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Single-Patient-Use vs Multiple-Patient-Use Dental Burs

By Keith Cyrus Keller, DMD

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ABSTRACT

Dental armamentarium has evolved since the first tool-assisted manipulation of teeth thousands of years ago. In the modern era, discussion continues as to which tools will provide the best outcomes for patients and dental providers. One significant debate, especially in light of the heightened awareness of infection control, pits dental burs that are single-patient-use vs multiple-patient-use. Important considerations include overhead costs, cutting efficiency, and infection control. Manufacturing of dental burs and other armamentarium has an interesting history, and in this course you will learn where the technology and science stand at this moment in time.

EDUCATIONAL OBJECTIVES

After completing this course, the reader should be able to:

- Discuss the history of dental burs and handpieces
- List the pros and cons of single-patient-use and multiple-patient-use armamentarium
- Analyze dental bur cost, efficiency, and infection control.

ABOUT THE AUTHOR

By Keith Cyrus Keller, DMD

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Introduction

Removing tooth structure is an essential procedure in dentistry. Archeological evidence (Figure 1) from 13,000 years ago in Tuscany, Italy, has shown "tool-assisted manipulation to remove necrotic or infected pulp in vivo and the subsequent use of a composite, organic filling."[1] Other findings include 11 drilled molar crowns from nine adults discovered in a graveyard in Pakistan that dates from 7,500 to 9,000 years ago.[2]

For thousands of years, hand-held drills could produce roughly 15 rotations per minute (rpm). In

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1864, British dentist George Fellows Harrington invented a mechanical, clockwork drill called Erado (from the Latin for "I scrape out"). It was the first continuously rotating drill that lasted 2 minutes (Figure 2). James Morrison devised a pedal-powered drill (2,000 rpm) in 1871; it operated on the same principle as the treadle sewing machine (Figure 3). George Green revolutionized dentistry in 1875 with a patent for the first electric drill (Figure 4). By 1914, electric drills could reach speeds of up to 3,000 rpm. A second wave of rapid development occurred in the 1950s and 1960s, including the development of the air-turbine drill. Current iterations can operate at up to 800,000 rpm; however, 400,000 rpm (high speed) and 40,000 rpm (low speed) handpieces are most common.

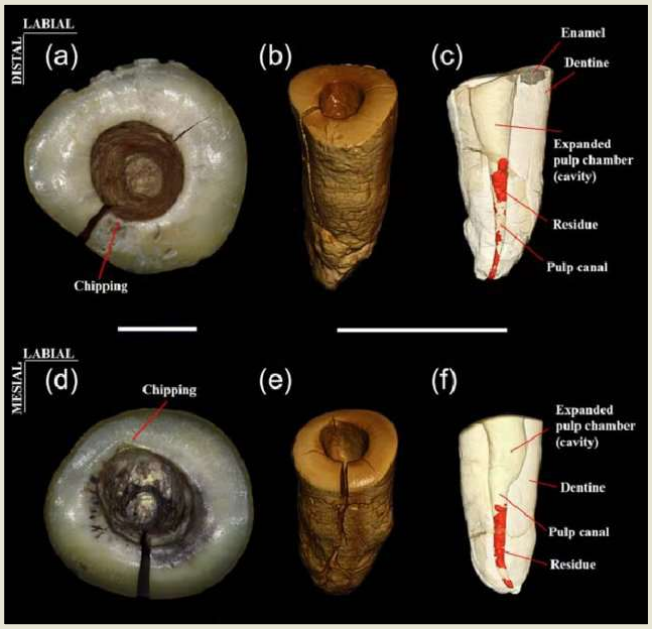


Figure 1—The upper right and left first incisors (RI1, LI1) of Riparo Fredian. (A) The RI1 in occlusal view. (B) Volume rendering of RI1 viewed from the lingual side. (C) Digital reconstruction of the RI1 with transparent dentine to show the residue; mesio-lingual view. (D) The LI1 in occlusal view; note the black patina within the cavity. (E) Volume rendering of LI1 viewed from the lingual side. (F) Digital reconstruction of LI1 with transparent dentine to show the residue: distal view. Scale bar: a and d 2 mm: b. c. e. and f 1 cm.

In addition to drills, dentists use metal, hand-held instruments in a variety of shapes that act as miniature chisels and excavators to remove caries and alter the architecture of a tooth in preparation for a restorative material. Although new techniques and technologies—such as lasers, air abrasion, and chemical dissolution—are advocated for removing dental hard tissue during tooth preparation, high- and low-speed rotary instruments remain the workhorses of modern dentistry and are used for caries removal, gross tooth reduction, margin refinement, enameloplasty, restoration removal, surgical extractions, crown lengthening, orthodontic adhesive removal, implant placement, and acrylic and metal appliance adjustment.

Dental Burs

The wide variety of available dental burs helps dentists accomplish many daily tasks (Figure 5). The International Organization for Standardization introduced a 15-digit code numbering system in 1979. The most up-to-date standard (ISO 6360-1:2004) helps to identify general and specific characteristics:

- The first group of three digits identifies materials used for the working part of instruments.
- The second group of three digits identifies instrument shanks and handles and overall instrument length.
- The third group of three digits identifies instrument shapes.
- The fourth group of three digits identifies specific characteristics for groups of instruments.
- The fifth group of three digits identifies the nominal diameter of the working part of the instruments (nominal size).[3]

The working part of a modern dental bur can be made of stone, stainless steel, stainless steel coated with tungsten carbide, pure tungsten carbide, diamond particles, ceramic, or plastic.

Tungsten Carbide

In chemistry, "carbide" describes a compound composed of carbon and a metal. Tungsten carbide contains equal parts tungsten (Figure 6) and carbon atoms. In its most basic form, tungsten carbide is a fine gray powder, but it can be pressed and formed into shapes via sintering. Compared to steel, tungsten carbide is approximately twice as stiff and double the density.[4]

In one study, five experienced operators were given a set of No. 330 tungsten carbide burs that had been separated into five blind categories: those not autoclaved at all and those that had been autoclaved one, two, five, or 10 times. Each operator was given a freshly extracted tooth and told to judge the cutting effectiveness of each bur by making an initial plunge into the tooth and then completing an occlusal cavity preparation in molar models made from composite. The results indicate that autoclaving tungsten carbide burs doesn't affect the subjective perception of effectiveness.[5]

Figure 2—George Fellows Harrington's first clockwork dental drill in a silver-plated veneered box. Invented in 1864, it had interchangeable drill heads and was operated by a spring-wound mechanism wound with a key.

Diamond

The first diamond burs were invented in 1897 by Willman and Schroeder from the University of Berlin, Germany.[6] These early burs were made by hammering diamond powder into the surface of soft copper or iron blanks. Silicone carbide burs had been used before this time, but they were found to wear when used on enamel. The modern diamond bur was created in 1932 by German industrialist W.H. Drendel, who developed a process for bonding diamond points to stainless steel.

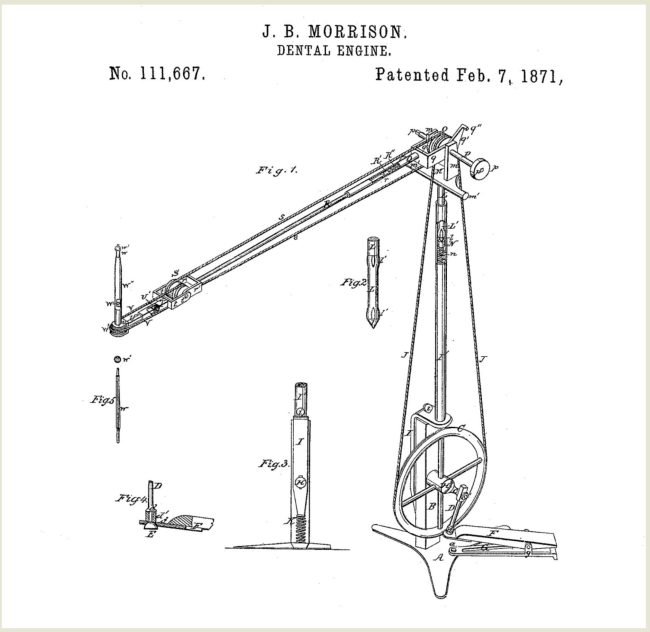
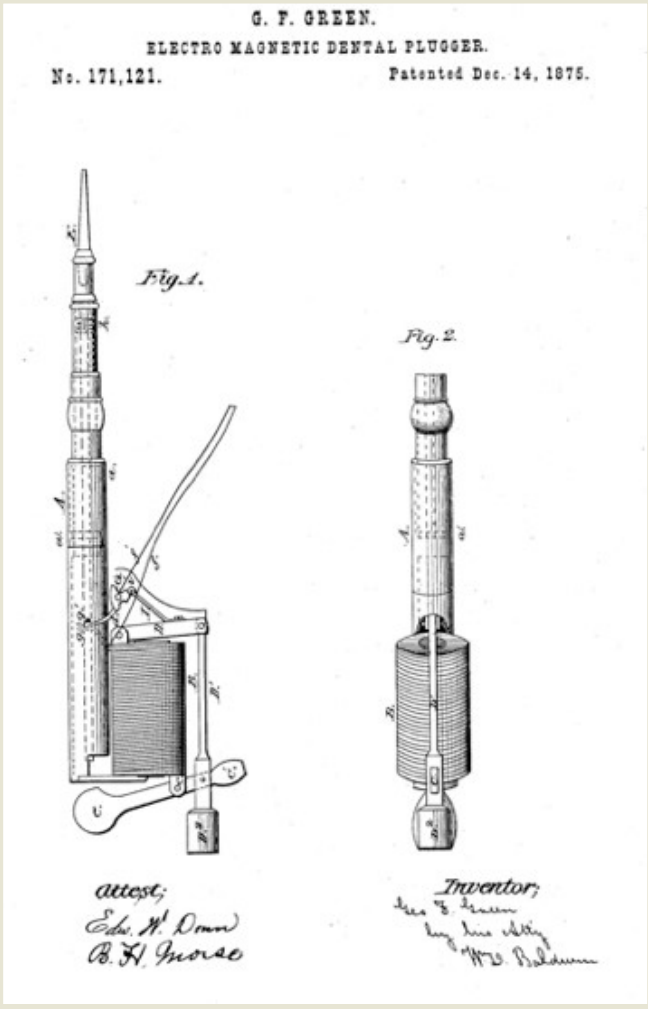


Figure 3—Dental foot engine designed by James B. Morrison and manufactured by S.S. White Dental Manufacturing Company.

The most common bonding method today is electrolytic co-deposition of natural or synthetic diamond particles within a nickel or duplex nickel–chromium matrix onto a stainless steel shank.[7] The diamond particles are embedded into the metal matrix, like chopped nuts embedded in caramel that coats a candied apple (Figure 7). Other techniques to attach diamond particles include microbrazing, chemical vapor deposition, sintering, and adhesives.[8] A survey of 131 dentists showed a preference for diamond burs (75%) over tungsten carbide burs (15%) and that most (85%) used their burs until they were worn out. Shockingly, clinicians usually sterilized burs either once daily (35%) or for every patient (35%).[9]


G. F. GREEN.

ELECTRO MAGNETIC DENTAL PLUGGER.

No. 171,121. Patented Dec. 14, 1875.

Fig. 1.

Fig. 2.

Attest:

Inventor:

Figure 4—1875 patent of first electric drill

Cutting Efficiency

In a study by Pilcher and colleagues, a scanning electron microscope was used to look at six different single-patient-use and two different multiple-patient-use diamond burs after making 20 cuts into a block of glass ceramic. Gradual reduction in cutting rates was observed and all eight burs exhibited diamond particle wear, as well

Figure 5—Burs with a variety of shapes, sizes, and materials

Figure 6—Tungsten rods with evaporated crystals, partially oxidized with colorful tarnish. Purity 99.98%, as well as a high pure (99.999% = 5N) 1 cm3 tungsten cube for comparison.

as loss of diamond particles and binder. Five of six single-patient-use burs had mean volumetric cutting rates similar to the multiple-patient-use diamonds.[10]

Another study looked at 16 different burs (some single-use and some multipatient-use) from a variety of manufacturers. "The results showed no differences in cutting efficiency between medium-grit conventional and disposable diamond burs."[11]

How often can a multiple-patient-use diamond be used? Researchers concluded that "diamond burs wear after multiple use and that they should be changed after five teeth preparations at most. A diamond bur should not be used for teeth preparation after try-in procedures of metal or zirconia substructures."[12]

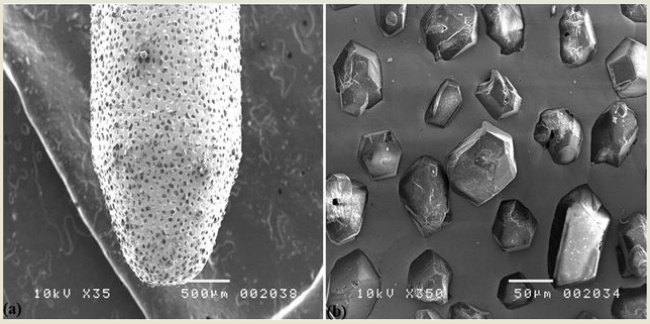


Figure 7—SEM micrographs showing (a) the morphology of a step diamond bur 12S, (b) diamond abrasives on the bur with approximately 64-µm grit size (Alao et al., 2017). Reprinted with permission from Elsevier.

Figure 8—Microcopy single-patient-use diamond burs.

What is happening at a microscopic level? Several theories have been given for the decreased efficiency of diamond burs, including diamond wear-out, diamond pull-out, clogging by debris, and degradation of the diamond binder material. In a study of 15 new diamond burs, a scanning electron microscope was used to view the same area of the bur before and after use on human teeth. The results showed that diamond pull-out did not contribute more than 10% to the total wear. Clogging was responsible for the wear of two out of 15 burs. Particle wear-out, with blunting of the sharp edges and intensive diamond mass loss, was found to be the dominant wear mechanism. Damage to the binder layer was not detected.[13]

Overhead Cost

Modern production techniques have resulted in a decrease in the price-point comparisons of tungsten carbide and diamond burs. Manufacturers offer single-patient-use burs that are less expensive than multiple-patient-use burs, but are they cost effective? Three aspects should be considered: initial bur cost, reusable bur longevity, and overhead costs (including the non-income-generating labor involved in cleaning, sorting, sterilizing, storing, and retrieving burs).

In a study comparing five different single-use and five different multiple-patient-use diamond burs, single-use burs were found to be more cost effective. When analyzing the longevity of the burs to perform full crown preps on lower first molars, all 10 brands cut the first crown within 2 minutes. All 10 brands cut more slowly on each subsequent preparation, and cut times doubled for all brands after about four preps. Overall, the author concluded that single-patient-use diamonds used for one crown prep had the best combination of speed and low

cost.[14] As noted previously, diamond burs should not be used for more than five tooth preparations. Following this recommendation, the price comparison favors single-patient-use burs (considering initial cost only).

It is time-consuming for staff to properly follow protocol when attempting to reuse burs. In addition to the time required and the questionable efficacy of reprocessing, personnel also must be aware of the potential for accidental sharps exposure, especially when hand scrubbing is used for presterilization cleaning. In a survey of 164 dentists, almost a third (51) reported having had a sharp injury within their career, needlestick (32%) and dental bur (26%) accidents were the most common.[15]

Infection Control

Three sterilization methods to remove bacterial spores, bacteria, viruses, molds, and fungi currently are used in dentistry: steam under pressure in a steam autoclave, dry heat in a sterilizing oven, and chemical vapor.[16] Each method is technique sensitive and has pros and cons. Are routine dental sterilization procedures effective? In one study, previously used burs and endodontic files were gathered from different dental offices after they had been packaged and sterilized for reuse. Sterilization procedures were carried out according to the protocols used by each office and, surprisingly, each technique was less than 100% effective.[17] The problem is the method used to remove gross debris before sterilization. However, if proper protocols are followed, most organic debris can be physically removed, making it theoretically possible to sterilize instruments. But which protocol is most effective?

Experiments conducted using *Streptococcus sanguinis*, a pathogen identified as the causative organism in bacterial endocarditis and meningitis,[18] have shown that autoclaving alone was not effective in decontaminating steel or diamond burs. The authors then tested three presterilization cleaning techniques: manual scrubbing, soaking in an enzymatic bath, and washer-disinfectors. Manual scrubbing, which was shown to be operator sensitive and inconsistent, is not recommended due to serious risk of cross-infection from puncture wounds. Enzymatic agents were very effective, but their use also is operator-dependent. The researchers concluded: "The washer-disinfectors investigated in this study rendered all test bacteria non-viable. Burs contaminated in practice may harbor spore-forming bacteria and blood-borne viruses that may not be killed by a washer-disinfector and should be autoclaved after precleaning." Due to the reproducibility, ease of operation, and minimal contact with contaminated instruments, washer-disinfectors were the most effective method of presterilization cleaning. "It is suggested that enzymatic agents should be confined for use immediately postoperatively, for immersion of instruments prior to washer-disinfectors."[19]

Of particular concern is the iatrogenic transmission of rare, fatal degenerative disorders of the nervous system, such as Creutzfeldt–Jakob disease, Gerstmann–Straussler–Scheinker disease, Kuru, and fatal familial insomnia. These diseases are caused by prions, infectious agents smaller than viruses that contain no DNA or RNA. Stanley B. Prusiner, MD, distinguished these infectious particles from viruses or viroids and designated them as prion proteins (PrP); in 1997, he was awarded the Nobel Prize in Physiology or Medicine. The incubation period ranges from two to 35 years, which means that people may transmit the diseases while asymptomatic for decades.[20] Prions are far more resistant to physical and chemical inactivation than even bacterial spores. The only sterilization methods that appear to be completely effective are sodium hypochlorite solutions or hot solutions of sodium hydroxide.[21] World Health Organization guidelines suggest the use of immersion in sodium hypochlorite (20,000 ppm available chlorine) for 1 hour, boiling in 1 mole/liter of sodium hydroxide

for 1 hour, or vacuum autoclaving at 121°C for 30 to 90 minutes in the presence of 2 moles/liter of sodium hydroxide.[21] "Such procedures are inappropriate for surgical or dental instruments due to degradation and tarnishing of the metal surface, hazards to the user and issues with disposal."[22] As of 2007, the United Kingdom has banned the reuse of endodontic files.

It has become common practice to minimize infectious particle transmission by using single-use armamentarium: masks, gloves, anesthetic carpules, syringe needles, scalpel blades, cotton rolls, gauze, prophylaxis cups, matrix bands, dental dams, saliva ejectors, impression trays, air–water syringe tips, bibs, and headrest and seat covers. The workflow required to reuse burs places an additional burden on staff to control the spread of infection from staff to patient, patient to staff, and patient to patient. Additionally, patients have peace of mind when they experience a well-run office that demonstrates infection-control techniques, including opening sterile packaging at chairside. For example, Microcopy manufactures a variety of diamond (Figure 8) and tungsten carbide burs designed for single-patient-use. Following the ISO 11137, which governs the sterilization of healthcare products, each bur is identified with "STERILE R" to indicate it is sterilized by gamma radiation.[23,24]

Centers for Disease Control and Prevention Recommendations

"Sometimes disposable patient-care items have reusable heat-tolerant alternatives. This is often true for prophylaxis angles, high-volume evacuator tips, impression trays, dental burs, and air and water syringe tips. In many instances, the reusable version of these items is hard to clean adequately, and it may be safer, easier, and more cost-effective to use the disposable version. When determining the cost-effectiveness of disposable and reusable items, dental healthcare personnel should consider not only the cost of the disposable item, but also the cost, time, and materials involved with cleaning and reprocessing the reusable item.

"Some devices—such as burs, endodontic files, and broaches—may be practical to consider single-use because the way they are constructed makes them hard to clean. In addition, cleaning and heat sterilization can lead to deterioration on the cutting surfaces and raise the potential for breakage during patient treatment. The Food and Drug Administration (FDA) considers all diamond-coated burs and scaler tips single-use unless their manufacturers have submitted a 510(k) for reprocessing...Dental healthcare personnel (DHCP) should always refer to manufacturer instructions to determine if a device is single-use. If a device does not have validated reprocessing (i.e., cleaning and disinfection or sterilization) instructions, it is considered single-use (i.e., disposable)."[25]

"During aerosol-generating procedures…in patients who are not suspected of being infected with an agent for which respiratory protection is otherwise recommended (e.g., M. tuberculosis, SARS, or hemorrhagic fever viruses), wear one of the following: a face shield that fully covers the front and sides of the face, a mask with attached shield, or a mask and goggles (in addition to gloves and gown)."[26]

Conclusion

Cost and efficiency are significant factors when operating a thriving practice, but infection control is paramount. Regulatory frameworks exist mainly in an effort to control infection with certain items mandated as single-patient-use. Infection control has become a focal point in the modern era, and the decision to move away from multiple-patient-use to single-patient-use armamentarium is ultimately up to the dentist. There has been an evolution in dental technology and scientific understanding of disease transmission, with concerns that are not unfounded. The AIDS pandemic revolutionized the use of personal protective equipment in the 1980s, and with the recent

outbreak of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and the associated coronavirus disease of 2019 (COVID-19), the dental world is poised to further embrace single-patient-use armamentarium and respirators during aerosol-producing procedures.

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Notes

CEQuiz

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1. **Archeological evidence from Tuscany, Italy, has shown that "tool-assisted manipulation" to drill into teeth is dated at ____.**
   a. 5,000 years ago
   b. 10,000 years ago
   c. 13,000 years ago
   d. 20,000 years ago

2. **Hand-held drills could produce how many rotations per minute?**
   a. 15
   b. 20
   c. 100
   d. 60

3. **Who invented the first electric drill?**
   a. James Morrison
   b. George Green
   c. George Fellows Harrington
   d. George Harrison

4. **Modern methods of removing dental tissue include all of the following except ____.**
   a. Lasers
   b. Air abrasion
   c. Chemical dissolution
   d. Radio frequency

5. **Which organization oversees the 15-digit code numbering system for dental burs?**
   a. European Union
   b. International Organization for Standardization
   c. United Nations
   d. World Health Organization

6. **Burs currently are made from all of the following materials except ____.**
   a. Plastic
   b. Tungsten
   c. Diamond
   d. Composite

7. **Tungsten carbide is ____ as stiff as steel.**
   a. 1/2 x
   b. 2 x
   c. 2.5 x
   d. 3 x

8. **The first diamond bur was invented in ____.**
   a. 1930
   b. 1880
   c. 1897
   d. 1902

9. **The modern diamond bur was invented in ____.**
   a. 1904
   b. 1924
   c. 1932
   d. 1945

10. **Which of following manufacturing processes is used to create diamond burs?**
    a. Electro-deposition
    b. Microbrazing
    c. Sintering
    d. All of the above

11. **In a survey of dentists, what percentage of respondents said they sterilized burs for every patient?**
    a. 15%
    b. 35%
    c. 75%
    d. 98%

12. **Studies have shown similar initial cutting rates for single-patient-use and multiple-patient-use burs.**
    a. True
    b. False

13. **Researchers have recommended that reusable diamond burs should be discarded after how many crown preps?**
    a. 3
    b. 5
    c. 7
    d. 10

14. **What is the dominant mechanism of wear of diamond burs?**
    a. Particle wear-out
    b. Particle pull-out
    c. Clogging by debris
    d. Degradation of binder material

15. **There is a significant difference in efficiency of single- vs multiple-patient-use diamond burs when judged by time to prepare a lower first molar.**
    a. True
    b. False

16. **In a survey of 164 dentists, what percentage reported having had a sharps injury thus far in their career?**
    a. 5%
    b. 31%
    c. 66%
    d. 89%

17. The most common sharps injuries are due to ____.
a. Burs
b. Needles
c. Cavitrons
d. Scalpels

18. The three main methods of sterilization include all of the following, except ____.
a. Steam and pressure
b. Dry heat
c. Chemical vapor
d. Enzymatic bath

19. Autoclave alone is sufficient to sterilize burs and endodontic files.
a. True
b. False

20. Which organism has been identified as a cause of endocarditis and meningitis?
a. Coronavirus
b. *Streptococcus sanguinis*
c. *Streptococcus mutans*
d. *Staphylococcus aureus*

21. According to research, what is the most effective presterilization method to remove debris?
a. Manual scrubbing
b. Cavitron bath
c. Enzymatic bath
d. Washer-disinfector

22. Prions contain ____.
a. DNA
b. RNA
c. Protein
d. Lipids

23. Which sterilization method is most effective against prions?
a. Steam autoclave
b. Enzymatic bath
c. Sodium hypochlorite
d. Dry heat

24. Which country has mandated single-patient-use endodontic files?
a. United Kingdom
b. South Korea
c. United States
d. Germany

25. A common manufacturing method used to sterilize burs is _____.
a. Enzymatic bath
b. UV-C
c. Dry heat
d. Gamma radiation

26. The Centers for Disease Control and Prevention considers all diamond-coated burs and scaler tips single-patient-use unless what happens?
a. Manufacturers submit a 510(k)
b. Manufacturers presterilize each bur
c. Manufacturers can prove the bur won't break
d. Manufacturers pay regulator fees

27. Prions have an incubation period of ____.
a. 5 days
b. 1 week
c. 3 months
d. 2-35 years

28. How many people are occupationally exposed to tungsten each year?
a. 17,000
b. 27,000
c. 47,000
d. 147,000

29. Diamond burs should only be used once if ____.
a. You are prepping a tooth
b. The patient has an infectious disease
c. Doing try-in procedures of metal or zirconia substructure
d. You don't have an autoclave

30. Which of the following is important when considering whether to adopt single-patient-use armamentarium?
a. Cost
b. Efficiency
c. Infection control
d. All of the above

CE ANSWER FORM (E-mail address required for processing)

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EDUCATIONAL OBJECTIVES

- Discuss the history of dental burs and handpieces
- List the pros and cons of single-patient-use and multiple-patient-use armamentarium
- Analyze dental bur cost, efficiency, and infection control.

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Please evaluate this course using a scale of 1 to 5, where 1 is poor and 5 is excellent.

1. Clarity of objectives ..... ① ② ③ ④ ⑤
2. Usefulness of content ..... ① ② ③ ④ ⑤
3. Benefit to your clinical practice ..... ① ② ③ ④ ⑤
4. Usefulness of the references ..... ① ② ③ ④ ⑤
5. Quality of written presentation ..... ① ② ③ ④ ⑤
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2.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	17.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
3.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	18.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
4.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	19.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
5.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	20.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
6.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	21.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
7.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	22.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
8.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	23.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
9.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	24.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
10.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	25.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
11.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	26.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
12.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	27.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
13.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	28.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
14.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	29.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
15.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	30.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ

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