

Occupational Risks of Blood Exposure in the Operating Room

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Bloodborne pathogens continue to be a source of occupational infection for healthcare workers, but particularly for surgeons. Over 1 per cent of the U.S. population has one or more chronic viral infections. Hepatitis B is the infection that has the longest known role as an occupational pathogen, but infection with this virus is largely preventable with the use of the effective hepatitis B vaccine. Hepatitis C affects the largest number of people in the United States, and there is no vaccine available for the prevention of this infection. HIV infection still has not been associated with a documented transmission in the operating room environment, but six cases of probable occupational transmission have been reported. A total of 57 healthcare workers have had documented occupational infection since the epidemic of HIV infection began. Infection of bloodborne pathogens to patients from infected surgeons remains a concern. Surgeons who are antigen-positive for hepatitis B have been well documented to be an infection risk to patients in the operating room. Only four surgeons have been documented to transmit hepatitis C, although other transmissions have occurred in the care of patients when practices of infection control have been violated. No surgical transmission of HIV to a patient has been identified at this time. Prevention of occupational infection requires use of protective barriers, avoidance of exposure risk by modification of techniques, and a constant awareness of sharp instruments in the operating room. Blood exposure in the operating room carries risk of infection and should be avoided. It is likely that other infectious agents will emerge as operating room threats. Surgeons must maintain vigilance in avoiding blood exposure and percutaneous injury.

BLOODBORNE TRANSMISSION OF VIRAL infections has been recognized as an occupational risk for healthcare workers since the early 1950s.^{1,2} "Serum hepatitis" in these early reports was subsequently identified as hepatitis B and with the development of antibody assays to specific antigens of the virus, the scope of this occupational infection was better characterized and understood. Non-A, non-B hepatitis emerged as a second bloodborne infection but without a serologic marker, the prevalence of the disease and its occupational risks were not appreciated. Concern about occupationally acquired hepatitis B languished in the 1970s and early 1980s because overt illness was not appreciated with acute infection in most cases and

because chronic infection was a relatively uncommon event (less than 10% of acute cases).³ With the identification of the human immunodeficiency virus (HIV) as the viral pathogen of the acquired immune deficiency syndrome (AIDS) in the mid-1980s, healthcare workers, and particularly surgeons, became very concerned about viral infection as a risk with exposure to infected patients. Many publications extolled the potential risks of HIV and hepatitis B and this led to involvement of the Centers for Disease Control and Prevention in developing recommendations,⁴ position statements by the American College of Surgeons,^{5,6} and ultimately to guidelines by the Occupational Safety and Health Administration⁷ during the early 1990s to reduce perceived risks and to modify behavior in the delivery of health care. Furthermore, with the documentation of HIV infection being transmitted from a dentist to several patients,⁸ public concerns surfaced about potential risks of bloodborne infection being transmitted to patients from infected healthcare workers. This led to an additional wave of federal and state regulations to protect patients.

However, after the feverish pitch of concern about

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occupational infection reached an emotional peak in the mid-1990s, the subject has progressively waned in attention. Indifference has replaced intense concern. The reasons for this dissipation of interest are many but certainly include 1) the very infrequent documentation of HIV infection after occupational exposure, 2) effective antiretroviral therapy that has apparently reduced the number of circulating viral copies in treated patients, which is thought to reduce risks of transmission, and 3) the generalized use of the highly effective hepatitis B vaccine.

It is the premise of this presentation that both old and potentially newer agents still pose occupational threats to surgeons from blood exposure in the care of patients. Lessons learned and modified behavioral patterns of the early 1990s must be revisited and continue to be practiced.

Hepatitis

There are currently six recognized hepatitis viruses (Table 1). Hepatitis A is the most common acute hepatitis infection worldwide.⁹ It is transmitted by the fecal-oral route. It causes a potentially severe acute infection that is infrequently fatal. It is very seldom associated with blood transfusion or percutaneous injury and it is not associated with a chronic form of hepatitis. It is not a virus of concern in occupational infection of surgeons. Similarly, hepatitis E is also a fecal-oral virus that is relatively uncommon in the United States and Western Europe and does not cause a chronic form of hepatitis.¹⁰ Hepatitis D is an incomplete RNA hepatitis virus that is bloodborne but requires preexistent acute or chronic hepatitis B infection to cause disease.¹¹ Hepatitis D is most commonly seen in intravenous drug abusers and has not been reported to be an issue for healthcare workers. Hepatitis G is a bloodborne virus that is infrequently associated with clinical disease but may be synergistic with other hepatitis viruses.¹² It does not appear to have any appreciable risk as an occupational pathogen in health care. Hepatitis B (HBV)¹³ and hepatitis C (HCV)¹⁴ remain the hepatitis viruses of greatest concern to surgeons.

Hepatitis B

Epidemiology and Pathogenesis

HBV is the sole DNA virus of the currently recognized hepatitis viruses. It is transmitted by percutaneous exposure to blood or blood products from infected individuals. The use of contaminated needles and syringes has been common sources of transmission among intravenous drug abusers. Sexual contact is a common source of transmission for HBV. Vertical transmission from infected mothers to newborn children remains a cause of transmission. Effective testing of the blood supply has resulted in transfusion being an infrequent source of transmission. HBV has been well documented to be an occupational infection of surgeons and other healthcare workers. A percutaneous injury with a hollow needle contaminated with infected blood is generally thought to result in a 30 per cent probability of transmission to a susceptible host.¹⁵

Exposure to the viral particle results in transport to the liver where the virus binds to the hepatocyte and is internalized into the cell. The DNA of the HBV migrates into the nucleus of the cell and begins the process of replication of new viral particles. During the acute infection, the particle counts reach a critical count within the infected cell. Hepatocyte injury may be the result of cytotoxic effects of the virus, toxic accumulation of hepatitis B protein products, or cytotoxic responses of the host inflammatory response in an attempt to eradicate the virus.

Only approximately 25 per cent of acute HBV infections are associated with the clinically apparent hepatitis syndrome of jaundice, fever, leukocytosis, and elevated liver enzymes.¹⁶ Nonspecific fatigue, malaise, nausea, and vomiting are more common and are interpreted as being an influenza-like syndrome. Thus, many patients have an acute episode of HBV that is not recognized as clinical hepatitis. Unfortunately, approximately 5 per cent of the acute HBV infections result in chronic hepatitis in which the patients become a carrier of the virus for life.¹⁷ Chronic HBV infection occurs independent of the severity of the acute infection with many patients having the chronic disease and no appreciation of having had an

TABLE 1. Summarizes the Currently Identified Hepatitis Viruses

Hepatitis Type	Nucleic Acid	Route of Transmission	Chronic Disease	Occupational Risk	Vaccine
A	RNA	Fecal-oral	No	No	Yes
B	DNA	Blood borne	Yes	Yes	Yes
C	RNA	Blood borne	Yes	Yes	No
D	RNA	Blood borne	Yes	Improbable	No
E	RNA	Fecal-oral	No	No	No
G	RNA	Blood borne	Yes	Uncertain	No

acute event. With chronic infection, many patients have a lifetime carrier status without progression of the disease to cirrhosis and its sequelae. For others, severe cirrhosis, portal hypertension, and hepatocellular carcinoma are the result.¹⁸ The progression of the disease commonly requires decades to unfold. Approximately 1.25 million people in the United States have chronic HBV infection.¹⁹

Diagnosis of Hepatitis B Virus Infection

The diagnosis of acute HBV infection is usually only made in those patients with the overt clinical hepatitis syndrome. These patients will test positive for the HBV surface antigen. A more common scenario is for the patient to have detection of the HBV antibody to the surface antigen (antiHBs). This is commonly identified when the individual has donated blood or is found with other serologic evaluation. A positive serology for antiHBs means that the individual has either had acute HBV infection in the past or has been vaccinated for HBV. Patients who are positive for antiHBs who have not been vaccinated then need to have an evaluation for HBV surface antigen. If they have a sustained positive status for the surface antigen, then it reflects a diagnosis of chronic HBV. Staging of the severity of chronic HBV infection will then require a thorough clinical evaluation, including a liver biopsy.

Prevention of Hepatitis B Virus Infection

HBV infection is preventable. A highly effective vaccine of surface antigen derived from recombinant technology is available and is recommended for all healthcare workers and all surgeons.²⁰ Vaccination is

recommended for all newborns and children. Vaccination is achieved generally with a three-dose regimen with the second and third doses being given 1 and 6 months after the initial dose. Because 5 per cent of vaccinations do not result in an antibody response, it is recommended that documentation of an antiHBs antibody response is necessary. Repeat vaccination is recommended for those who fail the initial attempt.

All surgeons should be successfully vaccinated against HBV. Surgeons who practiced in the era before the initiation of the vaccine have a 30 per cent positive rate for having had acute hepatitis, and approximately 5 per cent of those with prior infection will have chronic infection. It has been estimated that 250 healthcare providers die annually from the consequences of chronic HBV infection with most of those deaths being the consequences of end-stage liver disease or hepatocellular cancer 20 or more years after the acute infection.²¹ Although younger surgeons have consistently been vaccinated, as many as 30 per cent of surgeons who are 15 to 20 years out of residency training may still be unvaccinated at this time and are susceptible to acute HBV infection.²²

If a surgeon or other healthcare professional sustains a percutaneous exposure to blood or blood products from an HBV-infected patient, they should be tested for the currency of their vaccination status.²³ If the exposed individual is positive for antiHBs antibody from prior vaccination, then nothing needs be done. Nonvaccinated individuals should receive a dose of the HBV immunoglobulin and begin the vaccination sequence immediately. Table 2 summarizes the responses that should be undertaken after exposure to blood or blood products from an HBV-infected patient.

TABLE 2. *Strategy for Past-Exposure Prophylaxis*

Vaccination Status of Surgeon	Current Antibody (Anti-HBs) Status	
	Antibody Positive	Antibody Negative
Vaccinated and known responder	No treatment necessary	Give HBV immunoglobulin dose and booster dose of HBV vaccine.
Vaccinated and nonresponder to vaccine	No treatment necessary; evaluate for HBsAg*	Give HBV immunoglobulin dose; initiate revaccination or give two additional doses of immunoglobulin.†
Unvaccinated	No treatment necessary, evaluate for HBsAg‡	Give HBV immunoglobulin dose; initiate vaccination.

* A positive antibody test in a document nonresponder to vaccination implies that HBV infection has occurred. The surgeon should be evaluated for the HBV antigen because chronic infection may be present.

† If the nonresponder has undergone two successful full vaccinations, then two additional doses of HBV immunoglobulin should be given rather than repeat the vaccination series.

‡ An unvaccinated surgeon with a positive antibody test has had prior HBV infection. The surgeon should be evaluated for HBV antigen to determine whether chronic disease is present.

This table describes the strategy for post-exposure prophylaxis after an exposure event to a patient with known chronic HBV infection or in an event where the source of the exposure is high risk, but the infection status of the source patient is not known. The antibody status of the exposed surgeon is necessary to gauge the appropriate response. Surgeons should know their antibody status and have it reconfirmed every 10 years at least.

Unfortunately, exposure events in the operating room and in patient care in other settings occur with patients in which the HBV status of the patient is unknown. This raises the question if the surgeon should know their vaccination status at all times and should booster doses of the vaccine be received. Although there are no official guidelines on this subject, surgeons in high-exposure specialties (e.g., trauma, orthopedics, cardiac surgery) should know their antibody status. Some evidence indicates a loss of protective antibody within 10 years.²⁴ It is unclear whether lifetime protection results from successful vaccination and whether measurable antibody is essential for protection. The safety and inexpensive nature of the HBV vaccine makes a periodic booster dose (e.g., every 10 years) a practical consideration even in the absence of objective data to support this practice. Untoward events from booster doses of the vaccine are not reported.

Hepatitis B Virus-Infected Surgeon

There are numerous reports that have documented the transmission of HBV infection from the surgeon to patients.²⁵⁻²⁷ This occurs usually when the surgeon is positive for the "e" antigen of HBV (not to be confused with hepatitis E).²⁸ The e-antigen is a nucleocapsid degradation product that reflects rapid replication rates of the virus in liver and is associated with high numbers of viral copies per milliliter of blood in the infected individual. Only one report identifies transmission of infection from e-antigen-negative surgeons to patients and this was in an English report of a mutant strain of HBV that had high viral concentrations in the absence of the e-antigen.²⁹ It should be noted that transmission has occurred even when the surgeon double-gloved and used standards of infection control in the operating room. Surgeons with chronic

HBV infection should adhere to the recommendations of the American College of Surgeons (Table 3) and have their practice and their health status reviewed by a local panel of experts to determine whether clinical practice in surgery should continue. One nonsurgical organization has taken the position that all surgeons with e-antigen-positive chronic HBV infection should not practice.³⁰ The current evidence would generally favor the continuation of practice for those with chronic HBV infection but are e-antigen-negative and that nonsurgical career alternatives should be pursued by those who are e-antigen-positive.

Treatment of Hepatitis B Virus Infection

Until recently, patients with chronic HBV infection did not have effective antiviral treatment available to them. Considerable progress has been made with combination therapy.³¹ Interferon alfa-2b (Intron A®, Schering Corp., Kenilworth, NJ) at a dose of 5 million units daily or 10 million units three times per week has been approved for 4-month treatments of chronic HBV infection by the U.S. Food and Drug Administration. Lamivudine (Epivir® HBV™, GlaxoSmithKline, Research Triangle Park, NC) has similarly been approved at 100 mg daily for 1 year. Reduction in antigen load has been identified with these treatments, but long-term results still need to be evaluated.

Hepatitis C

After the recognition of HBV, a significant population of patients was noted to develop chronic hepatitis after blood transfusion and similarly, a large number of individuals in the intravenous drug abuse population were noted to have a chronic hepatitis syndrome but did not test positive for HBV. Non-A, non-B hepatitis was the descriptive term used to cover these patients, and considerable speculation focused on the

TABLE 3. *A Summary of the Recommendations of the American College of Surgeons in the Statement on the Surgeon and Hepatitis (http://www.facs.org/fellows_info/statements/st-22.html)*

- Relevant to all blood-borne pathogens: Surgeons should use the highest standards of infection control, including the use of barriers and practices to avoid blood exposure. This should be practiced in all sites where surgical care is rendered. Maximum effort should be extended to avoid blood exposure for all members of the surgical team.
- Relevant to hepatitis-infected patients: Surgeons have the ethical obligation to provide care to all patients, include those infected with hepatitis.
- Relevant to hepatitis B: Surgeons should know their antibody status. Surgeons with natural antibodies without prior vaccination should be evaluated for chronic HBV infection and if positive should be evaluated for the e-antigen of HBV. Those surgeons that are e-antigen positive or have high viral counts for HBV should have an expert panel convened to make recommendations about the continuation of clinical practice. Surgeons with chronic HBV infection should seek expert medical care to receive current treatment for their illness.
- Relevant to hepatitis B: All surgeons should be vaccinated for HBV if they have not previously had HBV infection. Surgeons must know that they have seroconverted at the completion of the vaccination process. A failed initial vaccination effort requires a second vaccination attempt. A failed second vaccination means particular adherence to practices to avoid blood exposure.
- Relevant to hepatitis C: Surgeons should know their antibody status for HCV. Avoiding blood exposure is the only preventive strategy in the absence of a vaccine against HCV infection. Surgeons with chronic HCV infection should adhere to strict infection control practice and use of barrier precautions. They should seek expert medical counsel for treatment of their infection.

identification of a third viral particle. In 1989, HCV was identified and refinements in the antibody testing for this unique hepatitis virus in 1992 resulted in effective detection of the disease.

Epidemiology and Pathogenesis

It is now estimated that three to four million people in the United States have chronic HCV infection.^{32, 33} The infection is associated with intravenous drug use and transfusion before 1992. Individuals with multiple sexual partners are also associated with higher rates of infection. Healthcare employment is a less common but associated risk for HCV infection.

Blood transport of the virus results in binding of the virus to the hepatocyte and after internalization of the viral nuclear material, the nuclear RNA serves as a direct template for protein synthesis and viral replication in the cytoplasm of the infected cell. Cell injury and lysis follows, albeit the damage and disruption of the cell may not be attributable to viral cytotoxicity but may rather be attributable to the vigorous inflammatory response of the host in the eradication of the viral infection.

HCV infection results in an overt hepatitis syndrome in approximately 25 per cent of acute infections.³⁴ Like HBV, HCV infection is not commonly appreciated and many individuals are not diagnosed with the disease during the acute phase, but rather many years later as an incidental finding at the time of evaluation for other illnesses or at the time of blood donation.

The natural history of the disease is highly unpredictable. Approximately 60 per cent to 80 per cent of acute infections result in chronic HCV infection.³⁵ Unlike HBV infection, those patients who recover completely from an acute HCV infection can be reinfected at a subsequent time. Patients with chronic HCV infection may be chronic carriers with little progression of the disease, and others may have seemingly a spontaneous resolution with disappearance of the virus. A significant number proceed to have hepatic cirrhosis, and it is thought that of the patients with cirrhosis, as many as 20 per cent will develop hepatocellular cancer.^{36, 37}

HCV infection from occupational exposure is a source of concern for surgeons and other healthcare workers. Percutaneous exposure from a hollow needle carries a 2 per cent risk of viral transmission.³⁸ Precise definition of transmission rates from operating room exposures remains poorly defined at this point but is likely to occur less than the 2 per cent rate from hollow needles and is more likely to occur from more dramatic injuries from scalpels, bone spurs, or wire sutures.

Diagnosis of Hepatitis C Virus Infection

As noted, many patients have atypical acute symptoms for hepatitis infection. Some will have an influenza-like syndrome and others have essentially no symptoms at all. Only 25 per cent have clinical jaundice. Chronic infection is associated with chronic fatigue, but it is commonly diagnosed after elevated liver enzymes are identified in the course of the evaluation of another disease.

The antibody test for HCV has been improved, but seropositivity may be delayed for several months after acute infection. Reverse transcriptase polymerase chain reaction studies will detect the viral RNA in either acute or chronic infections.

Prevention

There is no vaccine for HCV. The antibody that is detected for diagnosis is not a neutralizing antibody, and attempts at development of a vaccine have not been successful until now. Indeed, when the actual infection itself will not confer immunity, then the challenge for a vaccine is great. The only preventive strategy for healthcare professionals is safe clinical practice that avoids direct blood exposure and percutaneous injury.

If percutaneous injury or mucus membrane injury occurs from a patient with known HCV, the surgeon should be promptly tested following the procedure to establish the absence of preexistent infection. HCV antibody tests have traditionally been used, but HCV RNA can be detected much earlier. Prophylactic interferon/ribavirin is not recommended, but early intervention with anti-HCV chemotherapy can be pursued at a much earlier time in the infection with earlier detection of the infection.

Hepatitis C Virus-Infected Surgeon

HCV has become a source of concern for transmission of the infection to patients who are receiving care either in hospitals or other healthcare facilities. Individual patients are discovered to have developed nosocomial HCV, and this has led to larger studies of patients receiving care at the same time. The clinical settings associated with nosocomial transmission of HCV are identified in Table 4.

There are now four reports that have identified transmission of HCV infection from a surgeon to patients. One report identifies a single transmission from a cardiac surgeon among a total of 277 exposed patients who were studied.⁴⁸ A published series from Spain recognized six patients with HCV infection that developed after open heart surgery that could not be associated with transfusion or another source of the

TABLE 4. *The Clinical Circumstance of Transmission of HCV Infection Where Healthcare Providers, Who Were Themselves Not Infected with the Virus, Became the Vector for Transmission of Infection from One Patient to Another*

Provider/Facility or Unit for Transmission	Comment
Gynecologic Surgical Service ³⁹	The source of infection in four patients was a multidose propofol vial.
Cardiac Diagnostic Unit ⁴⁰	Infection occurred in 16 patients from a contaminated injectable radiopharmaceutical.
Hospital Ward ⁴¹	Five patients developed infection from transmission from a multidose saline vial.
Anesthesiologist ^{42, 43}	Two studies identified patients with infection, probably from a multidose vial.
Sclerotherapy Treatment for varicose veins ⁴⁴	A total of 196 patients had infection from a contaminated sclerotic agent.
Pain Remediation Clinic ⁴⁵	Six patients were infected from reuse of syringes and needles.
Liver Disease Unit ⁴⁶	Specific means of transmissions not identified, but six infections occurred in 357 patients with hospitalizations greater than 10 days.
Hematology/Oncology Unit ⁴⁷	A total of 99 patients were infected from shared saline reservoir bags used to withdraw saline for flushes.

virus. Five of these six patients had a genomic match with the HCV of the infected operating surgeon. The surgeon had a very high concentration of viral RNA units of 10^7 /mL of blood, and this unusual viral concentration was thought to be significant in these cases.⁴⁹ Two additional reports identify single transmissions from a gynecologist⁵⁰ and an orthopedic surgeon.⁵¹ There have been two reports of anesthesiologists with HCV who have similarly infected patients.^{52, 53}

Thus, there is very limited evidence that demonstrates transmission of HCV to patients when the operating surgeon has chronic HCV infection. The position of the American College of Surgeons remains the prudent one at this point (Table 3). HCV-infected surgeons should strictly adhere to conventional practices of infection control in the operating room. HCV-infected surgeons should not restrict their practices as long as they exercise strict compliance with infection control standards in the operating room.

Treatment of Hepatitis C Virus Infection

A sustained virologic response has been seen with the use of pegylated interferon (Peg-Intron, Schering Corp.; Pegasys, Hoffman-La Roche, Nutley, NJ) plus ribavirin (Rebetol, Schering Corp.; Copegus, Hoffman-La Roche) as the treatment of choice at this time.⁵⁴ Pegylation is the process of bonding polyethylene glycol to the interferon molecule, which permits less frequent administration of the interferon. Treatment courses may range from 6 to 12 months in duration. Response rates may be as high as 80 per cent with genotypes 2 or 3, but only approximately 40 per cent for chronic infection with genotype 1. Genotype one is the most common infection HCV genotype in the United States. Long-term follow up of apparent treatment successes is necessary to establish whether the sustained virologic response cures the infection permanently.

HIV Infection

Community-based transmission of HIV infection continues to be an uncontrolled epidemic in many areas of the world. In the United States, concern has substantially waned during the last 5 to 6 years. There are currently approximately 750,000 people estimated to be alive with HIV/AIDS infection, and approximately 550,000 have died from the disease by the end of 2005.⁵⁵ Occupational risks for surgeons and others in health care are seldom discussed at the present time compared with the rash of discussions 10 years ago.

Epidemiology and Pathogenesis

Infection from HIV results after the percutaneous or mucus membrane exposure to the virus. Viral exposure results in adherence of the virus to many cell types, but particularly to the CD⁺4 lymphocyte. The virus is a retrovirus and after target cell penetration, the action of viral reverse transcriptase results in the generation of the complimentary DNA from the RNA template of the viral genome. The complimentary DNA then becomes the source for transcription and translation processes that lead to the production of new viruses. The generation of large viral burden leads to cell lysis. Progressive loss of the CD⁺4 lymphocyte population over time results in the development of clinical immunosuppression and the clinical recognition of AIDS. The process is generally an indolent one that may require 10 years or longer from the time of actual infection until clinical AIDS emerges.

Infection occurs from contact with blood or body fluids from infected individuals. Intravenous drug abuse, sexual contact, and blood transfusion were routes for transmission. With the development of effective antibody detection, the screening of donated blood resources has virtually eliminated transfusion-

associated HIV infection. Despite considerable public discussion about the issue, new cases of HIV infection are occurring.

Occupational transmission has been documented to occur in 57 individuals after exposure to blood or body fluids of patients.⁵⁶ These documented cases were so defined when the exposed healthcare worker was identified to have the index event, was tested and found to be acutely seronegative for HIV infection, and was then proven to have seroconversion during the immediate follow-up period of time. The prospective analysis of percutaneous and mucus membrane exposures has defined the incidence of seroconversion at 0.3 per cent per event. As of this time, there has been no documented seroconversion of a surgeon from a percutaneous exposure in the operating room. Epidemiologic surveillance of patients with AIDS reported to the Centers for Disease Control and Prevention has identified another 138 individuals who are considered as probable occupational infections. Of these, six were surgeons. These probable infections were determined because the individuals were known to have repeated clinical exposure to patient blood as healthcare workers, but did not have identified nonoccupational risk factors. Of note, the list of probable and documented HIV occupational infections among healthcare workers has not been updated since 2001.

Diagnosis of HIV Infection

Patients with a suspected diagnosis of HIV infection are initially screened by an enzyme-linked immunosorbent assay, which detects both the antibodies for specific HIV antigens and also the p24 antigen itself. A Western blot is then performed to establish the diagnosis. An indeterminate Western blot may reflect a patient who is in the process of converting and should be repeated after several weeks. Rapid HIV tests have become available that provide results within a few minutes, but results need to be confirmed by conventional diagnostic methods.⁵⁷

Clinical AIDS exists when the patient who is HIV-positive develops infections or neoplastic disease that is associated with the immunosuppression of the illness. Infections associated with AIDS include *Pneumocystis jiroveci* (formerly *Pneumocystis carinii*) pneumonia, oral-esophageal candidiasis, human herpes infections (type 1-8), typical or atypical tuberculosis, *Cryptococcus neoformans* meningitis, toxoplasmosis, and cryptosporidia or microsporidia enteritis. Opportunistic cholangiopathy may also be seen.⁵⁸ Neoplasia associated with AIDS includes Kaposi's sarcoma, non-Hodgkin's lymphoma, anogenital cancers, and others.

Prevention of HIV Infection

No vaccine is currently available for prevention of HIV infection. Prevention for healthcare providers is uniform application of methods to prevent blood and body fluid exposure in the care of infected patients.

When exposure has occurred, the surgeon must get a baseline HIV serology done to document preexistent infection. Based on the severity of the exposure, the exposed individual should begin the recommended three-drug postexposure antiretroviral drug regimen as soon as possible.⁵⁹ There is no prospective study that documents effectiveness of postexposure prophylaxis, but statistical evidence points to probable effectiveness with this preventive strategy.⁶⁰

HIV-Infected Surgeons

As the bloodborne character of HIV infection became fully realized, concerns about occupational risks for surgeons was followed by a series of concerns about whether HIV-infected surgeons could potentially transmit the infection to their patients. The transmission of HIV infection to patients by a Florida dentist increased these concerns.⁶¹ There has not been a case of transmission of HIV infection from a surgeon to a patient that has been documented at this time in the United States. Several HIV-positive surgeons have had their patients studied and no evidence that transmission to patients has occurred.⁶² An orthopedic surgeon may have transmitted HIV infection to a patient in France, although some variation in the molecular analysis of the patient and the surgeon's viral sequence makes exact confirmation impossible.⁶³ The Statement of the American College of Surgeons on HIV and the Surgeon (Table 5) represents the appropriate position that should be followed at this time.

Treatment of HIV Infection

Although antiretroviral chemotherapy has not resulted in clinical cure for HIV-infected patients, significant improvement in treatment outcomes have been observed over the last 15 years. Over 20 antiretroviral drugs in four separate mechanistic classes have been approved.⁶⁴ Improved quality of life and longevity have been achieved. The classes of drugs by mechanism are nucleoside/nucleotide analog reverse transcriptase inhibitors (*e.g.*, zidovudine), nonnucleoside analog reverse transcriptase inhibitors (*e.g.*, efavirenz), protease inhibitors (*e.g.*, lopinavir), and entry inhibitors (*e.g.*, enfuvirtide).

Current treatment is to use combinations of three or four different agents concurrently under the therapeutic design of "highly active antiretroviral therapy," or HAART as it is referred to in the literature.⁶⁵ The

TABLE 5. *A Summary of the Recommendations of the American College of Surgeons in the Statement on the Surgeon and HIV Infection* (http://www.facs.org/fellows_info/statements/st-13.html)

- Surgeons have the same ethical obligation to render care to HIV-infected patients as they have to care for other patients.
- Surgeons should use the highest standards of infection control, including barriers and universal precautions. This practice should extend to all sites where surgical care is rendered.
- HIV-infected surgeons may continue practice until there is evidence that a risk of transmission exists, or until such time as the surgeon is not functionally able to continue in patient care in much the same fashion as would be true for any other illness. The determination to continue in practice should be made by the surgeons personal physician or by an institutional panel of experts convened for confidential counseling.
- Postexposure prophylaxis with antiretroviral chemotherapy is recommended.
- Surgeons should know their HIV infection status. Effective treatment for HIV infection is available. Knowledge of HIV infection status is not to be used for the determination of suitability for surgical practice. The HIV status of the surgeon is personal health information.

initial strategy is to diversify the drugs from separate mechanism-of-action classes. Therapy is monitored for effectiveness with CD4⁺ counts and quantitative measures of HIV RNA viral load.

Future Considerations

The reality of occupational infection from blood exposure in the operating room has existed for over 50 years. Attention to the problem has waxed and waned depending on the high-visibility concern of the moment. HIV infection brought an enormous amount of fear and prejudice to the clinical scene, and anxiety about occupational HIV infection then generated a general atmosphere of concern about the hepatitis diseases as well. The evidence that occupational HIV infection is very improbable has resulted in a decline of concern and a resumption of the indifferent practices of the past.

It should not be assumed that we understand or recognize all of the potential pathogens that may cause occupational infection in the operating room. Although the recognition of HIV infection accounted for over 80 per cent of the old non-A, non-B hepatitis syndrome, it is likely that at least one additional hepatitis virus remains to be identified. The TT virus appears to be another novel non-A-to-G hepatitis virus that remains undefined in its pathogenic or transmissible potential.⁶⁶ Episodic epidemics of West Nile virus, SARS, Asian influenza infection, and still yet others means that blood exposure can mediate the transmission of infection from any of a number of sources. Although many of these epidemics have a specific geographic locale, the current efficiency of transportation means that any viral infection of the world could be visited on an operating room close by. Experimental⁶⁷ and some clinical observations⁶⁸ have identified transmission of prion disease by blood and means that even "infectious protein" is yet another potential risk of unknown significance.

A recommitment to preventive strategies in the operating room is necessary for all surgeons. Although

minimally invasive procedures are reducing the risks attendant to cuts and injuries that have been commonplace, these same procedures have replaced scalpels with needles, trocars, cannulas, and other sharp devices, which means that the risk of injury and exposure to blood remains ever present.

Prevention requires that all patients be treated the same with respect to the use of personal protective equipment, sharp instruments, and responsiveness to a blood exposure event in the operating room. Face shields to avoid blood and fluid splashes into the eyes need to be continually worn in the operating room environment. Double-gloving has been documented in several studies to reduce blood contact with the hands,^{69, 70} although this practice does not necessarily avoid sharp injuries. Sleeve reinforcements, large shoe covers, and even plastic aprons may need to be considered for high-risk situations in which blood exposure would be an anticipated event.

Handling sharp instruments and needles with respect for oneself and for colleagues will reduce inadvertent injuries. Surgical "way" stations for frequent passes of needle holders can reduce injuries. Newer blunt needle technology may avoid the inevitable accident from being a percutaneous injury. Care should be exercised with wire closure of the sternum. Attention to bony edges in orthopedic procedures is necessary. Avoidance of blind suturing methods and palpation of the needle tip in poor exposure procedures is important. Any sharp instrument or device is a potential weapon and deserves respect for appropriate use in the operating room.

When a significant exposure occurs in the operating room environment from percutaneous injury or mucus membrane exposure, then cleansing the site of injury immediately is desirable. Surgical rescrubbing is probably best but is frequently impractical depending on the circumstances of the operative procedure. Many surgeons remove the surgical glove if the exposure event is to the hand, then locally irrigate the area with povidone iodine or isopropyl alcohol, and proceed

with the operation. This method is not proven, but the irrigation solutions are viricidal. Injuries, in which bleeding occurs at the wound site of the surgeon or healthcare provider, requires documentation and serologic studies to validate the individual's infection status at the time. The status of the patient relative to bloodborne infections will commonly not be known, and the response of the surgeon should be indexed to the severity of the injury.

In conclusion, bloodborne pathogens remain a source of occupational infection. Vigilance in prevention of operating room exposure to blood needs to be revitalized. Blood is a toxic substance and surgeons need to avoid needless and preventable exposure.

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