous Injuries/Year—Only U.S. Dentists Participating in the ADA Health Screening Program Reporting One or More Percutaneous Injuries, 1993-2006

Figure 5. Percutaneous Injuries in Last 30 Days by Dominant Hand: Practicing U.S. Dentists Participating in the ADA Health Screening Program (HSP)

Figure 6. Percutaneous Injuries in Last 30 Days by Age; (Less than 50 years old; 50 or older): U.S. Dentists Participating in the ADA Health Screening Program (HSP)

Figure 7. Percutaneous Injuries in Last 30 Days by Age (Less than 65 years old; 65 or older): Practicing U.S. Dentists Participating in the ADA Health Screening Program (HSP)
The following characteristics did not have a statistically significant relationship with reporting at least one percutaneous injury:

- Hepatitis C virus seropositivity
- Working <32 hours compared to >32 hours
- Being trained to use safety needles
- Predominantly using self-sheathing or retractable safety needles

These findings are provocative in that factors that may intuitively be expected to impact the frequency of percutaneous injuries in this injury-prone group apparently do not, such as increased work hours. The cause of increased injuries within this group remains to be determined.

Another smaller study surveyed percutaneous injuries among dentists in Taiwan (n=434) and found that 23% of responding dentists reported more than one per week and 28% reported needlestick injuries through recapping.12

Forty three percent of dentists in the study worked in hospitals. The factors associated with percutaneous injuries were older age, increasing years of practice, working in clinics, exhibiting lower compliance with infection control procedures, inadequate knowledge of bloodborne pathogens and worry over being infected by bloodborne pathogens.

While needlestick injuries might seem to dominate the popular media, they are not the most frequent of all percutaneous injuries. Needlestick injuries are only a small fraction of all percutaneous injuries suffered by dental professionals.

A prospective study of dentists found that dental burs accounted for most percutaneous injuries overall at 37.2 percent.13 In contrast, the study found that needlestick injuries occurred in 17.2 percent of dentists. Dentists reported 5.1 percutaneous injuries per year, which translates into 0.88 syringe needlestick injuries per year per dentist.

Most bur injuries occur on the arm from bumping into an exposed bur pointing towards the operator in the handpiece holder.13 A handpiece with a bur that is not in use must always be pointed away from the patient or clinician or be covered or removed from the handpiece to minimize accidental contact in absence of an engineered control. Dental burs cannot have a retractable shield like needles. Instead, some dental units are designed with a special handpiece holder that shields the tip of the bur.

Furthermore, the risk of transmitting an infectious agent through a narrow-gauge dental anesthesia needle is extremely low due to the small volume potential.14 Nonetheless, the standard post-exposure evaluation and follow-up protocol recommended by the Centers for Disease Control and Prevention (and required by OSHA) in the aftermath of a needlestick is so extensive and potentially costly to the employer, as well as invasive to the employee, that it is well worth the effort to take reasonable steps to avoid a needlestick in the first place.

Safety Devices

(Disclaimer: The products listed here do not imply an evaluation or endorsement by the ADA, but rather serve as a brief, illustrative list.)

Safety needles. Several safety injection products were sold to dentistry a decade ago, but most are no longer available. Today there is essentially one safety needle device specifically designed for use by dentists. As of this publication, only Septodont Ultra Safety Plus XL remains as an anesthetic safety delivery system available to dentists. This product is a sterile, disposable, single-patient use, auto-aspirating, reloadable injection system that is designed to reduce needle stick injuries.

The system consists of a preloaded triple bevel needle. This safety syringe can be used with an autoclavable or single-use plungers, which attach to the syringe. A protective shield slides back to expose the needle and is then pushed forward into a locked position to cover the needle after use. The barrel is transparent allowing visualization of the carpule. Brumley et al evaluated an earlier version of this device and reported the following problems: Difficult to see positive aspiration, syringe comes apart during injection, very difficult to change carpules and fills a sharps container quickly.16 It is unknown if the same deficiencies would be reported with the current product. The manufacturer responded to the previous statement with the following: “The company modified the product in 2003 by changing the plastic to be more transparent. The system is designed to be a single use needle system. Many experts recommend that a needle should only be used once and replaced after each injection. It is our intention that you only use the needle portion of the system for one cartridge and you use a new, sharp needle for a second injection. As to the system coming apart, that could be an issue with care taken, it should not fall apart.” (Matt Woolson, e-mail communication, November 2012)

There have been few clinical studies evaluating different brands of safety needles used in dentistry. Unfortunately, all were published at least 10 years ago. When evaluating new safety needle devices, it is useful to keep in mind the difficulties reported in these studies. Since Cuny et al published a study in which none of the safety devices tested successfully passed clinical evaluation by dental students, only one study has reported additional results.15 In that study, the researchers collected survey data from dentists on three safety devices, but problems were reported with all three devices, including: obstructed intraoral views, difficult to use in smaller mouths, intraoral fogging of the sheath, awkwardness in use, difficulty in changing carpules, and increased volume of waste.

In 2003, the American Dental Association's Division of Science, with the ADA Survey Center, surveyed 71 randomly selected dentists who commented on their experience with two brands of safety needle, neither
of which is currently on the market.\textsuperscript{17} Fifty percent of respondents concluded that the device did not need improvement, 68.3 percent agreed that it would meet the needs of the dental practice and 82.9 percent agreed that the syringe allowed a clear view of the injection site and needle tip. On the other hand, 41.5 percent thought that the safety syringe/needle was not suitable for one-handed operation, 32.9 percent indicated that the safety device did not maintain a positive lock upon activation and 27.1 percent thought that the device created a new hazard. Training or a period of acclimation for safety needle/syringe use is often cited as necessary for successful operation of the device. However, 75 percent of respondents indicated that they could have used this device correctly without special training. Results of this survey were equivocal, but they highlighted several areas needing improvement before routine use.

**Blunt-tip suture needles.** The FDA, NIOSH and OSHA strongly encourage the use of blunt-tip suture needles where appropriate for avoiding accidental needlesticks. However, blunt-tip suture needles have limited use for dental procedures. They predominately are used for suturing muscle and fascia and require more force to penetrate these tissues than conventional sharp suture needles. Therefore, they also require more force to penetrate an operator’s skin, thus reducing the potential for an accidental needlestick. Blunt-tip suture needles should be considered for any procedure where appropriate, such as in some oral and maxillofacial surgical procedures.

**Safety scalpels also have limited use in dentistry.** They work similar to safety needles, where a protective cover slides over the scalpel blade when not in use. Safety scalpels may be cumbersome for use intraorally. But they are important extraorally, where a contaminated scalpel blade is exposed during transport or sitting on a tray.

**Needle recapping.** There are several products that promote one-handed recapping of needles or safe installation of injection needles onto a syringe. All are relatively inexpensive, multiple-use devices. OSHA does not consider these types of devices to be safety devices \textit{per se}, but rather considers that they promote safer work practices.

**Disposal.** Of course, every percutaneous injury avoidance plan must include safe disposal of contaminated sharps. Dozens of sharps container products are available, and all must conform to the ASTM standard for puncture resistance.\textsuperscript{18} Care always must be exercised to avoid overfilling a sharps container, since overfilling increases the risk of sustaining a percutaneous injury during disposal of a sharp. A filled sharps container must have a positive locking system that prevents reopening of the container.

**Conclusion.** The past decade has seen few new developments in safety needle technologies suitable for dental use. The utility of safety needles is much clearer in non-dental settings, where the confined space of the oral cavity is not an issue.

There have been no recent confirmed transmissions of infection in dentistry that resulted from unsafe injection practices (including the 2012 Colorado case), and current data indicate that more than 91 percent of practicing dentists who participated in the 2006 ADA’s Health Screening Program experienced few percutaneous injuries. However, the much smaller proportion that do report percutaneous injuries report them at an alarmingly higher frequency. This would indicate that any additional efforts to further reduce the frequency should focus upon that group that experiences any percutaneous injury.

So what is a dental practitioner to do? Two basic principles are necessary to prevent infectious transmissions through any percutaneous injury:

1) Learn current percutaneous injury prevention recommendations from the CDC and OSHA.

2) Implement what is learned.

Many resources are available online describing accepted procedures for preventing percutaneous injuries. An educated practitioner can anticipate situations where a percutaneous injury is likely. Furthermore, implementing this knowledge will allow the practitioners to initiate work practice controls to avoid percutaneous injuries to themselves and staff. These controls must be strictly enforced, and eventually the controls will become “no brainer” habits. This is especially important under the stressful conditions of a difficult procedure, difficult patient or heavy workload.

Staying current on the availability of new safety devices and actually evaluating them under clinical conditions will help reinforce preventive avoidance of percutaneous injuries as a workplace habit. Finally, applying good avoidance judgment can be as simple as removing a dental bur after use or positioning the bur in the handpiece holder facing away from you. Percutaneous injuries, including needlesticks, can be prevented! It just requires conscientious and persistent determination.
Sample Safety Devices*

**Septodont**
800–872–8305
www.septodontusa.com

**Xodus Medical Inc.**
800–963–8776
www.xodusmedical.com

**Futura® Safety Scalpels – Futura/Hypoguard USA**
800–328–5536
www.pattersondental.com

**RazorMed, Inc.**
847–223–0966
http://safhandle.com/reusable_safety_scalpel.php

**Vibrashield**
ITL DENTAL
800–277–0073
www.itldental.com

**Certol Pro Tector**
Certol International
800–843–3343
www.certol.com

**Captor Deluxe Needle Handler**
Patterson Dental
800–328–5536
www.pattersondental.com

**Conta-Guard System**
Practicon
800–959–9505
www.practicon.com

*Disclaimer: The links to products listed above do not imply an evaluation or endorsement by the ADA, but rather only serve as a brief, illustrative list.*
Injection Safety Guidelines*

- Never administer medications from the same syringe to more than one patient, even if the needle is changed.
- Never enter a vial with a used syringe or needle.
- Never use medications packaged as single-dose vials for more than one patient.
- Assign medications packaged as multi-dose vials to a single patient whenever possible.
- Follow proper infection control practices during the preparation and administration of injected medications.

OSHA requires that employers who have staff at risk of sustaining percutaneous injuries caused by contaminated sharps consider the appropriate use of safety devices or document in their exposure control plans that safety devices have been considered but are not a practical alternative to the devices currently used.

Don’t Let This Happen to You!

References
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- Expanded section on the safe handling and disposal of needles and other sharps
- Updated infection control guidelines for radiographic procedures
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