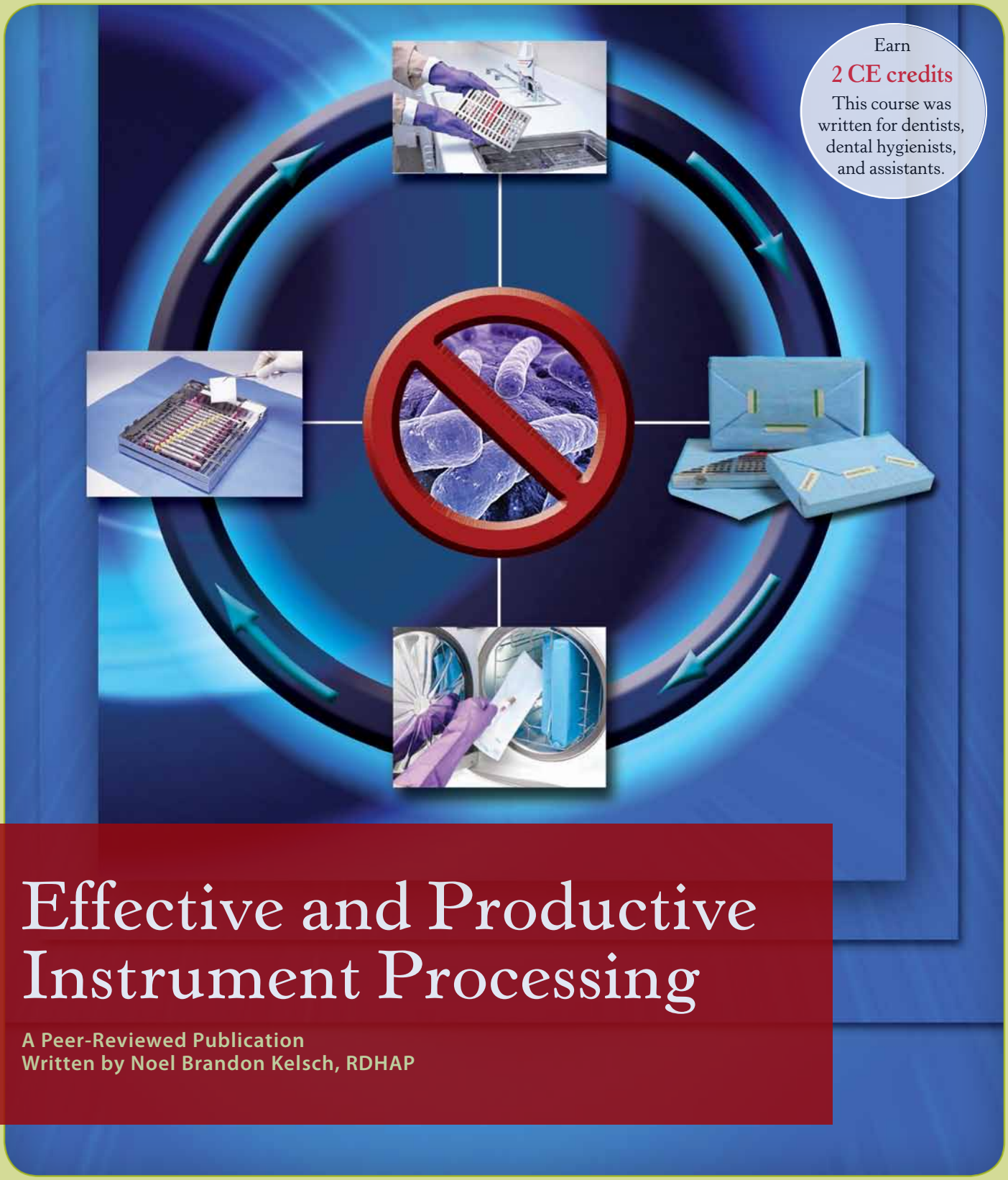

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Effective and Productive Instrument Processing

A Peer-Reviewed Publication
Written by Noel Brandon Kelsch, RDHAP

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Educational Objectives

The overall goal of this course is to provide information on infection control in the dental office. Upon completion of this course, the clinician will be able to do the following:

1. Describe the chain of infection and modes of transmission of microorganisms in the dental office.
2. List and describe the four basic principles and goals to reduce microbial transmission.
3. List and describe which instruments must be sterilized, the methods by which this can be achieved, and the role and importance of external and internal indicators on packaging.
4. List and describe instrument processing steps and the use of instrument management systems in this process.

Abstract

In order to meet the challenges of safety, time management and asepsis, the dental health care provider must have a plan for infection control, including the use and care of dental instruments and disposables. Following the basic CDC guidelines can help to significantly reduce the risk of microbial transmission. After the patient is dismissed, the operatory must be prepared for the next patient, including the treatment of surfaces and instrument processing. There is a variety of methods available to properly reprocess instruments. Choosing a system that minimizes risk, maximizes productivity and preserves instruments is essential.

Introduction

One of the most stressful times in dentistry can be the result of a single missing, damaged or nonsterile instrument. In order to meet the challenges of safety, time management and asepsis, the dental health care provider (DHCP) must have a plan for infection control, including the use and care of dental instruments. The plan must meet the guidelines of the Occupational Safety and Health Administration (OSHA) and the Centers for Disease Control (CDC).

The chain of infection

In order for a disease to occur, a number of conditions must exist. These conditions, called the *chain of infection*, are:

1. An appropriate portal of entry for a pathogen into a new host
2. A person who is not immune to the pathogen
3. A pathogen in sufficient numbers to cause infection
4. A place for the pathogen to reside and multiply
5. A way for the pathogen to leave its reservoir and reach the new host

All five conditions must be present for disease to occur.[1]

Modes of transmission

During and following dental treatment, diseases can be transmitted between:

- Patient and dental staff
- Patient and patient
- Dental staff and patient
- Dental staff and dental staff

In general, it is more likely that diseases would be transmitted from patients to clinicians than vice versa, because clinicians have frequent contact with patients' saliva and blood during dental procedures.

Occupational Exposure

Exposure of DHCPs and patients to pathogenic microorganisms can result from transmission through:

- Direct contact with blood, oral fluids, or other patient tissues
- Direct contact of intact or nonintact skin with blood, oral fluids or other potentially infectious patient materials
- Contact of conjunctival, nasal or oral mucosa with droplets (spray or spatter) containing microorganisms generated from an infected person and propelled a short distance (e.g., by coughing, sneezing or talking)
- Inhalation of airborne microorganisms that can remain suspended in the air for long periods[1]
- Indirect contact with contaminated objects (e.g., instruments, equipment or environmental surfaces)

Cross-contamination and Cross-infection

During treatment, areas of the operatory can become contaminated with pathogens from blood, saliva and other body fluids. For example, when working with equipment such as ultrasonic scalers and high-speed handpieces, aerosols are created that can land on environmental surfaces. When the DHCP touches those surfaces, the microorganisms can be transferred to his or her hands. If the DHCP does not wash his or her hands and then touches his or her eyes, mouth or nose, the microorganisms can enter the provider as a host. If the DHCP greets a patient and shakes his or her hand, transfer of the bacteria or virus to the patient can also occur. This process, called cross-contamination or cross-infection, can place the DHCP and patients at risk.[2,3]

Limiting Exposure through Infection Control

Although a DHCP's work may increase the risk of infection, a number of procedures used routinely in dental settings help keep that risk to a minimum.

Table 1. The Four Basic Principles

Keep yourself healthy. This has a major impact on disease transmission. It emphasizes the need for dental personnel to be protected through immunizations, work restrictions and regular hand hygiene.
Avoid contact with blood and body fluids. This focuses on the use of standard precautions, engineering controls and work practice controls. This principle also emphasizes the use of personal protection equipment (PPE) to prevent bloodborne exposure, as well as the management of postexposure incidents.
Limit contamination. This involves conducting general housekeeping, covering and disinfecting environmental surfaces, minimizing sprays and splashes, properly disposing of medical waste, and maintaining water quality in dental unit waterlines.[4]
Make objects safe for use. Single-use items and thorough cleaning and sterilization of patient care items help in this area. Using instrument management systems can help minimize handling, sharps injuries and exposure. Simply placing an instrument setup into a cassette limits DHCP exposure to sharps and contaminated instruments and allows for a more automated cleaning process.

Infection control refers to the basic principles and series of steps that help prevent disease transmission. Following the basic guidelines that the CDC has provided can help to significantly

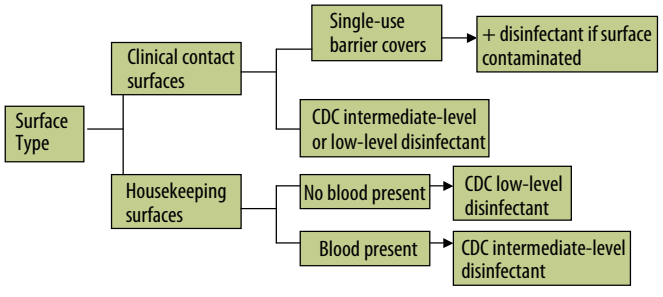
reduce the risk of microbial transmission in the dental setting. The goal of each of the four basic principles is to break one or more links in the chain of infection.[5]

Standard precautions

Universal precautions were created in the 1980s to help protect against bloodborne disease transmission. In dentistry, these include hand washing; use of PPE such as gloves, eyewear and face protection; and recommendations for proper handling of patient care items and contaminated surfaces. As the word "universal" suggests, the precautions are applied when treating all patients, regardless of health history or presumed risk of bloodborne disease. In the mid-1990s, the term "standard precautions" was introduced. While universal precautions focus mainly on preventing exposure to blood, standard precautions guard against exposure to all body fluids (except sweat, which is not considered infectious).[6] In the dental setting, there is little practical difference between universal and standard precautions. All of the precautions traditionally used to protect against blood and blood-contaminated saliva also protect against exposure to any other fluids that would typically be encountered in the dental setting. The DHCP should treat every patient as if he or she could be a source of infection.

Using standard precautions limits cross-contamination and cross-infection.[7,8] Single-use surface barriers such as plastic wrap or sheaths prevent contamination of surfaces.[9] These barriers should be used on as many surfaces as possible, and especially on surfaces that are difficult to access or disinfect (such as X-ray tubes). The use of barriers is reliable, saves time and reduces exposure to chemicals.[10] Clinical contact surfaces that do not have barrier covers or become contaminated during removal of the barrier require surface disinfection. Disinfection should be carried out using an EPA-registered disinfectant with tuberculocidal activity (i.e., CDC intermediate-level disinfectant) or a low-level disinfectant. Personnel and patients rarely come in contact with housekeeping surfaces. These require regular cleaning to remove soil and dust. These areas include floors, walls and some countertops. Cleaning should include use of an EPA-registered hospital disinfectant with no tuberculocidal activity (i.e., CDC low-level disinfectant) or an intermediate-level disinfectant if blood is visible.

Figure 1. Disinfection of Surfaces



In summary, with vaccination; appropriate hand hygiene; careful handling of sharp items; use of barrier techniques; and proper cleaning, disinfection and sterilization procedures, you can meet many requirements for a safe workplace. Instrument processing is a key component and, when performed appropriately, breaks the chain of infection, reduces DHCP stress, improves productivity and staff safety, and results in cost savings.

Instrument Processing and Infection Control

After the patient is dismissed, the operatory must be prepared for the next patient, including the treatment of surfaces and instrument processing. This process must be performed correctly every time to ensure items are properly processed. Having working, organized, sharp, debris-free and sterile (or disposable) instruments aids in the office's production, the quality of dentistry, and the safety of patients and staff. Quality sterile dental instruments are key to the practice of dentistry. Choosing a system that minimizes risk, maximizes productivity and saves money is important. In addition, while some instruments must be disposable, limiting the disposal of reusable devices helps keep the world greener. Using instrument cassettes minimizes DHCP contact with contaminated instruments, organizes the instruments for safe and efficient processing, keeps the instruments free from debris, protects instruments from damage and helps instruments remain sterile after processing. Sterilization cassettes also standardize procedural setups by organizing the instruments by procedure or type of user. This standardization enables any staff member to quickly identify the proper cassette for every procedure. Cassettes help eliminate lost instruments during instrument processing or transportation to and from the operatory. Dr. Lou Graham found that by creating standardized setups and using the cassette system in his office, his staff saved an average of five minutes per procedure, which allowed the staff to spend more time with patients and contributed to productivity and therefore revenue generation.[11] Instrument processing requires consideration of the necessary equipment, workflow and stages involved. In general, the processing can be divided into a chairside component and a processing area component.

Having organized, sharp, and sterile (or disposable) instruments aids in production, the quality of dentistry, and safety.

Chairside Procedure

Single-use disposable instruments

These are designed to be used only once - for one patient and discarded appropriately. They cannot be cleaned, disinfected or sterilized. These include blades, needles, prophylaxis angles, carpules, cups and brushes, evacuator tips, saliva ejectors, and air/water syringe tips.[3] These items are becoming more and more available and economical. They eliminate the chance of cross-contamination, the need for extensive postoperative handling (with a risk of sharps injuries) and exposure to sterilization chemicals. Disposing of all single-use items immediately after treatment limits the risk of sharps injuries.

The CDC recommends that there be a sharps container in every room in which treatment is delivered. Placing sharps in the container as soon as possible eliminates the hazard quickly.

Disposal of sharps and prevention of sharps injuries

Disposing of sharps is one of the riskiest tasks in dentistry.[9,12,13] All operatories that include use of disposable sharps (needles, blades, wires, etc.) should have a sharps container in the room.[5] All sharps should be removed from the tray and disposed of as soon as treatment is completed to decrease the risk of a sharps injury.

Figure 2. Sharps Container

One available device melts down and compresses used needles, needle sheaths and red bag waste into a disposable block (Demolizer II, BMTS). It is approved in most states and meets EPA and OSHA requirements. While not reducing the risk of sharps injuries during the removal of sharps, it offers a disposal alternative.

Figure 3. Demolizer

Disposal of non-sharps patient care items

It is important to contact your area waste management system to see if they allow empty carpules to go out with the general trash. Regulations vary by state for the disposal of intact, broken, blood-filled and empty carpules. Most disposable items can go out with the general trash. The exception is cotton materials that are soaked with blood to the point that blood can be wrung out of them. Clearing the tray of all non-sharp disposables early on will give the DHCP a clear view of sharps and instruments and decrease the likelihood of injury.[6]

The Instrument Processing Area

The flow, layout and appropriate use of the instrument processing area are determining factors in successful sterilization. Office policy should include the use of puncture- and chemical-resistant utility gloves by DHCPs when cleaning dental instruments and working with chemicals. Latex gloves are not puncture-resistant and can break down in the presence of chemicals. OSHA guidelines specifically state, "The person handling the instruments through removal, cleaning, packaging and sterilization needs to use heavy-duty gloves to help prevent injury with sharp contaminated instruments." Many DHCPs complain that heavy-duty gloves do not have the same tactile sensitivity as examination gloves. However, the fine tactile sensitivity that is needed during dental procedures is not necessary during instrument cleaning and sterilization. Additionally, some utility gloves come sized to meet your individual needs.

Figure 4. Use of Utility Gloves

The DHCP must wear proper protective equipment, including utility gloves, mask, glasses, and clinic gown or jacket, during instrument processing. Properly fitting masks, protective eye wear and a full gown must also be utilized to avoid contact with splashes, sprays and aerosols that are present in the sterilization area. The instrument processing area should be separated into four specific areas as far apart as possible and with clearly defined "clean" and "dirty" areas. The separate areas involved in instrument processing are as follows:

Receiving, Cleaning and Decontamination

Cassettes and instruments are placed here for removal of debris before processing. This area should be clearly defined to prevent cross-contamination. It is recommended that instrument handling be minimized, as this is where a high percentage of sharps injuries occur. Specific containers are also available for syringes, burs and other instruments. Handpieces must be heat-sterilized (autoclaved) after single patient use, and it is important to follow the manufacturer's instructions on cleaning, lubrication and sterilizing handpieces to ensure proper sterilization and to avoid handpiece damage.

Preparation and Packaging

This area must have enough space for safe packaging and preparation. Supplies should be readily available to eliminate the chance of contaminating drawer handles and cupboards. Before preparing and packaging, all instruments and other patient care items should be inspected for cleanliness and completely dried.

Sterilization

This is the most important area in the process. Contaminated items go into the sterilizer. If the sterilizer is working properly and the appropriate process is followed, instruments and other patient care items will be sterile. To prevent contamination of the front and handles of the sterilizer during the loading process, simply open the sterilizer door with a paper towel.

Tips for Instrument Processing Areas

- Every DHCP should have a personal set of heavy-duty utility gloves, disinfected and evaluated for cracks and integrity daily. This will help with compliance and guard against sharps injuries.
- To prevent having to change gloves, keep a spare set of clean cotton forceps or a set of tongs to open and take things out of drawers and cupboards.
- Keep sterilization pouches in an open, easy-to-access location to eliminate the risk of cross-contamination from opening drawers and cupboards.
- Having the sterilizer divide the room between clean and dirty (one side is the dirty side, one side is the clean side) is a simple way to help everyone understand the concept.
- An instrument management system that includes procedure tubs and cassettes is the most efficient and organized way to manage instruments and consumable products, and saves time.
- Procedure tubs and cassettes limit exposure to pathogens and sharps injuries.

Storage

The storage of instruments and cassettes following sterilization should preserve the integrity of the packaging material. Sterilized items should be stored in a clean, dry environment away from areas where contaminated instruments are present. Do not store instruments or supplies under sinks, over sterilization devices, or in areas where moisture or environmental factors could contaminate the packaging. To optimize organization of supplies, keeping tubs for supplies in a central location is ideal. Having a separate tub for different procedures saves time searching for and gathering supplies and maximizes use of materials. A simple inventory list accompanying each tub will help all staff maintain the system easily. These tubs can act as portable operatory drawers for storing, organizing and transporting consumable materials to and from storage, the sterilization area and the operatory.

Figure 5. Organization of Consumable Materials in Tubs

Instrument Processing of Non-disposable Items

Human error is the most common reason for failure. The instrument management process must be followed appropriately every time.

Divide and conquer

Before processing instruments, it is important to divide them into categories of use. *Critical instruments* are surgical and other instruments used to penetrate the mucosa and bone. This category includes bone chisels, scalers and burs. Critical instruments require heat sterilization or must be single-use disposable. Sterilization is achieved by steam under pressure (autoclaving), dry heat or heat/chemical sterilization. *Semi-critical instruments* are surgical and other instruments that are not used to penetrate soft tissue or bone, but come in contact with the oral tissue. These require heat sterilization or, if an item is heat sensitive, immersion in a high-level disinfectant/sterilant. A high-level disinfectant registered with the EPA as a sterilant/disinfectant must be clearly labeled as such. *Noncritical instruments* are instruments that only come in contact with intact skin. They do not come in contact with mucosa. These can be sterilized by immersing them in a high-level disinfectant or can be processed with an intermediate-level disinfectant. Such devices have a relatively low risk of transmitting infection. An intermediate-level disinfectant will be labeled as a hospital disinfectant and also for tuberculocidal activity (exemplified by phenolics, iodophors and chlorine-based compounds).[14]

Transporting instruments

Once all disposables and sharps are removed from the counter or chair tray and placed in the proper receptacles, all instruments should be kept in cassettes to limit handling and decrease the risk of sharps injury. Using instrument cassettes and sorting devices can make all the difference in the preparation and packaging area. Cassettes not only hold the instruments securely during cleaning and sterilization, but they also limit dulling, instrument loss, sharps injuries, warping of instruments and the frustration of trying to find missing instruments.[15] Using cassettes also helps avoid overloading the sterilizers with contaminated instruments, which can affect sterilization efficacy. Cassettes can be used for all instruments associated with specific procedures. A wide variety of cassettes is available to meet all instrument needs. Cassette accessories are available and sized for specific items such as burs.

The CDC guidelines state that "contaminated instruments should be handled very carefully to prevent exposure to sharps instruments that can cause percutaneous injury. Instruments should be placed in an appropriate container at the point of use to prevent percutaneous injuries during transportation to the instrument processing area." Locking, covered tubs developed for transport and storage of consumable materials help reduce exposure to cross-contamination. Using a color-coded system for cassettes and tubs helps organization. Tubs are available in colors that match cassette rails, allowing staff to match tubs and cassettes by procedure. For example, blue cassette rails and a blue tub can represent a composite procedure. All the consumable ma-

Table 2. Instrument Categories and Treatment

Category	Description	Example	Treatment
Critical	Instruments penetrate mucosa or bone	Surgical instruments	Heat sterilization
Semi-critical	Instruments come in contact with oral mucosa	Handpieces	Heat sterilization
		Heat-resistant instruments	Heat sterilization
		Heat-sensitive instruments	Immersion in high-level disinfectant/sterilant
Non-critical	Instruments come in contact with intact skin	Extra-oral instruments	Immersion in high-level disinfectant/sterilant or process in intermediate-level disinfectant

terials for composite procedures can be stored and organized in the blue tub and instrumentation stored in the cassette with blue rails, allowing for quick identification. Hu-Friedy's Signature Series Tubs and matching IMS cassette system is an example of this concept. Antibacterial properties such as Microban protection are integrated into the tub and tub components during the manufacturing process. Microban protection begins to work as soon as a microorganism comes into contact with the surface, and works continuously to inhibit microbial growth that can cause stains, odors and product degradation. Microban is registered with the EPA for these applications.

Cassettes with an efficient hole pattern are preferable, as they allow steam and chemicals to permeate while protecting instruments from protrusion. Cassettes are designed to fit into ultrasonic baths and sterilizers— minimizing handling, saving time, increasing productivity and reducing the risk of infection from contaminated instruments. Instruments and cassettes must be transported to and from the operatory and sterilization area in rigid, leak-proof trays or containers.[16]

Tips for Cassettes and Tubs

- Cassettes save time, prevent dulling of instruments and sharps injuries, prevent instrument loss, and reduce the chance of cross-contamination during transportation or processing.
- Locking covered tubs developed for transport and storage of consumable materials help reduce cross contamination and protect materials if the tub is dropped.
- Color-coded systems for cassettes and tubs help optimize office productivity and organization.
- Antibacterial properties in tubs inhibit microbial growth, reducing staining and odors.
- Matching cassette rail and tub colors by procedure allows for quick identification and improved workflow efficiency.

Procedure tubs increase the efficiency of materials management and eliminate time-consuming tray preparation for every procedure. Having tubs preloaded with items for procedures such as endodontics, orthodontics, bonding, etc., streamlines setup and increases efficiency. This system eliminates the time and frustration of having to gather several supplies from several areas. Specially designed dental supply tubs with dividers are great places to store your spare tips and handles for instruments with replaceable tips and endo files. This system of organization can also include a simple pull tag for inventory reordering that is stored right in the tub. These tubs give you a clear view of the inventory and keep the items organized, saving you time, money and frustration.

Precleaning solutions

If instruments cannot be cleaned immediately, it is important to put them in a precleaning solution or spray them with a precleaning gel or foam. Leaving instruments sitting in the open air allows the debris to harden, making it more difficult to process. A precleaning solution or spray may contain enzymes to help break down debris, as well as rust inhibitors. Instruments should be thoroughly rinsed after immersion. Sterilants and high-level disinfectants should not be used as holding solutions.

Figure 6. Tubs and Cassettes; Syringe Holder

Cleaning of instruments

Cleaning is a vital step in instrument processing. Heavily contaminated instruments pose a threat to personnel and patients, as dried blood, saliva or dental materials may insulate bloodborne pathogens from the direct microbial effects of heat or chemical sterilization. Organic contaminants also may retard or inactivate chemical disinfectants, contributing to corrosion and interfering with the instrument's functioning.

OSHA standards state that "all procedures involving blood or other potential infectious materials shall be performed in such a manner as to minimize splashing, spraying, spattering, and generation of droplets of these substances."[17] Scrubbing instruments by hand is discouraged because it creates aerosols and the potential for sharps injuries. One 10-year study by the New York University College of Dentistry found that 41 percent of exposures occurred during instrument cleanup.[18] Risks in the receiving area and during decontamination can be minimized by following simple steps. Using cassettes and tubs and simply carrying instruments in a covered container saves time, costs very little and minimizes potential exposure.[9]

Automated systems are the most effective and safest method of decontamination, and substantially reduce instrument handling.[4,19] Automated devices include ultrasonic cleaners and

automated dental washers. Ultrasonic cleaners utilize sound waves above human audibility that result in the formation of oscillating bubbles (cavitation) that then collapse and implode. Ultrasonic detergents are also available for use. More recently, some ultrasonic manufacturers have employed a new technology that uses a variable frequency as opposed to a fixed frequency in order to deliver reliable cavitation to all areas of the solution and reduce the potential for hot spots that could weaken cleaning ability. Additionally, some manufacturers are using materials with antimicrobial activity in the interior chamber of the ultrasonic unit. Regardless of the ultrasonic unit selected, it is important to suspend the instruments in a basket in the ultrasonic bath, as laying them flat inside the bath can result in inadequate cleaning and removal of debris. Also, refer to the manufacturer's instructions on how much weight can been put in the ultrasonic, as it is very important not to overload the sterilizer. Instruments should be either in cassettes or loose, do not band your instruments together because they will not be as well cleaned. Ultrasonic baths also have timers, and instruments should remain in the bath for the full length of time recommended by the manufacturer. Enzymatic solutions should be changed every shift (at least daily) or more often if receiving heavy loads of contaminated instruments (degree of contamination and frequency of use are contributing factors in determining how often to change the ultrasonic solution).

Instrument washers/disinfectors are a class of device traditionally used by central sterilization services such as those in hospitals. These medical devices wash, rinse and dry instruments, reducing the risk of pathogen transmission during subsequent instrument handling while processing. It is important to verify that the unit you are using has FDA clearance.

Instrument examination

Examine all instruments closely, checking for broken instruments, burs and debris. Remove an instrument from service if it is damaged. The preferred remedy when instruments do not come out of the ultrasonic bath or automatic washer free of debris is to run the instrument again to remove the debris or soak it in a presoak. If hand scrubbing becomes necessary:

- Scrub one instrument at a time with a long-handled brush.
- Do not scrub until the item has been run through a mechanical cleaner to remove as much organic matter as possible.
- Hold the instrument down low in the sink, preferably under water, to reduce aerosol formation as much as possible.

Tips for Instrument Cleaning and Examination

- Presoaks and sprays prevent debris from drying or hardening on instruments.
- Automated systems are the most effective and safest method of decontamination.
- Test your ultrasonic bath weekly.

Preparing and packaging, custom containers, wraps

After cleaning the instruments, it is critical to thoroughly rinse and dry the instruments. Rinsing is essential to remove chemical and detergent residues. This prevents spotting, pitting and staining of instruments by detergents, which can interfere with the smooth operation of instruments. Splashing should be minimized during rinsing. Packaging cleaned, dried instruments prior to placing them in the sterilizer is a standard of care that protects instruments. Following sterilization, storing the instruments in the packaging maintains their sterility until they are required for use on patients. Unprotected instruments can be recontaminated with dust or spatter or by coming in contact with nonsterile surfaces during transport, storage and tray setup.[20] Packaging used must be FDA-cleared as a medical device to guarantee that the wrapping has been tested and is permeable to the chemical and steam. There are wraps available for every size of instrument.[21] Packaging is not reusable unless otherwise indicated, and includes plastic tubing, wrap, and plastic/paper pouches. In addition, color-coded instrument rings and cassette ID labels help organize instrument processing. When it is necessary to process loose instruments, these should be packaged so that they lie in a single layer, permitting exposure of all areas of the instruments to the sterilizing agent. To maintain integrity of the package, follow the manufacturer's recommendations for sealing the package and do not use staples, pins or paper clips to seal packages. Do not overstuff packages.

To maintain the integrity of packaging, follow the manufacturer's instructions on sealing packages.

The new CDC 2008 guidelines state that an internal and external indicator should be in each package. Companies now have pouches with both an internal and an external indicator. The dates and record of the sterilizer used if there is more than one in your practice, should be placed on the packaging. This is recorded so that if a positive spore test is obtained, all packages for the dates involved can be pulled.

Figure 7. Packaging and Cassette

Sterilization Techniques

The basic methods of sterilization of heat-tolerant instruments are dry heat, steam under pressure (autoclave) and unsaturated chemical vapor. These are done with regulated medical devices that must be specifically designed to meet the needs of the dental setting. Each method has specific advantages and should be evaluated before a sterilizer is chosen. Take into consideration time, exposure to chemicals, temperature requirements and effects on instruments.

If the instrument is heat sensitive and is semi-critical or non-critical, it can be sterilized by immersing it in an EPA-registered high-level disinfectant/sterilant, which may require up to 10 hours. Surface (intermediate-level) disinfectants may not be used in place of high-level disinfectants/sterilants. Current CDC guidelines from 2008 state: "Handpieces should be heat sterilized after each patient. Handpieces that cannot be heat sterilized should not be used." High-level disinfection with chemical germicides cannot be biologically monitored to assure sterility, and extended contact with chemical germicides may corrode handpiece components.

Most sterilizer malfunctions are due to operator error. The most common reasons are inadequate space between instruments, improper packaging, overloading and excessive packaging. In one study of Minnesota dental offices, operator error rather than mechanical malfunction caused 87 percent of sterilization failures. Common factors in the improper use of sterilizers include chamber overload, low temperature setting, inadequate exposure time, failure to preheat the sterilizer and interruption of the cycle.

Monitoring Sterilizers

There are three basic ways to monitor the sterilizer.[22] These are:

Mechanical Technique: This includes monitoring the cycle time and temperature by observing the gauges and displays during the process, and monitoring the computer printout, if available, to detect any malfunction. This should be done for every single load.

Chemical Indicators: An indicator should be placed inside and outside every package or cassette. Many companies now manufacture packages that already contain both internal and external indicators. Chemical indicators are affixed on the outside of each package to show that the package has been processed through a sterilization cycle, but do not prove that sterilization has been achieved. A chemical indicator should also be placed on the inside of each package to verify sterilant penetration.[23] This distinguishes processed from nonprocessed items. It monitors sterilization parameters such as time, temperature and, for autoclaves, pressure. It helps to identify gross sterilizer malfunction.[24]

Biological Indicators: This test is performed at least weekly for both test and control spores and with every load that contains an implantable device. It evaluates the effectiveness of the cycle killing *Bacillus stearothermophilus* or, more recently, *Geobacillus stearothermophilus* in autoclaves and chemical vapor sterilizers. In dry heat systems, it tests with *Bacillus subtilis* and, more recently, *Bacillus atrophaeus*. Tests can be run in the office or sent out for processing, and directly measure the effectiveness of the sterilization process. All implantable items must go through this process before they can be placed. It is important to follow the manufacturer's steps and to use the proper test for your specific sterilizer. Do not use any items from a failed test. Pull all items that were processed during the time period following the last test that did not fail.[25] Sending out for processing requires up to a 14-day waiting period, and there is a chance of mishandling in the mail system. In-office biological monitoring systems are very simple to use and provide initial results in as little as 24 hours. In-office biological monitoring assures the operator that no environmental factors have affected the testing during mailing and allows for planning of delivery of items such as implants that must have biological monitoring confirmed before placement.

Table 4. Advantages of an Instrument Management System

Safety	Minimizes sharps handling and instrument handling
	Reduces risk of cross-contamination due to dropped instruments during transportation
	Cassettes fit in ultrasonic and automatic washer/cleaners
	Tubs are rigid and leak-proof
	Safer transportation of contaminated instruments
Sterility	Organizes instruments with proper spacing for efficient sterilization
	Avoids overloading the sterilizer
	Keeps instruments free from debris following sterilization
	Enables safe storage after sterilization, in packaging
Productivity, Efficiency	Color-coded cassettes and tubs organize instruments and consumables by procedure type and are easy to identify
	Reduces set-up time with organized instrument storage
	Enhances chairside efficiency and easy staff training
	Requires less counter space than with trays
	Reduces manual sorting of instruments into pouches
	Increases available time for revenue-generating activities
Cost	Holds instruments securely during cleaning, protecting them from damage
	Eliminates loss of instruments during transportation
	Reduces potential for instrument damage during storage, transportation and processing

Storage of instruments

Instruments should be stored in a clean place, preferably in a closed drawer or cupboard, away from the area where contaminated instruments are held and cleaned. They should not be stored under sinks or above sterilization devices. All instrument packaging should be checked for holes and tears before use. If there are any problems with the packaging, the instruments should be recleaned, repackaged and sterilized. Unwrapped items are easily contaminated. Unless an item is going to be used immediately, it should be wrapped. Unwrapped items should not be stored in drawers or cabinets because they cannot be kept sterile.[7,26]

Conclusions

Quality, sterile dental instruments are the key to the practice of dentistry. Having working, organized, sharp, debris-free instruments aids in production, quality of dentistry, safety and asepsis. There is a variety of methods available to reach the goal of properly reprocessing instruments. Choosing a reliable, effective instrument management system and protocol that minimizes risk and stress, maximizes productivity, saves money, and limits damage to instruments is essential for DHCPs, patients and the practice.

Table 3. Heat Sterilization Methods

Method	Temperature/Pressure	Exposure Time (a)	Advantages	Precautions
Steam autoclave (b)	121°C (250°F) 115 kPa 134°C (273°F) 216 kPa	13-30 min 3.5-12 min	- Good penetration - Nontoxic - Time efficient	- Non-stainless steel items corrode - May damage rubber & plastics - Cannot use closed containers - Unwrapped items quickly contaminated after cycle
Dry heat (c) (oven-type)	160°C (320°F)	60-120 min	- No corrosion - Nontoxic - Items are dry after cycle - Can use closed containers (d)	- Long cycle time - May damage rubber & plastics - Door can be opened during cycle, disrupting sterilization - Unwrapped items quickly contaminated after cycle - Many wraps and pouches are not compatible
Dry heat (c) (rapid heat transfer)	191°C (375°F)	12 min wrapped 6 min unwrapped	- No corrosion - Nontoxic - Time efficient - Items dry quickly	- May damage rubber & plastics - Door can be opened during cycle - Unwrapped items quickly contaminated after cycle - Many wraps and pouches are not compatible
Unsaturated chemical vapor (b)	134°C (273°F) 216 kPa	20 min	- No corrosion - Time efficient - Items dry quickly	- May damage rubber & plastics - Cannot use closed containers - Must use special solution - Uses hazardous chemical - Unwrapped items quickly contaminated after cycle

(a) These exposure times relate only to the sterilization portion of the total cycle and do not include any warm-up, come-down or drying times. The exposure time may vary depending upon the load and should be verified during actual use with biological monitoring (spore-testing) and chemical indicators.
(b) Monitor with spores of *Bacillus stearothermophilus*.
(c) Monitor with spores of *Bacillus subtilis*.
(d) Confirm by using biological indicator on inside of container.
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Author Profile

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Noel Brandon Kelsch is a freelance cartoonist, writer, international speaker and Registered Dental Hygienist in Alternative Practice. Her articles have been published in dental and nursing trade magazines. She has written articles for National Journals and Corporations on Methamphetamine abuse. Her passion for getting information to the dental professional and the public on the oral effects of this devastating drug has taken her from NBC news to ESPN. Noel has received many national awards including Colgate Bright Smiles Bright Futures, RDH Magazine Sun Star Butler Award of Distinction, USA magazine Make a Difference Day award, Presidents Service award, Foster Parent of the Year, and is a five-time winner of the Castroville Artichoke cook off! Noel is the current President of California Dental Hygienists Association, a member of Organization for Safety and Asepsis Procedures and board member of Simi Valley Free Clinic.

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Questions

1. The conditions that must exist in order for a disease to occur are called the _____.
   a. chance of infection
   b. chain of transmission
   c. chain of infection
   d. none of the above

2. In general, it is more likely that disease would be transmitted from _____ than vice versa.
   a. clinician to patient
   b. clinician to auxiliary
   c. patient to clinician
   d. none of the above

3. _____ contact with pathogenic microorganisms in the dental setting can lead to disease transmission.
   a. Indirect
   b. Direct
   c. No
   d. a and b

4. Standard precautions guard against exposure to _____.
   a. blood
   b. blood and saliva
   c. blood and sweat
   d. all body fluids except sweat

5. The DHCP should treat _____ as a potential source of infection.
   a. every patient
   b. most patients
   c. a few patients
   d. suspect patients

6. Single-use surface barriers _____.
   a. protect surfaces from contamination
   b. should be used on as many surfaces as possible
   c. reduce exposure to chemicals
   d. all of the above

7. Instrument processing is a _____ component of infection control.
   a. nominal
   b. key
   c. relatively important
   d. relatively unimportant

8. Using instrument cassettes _____.
   a. protects instruments
   b. limits DHCP contact with contaminated instruments
   c. keeps instruments free of debris
   d. all of the above

9. Using standardized set-ups and an instrument cassette system _____.
   a. saves time in the dental office
   b. increases time in the dental office
   c. helps increase productivity
   d. a and c

10. If necessary, single-use disposable instruments can be _____.
    a. disinfected
    b. heat sterilized
    c. chemical sterilized
    d. none of the above

11. A sharps container should be kept in _____.
    a. a central location
    b. a remote location
    c. one operatory
    d. each operatory

12. One available device that melts down and compresses used needles _____.
    a. helps reduce sharps injuries during sharps removal and offers a disposal alternative
    b. offers a disposal alternative
    c. meets OSHA and EPA requirements
    d. b and c

13. Intact, broken and empty carpules can be disposed of in the general trash in _____.
    a. some states
    b. all states
    c. only one state
    d. no states

14. Puncture- and chemical-resistant utility gloves _____.
    a. should be worn during instrument processing by the DHCP handling contaminated instruments
    b. should be inspected at least daily for cracks and integrity
    c. are a requirement based on OSHA guidelines
    d. all of the above

15. Cassettes and instrument trays are placed in the _____ area for removal of debris before processing.
    a. sterilization
    b. receiving, cleaning and decontamination
    c. prepping
    d. any of the above

16. An instrument management system that includes the use of instrument tubs and cassettes is the _____ way to manage consumable products and instruments.
    a. least efficient
    b. most efficient
    c. least ergonomic
    d. most resource intense

17. A biological indicator test is performed _____ for test and control spores.
    a. daily
    b. weekly
    c. monthly
    d. as often as deemed necessary, depending on the infection risk from a given office's patients

18. To save storage space, sterilized instruments may be carefully stored in their packaging _____.
    a. above the sterilizer
    b. under the counter
    c. in the reception area
    d. none of the above

19. Critical instruments _____.
    a. require heat sterilization or must be single-use disposable
    b. require chemical or heat sterilization or must be single-use disposable
    c. require disinfection or must be single-use disposable
    d. must be disposable

20. Antibacterial properties incorporated into instrument tubs _____.
    a. ensure that no cross-infection is possible
    b. help prevent odors and staining of the tub
    c. help prevent degradation of the tub
    d. b and c

21. Cassettes with an efficient hole pattern _____.
    a. allow steam to permeate the cassette
    b. allow chemicals to permeate the cassette
    c. protect instruments from protrusion
    d. all of the above

22. A precleaning solution may contain _____.
    a. enzymes
    b. rust inhibitors
    c. bacteria
    d. a and b

23. One ten-year study found that _____ of sharps injury exposures occurred during instrument cleaning.
    a. 21 percent
    b. 31 percent
    c. 41 percent
    d. 51 percent

24. Automated systems are the _____ method of instrument reprocessing.
    a. safest but least effective
    b. safest and most effective
    c. safest and most time consuming
    d. none of the above

25. After cleaning the instruments, it is critical to _____ the instruments.
    a. thoroughly rinse
    b. thoroughly dry
    c. thoroughly oil
    d. thoroughly rinse and dry

26. _____ can be used for instrument packaging.
    a. Regular wrapping paper
    b. Regular wrapping packs
    c. Sterilization wrapping
    d. all of the above

27. The new CDC guidelines of 2008 state that packaging must have _____.
    a. an external indicator
    b. an internal indicator
    c. a lateral indicator
    d. both an external and an internal indicator

28. According to the 2008 CDC guidelines, handpieces can be _____ if they are heat-sensitive.
    a. chemically sterilized
    b. disinfected
    c. washed and dried
    d. none of the above

29. Sterilizers can be monitored using _____.
    a. mechanical techniques
    b. biological indicators
    c. chemical indicators
    d. all of the above

30. A reliable, effective instrument management system used as part of an infection control program _____.
    a. minimizes risk
    b. maximizes productivity
    c. limits damage to instruments
    d. all of the above

ANSWER SHEET

Effective and Productive Instrument Processing

Name: Title: Specialty:

Address: E-mail:

City: State: ZIP: Country:

Telephone: Home ( ) Office ( )

Requirements for successful completion of the course and to obtain dental continuing education credits: 1) Read the entire course. 2) Complete all information above. 3) Complete answer sheets in either pen or pencil. 4) Mark only one answer for each question. 5) A score of 70% on this test will earn you 2 CE credits. 6) Complete the Course Evaluation below. 7) Make check payable to PennWell Corp.

Educational Objectives

1. Describe the chain of infection and modes of transmission of microorganisms in the dental office
2. List and describe the four basic principles and goals to reduce microbial transmission
3. List and describe which instruments must be sterilized, the methods by which this can be achieved, and the role and importance of external and internal indicators on packaging
4. List and describe instrument processing steps and the use of instrument management systems in this process.

Course Evaluation

Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

1. Were the individual course objectives met? Objective #1: Yes No Objective #3: Yes No
   Objective #2: Yes No Objective #4: Yes No
2. To what extent were the course objectives accomplished overall? 5 4 3 2 1 0
3. Please rate your personal mastery of the course objectives. 5 4 3 2 1 0
4. How would you rate the objectives and educational methods? 5 4 3 2 1 0
5. How do you rate the author's grasp of the topic? 5 4 3 2 1 0
6. Please rate the instructor's effectiveness. 5 4 3 2 1 0
7. Was the overall administration of the course effective? 5 4 3 2 1 0
8. Do you feel that the references were adequate? Yes No
9. Would you participate in a similar program on a different topic? Yes No
10. If any of the continuing education questions were unclear or ambiguous, please list them.

    _____

11. Was there any subject matter you found confusing? Please describe.

    _____

    _____

12. What additional continuing dental education topics would you like to see?

    _____

    _____

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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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PLEASE PHOTOCOPY ANSWER SHEET FOR ADDITIONAL PARTICIPANTS.

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