

RECOMMENDATIONS FOR INFECTION CONTROL FOR THE PRACTICE OF ANESTHESIOLOGY  
(SECOND EDITION)

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**American Society of Anesthesiologists  
Committee on Occupational Health of Operating Room Personnel**

Arnold J. Berry, M.D., Chair

William P. Arnold III, M.D., Past Chair

**Task Force on Infection Control**

Samuel C. Hughes, M.D., Chair

Morris Brown, M.D.

Lyndon John Busch, M.D.

Stuart DuPen, M.D.

Mark P. Fritz, M.D.

Alexander W. Gotta, M.D.

Elliott Greene, M.D.

David Eric Lees, M.D.

Gene Peterson, M.D.

Andrew D. Rosenberg, M.D.

Michael Smalkey, M.D.

Robin Stackhouse, M.D.

## INTRODUCTION

The Centers for Disease Control and Prevention and other interested groups have published infection control recommendations for both nosocomial and occupationally acquired infections. Since these often do not specifically address the practice of anesthesiology, we have attempted to take the most current recommendations and apply them to our specialty.

In portions of this document, the term "health care worker" (HCW) has been used instead of "anesthesiologist" to include all members of the anesthesia care team. The recommendations are made to protect patients, anesthesiologists and support staff. In emergent situations, the physician must use professional judgment in the application of infection control so that patient care is not compromised.

The first portion of this document covers prevention of nosocomial infections in patients, and the latter is devoted to prevention of occupationally acquired infections in anesthesiologists. A bibliography of pertinent literature is included for individuals who would like more detailed information.

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## PREVENTION OF NOSOCOMIAL INFECTIONS IN PATIENTS

### I. DISINFECTION OF EQUIPMENT

Anesthesia equipment may be exposed to potentially infectious material during ordinary use. Equipment can become contaminated through direct contact with the patient's skin, mucous membranes, secretions and blood. The interior of the breathing circuit may become contaminated through contact with respiratory secretions. Contamination may also occur through contact with HCWs, splashes/spillage from the surgical field, improper handling of used equipment or breaks in infection control techniques. Although documented transmission of infection through anesthesia equipment is rare, if proper procedures are not followed, it is possible for contaminated anesthesia equipment to transmit infection to patients.

Since it is impossible to know which equipment has become contaminated, all used equipment should be considered contaminated, and appropriate infection control precautions should be taken in handling used equipment. [1,3](#) The guidelines in this section are intended to reduce the risk for transmission of infection via anesthesia equipment through proper infection control procedures.

#### A. EQUIPMENT REQUIRING STERILITY

##### *Recommendation*

Equipment that will enter or contact any body area that is normally sterile must be sterile at the time of use, and aseptic techniques must be employed to maintain sterility.

##### *Rationale and Interpretive Statements*

This equipment would include vascular needles and catheters; regional block needles and catheters; the interior of associated tubing, connectors and syringes; and urinary catheters (Spaulding's "Critical" items).<sup>1</sup>

Reusable equipment must be thoroughly cleaned and subjected to a sterilization process prior to reuse.

Sterility must be assured at the time of use. If an item's sterility is in doubt, it should not be used.

To avoid introduction of pathogens into sterile areas, aseptic techniques should be followed in handling and using sterile equipment.

#### B. EQUIPMENT REQUIRING HIGH-LEVEL DISINFECTION

##### *Recommendation*

Equipment that will contact mucous membranes but would not ordinarily penetrate body surfaces should be free from contamination but need not be sterile.

##### *Rationale and Interpretive Statements*

This equipment would include laryngoscope blades, oral and nasal airways, face masks, breathing circuits and connectors, self-inflating resuscitation bags, esophageal stethoscopes and esophageal/nasopharyngeal/rectal temperature probes (Spaulding's "Semi-critical" items).<sup>1,3</sup>

Condensate that collects in the tubing of breathing circuits should periodically be drained away from the patient's airway and discarded.<sup>3</sup>

Endotracheal and endobronchial tubes should be kept free from contamination until the time of use, although it is expected that some contamination from oral/nasal secretions is likely during placement of these tubes. Other contamination should be avoided carefully. Lubricants, stylets and suction catheters for use with these tubes should also be free from contamination.

Reusable items should be rinsed to remove blood and secretions as soon as possible after use. Reusable items must be decontaminated prior to reuse by thorough cleaning, followed by either a sterilization process or high-level disinfection.<sup>6</sup>

Routine sterilization/disinfection of the internal components of the anesthesia machine (e.g., gas outlets, gas valves, pressure regulators, flow meters and vaporizers) is not necessary or reasonably feasible. Unidirectional valves and carbon dioxide absorber chambers should be cleaned and disinfected periodically. The manufacturer's recommendations should be followed in cleaning and disinfecting anesthesia machines. Routine bacterial culture monitoring of the internal components of the anesthesia machine is not indicated.

There are insufficient clinical outcome data to support the routine use of bacterial filters for breathing circuits or anesthesia ventilators at this time.<sup>3</sup> A filter should be used on the anesthesia breathing circuit between the patient's airway and the Y-connector prior to contacting a patient with or at high risk for having pulmonary tuberculosis.<sup>4</sup>

Anesthesia ventilator tubing and bellows should be cleaned and disinfected at regular intervals. In contrast to respiratory therapy equipment, anesthesia ventilators are thought to represent a low risk for infection transmission and need not undergo cleaning and disinfection following each use.

Lensed equipment, including flexible fiberoptic endoscopes, requires special processing to avoid damaging the instrument during cleaning and disinfection/sterilization.<sup>5-6</sup> Manufacturer's instructions should be followed for cleaning and disinfecting/sterilizing these instruments. Since suction and other working channels of flexible endoscopes may become contaminated with organic material during use, it is important that the lumens be rinsed as soon as possible after use and thoroughly cleaned of organic debris before disinfection/sterilization. Endoscopes that contact only mucous membranes should receive at least high-level disinfection, while those that enter sterile body spaces should undergo sterilization.

## **C. EQUIPMENT REQUIRING CLEANING**

### ***Recommendation***

Equipment that does not ordinarily touch the patient or that touches only intact skin should be cleaned with a disinfectant at the end of the day and whenever visibly contaminated.

### ***Rationale and Interpretive Statements***

This equipment includes noninvasive blood pressure cuffs and tubing, pulse oximeter probes and cables, stethoscopes, electrocardiographic cables, skin temperature sensors, head straps, blood warmers, the exterior of the anesthesia machine, the exterior of monitoring equipment and equipment carts.

Horizontal surfaces (e.g., anesthesia machines and equipment carts) are more prone to contamination during use and should be cleaned after each patient. Frequently used knobs (e.g., pop-off, flow controls and vaporizers) also should be cleaned regularly.

## **D. SINGLE-USE EQUIPMENT**

### ***Recommendation***

The reuse of disposable (single-use) equipment is not recommended. There are insufficient data on the safety of this practice for anesthesia equipment.

### ***Rationale and Interpretive Statements***

Reuse of most disposable equipment will require sterilization or disinfection of the items. The chemical disinfection or sterilization processes may damage or weaken the integrity of the single-use (disposable) item making it unsafe to reuse. Reuse of disposable devices shifts all responsibility (and liability) from the original manufacturer to the individual user. Although there is some evidence that certain disposable medical devices may be reused safely after disinfection or sterilization, there are insufficient data on disposable anesthesia equipment.<sup>6</sup> Quality assurance programs and policies need to be formulated by departments that reuse disposable equipment to ensure that disinfection/sterilization is adequate and that the function and integrity of the product are not

compromised.

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**Questions and comments on this document can be directed to: Robin A. Stackhouse, M.D. at [stackr@anesthesia.ucsf.edu](mailto:stackr@anesthesia.ucsf.edu)**

## II. PREVENTING CONTAMINATION OF MEDICATIONS

Safe handling of parenteral medications is required to prevent nosocomial infections in patients undergoing anesthesia or sedation. While contamination of medications or fluids can occur from extrinsic or intrinsic sources, some preparations are more likely to support the growth of microorganisms.

### A. PRESERVATIVE-FREE MEDICATIONS

#### ***Recommendations***

Preservative-free ampules, vials and prefilled syringes are single-patient, single-dose items. The labels of all rubber-stopped vials should be checked for the presence of preservative agents because some vials are single-dose preparations.

The ampule, vial or prefilled syringe should be opened at the time of use.

Use aseptic technique, including use of an alcohol swab or appropriate disinfectant, to cleanse the vial's rubber septum before entering.

Cleanse the neck of glass ampules with an alcohol swab and let dry before opening.

Sterile needles and syringes should always be used to aspirate the contents of an ampule or vial.

Single-use ampules and vials should be discarded after the contents have been drawn up, and the prefilled syringe should be discarded after use is completed.

#### ***Rationale***

A single-dose ampule, vial or prefilled syringe contains medication intended for administration to a single patient and does not generally contain bacteriostatic/preservative agents found in multidose vials. The labels of all rubber-stopped vials should be checked for the presence of preservative agents because some vials are single-dose preparations. The Centers for Disease Control and Prevention (CDC) suggests that medications be drawn up as close as possible to the time of administration.

Drugs in partially used, open ampules may be contaminated with bacteria or other microorganisms from nonsterile glass fragments, from airborne contaminants or by failure to use aseptic technique.<sup>1</sup> Rubber septum failure may allow vial contamination to occur.

These recommendations apply to all items; microorganisms proliferate more readily, however, in some solutions and medications.<sup>2</sup> Postsurgical fever, infection, sepsis, other life-threatening illness and/or death have been reported after extrinsic contamination of propofol<sup>3-7</sup> (see "[Expiration Time for Medications](#),").

### B. USE OF SYRINGES

#### ***Recommendations***

Syringes and needles are sterile, single-patient use items.

Medications from a syringe must not be administered to multiple patients even if the needle on the syringe is changed.

After entry into or connection with a patient's intravenous (IV) infusion, the syringe and needle should be considered contaminated and used only for that patient.

After use or at the latest, at the end of each patient's anesthetic, all used syringes and needles should be discarded immediately in an appropriate puncture-resistant container.

Unused syringes, needles and related items should be stored in a clean area to avoid contamination by contaminated syringes and equipment.

#### ***Rationale***

All current literature advises against administering medications to multiple patients from the same syringe, even if the needle is

changed. Removing the needle from a syringe creates a siphoning effect that aspirates the needle contents into the syringe. A needle containing viruses or bacteria will contaminate the syringe even if the needle is flushed prior to removing it from the syringe.<sup>8-9</sup> Disposable syringes are labeled for "single-use only" by the manufacturer.

Syringes may become contaminated with bloodborne pathogens when used for IV, intramuscular or subcutaneous administration of medications. IV administration tubing can become contaminated with blood if backflow occurs during blood sample aspiration or from a blood transfusion. Infectious bloodborne pathogens may be present even if blood is not visible in the tubing.<sup>10-11</sup>

The syringe, plunger and contents can also be contaminated by direct contact or airborne transmission. Fluidborne contaminants on the open back end of the syringe and plunger will readily contaminate the syringe contents after several cycles of withdrawal and injection of the plunger.<sup>12</sup> Multiple injections increase the chances of syringe contamination.

Reusing syringes or needles places subsequent patients at risk of cross-infection<sup>13</sup> and places HCWs at risk of infection if a needlestick injury were to occur.

Some practitioners choose to mix more than one medication in a syringe for simultaneous administration. If this is done, the procedure should be performed in an aseptic fashion, and the solutions must be chemically and physically compatible. Although this may be acceptable practice in some situations, the additional maneuvers in this procedure may increase the likelihood of contamination.

## **C. EXPIRATION TIME FOR MEDICATIONS**

### ***Recommendations***

Medications should be drawn up as close as possible to the time of administration.

All medications drawn into a syringe should be discarded within 24 hours or when completely used, whichever comes first, unless otherwise specified by the medication's manufacturer or the hospital pharmacy.

An exception to the 24-hour use limit is any medication that is formulated as a lipid emulsion (e.g., propofol). When used in anesthesia, any unused portion of propofol in a syringe, reservoir or dedicated administration tubing must be discarded at the end of the procedure or within six hours after the ampule, vial or prefilled syringe is opened, whichever occurs sooner. The IV line should be flushed every six hours and at the end of the anesthetic procedure to remove residual propofol. A syringe containing propofol should be labeled with the date and time that the ampule, vial or prefilled syringe was opened.

When propofol is administered directly from the vial for intensive care unit sedation, the tubing and any unused portions must be discarded within 12 hours after the vial has been entered.

Propofol should be prepared for single-patient use only.

### ***Rationale***

Several factors affect the stability and sterility of medications. These include the particular drug, the presence of a bacteriostatic or preservative agent, the solution used for admixture (if any), potential for contamination during the process, attention to aseptic technique, the storage conditions and the chemical stability of the compound. Given favorable growth conditions, many bacteria enter a "log" growth phase after about 24 hours, which markedly increases the contaminant concentration. Drawing up medications as close as possible to the time of administration will help minimize the potential for significant bacterial growth or endotoxin formation.<sup>3,5</sup>

Drugs, such as propofol, that are formulated in a lipid emulsion support bacterial growth that increases rapidly starting six hours after inoculation.<sup>2,7</sup> Postsurgical fever, infection, sepsis, other life-threatening illness and/or death have been reported after extrinsic contamination of propofol.<sup>3-7</sup> Propofol now has a bacteriostatic agent, disodium edetate, added to the solution to slow the rate of growth of microorganisms in the event of accidental extrinsic contamination; propofol can still support the growth of microorganisms, however, since it is not an antimicrobially preserved product under United States Pharmacopeial Convention Inc. (USP) Standards.<sup>7</sup>

## **D. USE OF MULTIDOSE VIALS**

### ***Recommendations***

If aseptic technique is used consistently, an uncontaminated multidose vial may be used until the manufacturer's expiration date.

If suspected or visible contamination has occurred or if sterility is questionable, the vial should be discarded.

Each time a multidose vial is entered, aseptic technique should be used, including cleansing the rubber stopper with alcohol and using a sterile needle and syringe.

### ***Rationale***

The risk of nosocomial infection caused by extrinsic contamination of multidose vials is small, estimated to be 0.5 per 1,000 vials;<sup>14</sup> outbreaks of viral and bacterial infections, including fatal hepatitis B virus (HBV) infection, however, have been traced to contaminated multidose vials.<sup>15-18</sup> With breaks in aseptic technique, microbial contamination of the needle, syringe or rubber septum can be introduced into the vial. Although bacterial culture of random multidose vials used in an anesthesia practice yielded no positive cultures,<sup>19</sup> deliberate contamination of vials demonstrated that viable bacteria may exist for up to 16 hours.<sup>16</sup> Another study of deliberate contamination found no microorganisms could be recovered from some commonly used medications after 96 hours with rare exceptions, whether or not the medications contained a preservative.<sup>14,20</sup> Endotoxin, produced by bacterial contaminants, may also be present in some contaminated multidose vials.<sup>20</sup> Viral particles may survive in some multidose vials for at least one day.<sup>21</sup>

Multidose vials should be discarded if the contents are outdated (manufacturer's expiration date has been reached) or grossly contaminated or if the vial has been entered without proper aseptic technique.<sup>14</sup> When appropriate sterile precautions have been used with multidose vials, an institution may set a specific time period for use of opened vials<sup>22-23</sup> so that the multidose vial is dated when first entered and discarded after expiration of the time specified. If previously used multidose vials will be kept for prolonged periods, it is good practice to use the older stock before the newer items. In clinical areas such as the operating room or emergency department, where it is more likely that treatment of critically ill patients may result in breaks in aseptic technique, some data and institutions suggest use of only single-dose vials or recommend discarding multidose vials after use on a single patient.<sup>24</sup> Some drugs may require refrigeration and are labeled as such on the container and package insert.

## E. USE OF INFUSIONS

### **Recommendations**

All infusions (fluids and containers) and administration sets (IV tubings and connections) are single-patient use. This includes disposable pressure transducers and tubing and other items that contact the vascular system or other sterile body fluids.

Aseptic technique should be used when preparing IV infusion and administration sets, and entry into or breaks in the tubing should be minimized.

Check all containers of parenteral fluids for visible turbidity, leaks, cracks, particulate matter and the manufacturer's expiration date before use. Use single-dose vials for parenteral additives or medications whenever possible.

Stopcocks, injection ports and other portals of access to sterile fluids should be maintained with sterile technique. Stopcocks should be kept free of blood and covered by a sterile cap or syringe when not in use. IV injection ports should be cleaned with an appropriate disinfectant prior to entry.

For propofol infusions, see "[Expiration Time for Medications](#)".

### **Rationale**

Items that contact the vascular system or other sterile body areas must be sterile.<sup>22,25</sup> Sterility cannot be guaranteed if an infusion is used on multiple patients. Blood backup, withdrawal or transfusion can potentially contaminate the entire infusion or administration set. A one-way valve in the administration tubing does not prevent retrograde blood flow from entering the tubing via the IV catheter.<sup>10</sup> Product sterility and absence of blood contamination cannot be guaranteed by visual inspection.

Infusions may be contaminated by failure to use aseptic technique, by airborne or contact transmission of microorganisms during breaks in infusion system continuity, or by direct transmission from a patient. Bacterial and fungal infections in surgical patients have been associated with extrinsically contaminated infusions as well as infusions that were used on multiple patients.<sup>4</sup> For propofol infusions, see "[Expiration Time for Medications](#)".

## F. NONINJECTABLE DRUGS

### **Recommendations**

Noninjectable drugs such as topical ointments and sprays that are packaged in multiple-dose containers should be administered in such a manner as to avoid cross-contamination.

Any noninjectable drug should be discarded if visible or suspected contamination has occurred.

### **Rationale**

Proper technique is required to prevent cross-infection between patients via these items. Product contamination can occur by airborne transmission or direct contact with blood, any body fluid or tissue, or any item soiled with these. Many noninjectable drugs are packaged in single-patient, unit-dose form. In many instances, the unit dose containers are preferable since contamination of a larger multidose container may not be visible.



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Questions and comments on this document can be directed to: Robin A. Stackhouse, M.D. at [stackr@anesthesia.ucsf.edu](mailto:stackr@anesthesia.ucsf.edu)

### III. PREVENTION OF INFECTION DURING INSERTION AND MAINTENANCE OF CENTRAL VENOUS CATHETERS

The use of central venous catheters (CVCs) may be complicated by a variety of local or systemic infectious complications, including septic thrombophlebitis, endocarditis, bloodstream infections and metastatic infection. Catheter-related infections are associated with increased morbidity and mortality, prolonged hospitalization and increased medical costs.<sup>1-2</sup> The following recommendations to reduce catheter-related infections are based on guidelines published from the CDC.<sup>1</sup> (Original references cited in the CDC document are indicated for each topic.)

#### A. HANDWASHING

##### *Recommendation*

Wash hands before and after palpating, inserting, replacing or dressing any intravascular device.<sup>3</sup>

##### *Rationale*

Strict adherence to handwashing and aseptic technique remains the cornerstone of prevention of catheter-related infections. Failure of hospital personnel to perform appropriate handwashing technique is well-documented, and numerous epidemics of device-associated bacteremia have been linked to hospital personnel transmitting the epidemic strain from their hands.<sup>4</sup>

#### B. SKIN PREPARATION

##### *Recommendation*

Cleanse the skin site with an appropriate antiseptic, such as 70-percent alcohol, 10-percent povidone-iodine, 4-percent chlorhexidine or 2-percent tincture of iodine, before catheter insertion.<sup>5</sup>

##### *Rationale*

The use of skin cleansing/antiseptics has been shown to reduce the incidence of CVC infections.<sup>6</sup>

#### C. SELECTION OF CATHETER

##### *Recommendation*

Use a single-lumen CVC unless multiple ports are essential for the management of the patient.

For institutions that have an unacceptably high rate of infection after full adherence to other catheter related infection control practices, the use of antimicrobial- or antiseptic-impregnated CVCs may be considered.

##### *Rationale*

Multilumen catheters are associated with a higher risk of infection than single-lumen catheters.<sup>7</sup>

#### D. SELECTION OF INSERTION SITE

##### *Recommendation*

When choosing the site for insertion of a CVC, the risks and benefits inherent with subclavian, jugular and femoral catheterization must be considered in the context of each patient's medical and surgical conditions.

##### *Rationale*

Catheters inserted into subclavian veins have a lower risk for infection than do those inserted via either jugular or femoral veins; the mechanical complications are less common, however, with internal jugular vein insertions than with subclavian vein insertions.<sup>8</sup> The risk of complications such as pneumothorax must be considered along with the risk of infectious complications when choosing a site for CVC placement.

#### E. BARRIER PRECAUTIONS DURING CATHETER INSERTION

## **Recommendation**

Use sterile techniques, including, ideally, a sterile gown and gloves, a mask and a large drape (i.e., maximal barrier precautions), for the insertion of CVCs. Use these precautions even if the catheter is inserted in the operating room.

## **Rationale**

The risk of infection of CVCs is associated with the specific barrier protection used during catheter insertion rather than the sterility of the surrounding environment (i.e., ward vs. operating room).<sup>9-10</sup> Maximal barrier precautions include a large drape (rather than a small fenestrated drape) that covers the patient's head and body.<sup>9</sup> Recommendations from the CDC were based on long-term catheter placement. The risk of infection for short-term catheter placement has not been evaluated fully.

## **F. SITE CARE**

### **Recommendation**

Use either a sterile gauze or transparent dressing to cover the catheter site.<sup>11</sup>

### **Rationale**

Transparent dressings that permit the escape of moisture from beneath the dressing may be associated with lower rates of skin colonization and catheter-related infection. Comparable infection rates have been documented when a sterile gauze dressing is used.<sup>12</sup>

### **Recommendation**

Do not routinely apply topical antimicrobial ointment to the insertion site.

### **Rationale**

Studies of the efficacy of this practice are contradictory and the use of polyantibiotic ointments that are not fungicidal may significantly increase the rate of catheter colonization by *Candida* species.<sup>13</sup>

## **G. REPLACEMENT OF CATHETER**

### **Recommendation**

Do not routinely replace nontunneled CVCs as a method to prevent catheter-related infections.<sup>14</sup>

### **Rationale**

The daily risk of infection remains constant over time, and routine replacements of CVCs do not reduce the rate of catheter colonization or catheter-related bloodstream infections.<sup>14</sup>

## **H. ADMINISTRATION SET REPLACEMENT**

### **Recommendation**

Fluid administration sets should be changed at 72-hour intervals.

### **Rationale**

There is no reduction in infection rates if administration sets are routinely changed more frequently.<sup>15</sup>

## **I. PRESSURE TRANSDUCERS**

### **Recommendation**

Use disposable rather than reusable pressure transducer assemblies when possible.

### **Rationale**

Pressure monitoring systems have been associated with nosocomial bloodstream infections, due to contaminated infusate fluid or difficulties of sterilizing reusable transducers.<sup>1</sup> The use of continuous flush devices and disposable transducers has reduced the risk of infection; no outbreaks have been reported with use of disposable transducers.<sup>1</sup>

## J. UNRESOLVED ISSUES<sup>1</sup>

1. In pediatric patients, no recommendation for the use of antimicrobial- or antiseptic-impregnated central venous catheters.
2. No recommendation on preferred site for insertion of pulmonary artery (Swan-Ganz) catheters.
3. No recommendation for the frequency of replacement of peripherally inserted central venous catheters.
4. No recommendation for frequency of replacement of totally implantable devices (i.e., ports) or the needles used to access them.
5. No recommendation for the removal of central catheters inserted under emergency conditions, when breaks in aseptic technique are likely to occur.
6. No recommendation for obtaining blood samples for culture through central venous or central arterial catheters.
7. No recommendation for the frequency of routine replacement of dressings used on central catheter sites.

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Questions and comments on this document can be directed to: Robin A. Stackhouse, M.D. at [stackr@anesthesia.ucsf.edu](mailto:stackr@anesthesia.ucsf.edu)

## IV. PROTECTION OF THE IMMUNOSUPPRESSED PATIENT

### **Recommendation**

Standard Precautions (see "[Prevention of Occupational Transmission of Infection to Anesthesiologists](#),") and appropriate sterile technique should be used by anesthesiologists in dealing with all patients, especially in the management of immunosuppressed patients.

### **Rationale**

While it is widely recognized that the patient with acquired immunodeficiency syndrome (AIDS) represents an occupational infectious hazard to the HCW, it is equally important to recognize that the HCW may transmit infectious agents to an immunosuppressed patient. The normal bacterial, viral or protozoal flora carried by HCWs have their pathogenic potential held in check by an intact immune system, and yet, transmission of ordinarily benign organisms to an immunosuppressed patient (e.g., organ transplant or AIDS patients) may cause life-threatening infections. In the immune competent patient, herpes simplex infection is painful and unsightly but also short-lived. Herpes simplex infection in the AIDS patient or other immunosuppressed patient is often fulminant, debilitating, painful and potentially fatal. Many asymptomatic HCWs harbor *Pneumocystis carinii* or cytomegalovirus and remain in good health as long as their immune systems are intact. These organisms in the AIDS patient, for example, are among the leading causes of severe illness and death. The skin of the HCW is often contaminated with pathogenic bacteria that may be transmitted to a patient.

It is imperative that all appropriate precautions be taken to ensure that potentially harmful organisms are not transmitted from anesthesiologists to patients. Standard Precautions, which serves to protect the HCW from infections carried by a patient, also serves to protect the patient from the HCW. Frequent handwashing and use of barrier precautions such as gloves and masks are particularly important. Gloves and masks are not warranted unless there is direct contact between HCW and patient.

The immunosuppressed patient is particularly vulnerable when the protective envelope of skin or mucous membrane has been disrupted, and every precaution must be taken to ensure cleanliness and, when warranted, sterility of equipment (see "[Disinfection of Equipment](#),").

Prior to starting an IV infusion, the patient's skin should be scrubbed well with a disinfectant, and the physician should wear sterile gloves as well as a mask and cap. Before placement of invasive monitors (e.g., arterial line or pulmonary artery catheter), the skin should be similarly prepared and the area draped with sterile towels. In addition, use sterile techniques, including, ideally, a sterile gown and gloves, a mask and a large drape (i.e., maximal barrier precautions) (see "[Prevention of Infection During Insertion and Maintenance of Central Venous Catheters](#),"). Sterile dressings should be applied and maintained at all catheter sites.

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## V PREVENTION OF TRANSMISSION OF TUBERCULOSIS AND THE ANESTHESIOLOGIST

Anesthesiologists and other HCWs have been at risk for nosocomial infection with tuberculosis (TB) for many years; the advent of effective infection control techniques and the development of antibiotics for *Mycobacterium tuberculosis* (*M. tuberculosis*), however, have decreased TB in the general population and the risk of nosocomial infection.<sup>1</sup> More recently, TB caused by strains of *M. tuberculosis* resistant to two or more antibiotics (MDR-TB) has become a new concern, and nosocomial transmission is now well-documented.<sup>2</sup> This section will review the mechanism of transmission of *M. tuberculosis*, summarize the relevant portions of recently published guidelines from the CDC<sup>3</sup> and discuss specific measures that anesthesiologists can take to protect themselves, their patients and fellow HCWs.

### **A. TUBERCULOSIS: GENERAL INFORMATION**

Tuberculosis is caused by the bacteria *M. tuberculosis*. A majority of TB infections are caused by inhalation of infectious droplet nuclei that are produced by persons with pulmonary TB. These droplet nuclei (1 to 4  $\mu\text{m}$ ) stay suspended in air currents and can spread throughout a room or building. After entry through the lungs, an immune response that limits further spread of the bacilli generally develops within two to 10 weeks, and immunity can be detected by a positive tuberculin skin test. Individuals found to have a positive skin test are candidates for treatment of their tuberculous infection to minimize the chance of developing active disease.<sup>4</sup> As the incidence of infections with MDR-TB increases, initial antibiotic therapy for active pulmonary tuberculosis is expanding from two- to three-drug therapy to four or more drugs. Strains of TB have been identified that are resistant to seven drugs.<sup>3</sup>

## **B. CDC GUIDELINES UPDATED, 1994**

Because of the increasing rates of TB in hospitalized patients, the CDC published Guidelines for Preventing the Transmission of *Mycobacterium Tuberculosis* in Health Care Facilities, 1994,<sup>3</sup> which specifically addresses the operating room environment. The CDC guidelines require institutions that treat patients with TB to follow a hierarchy of controls for prevention of TB transmission, including early identification, isolation and treatment of patients with active TB. Engineering controls are required to prevent the spread and reduce the concentration of the infectious droplets, including the availability of rooms for respiratory isolation using adequate ventilation, filters and ultraviolet light.

### **1. Elective Surgery for Patients With TB**

#### ***Recommendation***

Elective operative procedures on a patient who has TB should be delayed until the patient is no longer infectious.

#### ***Rationale***

When the criteria are met for discontinuation of TB isolation, patients may undergo elective surgery. Patients are unlikely to transmit *M. tuberculosis* if they have been on effective antibiotic therapy, are improving clinically and have had three consecutive negative sputum acid fast bacillus smears collected on different days.<sup>3</sup>

### **2. Surgery on Patients With TB**

#### ***Recommendation***

When operative procedures must be performed on patients with or suspected of having active pulmonary TB, the doors of the operating room should be closed, and traffic into and out of the room should be minimized. Attempts should be made to perform the procedure at a time when other patients are not present in the operating room suite and when a minimal number of personnel are present (e.g., at the end of the day). Patients with TB who need to be out of their respiratory isolation room to go to the OR for nonelective surgery should be transported to the OR wearing surgical masks to prevent respiratory secretions from entering the air.<sup>3</sup>

#### ***Rationale***

Designing an ideal OR for the prevention of TB transmission presents challenges for hospital ventilation engineers. An ideal OR designed to prevent suspended infectious droplets from leaving it would have an anteroom that is negative pressure to the corridor and the OR. Most current operating rooms lack an anteroom and are actually designed to be positive pressure relative to the surrounding areas in order to prevent contaminants from being drawn into the sterile OR environment. After evaluation of airflow and air turnover with the help of a ventilation engineer, an OR with the most favorable airflow patterns can be designed to minimize infectious droplets reaching the HCWs in the OR and to ensure that the exhausted air does not return to the other parts of the hospital.

### **3. Use of Filters on Anesthesia Breathing Circuit**

#### ***Recommendation***

When anesthetizing a patient with confirmed or suspected TB, placing a bacterial filter between the anesthesia circuit and the patient's airway will prevent contamination of anesthesia equipment or discharge of tubercle bacilli into the ambient air.

#### ***Rationale***

Although there have been no documented cases of TB transmission via a ventilator or anesthesia machine, technology exists to prevent infectious droplets from contaminating anesthesia equipment.<sup>3,5</sup> High-efficiency particulate air filters remove 99.97 percent of all particles greater than or equal to 0.3  $\mu\text{m}$ . These filters can be placed between the Y-connector and the mask or the endotracheal tube and serve to keep infectious particles from getting into the operating room air, the breathing circuit, the anesthesia machine and the scavenging system. It is prudent to use these filters when there is any suspicion of a patient having pulmonary TB.<sup>6-7</sup>

### **4. Recovery From Anesthesia**

#### ***Recommendation***

During recovery from anesthesia, the patient should be monitored and should be placed in a private room that meets recommended ventilation standards for respiratory isolation rooms.

#### ***Rationale***

The ideal recovery room for caring for patients with active TB would have negative pressure to the surrounding rooms, exhaust all air



to the outside, have an anteroom to act as an airlock and utilize ultraviolet lights to kill the *M. tuberculosis* in the infectious droplets. Since most institutions will not have TB isolation rooms in the postanesthetic care unit that meet these criteria, patients should be recovered in the OR used for the surgical procedure or in the patient's hospital isolation room. Appropriate monitoring and emergency equipment should be made available in these locations.

## 5. Respiratory Protective Devices for HCWs

### **Recommendation**

When operative procedures (or other procedures requiring a sterile field) are performed on patients who may have infectious TB, respiratory protective devices worn by the HCW must protect the sterile field from the respiratory secretions of the HCW and protect the HCW from the infectious droplet nuclei generated by the patient. Valved or positive pressure respirators do not protect the sterile field; therefore, a respirator that does not have a valve and that meets the National Institute for Occupational Safety and Health (NIOSH) N95 Standard should be used.<sup>9</sup>

### **Rationale**

NIOSH guidelines describe filtration characteristics of masks believed to be necessary to protect HCWs from respiratory transmitted pathogens.<sup>9</sup> Masks for the OR environment cannot have a positive pressure exhaust valve and should be fit-tested for each worker using an aerosolized substance to ensure minimal face seal leakage. Masks that fulfill the NIOSH N95 guidelines are listed on the NIOSH World Wide Web page <<http://www.cdc.gov/niosh/homepage.html>> or can be obtained by calling the NIOSH at (800) 35-NIOSH. HCWs should wear the mask for the entire time they are exposed to air containing infectious droplets. For high-risk procedures, such as bronchoscopy on a patient with pulmonary TB, or for HCWs with facial hair that would produce unacceptable leakage around a face mask, a higher level of respiratory protection can be obtained with powered air respirators or respirators run from central medical air sources.<sup>3</sup>

## 6. Skin Testing Programs for HCWs

### **Recommendations**

Anesthesia personnel should have baseline and periodic testing with purified protein derivative of tuberculin (PPD). A two-step PPD test<sup>\*</sup> may be required if it has been greater than one year since last PPD testing. Individuals with newly recognized positive PPD test results or conversion need evaluation for active TB, including a follow-up chest radiograph (CXR) and symptom review. Therapy is based on the results of the CXR and evaluation.

Those individuals who have previously been vaccinated with Bacille of Calmette and Guérin (BCG) should also have periodic screening (either PPD or symptom review).

Individuals who have previously tested positive for PPD secondary to TB exposure should have periodic screening by symptom review. If the symptom review is positive, a CXR and evaluation for preventive therapy should follow.

Personnel exposed to individuals with active TB should have postexposure follow-up screening (usually 12 weeks post exposure).

### **Rationale**

The CDC has set guidelines for preventing nosocomial transmission of TB in health care facilities.<sup>3</sup> The CDC recommendations for the frequency of TB screening of HCWs is based on TB risk assessment. An individual's risk of exposure depends on the prevalence of active TB in the patient population of the health care facility and the incidence of contact between the practitioner and patients with active TB. Patient populations that have been shown to have a higher prevalence of TB include immigrants from endemic areas (e.g., Asia, Africa, the Caribbean and Latin America), individuals from institutional or congregate living settings, medically underserved populations, immunocompromised individuals, renal failure patients and IV drug abusers.

The CDC recommends that the frequency of TB screening be based on exposure risk, which is derived by analyzing the community TB profile of the health care facility and the risk of individual occupational groups. If no patients with active TB were admitted to an area during the past year, the risk of exposure would be considered very low, and a set frequency for screening is not recommended. For low risk of exposure (less than six patients in past year), yearly screening is recommended. Those at intermediate risk (greater than six patients per year) should be screened every six to 12 months. High-risk HCWs should be screened every three months.

TB screening tests will not prevent TB exposure and transmission but will allow for earlier diagnosis and treatment of latent or active TB and guide improvement in the tuberculosis control plan of the health care facility.

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\*Individuals who have not undergone PPD testing at regular intervals may have a false-negative reaction on initial testing. The two-step test controls for this circumstance. The initial test boosts the immune response, making a second test one to five weeks later more accurate. A negative reaction on the second test indicates no exposure or anergy, while a positive reaction indicates remote exposure.

**Questions and comments on this document can be directed to: Robin A. Stackhouse, M.D. at [stackr@anesthesia.ucsf.edu](mailto:stackr@anesthesia.ucsf.edu)**



## PREVENTION OF OCCUPATIONAL TRANSMISSION OF INFECTION TO ANESTHESIOLOGISTS

### I. STANDARD PRECAUTIONS\*

Anesthesia personnel are at risk for occupationally acquired infections including respiratory infections and bloodborne infections. The respiratory infection of greatest importance is TB (see "[Prevention of Transmission of Tuberculosis and the Anesthesiologist](#),"), while the bloodborne infections of greatest concern include human immunodeficiency virus (HIV), hepatitis B virus (HBV) and hepatitis C virus (HCV). The principal routes of occupational exposures resulting in transmission of bloodborne pathogens are percutaneous injuries (needlesticks and other sharp object injuries), mucosal contact (eye, mouth or other mucous membrane) or contact of nonintact skin (broken or injured skin).<sup>1</sup> Fluids documented to be infectious for HIV, HBV or HCV from occupational exposures include blood, blood products, bloody fluids and concentrated virus in a laboratory setting.<sup>2-3</sup> Other potentially infectious materials for these viral agents include cerebrospinal, amniotic, pleural, pericardial, peritoneal and synovial fluids, and inflammatory exudates.

The Occupational Safety and Health Administration (OSHA) Bloodborne Pathogens Standard, enacted in 1991, mandates use of Universal Precautions, now part of Standard Precautions\* (universal application of blood and body fluid precautions designed to reduce the risk of transmission of bloodborne pathogens to HCWs) and requires employers to institute the following controls and protective equipment: engineering controls that isolate or remove bloodborne pathogen hazards from the workplace (e.g., puncture-resistant, leak-proof sharps disposal containers that are placed near the point of use and replaced before becoming overfilled, self-sheathing needles and needleless IV access systems), work practice controls that reduce the likelihood of exposure by altering the manner in which a task is performed (e.g., prohibiting needle recapping by the two-hand technique or bending, breaking or otherwise handling used needles) and personal protective equipment such as specialized clothing or equipment worn for protection against a hazard (e.g., gloves, liquid-resistant gowns, and face and eye protection).<sup>4</sup> The OSHA Standard also requires employers to provide postexposure evaluation with appropriate treatment, infection prophylaxis and follow-up care; maintain records of exposures; provide a free HBV vaccine to all at-risk employees; and provide annual training for all at-risk employees. The education requirement includes Universal Precautions, safe work practices and the employer's obligations under OSHA.

### A. HANDWASHING

#### *Recommendation*

Wash hands before performing invasive procedures. Wash hands after touching blood, body fluids, secretions, excretions and contaminated items, whether or not gloves are worn. Wash hands immediately after gloves are removed, between patient contacts and when otherwise indicated to avoid transfer of microorganisms to other patients or environments. It may be necessary to wash hands between tasks and procedures on the same patient to prevent cross-contamination of different body sites. Waterless handwashing solutions may be considered when the anesthesiologist cannot leave the room.

#### *Rationale*

Handwashing is one of the most effective means of infection control to protect HCWs and patients. Body fluids that contain disease-producing microorganisms easily contaminate the skin of ungloved hands. Additionally, hands may be contaminated via leakage or tears in gloves.<sup>5</sup> In the hospital environment, pathogenic microorganisms that are often found on the skin of HCWs are acquired from colonized or infected patients and may be the source of nosocomial infections. These microbial flora are easily removed by handwashing.

### B. USE OF BARRIERS

#### *Recommendation*

Appropriate barrier precautions such as gloves, fluid-resistant masks, face shields and gowns must be used routinely with all patients to prevent skin and mucous-membrane exposure when any contact with blood or body fluids is anticipated or possible. Choice of barrier should be commensurate with the expected extent of exposure. Remove gloves and gowns promptly after use, before touching noncontaminated items and environmental surfaces, and wash hands before seeing another patient. Continuing education about the degree of risk entailed and procedures to minimize risk should be provided routinely.

#### *Rationale*

Recommendations developed by the CDC stress Standard Precautions.<sup>5-10</sup> "Medical history and examination cannot reliably identify all patients infected with HIV or other bloodborne or body substance pathogens."<sup>5-6,8</sup> Therefore, it is recommended that barrier precautions should be used consistently for all patients. The increasing prevalence of bloodborne infections in all parts of the country

increases the risk that an HCW will be exposed to blood of patients carrying pathogens.<sup>11</sup> It has been demonstrated that 98 percent of anesthesiologists' contact with patient blood could be prevented by routine use of gloves.<sup>12</sup>

The average risk of HIV transmission after mucous membrane or skin contact with HIV-infected blood is estimated to be 0.1 percent or less. The risk increases with the size of the viral inoculum, with a higher viral titer in the source blood, with prolonged contact time, when a large surface area is involved or when the HCW has visible skin lesions. There are limited data on conjunctival exposures to HIV- and/or HCV-infected blood or other body fluids, but two HIV and one HCV seroconversions have been documented, with transmission rates of 0.8 percent for HIV and 0.3 percent for HCV.<sup>1</sup> In most cases of eye exposure, the HCW either was not wearing protective eyewear or used eyewear that was ineffective. Mucocutaneous HBV transmission has been documented, but the risk has not been quantified; however, the magnitude of transmission risk in susceptible HCWs is probably high compared to that for HIV and HCV.<sup>2</sup>

Institutions should educate HCWs who are at risk for exposure to blood and other potentially infective body substances (e.g., amniotic fluid, cerebrospinal fluid, feces, urine, sputum, wound drainage and other body fluids) on the specifics of Standard Precautions and should supply the appropriate protective equipment in readily accessible locations. They should also be responsible for monitoring compliance with Standard Precautions.

Prolonged contact with or exposure to latex gloves may be responsible for the increase in latex sensitivity noted in anesthesia personnel.<sup>12a</sup> Use of powder-free latex gloves can eliminate airborne exposure to latex proteins carried via powder inhaled onto HCWs' respiratory mucosa.<sup>12b</sup> Sources such as the NIOSH Web page <<http://www.cdc.gov/niosh/homepage.html>> can be consulted for a consideration of alternatives to powdered latex gloves.<sup>12c</sup>

## C. PREVENTION OF ACCIDENTAL NEEDLESTICKS

### **Recommendation**

Prevention of injuries by needles, scalpels or other sharp instruments is vital. Contaminated needles should never be removed from disposable syringes by hand and should not be bent, broken or otherwise manipulated by hand. If it is absolutely necessary to recap contaminated needles, a single-handed technique\* or a mechanical protective device should be used. Use of "needleless" systems (e.g., stopcocks, one-way valves, etc.) or shielded needle products should be encouraged to prevent injury.<sup>13-14</sup> Puncture-resistant, leak-proof containers for disposal of used needles and syringes, scalpel blades and other sharp items should be easily accessible to personnel and located as close as is feasible to the immediate area where sharps are used.<sup>4</sup>

### **Rationale**

Percutaneous injury, such as an accidental needlestick, is associated with the greatest risk of transmission of bloodborne infection. The average risk of acquiring HIV infection after an accidental parenteral exposure (needlestick or cut) to blood from a known HIV-infected patient is estimated to be 0.3 percent.<sup>9,15</sup> The risk of HIV infection transmission to the injured HCW is increased if the exposure is a deep injury, there is blood visible on the sharp device, the needle was placed directly in the patient's vein or artery or the source patient has acute retroviral illness or is in the late stages of AIDS (due to higher HIV titers in source patient).<sup>15-17</sup> Blood, serum and cerebrospinal fluid have been shown to have higher concentrations of HIV and thus represent a greater risk upon exposure, while saliva, tears, urine, breast milk, amniotic fluid and vaginal secretions pose lower risks.<sup>8,17</sup>

The risk of HBV transmission to a nonimmune HCW after a percutaneous exposure to HBV-infected blood ranges from 6 percent to 37 percent.<sup>13</sup> The risk of HCV transmission to an HCW after an HCV-infected percutaneous exposure is about 3 percent to 10 percent.<sup>2,18</sup>

Double-gloving offers increased protection from penetrating injuries to the hands, compared to wearing a single pair.<sup>18-21</sup> The use of gloves may also decrease the risk of infection by decreasing inoculum size from some types of needlestick injuries.<sup>20-22</sup>

## D. TREATMENT OF BLOOD EXPOSURES

### **Recommendation**

All health care institutions should have a detailed protocol in place for treatment and follow-up of an HCW who has had an occupational exposure to blood or body fluids. HBV immunization and HBV immunoglobulin are used to reduce the risk of HBV transmission to HCWs. Use of multidrug prophylactic antiviral therapy for HIV exposure is now recommended by the Public Health Service (PHS).<sup>16,23-25</sup> Current recommendations for treatment and follow-up should be consulted since choice of antiviral agents may change.

### **Rationale**

Appropriate intervention may be helpful in preventing HBV in susceptible HCWs. HCWs exposed to HIV should be offered postexposure prophylactic (PEP) antiviral therapy and counseling.<sup>16,21-25</sup> PEP may not be effective if withheld 24 to 36 hours post

exposure, but this is not certain. Expert help with the decision to take zidovudine (ZDV) and other antiviral drugs, most often lamivudine (3TC) and indinavir (IDV), should be immediately available.<sup>23-25</sup> The CDC report that notes a 79-percent decrease in the risk for HIV infection among HCWs who used ZDV after percutaneous exposure to HIV-infected blood (more than 90 percent of exposures were needlesticks)<sup>15</sup> has caused the PHS to issue new recommendations.<sup>16,21-25</sup> Experts disagree on the drugs and dose to take, so expert consultation is advised.\* Follow-up serologic testing and counseling is necessary, and potential toxicity of antiviral agents should be monitored. There is no antiviral agent available to reduce the risk of HCV infection after occupational exposure.<sup>26</sup>

## E. EMERGENCY VENTILATION DEVICES

### **Recommendation**

When emergency mouth-to-mouth resuscitation is indicated or might be required, mouthpieces, resuscitation bags or other ventilation devices should be available.

### **Rationale**

Cutaneous or mucous membrane contact with saliva has not been implicated in HIV, HBV or HCV transmission, but caution is appropriate.<sup>2,24</sup> Blood may contaminate saliva and thus increase the risk with direct contact. Placement of ventilation devices in locations of anticipated use should prevent the need for the HCWs to contact saliva during emergency ventilatory support of patients.

## F. PERSONNEL WITH CUTANEOUS LESIONS

### **Recommendation**

HCWs with breaks in the skin or exudative/weeping lesions should refrain from direct patient contact and from handling patient care equipment unless the open area can be protected.

### **Rationale**

The conduct of anesthesia results in a 36-percent rate of contact with body fluids, and while this can be dramatically reduced with appropriate precautions,<sup>12</sup> contact with unprotected lesions represents a significant and unacceptable risk for both the patient and the HCW. Open skin lesions may be a portal of entry for bloodborne pathogens so that an otherwise innocuous cutaneous exposure could result in transmission of infection. Microorganisms residing in uncovered skin lesions may be transmitted to patients.

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## II. HEPATITIS B VACCINE

### **Recommendation**

All anesthesiologists who do not have documented immunity to HBV should receive an HBV vaccine.

### **Rationale**

HBV infection is an occupational hazard for HCWs who have frequent contact with blood and body fluids.<sup>1</sup> The CDC estimates that in 1994, 1,000 HCWs were infected with HBV.<sup>2</sup> The prevalence of serum markers for prior HBV infection was 19 percent in one multicenter study of anesthesiologists.<sup>3</sup> This is four to six times the seroprevalence in the general population. Since the risk for HBV infection is increased in unprotected HCWs, immunization should be completed during training in medical, dental and other health profession schools before the first occupational exposure to blood.<sup>1</sup>

Several HBV vaccines are available for use in the United States, and all are considered safe and have been shown to be effective in producing immunity in more than 90 percent of healthy recipients.<sup>4</sup> Immunization is the primary strategy for prevention of HBV in anesthesiologists.

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### III. SMOKE EVACUATION DURING THE USE OF LASERS OR ELECTROSURGICAL UNITS

#### **Recommendation**

A smoke evacuator should be utilized to remove potentially infectious particles during laser operations that create a smoke plume. To be most effective, the evacuator nozzle should be positioned as close as possible to the operative field and be functional before, during and for 30 seconds after tissue is vaporized. Personnel should wear gloves and high-efficiency surgical masks that remove submicron particulate matter. These should be removed and properly discarded as soon as possible after use. Smoke generated by electrosurgical units (ESUs) should be evacuated during procedures that cause the operating room staff to have discomfort from the irritating effects of the smoke.

#### **Rationale**

Clinical and laboratory studies indicate that viral DNA can be found in the plume after a carbon dioxide laser is used to vaporize verrucae such as condyloma acuminata<sup>1</sup> and warts,<sup>2</sup> but infectivity has not been proven. An *in vitro* model using bacteriophage demonstrated that viable viruses might be transmitted via smoke particles of laser plumes, but since they are carried on larger particles, viable phage only traveled 100 mm from the site.<sup>3</sup> Use of smoke evacuators should adequately remove potentially infectious particles when the evacuator nozzle is held close to the operative site and is functional before, during and after the period of tissue vaporization.<sup>4</sup> The use of barrier precautions such as masks and gloves should prevent viruses from contacting mucous membranes of the mouth and nose as well as the hands, from which self-inoculation may occur. Conclusive evidence of viral infection transmission via laser smoke or ESU plume has not been demonstrated.<sup>5</sup> There is a clinical report documenting laryngeal papillomata in a laser surgeon, but there is no proof that it was acquired via smoke plumes.<sup>6</sup>

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\* Standard Precautions (new terminology) was designed for the care of all patients and incorporated the major features of Universal Precautions (designed to reduce the risk of transmission of bloodborne pathogens) and Body Substance Isolation (designed to reduce the risk of transmission of pathogens from moist body substances). Standard Precautions applies to blood and all body fluids, secretions, excretions, nonintact skin and mucous membranes. For patients with specific infections, additional isolation precautions, Transmission-Based Precautions, are applied with Standard Precautions. These are designed to reduce the risk of airborne, droplet or contact transmission of pathogens.<sup>5</sup> The advantages of Standard Precautions include the simplicity of one broad strategy for infection control. This protects HCWs and patients from diagnosed as well as unrecognized infections.

\* A single-handed recapping technique is one in which the needle is never directed toward a hand. For example, a hemostat or other device may be used to hold the needle cap, or alternatively, a needle may be "scooped" into an unheld needle cap, which is then seated onto the needle hub. Needle cap perforation by the needle is possible when recapping; therefore, observe caution.

\* Current recommendations (June 1998) at San Francisco General Hospital include zidovudine (ZDV), 200 mg at three doses/day, and lamivudine (3TC), 150 mg at two doses/day for four weeks. Indinavir, 800 mg, or nelfinavir, 750 mg, at three doses/day, should be considered if it is a high-risk exposure<sup>16,23-25</sup> or if the source patient is taking multidrug antiviral therapy for HIV infection (i.e., ZDV and 3TC). Other antiretroviral drugs may be considered on a case-by-case basis, but data are lacking. A multicenter protocol and other information may be obtained by e-mailing a request to <protocol@epi-center.ucsf.edu>. The CDC home page <http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5011a1.htm> will have updated recommendations and is an excellent source. A national hotline, National Clinicians' Post-Exposure Prophylaxis Hotline, has been established (January 1998) to counsel and make recommendations to HCWs who have sustained occupational exposures to bloodborne pathogens; the toll-free number is (888)

448-4911. A national registry for all HCWs who receive postexposure chemoprophylaxis can be reached at the toll-free telephone number (888) PEP-4 HIV, i.e., (888) 737-4448.

**Questions and comments on this document can be directed to: Robin A. Stackhouse, M.D. at [stackr@anesthesia.ucsf.edu](mailto:stackr@anesthesia.ucsf.edu)**

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**APPENDIX A:****DEFINITIONS OF INFECTION CONTROL TERMS**

**Antiseptic** - A chemical germicide formulated for use on living tissue.

**Cleaning** - Removal of foreign material from an item. This usually involves friction and washing with a detergent or disinfectant to remove contamination, followed by rinsing and thorough drying.

**Decontamination** - A process that renders a contaminated item safe to handle (reasonably free from the likelihood of transmitting infection).

**Disinfectant** - A chemical germicide formulated for use on nonliving items.

**High-Level Disinfection** - A procedure that kills vegetative bacteria (but not necessarily high numbers of endospores), fungi and viruses. The Environmental Protection Agency (EPA) would classify these disinfectants as "Sporicidal Hospital Disinfectants" or as "Sterilants." (With sufficient contact time, these high-level disinfectants may produce sterilization.)

**Intermediate-Level Disinfection** - A procedure that kills vegetative bacteria (but not endospores), fungi and viruses (except small, nonlipid viruses). The EPA would classify these disinfectants as "Tuberculocidal Hospital Disinfectants."

**Low-Level Disinfection** - A procedure that kills most vegetative bacteria (except *Mycobacterium tuberculosis* and endospores), some fungi and some viruses (lipid and medium-sized). The EPA would classify these disinfectants as "Sanitizer Hospital Disinfectants."

**Sterile** - Completely free of all microorganisms.

**Sterilization** - A procedure that kills all bacteria (including large numbers of endospores), fungi and viruses. Operationally, sterilization is a process that results in a probability of a microorganism surviving on an item of less than 1 in 1 million ( $1 \times 10^{-6}$ ).

**Questions and comments on this document can be directed to: Robin A. Stackhouse, M.D. at [stackr@anesthesia.ucsf.edu](mailto:stackr@anesthesia.ucsf.edu)**

## APPENDIX B: RECOMMENDATIONS FOR DISINFECTION

### RECOMMENDATIONS FOR HIGH-LEVEL DISINFECTION OF SEMI-CRITICAL DEVICES (E.G., LARYNGOSCOPE BLADES, BRONCHOSCOPES)

Infections may be transmitted via semi-critical devices as a result of inadequate cleaning, improper selection of the disinfection agent or failure to follow recommended cleaning and disinfection procedures. The manufacturer's recommendations should be consulted to determine acceptable disinfection procedures and compatible disinfectants to be used with each device. The following recommendations are therefore general in nature:

1. As soon as possible after use, all surfaces of equipment should undergo meticulous mechanical cleaning with a low-sudsing enzymatic detergent, followed by rinsing with water to remove organic material. Sequestered organic material poses the greatest risk of cross-contamination for patients undergoing endoscopic procedures. All channels of fiberoptic equipment should be irrigated and brushed to remove particulate matter. Brushes used for cleaning should be disposable or should be cleaned and sterilized or undergo high-level disinfection at least daily.
  
2. When liquid disinfectants are used for high-level disinfection, all immersible internal and external surfaces must be in contact with an EPA-registered sterilant/disinfectant for at least 20 minutes.  
EPA-recommended agents for high-level disinfection (use according to the manufacturer's recommendations) include:
  - a. 2-percent alkaline glutaraldehyde: activated by bicarbonate to raise pH to 7.5-8.5.  
*Advantages:* noncorrosive, highly resistant to neutralization by organic substances  
*Disadvantages:* shelf life of activated solution is about 14 days.
  - b. 2-percent acid glutaraldehyde: pH 3.0-6.3.  
*Advantages:* stable for long periods.  
*Disadvantages:* may be corrosive to metal.
  - c. 6-percent hydrogen peroxide/0.85-percent phosphoric acid.  
*Advantages:* potent antimicrobial agent, relatively free of toxic fumes.  
*Disadvantages:* can damage rubber and plastic, and may corrode copper, zinc and brass.
  - d. 1-percent peracetic acid: a mixture of acetic acid, hydrogen peroxide and water. Automated reprocessing (sterilizing) systems dilute peracetic acid to a final concentration of 0.2 percent and add a buffer and an anticorrosive agent.
  
3. Rinse equipment thoroughly (including channels) with sterile water followed by a 70-percent alcohol rinse.



4. Nonimmersible parts/equipment should be physically cleaned with water and detergent, then wiped with 70-percent alcohol (may have incomplete effect against hydrophilic viruses).
5. To prevent microbial growth or transmission in a moist environment, instruments and channels should be thoroughly dried. Compressed air and 70-percent ethyl or isopropyl alcohol will facilitate drying.
6. Store bronchoscopes uncoiled in clean areas to protect the instrument, prevent recontamination and minimize potential for accumulation of residual moisture.
7. Air exchange equipment (e.g., ventilation system and exhaust hoses) should be employed in areas used to disinfect equipment to minimize exposure of personnel to potentially toxic vapors, such as from glutaraldehyde.

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## RECOMMENDATIONS FOR INTERMEDIATE-LEVEL AND LOW-LEVEL DISINFECTION OF NONCRITICAL ITEMS

Noncritical items do not contact patients or contact only intact skin (e.g., blood pressure cuffs and tubing, pulse oximeter probes and cables, stethoscopes, anesthesia machines and equipment carts). The risk of transmitting infectious agents to patients via these items is low; transmission could occur, however, with contamination of an HCW's hands or via contaminated medical devices that subsequently are used for other patients. Either intermediate-level or low-level disinfectants may be used for noncritical items.

1. Meticulous mechanical cleaning of all surfaces of equipment should be performed as with high-level disinfection procedures (see above) prior to intermediate-level or low-level disinfection.
2. Immerse all surfaces of equipment to be disinfected in a suitable disinfectant for up to 10 minutes. Recommended agents:
  - a. Sodium hypochlorite (5.25 percent household bleach) 1:50 dilution (1,000 ppm free chlorine) is appropriate for intermediate-level disinfection; 1:500 dilution (100 ppm free chlorine) for low-level disinfection. Calcium hypochlorite or sodium dichloroisocyanurate are alternatives in solid forms.  
*Advantages:* broad spectrum, inexpensive, fast-acting, stable for one month at room temperature in an opaque plastic container or longer in a closed brown bottle.  
*Disadvantages:* corrosive, inactivated by organic matter, may produce carcinogens (when exposed to formaldehyde or hyperchlorinated), produces toxic chlorine gas when combined with acid. Before application of the disinfectant, the device must be cleaned with a detergent solution to remove adherent organic material.
  - b. Ethyl or isopropyl alcohol (70 percent to 90 percent); either may be used for intermediate- or low-level disinfection.  
*Advantages:* rapidly active against vegetative bacteria, mycobacteria, fungi and viruses.  
*Disadvantages:* cannot penetrate protein-rich matter, before application of the disinfectant the device must be cleaned with a detergent solution to remove adherent organic material, may damage shellac mounting on lensed instruments, ages plastic and rubber, flammable, evaporates quickly from device being disinfected or from an open container. Note: Isopropyl alcohol will not inactivate hydrophilic viruses such as echovirus and coxsackie virus.
  - c. Phenolic germicidal detergent solution (follow product label for use/dilution) for intermediate- or low-level disinfection.  
*Advantages:* cidal against mycobacteria, fungi, viruses and vegetative bacteria.  
*Disadvantages:* residual may cause tissue irritation, causes hyperbilirubinemia in neonates.
  - d. Iodophor germicidal detergent solution (follow product label for use/dilution) for intermediate or low-level disinfection.  
*Advantages:* bactericidal, virucidal, mycobactericidal.  
*Disadvantages:* may not be cidal for fungi without prolonged contact time. Note: Dilution is important to efficacy, probably secondary to increased free iodine concentration.
  - e. Quaternary ammonium germicidal detergent solution (follow product label for use/dilution) for low-level disinfection.  
*Advantages:* effective against fungi, bacteria and lipophilic viruses.  
*Disadvantages:* ineffective against mycobacteria or hydrophilic viruses.
3. Rinse equipment thoroughly.
4. Dry equipment.
5. Process items on a routine basis (i.e., daily as a minimum) and when contaminated.

6. Horizontal work surfaces of the anesthesia machine, drug carts and some other items are more prone to contamination and should be cleaned and disinfected after each patient. Blood spills should be wiped up as soon as possible with a disinfectant effective against HBV.

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**Questions and comments on this document can be directed to: Robin A. Stackhouse, M.D. at [stackr@anesthesia.ucsf.edu](mailto:stackr@anesthesia.ucsf.edu)**

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**Questions and comments on this document can be directed to: Robin A. Stackhouse, M.D. at [stackr@anesthesia.ucsf.edu](mailto:stackr@anesthesia.ucsf.edu)**

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