

Infection control during GI endoscopy

This is one of a series of statements discussing the use of GI endoscopy in common clinical situations. The Standards of Practice Committee of the American Society for Gastrointestinal Endoscopy (ASGE) prepared this text. In preparing this guideline, a search of the medical literature was performed by using PubMed, supplemented by accessing the “related articles” feature of PubMed. Additional references were obtained from the bibliographies of the identified articles and from recommendations of expert consultants. When little or no data exist from well-designed prospective trials, emphasis is given to results from large series and reports from recognized experts. Guidelines for appropriate use of endoscopy are based on a critical review of the available data and expert consensus at the time the guidelines are drafted. Further controlled clinical studies may be needed to clarify aspects of this guideline. This guideline may be revised as necessary to account for changes in technology, new data, or other aspects of clinical practice. The recommendations were based on reviewed studies and were graded on the strength of the supporting evidence (Table 1).

This guideline is intended to be an educational device to provide information that may assist endoscopists in providing care to patients. This guideline is not a rule and should not be construed as establishing a legal standard of care or as encouraging, advocating, requiring, or discouraging any particular treatment. Clinical decisions in any particular case involve a complex analysis of the patient’s condition and available courses of action. Therefore, clinical considerations may lead an endoscopist to take a course of action that varies from these guidelines.

BACKGROUND

Despite the large number and variety of GI endoscopic procedures performed, documented instances of infectious complications remain rare, with an estimated frequency of 1 in 1.8 million procedures.¹ Endoscopy-related infection may occur under the following circumstances: (1) microorganisms may be spread from patient to patient by contaminated equipment (exogenous infec-

tions), (2) microorganisms may spread from the GI tract through the bloodstream during an endoscopy to susceptible organs or prostheses, or may spread to adjacent tissues that are breached as a result of the endoscopic procedure (endogenous infections), or (3) microorganisms may be transmitted from patients to endoscopy personnel and perhaps from endoscopy personnel to patients.

The purpose of this document is to disseminate information and promote understanding, which leads to the prevention of infection as a result of a GI endoscopy. Circumstances in which an endoscopy-related infection might occur are discussed, as are measures to prevent such infection, including endoscope reprocessing, antibiotic prophylaxis, and protection of endoscopy personnel.

PATIENT TO PATIENT TRANSMISSION OF MICROORGANISMS (EXOGENOUS INFECTIONS)

Over the course of an endoscopic examination, the external surface and internal channels of flexible endoscopes are exposed to body fluids and contaminants. Disinfection of these reusable instruments poses special problems. Given their relatively delicate structure, these instruments cannot be autoclaved. Therefore, processing is achieved by mechanical cleaning, followed by high-level disinfection (HLD), rinsing, and drying. Stringent guidelines for the reprocessing of flexible endoscopes were developed by the ASGE and the Society for Healthcare Epidemiology of America, who convened with representatives from physician, nursing, and infection control organizations, industry leaders, and federal and state agencies. This conference resulted in the publication, in 2003, of the multisociety guideline for reprocessing of flexible GI endoscopes.² Since that time, there have been no reported cases of transmission of infection when these HLD guidelines were followed. In the absence of defective equipment, all subsequent reported cases of transmission of infection resulted from failure to adhere to these guidelines.

TRANSMISSION OF MICROORGANISMS BY ENDOSCOPY

The potential for transmission of infection during a GI endoscopy is a matter of concern to both physicians and patients. Fortunately, such transmission is very rare.

TABLE 1. Grades of recommendation*

Grade of recommendation	Clarity of benefit	Methodologic strength/supporting evidence	Implications
1A	Clear	Randomized trials without important limitations	Strong recommendation; can be applied to most clinical settings
1B	Clear	Randomized trials with important limitations (inconsistent results, nonfatal methodologic flaws)	Strong recommendation; likely to apply to most practice settings
1C+	Clear	Overwhelming evidence from observational studies	Strong recommendation; can apply to most practice settings in most situations
1C	Clear	Observational studies	Intermediate-strength recommendation; may change when stronger evidence is available
2A	Unclear	Randomized trials without important limitations	Intermediate-strength recommendation; best action may differ depending on circumstances or patient or societal values
2B	Unclear	Randomized trials with important limitations (inconsistent results, nonfatal methodologic flaws)	Weak recommendation; alternative approaches may be better under some circumstances
2C	Unclear	Observational studies	Very weak recommendation; alternative approaches likely to be better under some circumstances
3	Unclear	Expert opinion only	Weak recommendation; likely to change as data become available

*Adapted from Guyatt G, Sinclair J, Cook D, et al. Moving from evidence to action: grading recommendations—a qualitative approach. In: Guyatt G, Rennie D, editors. Users' guides to the medical literature. Chicago: AMA Press; 2002. pp. 599-608.

Spach et al³ reviewed the literature between 1966 and 1992 and were able to document 281 reported cases of transmission of microorganisms by GI endoscopy.

The vast majority of these cases occurred before the adoption of the initial 1988 guidelines, which stressed the need for thorough manual cleaning of endoscopes before disinfection.⁴ Only 28 cases of endoscopic transmission of infection were reported between 1988 and 1992, with an estimated 40 million GI endoscopies performed over the same period. The transmission rate of infection by a GI endoscopy, therefore, was estimated to be 1 in 1.8 million.¹ It has been argued that this figure may be an underestimate, because of a combination of underreporting, unrecognized asymptomatic infections, or an unrecognized association of infections with prior endoscopy, where the incubation period of the infecting organism is very long. Equally, it has been argued that, with the adoption of the stringent 2003 multisociety guidelines,² the transmission rate of infection by an endoscopy may now be considerably lower.⁵ Nevertheless, it is evident that transmission of infection because of a GI endoscopy is a very rare event, and, when the multisociety guidelines were followed, no cases of transmission of infection were reported.

Bacterial infections

When significant bacterial infections are transmitted, they are usually recognized, because their incubation pe-

riods are often short, and patients usually develop overt clinical symptoms. Transmission of bacterial infection from endoscopes has been rare after the adoption of the current reprocessing guidelines, which were shown to effectively eliminate microorganisms.⁶ Most reported cases predate these guidelines.

A total of 84 cases of endoscopy-related transmission of *Salmonella* species between patients was reported between 1974 and 1987⁷⁻¹⁵ but none since that time. Forty-five cases of endoscopic transmission of *Pseudomonas* species were reported between 1974 and 1993.^{16,17} In addition to inadequate reprocessing of the endoscope itself, the bacterium's propensity for growth in moisture-rich conditions has frequently been a factor that has facilitated transmission. In some instances, an unsterilized irrigation water bottle attached to the endoscope was identified as a source of infection.^{18,19} A lack of cleaning and drying of the air-water and/or the elevator channels of duodenoscopes was also implicated in some cases of transmission of *Pseudomonas* infection.^{20,21} Also, several cases were related to flawed automated endoscope washer-dryers.^{21,22}

A few reports of endoscopic transmission of *Helicobacter pylori* were related to inadequate reprocessing of endoscopes and biopsy forceps.^{23,24} Up to 61% of endoscopes became contaminated after use in patients infected with *H. pylori*,²⁵ but conventional cleaning and

disinfection of the instruments is highly effective in eliminating *H pylori*. Isolated reports of endoscopic transmission of other enteric bacteria included *Klebsiella*,²⁶ *Enterobacter*,¹⁷ *Serratia*,²⁷ and *Staphylococcus*²⁶ before adequate reprocessing by currently accepted standards.

There were no reports of transmission of mycobacteria by a GI endoscopy. Current reprocessing guidelines were shown to be adequate in eradicating mycobacteria.²⁸ Similarly, current reprocessing guidelines were shown to inactivate *Clostridium difficile* spores,²⁹ and no cases of transmission of this infection were reported.

Chronic viral infections

Documentation of transmission of viral infections by endoscopy is more difficult, because these infections have a longer incubation period, and patients may be asymptomatic or minimally symptomatic. Thus, linking transmission of these infections to a procedure done in the past may be difficult.

Hepatitis C. There are rare reports of transmission of hepatitis C in situations where lapses in HLD of endoscopes occurred. Bronowicki et al³⁰ documented transmission of hepatitis C from an infected patient to 2 subsequent patients who underwent colonoscopic procedures with the same instrument. Transmission was attributed to 2 breaches in endoscope reprocessing: failure to mechanically clean the working channel of the endoscope before disinfection and failure to sterilize the biopsy forceps between patients. However, inadequate aseptic techniques practiced at this center also raise the possibility of transmission of the virus via contaminated IV tubing, syringes, or multidose vials rather than the colonoscope. Older case reports and epidemiologic studies suggested an association between endoscopy and hepatitis C virus (HCV) seropositivity. However, these are difficult to interpret because of a reliance on self-reporting of risk factors for HCV and other inherent biases. Also, in many instances, the "link" between an endoscopy and an infection may not be an improperly processed endoscope, but rather, inadequate aseptic techniques.

Two recent studies indicate that, when currently accepted reprocessing guidelines are followed, transmission of hepatitis C does not occur. In a multicenter prospective cohort study, 8260 patients who were HCV seronegative and undergoing an endoscopy were observed.³¹ All centers reported adherence to internationally accepted guidelines for cleaning and disinfection of endoscopes. All 8260 patients, including 912 patients who underwent an endoscopy with an instrument previously used on HCV carriers, remained seronegative at follow-up testing performed 6 months after their endoscopic procedure. Four seroconversions occurred over the study period in a control group of 38,280 blood donors, which indicated a background seroconversion rate of 0.042 per 1000 patient-years.

Similar results were reported in a prospective cohort study of 859 patients, with a prevalence of hepatitis C of

71%.³² Endoscopes were cleaned and disinfected by using guidelines published by the ASGE and the Society of Gastroenterology Nurses and Associates (SGNA). Of 149 patients who were seronegative and for whom follow-up serology could be obtained, 4 subsequently developed antibodies to HCV. Two were found to have had HCV RNA in blood samples obtained before an endoscopy, which indicated that they were infected before undergoing endoscopy. Of the remaining 2 patients who developed anti-HCV antibodies after an endoscopy, neither had HCV RNA detected on follow-up testing at 3 and 6 months after the procedure, which suggested false-positive serologic tests. Thus, endoscopy did not result in transmission of hepatitis C, despite the extremely high exposure risk in this cohort.

Together, these studies indicate that, when currently accepted guidelines for cleaning and disinfection of endoscopes are followed, transmission of hepatitis C through endoscopes does not occur or is very rare.

Hepatitis B. A handful of isolated case reports suggested that transmission of hepatitis B is possible when endoscopes are inadequately reprocessed.³³⁻³⁵ However, transmission of hepatitis B appears to be very rare, even with inadequate cleaning and disinfection, and there are no reported cases of transmission when accepted guidelines were followed.

In 5 prospective studies, 120 patients who had undergone an endoscopy with an instrument previously used in a patient infected with hepatitis B were followed.³⁶⁻⁴⁰ No patients who were hepatitis B virus (HBV) seronegative developed clinical or serologic evidence of hepatitis B over a 6-month follow-up. In 4 further prospective studies, a total of 722 patients who were HBV seronegative were observed for up to 12 months after an endoscopy.⁴¹⁻⁴⁴ The background prevalence rates of hepatitis B surface antigen (HBsAg) positivity in these populations were up to 9.6%. Despite minimal disinfection of the endoscopes between procedures, only 3 patients seroconverted. None of the seroconversions were thought to be related to the endoscopy, because none of these patients had undergone an endoscopy with an instrument previously used on a patient who was infected. In addition, the seroconversion rate was lower than that for a control population not undergoing an endoscopy. In a recent prospective cohort study from a center in which ASGE reprocessing guidelines were followed, none of 30 patients who were seronegative and were undergoing an endoscopy with instruments previously used in patients who were HBsAg positive subsequently seroconverted.³²

These data, taken as a whole, indicate that, when currently accepted guidelines for cleaning and disinfection of endoscopes are followed, transmission of hepatitis B does not occur or is very rare after endoscopic procedures.

HIV. There are no reports of transmission of HIV by endoscopy. Manual cleaning of the endoscope with

detergent eradicates >99.0% of the virus from the instrument, and subsequent disinfection with glutaraldehyde for as little as 2 minutes was shown to eliminate the virus from endoscopes.⁴⁵⁻⁴⁷

Miscellaneous microbial transmission

Parasites. A single report documented transmission of *Strongyloides* to 4 patients from a contaminated instrument.⁴⁸ There are no other reports of transmission of parasites by endoscopy.

Fungi. There are no documented cases of transmission of fungal infections by GI endoscopy.

Prions. Creutzfeldt-Jacob disease (CJD) is a neurologic disease that is transmitted by proteinaceous agents called prions. GI endoscopy does not result in contact of the endoscope or accessories with prion-infected tissues, and, therefore, there is no theoretical need for any special processing of endoscopes used on patients with CJD.⁴⁹ There are no reports of transmission of CJD by endoscopy.

Variant Creutzfeldt-Jacob disease (vCJD) is a related condition caused by the consumption of beef contaminated by the bovine spongiform encephalopathy agent. Approximately 125 cases have been reported worldwide, with a single case reported in the United States. vCJD differs from CJD in that the mutated prion protein can be found in lymphoid tissue throughout the body, including the tonsils and the gut. The mutated prions are resistant to conventional disinfectants and sterilants. The European Society of Gastrointestinal Endoscopy (ESGE), therefore, recommends that an endoscopy be avoided, if at all possible, in patients with known vCJD.⁵⁰ When an endoscopy is unavoidable, the ESGE suggests use of an instrument dedicated for patients with vCJD or use of an endoscope that is approaching the end of its useful life and that can be destroyed after use or quarantined until needed for other patients with vCJD. Given the absence of any further reported cases of vCJD in the United States, no changes to general reprocessing guidelines are warranted at this time. However, following ESGE guidelines is reasonable if a case of vCJD is detected and an endoscopy is necessary.

REPROCESSING OF ENDOSCOPES

The single best protection against patient-to-patient transmission of microorganisms by an endoscopy is stringent reprocessing of endoscopes after use, with careful adherence to the multisociety guidelines. This section defines and discusses key concepts in endoscope reprocessing.

DEFINITIONS

Cleaning: This is defined as the physical removal of organic material and/or soil, usually by using water with

detergents. This process is designed to remove microorganisms rather than to kill them.⁵¹

Disinfection: Disinfection accomplishes the killing of most microorganisms and is commonly performed by using liquid chemical germicides (LCG). Three levels of disinfection are achievable: high, intermediate, and low, depending on the amount and kind of microbial killing involved. HLD destroys vegetative microorganisms, mycobacteria, fungi, small or nonlipid viruses, medium or lipid viruses, but not necessarily large numbers of bacterial spores. Chemical germicides registered as "sterilants" may be used for sterilization or for HLD, depending on such factors as dilution, contact time, and frequency of reuse. The specifics of such factors may vary with each product and are included on approved labeling.⁵¹

Sterilization: Sterilization is the act of killing all microbial life, including the elimination of bacterial spores. It is most commonly achieved with heat or ethylene oxide gas.⁵¹ The Spaulding classification system allows categorization of medical devices based on the risk of infection involved with use. The categories of medical devices and their associated level of disinfection are as follows:

- **Critical use items:** Items that enter sterile tissue or vascular spaces and hence carry significant risk for infection if contaminated. These items include needles, surgical instruments, biopsy forceps, and urinary catheters. Processing for reuse of these items requires sterilization. In some instances, GI endoscopes are sterilized when intended for use in sterile environments.
- **Semicritical use items:** Items that come in contact with mucous membranes and do not ordinarily penetrate sterile tissue. These include thermometers, endoscopes, and anesthesia equipment. Processing for reuse of these items requires at least HLD.
- **Noncritical items:** Items that do not ordinarily touch the patient or touch only intact skin, such as stethoscopes or patient carts. These items may be cleaned by low-level disinfection.

ENDOSCOPE REPROCESSING

Endoscope reprocessing is a multistage process that includes the following steps.

Manual cleaning

The first and most important step in the prevention of transmission of infection by an endoscopy is manual cleaning of the endoscope with detergent solution and brushes.^{52,53} Manual cleansing minimizes the chances of bacterial biofilm developing within the endoscope channels. The efficacy of cleaning and disinfection is personnel dependent, hence, training and quality control are critical for reliable infection control. Manufacturers' recommendations should be adhered to for each type of endoscope. The multisociety guideline for reprocessing flexible

endoscopes provides detailed instructions about both the specific steps and the rationale for endoscope cleaning and disinfection.² The U.S. Food and Drug Administration (FDA) approved new labeling for an automatic endoscope reprocessor (AER) in 2006 as a “washer-disinfector,” for processing endoscopes without prior manual washing and channel brushing.⁵⁴ However, at this time, there are no independent confirmatory data regarding the efficacy of this machine.

HLD

HLD is the standard of care recommended by governmental agencies and all pertinent professional organizations for the processing of flexible GI endoscopes.^{2,4,55,56} HLD is operationally defined by the FDA as a 6-log reduction of *Mycobacteria*.⁵⁷ HLD may be achievable by using a variety of FDA-approved LCG solutions with a manual process or an automated process with an AER.^{51,58} Costs can be significantly influenced by selection between manual and automated systems and by the type of LCG used. Most LCGs are reusable. However, serial dilutions that occur during repeated use necessitates regular testing of the LCG to ensure the adequacy of germicidal concentrations. It is important to adopt quality-control methods to ensure an adequate performance of the HLD system used.

The regulation of LCGs has been under the purview of the FDA since 1993. Confusion about the differences between recent labeling changes and usual and standard practices for disinfection duration, concentration, and temperature requirements of LCG products led to the publication of the multisociety *Position Statement on Reprocessing of Flexible Gastrointestinal Endoscopes* found in the ASGE Policy and Procedure Manual.⁵⁹ This document underscores the importance of (1) reliable and consistent mechanical cleaning as the first step in endoscope reprocessing, (2) adherence to written manufacturers' reprocessing protocols and national standards, and (3) training and quality assurance programs for endoscope reprocessing.

There is evidence that *Mycobacterium tuberculosis*,^{60,61} HBV,⁶² HCV,⁶³ and HIV^{45,47,64} are readily inactivated by commonly used cleansing methods and appropriate (ie, HLD/sterilant) LCGs. The Centers for Disease Control (CDC) states that currently recommended sterilization and disinfection procedures are adequate for endoscopes contaminated with pathogens, including HIV.⁶⁴ Thus, by following GI endoscopic procedures on patients with transmissible infections, the instrument should be cleaned and reprocessed in the usual fashion. Dedicated instruments are not necessary for patients infected with transmissible diseases other than known vCJD. Patients with severe neutropenia, immune deficiency syndromes, and those patients who receive immunosuppressive agents may be at increased risk for local or systemic infection as a result of endoscopy-related translocation of gut

organisms to deeper tissues or to the bloodstream. Endoscopes used in these patients should undergo standard reprocessing with HLD.

Sterilization

Sterilization of endoscopes and accessories is indicated in the rare occasions when they are to be used as “critical” medical devices, where there is a potential for contamination of an open surgical field.⁶⁵ Sterilization can be achieved by using a variety of methods, including ethylene oxide gas treatment, and may also be achieved with appropriately long exposure to LCGs.^{58,66} Because of the complexity of the instrument channel design, endoscope sterilization is difficult to accomplish.^{67,68} Endoscope sterilization, as opposed to HLD, is not required for a standard GI endoscopy in any patient subgroup or setting. To date, there have been no demonstrable benefits to the further reduction in endoscope bacterial spore counts achieved by sterilization instead of HLD.⁶⁷ However, reusable biopsy forceps, snares, sphincterotomes, and other accessories designed to breach the GI mucosal surface all require sterilization. Similarly, water bottles should also be disinfected or sterilized, and sterile water should be used in the water bottle.⁶⁹

Rinsing, drying, and storage

A critical part of the cleaning and disinfecting process involves proper rinsing and drying of the endoscope channels. Rinsing requires flushing large volumes of water through all channels to accomplish complete evacuation of LCGs. Endoscopes that were sterilized with ethylene oxide must have the channels purged by flushing them with room air. Water used for rinsing endoscopes after HLD varies in different institutions and is either potable tap water, bacteria-free water, or “sterile” or “sterile filtered” water.^{70,71} However, none of these water types are necessarily free of bacteria, despite their label claims, and the potential for contamination of disinfected endoscopes and, therefore, for nosocomial infection exists.^{5,70,72} Microbiologic monitoring of rinse water is not recommended by the CDC, although this remains a controversial issue,^{5,73-76} with some countries encouraging the practice.⁷⁷

Thorough drying of the endoscope after rinsing minimizes the risk associated with the presence of microorganisms in the rinse water. It prevents proliferation of microorganisms during storage, because residual rinse water that remains in endoscope channels may provide an environment for the microorganisms to colonize and multiply.^{5,69} After rinsing with water, a 70% alcohol flush promotes drying and inhibits the growth of organisms in stored instruments.⁷⁸ After the instruments are dried, they should be stored in an upright hanging position as per manufacturers' recommendations. Once endoscopes are placed in storage, there are few data as to how long they may remain unused before reprocessing is required.

Two studies indicate that once endoscopes are appropriately reprocessed, dried, and stored, it may not be necessary to reprocess them if used within 5 to 7 days.^{79,80} If an endoscope is appropriately cleaned, disinfected, dried, and stored in accordance with current guidelines, there is no evidence that an additional reprocessing cycle immediately before use at the beginning of the day (so-called “first-use reprocessing”) is necessary.

The efficacy of manual cleaning and HLD is personnel dependent. Reprocessing failure incidents typically arise as a result of human error, or because of equipment (AER) or product (HLD) failure.⁸¹ Therefore, quality assurance, process validation, assignment of personnel responsible for endoscope reprocessing, and extensive training of the reprocessing personnel cannot be overemphasized.

ENDOGENOUS INFECTIONS

Bacterial translocation of endogenous microbial flora into the bloodstream may occur during an endoscopy because of mucosal trauma related to the procedure. The risk of bacteremia and, theoretically, the risk of subsequent localization of infection in tissues vary, depending on the procedure performed and on the susceptibility of tissues. Low mean rates of bacteremia are seen with a diagnostic EGD (4.1%) and colonoscopy (4.4%), with the highest mean rates of bacteremia noted with esophageal variceal sclerotherapy (14.6%) and esophageal dilation (22.8%).⁸² It is unclear if this typically brief bacteremia is clinically significant, and, furthermore, it is unclear whether antibiotic prophylaxis, if instituted, will prevent distant infections such as infectious endocarditis (IE).⁸³

An endoscopy may also result in local infections when a typically sterile space, such as the bile duct or a pancreatic cyst, is breached and contaminated by an endoscopic accessory or contrast injection. Similarly, breaching of the anterior abdominal wall during placement of a percutaneous gastrostomy tube is associated with the risk of peritoneal infection.

ANTIBIOTIC PROPHYLAXIS FOR GI ENDOSCOPIC PROCEDURES

The purpose of antibiotic prophylaxis during a GI endoscopy is to reduce the risk of significant endogenous infectious complications. Antibiotic prophylaxis against endoscopically induced local or systemic infections were previously discussed in detail in a guideline published by the ASGE, *Antibiotic Prophylaxis for GI Endoscopy*.⁸⁴

The American Heart Association recently revised their guidelines for prophylaxis of IE,⁸³ which depart significantly from the 1997 guidelines. For endoscopic practice, a landmark change is that administration of prophylactic antibiotics solely to prevent IE is not recommended for patients who undergo GI-tract procedures. The ASGE

has also updated its recommendations for antibiotic prophylaxis for GI endoscopy.⁸⁵

TRANSMISSION OF INFECTION FROM ENDOSCOPY PERSONNEL TO PATIENTS

The risk for transmission of serious infection from hospital personnel to patients is small and task dependent. An endoscopy may be considered a low-risk task for such transmission, given the lack of direct contact between the endoscopist and patients' tissues. The CDC and U.S. Public Health Service provided guidance about the assessment of procedure risk and management of privileges in those who are potentially infectious.^{86,87} Although there are several documented cases of transmission of infection from health care workers to patients, there are no documented cases of transmission of infection from endoscopy personnel to patients.

GENERAL INFECTION CONTROL

Endoscopy personnel may facilitate transmission of infection from patient to patient if they fail to carefully adhere to general infection control principles. In particular, appropriate aseptic techniques and safe injection practices should be followed. Thus, improper reuse of syringes and the use of contaminated multiple dose drug vials have been linked to the transmission of hepatitis B and C between consecutive patients treated at health care facilities.⁸⁸⁻⁹⁰ Such practices should be avoided, and single-use drug vials are recommended. Similarly, use of gloves by health care workers was shown to decrease the incidence of *Clostridium difficile* associated diarrhea and the point prevalence of asymptomatic *C difficile* carriage in inpatients.⁹¹

TRANSMISSION OF INFECTION FROM PATIENTS TO ENDOSCOPY PERSONNEL

There are several reports of documented transmission of infection from patients to health care personnel. Potential modes of transmission may include needlestick injury,^{92,93} blood splashes to the conjunctiva,⁹⁴ inhalation of aerosolized microorganisms,⁹⁵ and transfer from direct handling of patients. Studies demonstrated a higher prevalence of *H pylori* infection in endoscopy personnel,⁹⁶⁻⁹⁹ with an increased prevalence with increased years of practice. Appropriate use of personal protective equipment should minimize such infection risks.

PROTECTION OF PERSONNEL

The Occupational Safety and Health Act (OSHA) of 1991, updated in 2001, established guidelines for health

care facilities for the protection of their personnel.^{100,101} The OSHA Bloodborne Pathogens Standard (OSHA ST 29 CFR part 1910.1030), requires the employer to evaluate each task and provide training to protect employees from exposure to harmful substances. These potentially harmful substances include blood and other body fluids. OSHA mandates include the development of an institutional-wide infection exposure plan that defines anticipated exposure risks for each employee task and that outlines risk-reduction approaches that involve education, changes in practices, engineering controls, and the use of protective barriers or personal protective equipment.

Standard precautions

Standard precautions¹⁰² are a major thrust of OSHA regulations. Endoscopy personnel should be made aware of the dangers of blood and other body fluids, contaminated equipment, and the modes of disease transmission. Because a patient's infectious status is often unknown at the time of an endoscopy, it is prudent to apply standard precautions for blood and body fluids when interacting with all patients.

Precautions at the institutional level

OSHA mandates that all employees should be immunized against HBV,¹⁰³ although the risk of HBV infection to endoscopy personnel is small.¹⁰⁴ A variety of other measures are needed for optimal infection control among employees, both before and during the period of employment. In particular, an effective and readily accessible employee health service plays a critical role in the management of postexposure prophylaxis.¹⁰⁵

Precautions in the endoscopy suite

After the endoscopic procedure, exposed surfaces should be thoroughly cleaned of visible contaminants and then disinfected with an Environmental Protection Agency registered hospital disinfectant.⁶⁵ Hands should be washed before and after each patient interaction, irrespective of whether or not gloves are worn. Isolation precautions that are otherwise indicated in patients who are potentially infected should be maintained when patients are transported to endoscopy units. For some patients, convenience or isolation requirements may require performance of an endoscopy at the bedside, rather than in the endoscopy unit. Needles should be discarded in "sharps" containers without recapping to avoid inadvertent sticks. Endoscopy units and institutions should adopt needleless systems for administration of parenteral drugs whenever feasible. Endoscopy unit infection control policies should address procedure room work areas, the separation of soiled and clean tasks, and the handling of specimens, tissues, soiled linens, and contaminated wastes.¹⁰⁶ The physical design of the endoscopy unit and rooms significantly influences whether these infection control issues can be adequately and efficiently addressed.^{107,108}

Prevention of transmission of *C difficile* should be considered when performing endoscopy in patients with diarrhea or known *C difficile* carriage. Hand washing with soap and water rather than alcohol-based hand rubs should be used for mechanical removal of spores from hands. Rigorous cleaning of the endoscopy suite with a bleach-containing disinfectant (5000 ppm) for environmental disinfection is effective in killing the organism.

Personal protective equipment

Personal protective equipment is defined as specialized clothing or equipment that does not permit blood or other potentially infectious material to pass through clothes or into skin, eyes, or mouth when worn by an employee for protection against a hazard. OSHA requires that employers provide all generally available protective attire, that they instruct employees in their use, and that they ensure their use by the employee.¹⁰⁶ The technology assessment committee of the ASGE provided a thorough discussion of personal protective equipment, their rationale, and the applicable regulations about their use.¹⁰⁹ Although there are no endoscopy-specific mandates, institution-wide policies must define appropriate protective wear for the reasonably anticipated exposure of a given task.¹⁰⁶ Gowns, gloves, masks, and eyewear should be worn in all settings where contact with blood-borne pathogens or other potentially infectious materials might be anticipated. Special precautions are required for patients with active pulmonary tuberculosis.

Management of exposure of endoscopy personnel to infectious agents

In the event of inadvertent exposure of endoscopy personnel to potentially infectious agents, institutional guidelines should be followed. OSHA and the U.S. Public Health Service published recommendations for postexposure management.^{87,101}

SUMMARY

- Transmission of infection as a result of GI endoscopes is extremely rare, and recently reported cases are invariably attributable to lapses in currently accepted endoscope reprocessing protocols or to defective equipment. (Level 1C+)
- Endoscopes should undergo HLD as recommended by governmental agencies and all pertinent professional organizations for the reprocessing of GI endoscopes. (Level 1C+)
- Extensive training of staff involved in endoscopic reprocessing is mandatory for quality assurance and for effective infection control. (Level 1C)
- General infection control principles should be adhered to at the endoscopy unit. (Level 1C+)

- Transmission of infection from patients to endoscopy personnel can be avoided by application of standard precautions. (Level 1C+)

Abbreviations: AER, automatic endoscope reprocessor; ASGE, American Society for Gastrointestinal Endoscopy; CDC, Centers for Disease Control; CJD, Creutzfeldt-Jacob disease; ESGE, European Society of Gastrointestinal Endoscopy; FDA, U.S. Food and Drug Administration; HBsAg, hepatitis B surface antigen; HBV, hepatitis B virus; HCV, hepatitis C virus; HLD, high-level disinfection; IE, infectious endocarditis; LCG, liquid chemical germicide; OSHA, Occupational Safety and Health Act; SGNA, Society of Gastroenterology Nurses and Associates; vCJD, variant Creutzfeldt-Jacob disease.

REFERENCES

1. Kimmey MB, Burnett DA, Carr-Locke DL, et al. Transmission of infection by gastrointestinal endoscopy. *Gastrointest Endosc* 1993;36:885-8.
2. American Society for Gastrointestinal Endoscopy. Multi-society guideline for reprocessing flexible gastrointestinal endoscopes. *Gastrointest Endosc* 2003;58:1-8.
3. Spach DH, Silverstein FE, Stamm WE. Transmission of infection by gastrointestinal endoscopy and bronchoscopy. *Ann Intern Med* 1993;118:117-28.
4. Cleaning and disinfection of equipment for gastrointestinal flexible endoscopy: interim recommendations of a Working Party of the British Society of Gastroenterology. *Gut* 1988;29:1134-51.
5. Nelson DB, Muscarella LF. Current issues in endoscope reprocessing and infection control during gastrointestinal endoscopy. *World J Gastroenterol* 2006;12:3953-64.
6. Cronmiller JR, Nelson DK, Salman G, et al. Antimicrobial efficacy of endoscopic disinfection procedures: a controlled, multifactorial investigation. *Gastrointest Endosc* 1999;50:152-8.
7. Holmberg SD, Osterholm MT, Senger KA, et al. Drug-resistant *Salmonella* from animals fed antimicrobials. *N Engl J Med* 1984; 311:617-22.
8. Chmel H, Armstrong D. *Salmonella oslo*: a focal outbreak in a hospital. *Am J Med* 1976;60:203-8.
9. Dean AG. Transmission of *Salmonella typhi* by fiberoptic endoscopy. *Lancet* 1977;ii:134.
10. Beecham HJ 3rd, Cohen ML, Parkin WE. *Salmonella typhimurium*: transmission by fiberoptic upper gastrointestinal endoscopy. *JAMA* 1979;241:1013-5.
11. Schliessler KH, Rozendaal B, Taal C, et al. Outbreak of *Salmonella agona* infection after upper intestinal fiberoptic endoscopy. *Lancet* 1980;ii:1246.
12. Hawkey PM, Davies AJ, Viant AC, et al. Contamination of endoscopes by *Salmonella* species. *J Hosp Infect* 1981;2:373-6.
13. O'Connor BH, Bennett JR, Alexander JG, et al. Salmonellosis infection transmitted by fiberoptic endoscopes. *Lancet* 1982;ii:864-6.
14. Dwyer DM, Klein EG, Istre GR, et al. *Salmonella* newport infections transmitted by fiberoptic colonoscopy. *Gastrointest Endosc* 1987; 33:84-7.
15. Tuffnell P. *Salmonella* infections transmitted by a gastroscope. *Can J Public Health* 1976;67:141-2.
16. Greene WH, Moody M, Hartley R, et al. Esophagoscopy as a source of *Pseudomonas aeruginosa* sepsis in patients with acute leukemia: the need for sterilization of endoscopes. *Gastroenterology* 1974;67:912-9.
17. Elson CO, Hattori K, Blackstone MO. Polymicrobial sepsis following endoscopic retrograde cholangiopancreatography. *Gastroenterology* 1975;69:507-10.
18. Doherty DE, Falko JM, Lefkowitz N, et al. *Pseudomonas aeruginosa* sepsis following retrograde cholangiopancreatography (ERCP). *Dig Dis Sci* 1982;27:169-70.
19. Bass DH, Oliver S, Bornman PC. *Pseudomonas* septicaemia after endoscopic retrograde cholangiopancreatography: an unresolved problem. *S Afr Med J* 1990;77:509-11.
20. Cryan EM, Falkiner FR, Mulvihill TE, et al. *Pseudomonas aeruginosa* cross-infection following endoscopic retrograde cholangiopancreatography. *J Hosp Infect* 1984;5:371-6.
21. Struelens MJ, Rost F, Deplano A, et al. *Pseudomonas aeruginosa* and *Enterobacteriaceae* bacteremia after biliary endoscopy: an outbreak investigation using DNA macrorestriction analysis. *Am J Med* 1993; 95:489-98.
22. Alvarado CJ, Stolz SM, Maki DG. Nosocomial infections from contaminated endoscopes: a flawed automated endoscope washer. An investigation using molecular epidemiology. *Am J Med* 1991;91: 272S-80S.
23. Graham DY, Alpert LC, Smith JL, et al. Iatrogenic *Campylobacter pylori* infection is a cause of epidemic achlorhydria. *Am J Gastroenterol* 1988;83:974-80.
24. Langenberg W, Rauws EA, Oudbier JH, et al. Patient-to-patient transmission of *Campylobacter pylori* infection by fiberoptic gastro-duodenoscopy and biopsy. *J Infect Dis* 1990;161:507-11.
25. Fantry GT, Zheng QX, James SP. Conventional cleaning and disinfection techniques eliminate the risk of endoscopic transmission of *Helicobacter pylori*. *Am J Gastroenterol* 1995;90:227-32.
26. Parker HW, Geenen JE, Bjork JT, et al. A prospective analysis of fever and bacteremia following ERCP. *Gastrointest Endosc* 1979;25:102-3.
27. Gorse GJ, Messner RL. Infection control practices in gastrointestinal endoscopy in the United States: a national survey. *Infect Control Hosp Epidemiol* 1991;12:289-96.
28. Muscarella LF. Automatic flexible endoscope reprocessors. *Gastrointest Endosc Clin N Am* 2000;10:245-57.
29. Rutala WA, Gergen MF, Weber DJ. Inactivation of *Clostridium difficile* spores by disinfectants. *Infect Control Hosp Epidemiol* 1993;14:36-9.
30. Bronowicki JP, Venard V, Botte C, et al. Patient-to-patient transmission of hepatitis C virus during colonoscopy. *N Engl J Med* 1997;337:237-40.
31. Ciancio A, Manzini P, Castagno F, et al. Digestive endoscopy is not a major risk factor for transmitting hepatitis C virus. *Ann Intern Med* 2005;142:903-9.
32. Mikhail NN, Lewis DL, Omar N, et al. Prospective study of cross-infection from upper-GI endoscopy in a hepatitis C-prevalent population. *Gastrointest Endosc* 2007;65:584-8.
33. Morris IM, Cattle DS, Smits BJ. Letter: Endoscopy and transmission of hepatitis B. *Lancet* 1975;ii:1152.
34. Seefeld U, Banský G, Jaeger M, et al. Prevention of hepatitis B virus transmission by the gastrointestinal fibrescope. Successful disinfection with an aldehyde liquid. *Endoscopy* 1981;13:238-9.
35. Birnie GG, Quigley EM, Clements GB, et al. Endoscopic transmission of hepatitis B virus. *Gut* 1983;24:171-4.
36. McDonald GB, Silverstein FE. Can gastrointestinal endoscopy transmit hepatitis B to patients? *Gastrointest Endosc* 1976;22:168-70.
37. McClelland DB, Burrell CJ, Tonkin RW, et al. Hepatitis B: absence of transmission by gastrointestinal endoscopy. *Br Med J* 1978;1:23-4.
38. Morgan AG, McAdam WA, Walker BE. Hepatitis B and endoscopy. *Br Med J* 1978;1:369.
39. Moncada RE, Denes AE, Berquist KR, et al. Inadvertent exposure of endoscopy patients to viral hepatitis B. *Gastrointest Endosc* 1978; 24:231-2.
40. Chiaramonte M, Farini R, Truscia D, et al. Risk of hepatitis B virus infection following upper gastrointestinal endoscopy: a prospective study in an endemic area. *Hepatogastroenterology* 1983;30:189-91.
41. Hoofnagle JH, Blake J, Buskell-Bales Z, et al. Lack of transmission of type B hepatitis by fiberoptic upper endoscopy. *J Clin Gastroenterol* 1980;2:65-9.
42. Ayoola EA. The risk of type B hepatitis infection in flexible fiberoptic endoscopy. *Gastrointest Endosc* 1981;27:60-2.
43. Villa E, Pasquinelli C, Rigo G, et al. Gastrointestinal endoscopy and HBV infection: no evidence for a causal relationship. A prospective controlled study. *Gastrointest Endosc* 1984;30:15-7.

44. Lok A, Lai C, Hui W, et al. Absence of transmission of hepatitis B by fiberoptic upper gastrointestinal endoscopy. *J Gastroenterol Hepatol* 1987;2:175-90.
45. Hanson PJ, Gor D, Jeffries DJ, et al. Elimination of high titre HIV from fiberoptic endoscopes. *Gut* 1990;31:657-9.
46. Classen M, Dancygier H, Gurtler L, et al. Risk of transmitting HIV by endoscopes. *Endoscopy* 1988;20:128.
47. Hanson PJ, Gor D, Clarke JR, et al. Contamination of endoscopes used in AIDS patients. *Lancet* 1989;ii:86-8.
48. Mandelstam P, Sugawa C, Silvis S, et al. Complications associated with esophagogastroduodenoscopy and with esophageal dilation. *Gastrointest Endosc* 1976;23:16-9.
49. Rutala WA, Weber DJ. Creutzfeldt-Jakob disease: recommendations for disinfection and sterilization. *Clin Infect Dis* 2001;32:1348-56.
50. Axon AT, Beilenhoff U, Bramble MG, et al. Variant Creutzfeldt-Jakob disease (vCJD) and gastrointestinal endoscopy. *Endoscopy* 2001;33:1070-80.
51. Rutala WA. Disinfection and sterilization of patient-care items. *Infect Control Hosp Epidemiol* 1996;17:377-84.
52. Nelson DB. Infectious disease complications of GI endoscopy: part II, exogenous infections. *Gastrointest Endosc* 2003;57:695-711.
53. Ishino Y, Ido K, Koiwai H, et al. Pitfalls in endoscope reprocessing: brushing of air and water channels is mandatory for high-level disinfection. *Gastrointest Endosc* 2001;53:165-8.
54. ASGE emphasizes steps in endoscope reprocessing. Available at: http://www.olympusamerica.com/msg_section/files/Evotech_July2007_final_ASGEnews.pdf. Accessed February 19, 2008.
55. Martin MA, Reichelderfer M. APIC guidelines for infection prevention and control in flexible endoscopy. Association for Professionals in Infection Control and Epidemiology, Inc. 1991, 1992, and 1993 APIC Guidelines Committee [see comment]. *Am J Infect Control* 1994;22:19-38.
56. Standard practice for cleaning and disinfection of flexible fiberoptic and video endoscopes used in the examination of hollow viscera. ASTM Standard F1518-94. Philadelphia (Pa): American Society for Testing and Materials; 2000.
57. Food and Drug Administration, Infection Control Devices, Branch Division of General and Restorative Devices, Office of Device Evaluation. Guidance on the content and format of premarket notification [510 (k)] submissions for liquid chemical germicides. Rockville (Md): FDA; 1992.
58. Babb JR, Bradley CR. Endoscope decontamination: where do we go from here? *J Hosp Infect* 1995;30(Suppl):543-51.
59. American Society for Gastrointestinal Endoscopy ad hoc Committee on Disinfection. Reprocessing of flexible gastrointestinal endoscopes. Manchester (Mass): ASGE; 1995.
60. Rutala WA, Cole EC, Wannamaker NS, et al. Inactivation of *Mycobacterium tuberculosis* and *Mycobacterium bovis* by 14 hospital disinfectants. *Am J Med* 1991;91:2675-715.
61. Cole EC, Rutala WA, Nessen L, et al. Effect of methodology, dilution, and exposure time on the tuberculocidal activity of glutaraldehyde-based disinfectants. *Appl Environ Microbiol* 1990;56:1813-7.
62. Bond WW, Favero MS, Petersen NJ, et al. Inactivation of hepatitis B virus by intermediate-to-high-level disinfectant chemicals. *J Clin Microbiol* 1983;18:535-8.
63. Rey JF, Halfon P, Feryn JM, et al. Risque de transmission du virus de l'hépatite C par l'endoscopie digestive. *Gastroenterol Clin Biol* 1995;19:346-9.
64. Recommendations for prevention of HIV transmission in health care settings. *MMWR* 1987;36(Suppl 2S):25-185.
65. Rutala WA. APIC guideline for selection and use of disinfectants. 1994, 1995, and 1996 APIC Guidelines Committee. Association for Professionals in Infection Control and Epidemiology, Inc [see comment]. *Am J Infect Control* 1996;24:313-42.
66. Kanemitsu K, Ogawa A, Hatori T, et al. Validation of low-temperature steam with formaldehyde sterilization for endoscopes, using validation device. *Gastrointest Endosc* 2005;62:928-32.
67. Muscarella LF. High-level disinfection or "sterilization" of endoscopes? *Infect Control Hosp Epidemiol* 1996;17:183-7.
68. Bond W, Ott B, Franke K, et al. Effective use of liquid chemical germicides on medical devices: instrument design problems. Philadelphia: Lea and Febiger; 1991.
69. Muscarella LF. Inconsistencies in endoscope-reprocessing and infection-control guidelines: the importance of endoscope drying. *Am J Gastroenterol* 2006;101:2147-54.
70. Pang J, Perry P, Ross A, et al. Bacteria-free rinse water for endoscope disinfection. *Gastrointest Endosc* 2002;56:402-6.
71. Humphreys H, McGrath H, McCormick PA, et al. Quality of final rinse water used in washer-disinfectors for endoscopes. *J Hosp Infect* 2002;51:151-3.
72. Willis C. Bacteria-free endoscopy rinse water: a realistic aim? *Epidemiol Infect* 2006;134:279-84.
73. Joint Working Group of the Hospital Infection Society (HIS) and the Public Health Laboratory Service (PHLS). Rinse water for heat labile endoscopy equipment. *J Hosp Infect* 2002;51:7-16.
74. Muscarella LF. Application of environmental sampling to flexible endoscope reprocessing: the importance of monitoring the rinse water. *Infect Control Hosp Epidemiol* 2002;23:285-9.
75. Beilenhoff U, Neumann CS, Biering H, et al. ESGE/ESGENA guideline for process validation and routine testing for reprocessing endoscopes in washer-disinfectors, according to the European Standard prEN ISO 15883 parts 1, 4 and 5. *Endoscopy* 2007;39:85-94.
76. Beilenhoff U, Neumann CS, Rey JF, et al. ESGE-ESGENA guideline for quality assurance in reprocessing: microbiological surveillance testing in endoscopy. *Endoscopy* 2007;39:175-81.
77. Systchenko R, Marchetti B, Canard JN, et al. Guidelines of the French Society of Digestive Endoscopy: recommendations for setting up cleaning and disinfection procedures in gastrointestinal endoscopy. *Endoscopy* 2000;32:807-18.
78. Alfa MJ, Sitter DL. In-hospital evaluation of contamination of duodenoscopes: a quantitative assessment of the effect of drying. *J Hosp Infect* 1991;19:89-98.
79. Riley R, Beanland C, Bos H. Establishing the shelf life of flexible colonoscopes. *Gastroenterol Nurs* 2002;25:114-9.
80. Rejchrt S, Cermak P, Pavlatova L, et al. Bacteriologic testing of endoscopes after high-level disinfection. *Gastrointest Endosc* 2004;60:76-8.
81. Rutala WA, Weber DJ. How to assess risk of disease transmission to patients when there is a failure to follow recommended disinfection and sterilization guidelines. *Infect Control Hosp Epidemiol* 2007;28:146-55.
82. Nelson DB. Infectious disease complications of GI endoscopy: part I, endogenous infections. *Gastrointest Endosc* 2003;57:546-56.
83. Wilson W, Taubert KA, Gewitz M, et al. Prevention of infective endocarditis. Guidelines from the American Heart Association. A Guideline From the American Heart Association Rheumatic Fever, Endocarditis, and Kawasaki Disease Committee, Council on Cardiovascular Disease in the Young, and the Council on Clinical Cardiology, Council on Cardiovascular Surgery and Anesthesia, and the Quality of Care and Outcomes Research Interdisciplinary Working Group. *Circulation* 2007;116:1736-54.
84. Hirota WK, Petersen K, et al. Standards of Practice Committee of the American Society for Gastrointestinal Endoscopy. Guidelines for antibiotic prophylaxis for GI endoscopy. *Gastrointest Endosc* 2003;58:475-82.
85. Banerjee S, Shen B, Nelson DB, et al. Antibiotic prophylaxis for GI endoscopy. *Gastrointest Endosc* 2008. In press.
86. Centers for Disease Control. Recommendations for preventing transmission of human immunodeficiency virus, hepatitis B virus to patients during exposure-prone invasive procedures. *MMWR* 1991;40:1-9.
87. U.S. Public Health Service. Updated U.S. Public Health Service guidelines for the management of occupational exposures to HBV, HCV

- and HIV and recommendations for postexposure prophylaxis. *MMWR* 2001;50:1-52.
88. Macedo de Oliveira A, White KL, Leschinsky DP, et al. An outbreak of hepatitis C virus infections among outpatients at a hematology/oncology clinic. *Ann Intern Med* 2005;142:898-902.
 89. Tallis GF, Ryan GM, Lambert SB, et al. Evidence of patient-to-patient transmission of hepatitis C virus through contaminated intravenous anaesthetic ampoules. *J Viral Hepat* 2003;10:234-9.
 90. Transmission of hepatitis B and C viruses in outpatient settings: New York, Oklahoma, and Nebraska, 2000-2002. *MMWR* 2003;52:901-6.
 91. Johnson S, Gerding DN, Olson MM, et al. Prospective, controlled study of vinyl glove use to interrupt *Clostridium difficile* nosocomial transmission. *Am J Med* 1990;88:137-40.
 92. Oksenhendler E, Harzic M, Le Roux JM, et al. HIV infection with seroconversion after a superficial needlestick injury to the finger. *N Engl J Med* 1986;315:582.
 93. Wallace MR, Harrison WO. HIV seroconversion with progressive disease in health care worker after needlestick injury. *Lancet* 1988;i:1454.
 94. Sartori M, La Terra G, Aglietta M, et al. Transmission of hepatitis C via blood splash into conjunctiva. *Scand J Infect Dis* 1993;25:270-1.
 95. Tang JW, Li Y, Eames I, et al. Factors involved in the aerosol transmission of infection and control of ventilation in healthcare premises. *J Hosp Infect* 2006;64:100-14.
 96. Mitchell HM, Lee A, Carrick J. Increased incidence of *Campylobacter pylori* infection in gastroenterologists: further evidence to support person-to-person transmission of *C. pylori*. *Scand J Gastroenterol* 1989;24:396-400.
 97. Wilhoite SL, Ferguson DA Jr, Soike DR, et al. Increased prevalence of *Helicobacter pylori* antibodies among nurses. *Arch Intern Med* 1993;153:708-12.
 98. Chong J, Marshall BJ, Barkin JS, et al. Occupational exposure to *Helicobacter pylori* for the endoscopy professional: a sera epidemiological study. *Am J Gastroenterol* 1994;89:1987-92.
 99. Lin SK, Lambert JR, Schembri MA, et al. *Helicobacter pylori* prevalence in endoscopy and medical staff. *J Gastroenterol Hepatol* 1994;9:319-24.
 100. Occupational Safety and Health Administration. Occupational exposure to bloodborne pathogens: final rule. *Federal Register* 1991;56:64003-182.
 101. Occupational exposure to bloodborne pathogens; needlestick and other sharps injuries; final rule. Occupational Safety and Health Administration (OSHA), Department of Labor. *Federal Register* 2001;66:5318-25.
 102. Centers for Disease Control. Update: universal precautions for prevention of transmission of human immunodeficiency virus, hepatitis B virus and other bloodborne pathogens in health-care settings. *MMWR* 1988;37:377-82 387-8.
 103. Centers for Disease Control. Protection against viral hepatitis: recommendations of the Immunization Practices Advisory Committee (ACIP). *MMWR Recomm Rep* 1990;39:1-26.
 104. Koretz RL, Chin K. Is endoscopy hazardous to your liver? *Dig Dis Sci* 1987;32:759-62.
 105. Diekema DJ, Doebbeling BN. Employee health and infection control. *Infect Control Hosp Epidemiol* 1995;16:292-301.
 106. Decker MD. The OSHA bloodborne hazard standard. *Infect Control Hosp Epidemiol* 1992;13:407-17.
 107. Burton D, Ott BJ, Gostout CJ, et al. Approach to designing a gastrointestinal endoscopy unit. *Gastrointest Endosc Clin N Am* 1993;3:525-40.
 108. Gostout CJ, Ott BJ, Burton D, et al. Design of the endoscopy procedure room. *Gastrointest Endosc Clin N Am* 1993;3:509-24.
 109. Carr-Locke DL, Conn MI, Faigel DO, et al. Technology status report: personal protective equipment. *Gastrointest Endosc* 1999;49:854-7.

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