Current Risks of Occupational Blood-Borne Viral Infection

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Abstract

Background: Human immunodeficiency virus (HIV), hepatitis B virus (HBV), hepatitis C virus (HCV), and other viruses remain occupational risks for both surgeons and patients in the operating room environment. In the past, this concern attracted great attention, but recently, this subject has been given much less attention.

Methods: Review of the literature over the past 50 years on occupational risks of viral infection in the operating room.

Results: Transmission of HIV still looms as a potential pathogen in the operating room, but no case has been documented in the United States. Infection with HBV can be prevented by a safe and effective vaccine. Chronic HCV infection is present in more than three million U.S. residents and remains a risk that can be managed only by adhering to strict infection control practices and avoiding blood exposure.

Conclusions: The risks of viral infection in the operating room remain the same as a decade ago even though attention to this issue has waned. The avoidance of blood exposure to prevent transmission of both known and unknown blood-borne pathogens continues to be a goal for all surgeons.
The furor over HIV and HBV as occupational risks reached a crescendo in the mid-1990s, but by the end of the decade, the furor had subsided. Operating room rates of HIV transmission were minuscule, with no case of transmission documented in the United States. The American College of Surgeons (ACS) took a strong position that the risk of transmission from patients, or to patients, in the operating room was negligible when appropriate infection control practices were employed [19,20]. As of 1996, marked declines were reported in the incidences of new HIV infections and deaths as a consequence of education programs and the use of highly-active anti-retroviral therapy (HAART) in the treatment of established infections [21,22].

Unfortunately, attitudes about occupational infection have returned to the indifference of the pre-AIDS era. Public and professional discussion of occupational infection in healthcare providers or risks to patients has quieted, being ignited only sporadically by the occasional cluster of HCV infections when infection control practices are applied poorly or ignored. Are eye shields or double gloves worn with the same frequency today as in the mid-1990s? Probably not! The pathogens in the surgical population are still there, and the risks are still real. Continued awareness and sensitivity to the specific viral pathogens and to easily applied preventive strategies still are needed.

HIV Infection

There are approximately one million people living with HIV infection in the United States, with about 35,000–38,000 new cases and 16,000–18,000 deaths per year [23]. There has been little change in the number of cases of documented occupational infections of healthcare workers or of epidemiologically suspected cases since 2001 [24]. There have been 57 documented cases of occupational transmission of HIV where individuals seroconverted after having negative serology at the time of the index exposure event (Table 1). An additional 140 healthcare workers with HIV infection possibly acquired in the work place. These persons did not have non-occupational risk factors for the development of the infection. No surgeon has been documented to have HIV conversion after exposure, although six surgeons have been identified as possible transmissions on the basis of exposure history. Studies of patients undergoing invasive procedures by surgeons with HIV infection have demonstrated no transmission [25]. On the basis of these observations combined with the serological surveillance study done with a large population of orthopedic surgeons that demonstrated no HIV infection in the absence of non-occupational risk factors [26], it can be concluded that surgical activity is associated seldom with HIV transmission to surgeons or to patients.

In prospective studies of healthcare workers, the average risk for HIV transmission after a percutaneous exposure to HIV-infected blood has been estimated to be approximately 0.3% (95% confidence interval [CI] 0.2%, 0.5%) [27] and after a mucous membrane exposure, approximately 0.09% (CI 0.006, 0.5%) [28]. Most transmissions have occurred in nurses and medical technologists. Most injuries in which transmission has occurred have been dramatic, not superficial needle sticks. Either mucus membrane or percutaneous injury requires consideration for post-exposure prophylaxis (PEP) with anti-retroviral chemoprophylaxis.

Recommendations for PEP are summarized in Table 2 [29]. Percutaneous injuries to patients with known HIV infection should trigger a basic two-drug regimen if the disease was asymptomatic in the index patient or a three-drug (or more) regimen when the index patient has symptomatic infection. The drug choices recommended are listed in Table 3, and the number of antiretroviral agents continues to expand. Prophylaxis should be initiated as soon as possible after exposure and be continued for four weeks. Because of indeterminate issues of severity of disease in the index patient, the volume of inocula in mucous membrane exposure, the vast choices of different antiretroviral drugs, and the potential toxicity of PEP, it usually is necessary to have an infectious disease specialist knowledgeable in HIV infection manage the course of PEP. Serologic post-exposure testing for HIV and other blood-borne viruses is recommended at six weeks, 12 weeks, and six months after the exposure.

Hepatitis B Infection

There are more than one million people in the U.S. with chronic HBV infection [30]. The infection became widely disseminated by intravenous drug abuse, sexual transmission, and, prior to 1970, blood transfusions. Hepatitis B has been a particularly common occupational infection for surgeons, with 25–30% of surgeons in the >60-year-old group having serologic evidence of prior acute infection [31]. Fortunately, only a small minority developed chronic infection. However, chronic infection is a serious situation because it leads to end-stage liver disease, hepatocellular carcinoma, and portal hypertension. Because 70–75% of acute HBV infections are clinically occult, many surgeons were unaware of chronic infection until clinical sequelae occurred with advanced disease, often 20 or more years after acute infection [13].

Unlike HIV infection, HBV transmission occurs quite efficiently to healthcare personnel from infected patients. Per-
Effective PEP after exposure to blood of an infected patient requires that surgeons know their status for HBV antibodies [39]. A strongly positive surface antibody test means that the surgeon is protected from the virus. If immunization has been performed and the surgeon is weakly positive for the surface antibody or is non-reactive, administration of a dose of HBV immunoglobulin is necessary, and a booster dose of HBV vaccine should be given immediately. If the surgeon or other exposed healthcare worker has not been immunized at the time of an exposure and the exposed individual is seronegative for HBV surface antibody, then a dose of HBV immunoglobulin should be given; the full vaccination series should be started immediately. The unvaccinated surgeon positive for the HBV core antibody has had a prior infection and does not need PEP. However, the antibody-positive but unvaccinated surgeon should have followup studies to determine if there is chronic HBV infection.

Should the surgeon with HBV infection continue to practice surgery? If he or she is antigen-negative, the prior acute infection has resolved, and there are no health risks for the surgeon or the patients. Antigen-positive surgeons should be tested for the e antigen. If positive, they should consult with a locally convened group of experts to advise them about continuing surgical practice [20]. Whether positive or not for the e antigen, treatments for chronic HBV are now available, and the chronically-infected surgeon should receive appropriate care.

**Hepatitis C Infection**

Hepatitis C is by far the most serious blood-borne viral infection of the current era. There are some 3–4 million people in the U.S. with chronic HCV infection [40]. It is associated with intravenous drug abuse, multiple sexual partners, and blood transfusion prior to 1992 [41] (Table 4). As with HBV, it is an occult acute infection for the majority of patients, but unlike HBV, more than 60% of acute events result in chronic disease. The infection is associated with a 2% frequency of transmission with percutaneous exposure in the healthcare setting [42]. Surgeons have higher rates of chronic HCV

<table>
<thead>
<tr>
<th>Type of exposurea</th>
<th>HIV-positive Class 1b</th>
<th>HIV-positive Class 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percutaneous injury</td>
<td>Two-drug</td>
<td>≥ Three-drug</td>
</tr>
<tr>
<td>Less severe</td>
<td>Two-drug</td>
<td>≥ Three-drug</td>
</tr>
<tr>
<td>Severe</td>
<td>Three-drug</td>
<td>Three-drug</td>
</tr>
<tr>
<td>Mucous membrane or non-intact skin</td>
<td>Two-drug</td>
<td>Two-drug</td>
</tr>
<tr>
<td>Small volume</td>
<td>Two-drug</td>
<td>Two-drug</td>
</tr>
<tr>
<td>Large volume</td>
<td>Two-drug</td>
<td>≥ Three-drug</td>
</tr>
</tbody>
</table>

*Severity of percutaneous injury or volume of mucous membrane exposure is a subjective decision, and no guidelines for differentiation are available.

*Class 1 is an asymptomatic patient, and Class 2 is a symptomatic patient with clinical acquired immunodeficiency syndrome.

<table>
<thead>
<tr>
<th>Drug</th>
<th>Preferred dose</th>
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<tbody>
<tr>
<td>Zidovudine/Lamivudine</td>
<td>600 mg daily (two or three doses)</td>
</tr>
<tr>
<td></td>
<td>300 mg daily (one or two doses)</td>
</tr>
<tr>
<td>Zidovudine/Emtricitabine</td>
<td>600 mg daily (two or three doses)/200 mg daily</td>
</tr>
<tr>
<td>Tenofovir/Lamivudine</td>
<td>300 mg daily/300 mg daily (one or two doses)</td>
</tr>
<tr>
<td>Tenofovir/Emtricitabine</td>
<td>300 mg daily/200 mg daily</td>
</tr>
<tr>
<td>Lopinavir/ritonavir</td>
<td>400/100 mg twice daily</td>
</tr>
<tr>
<td>Atazanavir ± ritonavir</td>
<td>300 g daily ± 100 mg daily</td>
</tr>
<tr>
<td>Fosamprenavir ± ritonavir</td>
<td>700–1400 mg twice daily ± 100–200 mg daily</td>
</tr>
<tr>
<td>Indinavir ± ritonavir</td>
<td>800 mg ± 100 mg twice daily</td>
</tr>
<tr>
<td>Saquinavir ± ritonavir</td>
<td>1000 mg ± 100 mg twice daily</td>
</tr>
<tr>
<td>Nelfinavir</td>
<td>1250 mg twice daily</td>
</tr>
<tr>
<td>Efavirenz</td>
<td>600 mg daily</td>
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</tbody>
</table>

*The basic regimen is the two-drug recommended PEP, and the preferred and alternate expanded regimens are those choices added to the basic regimen when three or more drugs are used for severe exposures or for exposures to Class 2 patients.
Infectious status of index patient

<table>
<thead>
<tr>
<th>Susceptibility of exposed healthcare worker</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and amount of exposure</td>
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<tr>
<td>Type of exposure</td>
</tr>
<tr>
<td>Prevention of Blood Exposure</td>
</tr>
</tbody>
</table>

**Table 4. Risk Factors for Hepatitis C Virus (HCV) Infection**

- Past transfusion
- HIV infection
- IV drug injection
- Hemodialysis
- Organ transplantation
- Percutaneous injury (healthcare workers)
- Multiple sex partners
- Household exposures (episodic cases)
- Tattoos
- Body piercing
- Incarceration in jail/prison

*A large number of HCV infection do not have a readily identified cause.

HIV = human immunodeficiency virus; IV = intravenous.

**Table 5. Factors that Need To Be Considered in Making a Decision about Post-Exposure Prophylaxis and Need for Followup after Occupational Exposure**

- Type of exposure
- Percutaneous injury
- Pin prick
  - Major cut/laceration
- Mucous membrane exposure
- Non-intact skin exposure
- Type and amount of exposure
- Pure blood
- Bloody fluids/irrigation solutions
- Non-blood body fluids
  - Vaginal secretions
  - Cerebrospinal fluid
  - Pleural/peritoneal fluid
  - Amniotic fluid
- Infectious status of index patient
  - Positive for hepatitis B virus antigen
  - Positive for hepatitis C virus antibody
  - Positive for human immunodeficiency virus antibody
- Susceptibility of exposed healthcare worker
- HBV vaccination status

HBV = Hepatitis B virus.
review identified the multiple studies that have validated the view that double gloving reduces blood exposure and may reduce the transmission of viral pathogens [58]. An indicator double gloving system has been developed to facilitate recognition that the outer glove has been violated [59]. Despite the clear evidence that double gloving prevents blood exposure of the hands, it still is not employed uniformly. Presumed restriction of hand movement, reduced tactile sensation, and “claudication” of the digits are common reasons for not double gloving. The practice of placing a half-size larger glove underneath with the correct glove size over the top has been useful to enhance the comfort of double gloving.

Other tactics include sleeve re-enforcements for operations in the chest or abdomen, where blood breakthrough above the proximal extension of the glove is a risk. Plastic aprons underneath the gown will prevent torso breakthrough but are commonly unbearable hot. Trauma boots to cover the lower extremity to the upper shin or knee are used when large-volume blood loss is anticipated.

**Technique**

Technical considerations in the prevention of injury and blood exposure in the operating room require constant awareness of sharp instruments and the potential for harm. Double gloving for tying large monofilament suture under tension when closing the abdomen and chest will avoid shearing injuries of the digits. Swaged needles need to be removed before tying the suture. Spent needles need to be introduced tip-down into a polystyrene foam block or some similar medium to eliminate accidental puncture wounds. Blunt needle technology that has been recommended by the ACS should be employed [60]. Blind suturing techniques that employ palpation of needle tips should be avoided. When frequent exchanges of loaded needle holders are required, a Mayo stand can serve as a convenient “way station” to avoid injury in passing the loaded needle holder (hands-free technique) [61]. Selected operations may be performed without sharp instrumentation on the surgical field [62].

**Response to exposure event**

Despite adherence to all barrier and technical tactics, exposure events will occur inevitably. Blood breakthrough onto the hands should result in immediate rescrubbing. Unfortunately, this commonly is impractical in the middle of a procedure, in which case, the glove is removed, the local site is irrigated with povidone-iodine solution or isopropyl alcohol, and the procedure is completed. These antiseptics are viricidal in the laboratory, but no clinical evidence demonstrates effectiveness in the prevention of transmission of viral infections. Blood exposure from penetration of the surgical gown requires removal of the gown, local irrigation, and regowning.

Multiple parameters should be considered in concluding that a given exposure is high risk (Table 5). High-risk events should be followed by immediate serologic testing and PEP strategies as described above. Criteria for “high-risk exposure” are measured in terms of the likelihood of the patient harboring infection, the magnitude of the exposure event, and the concern that the exposed individual has for potential transmission.

**Future Considerations**

The transmission of blood-borne pathogens continues to be a risk for members of the surgical team. Whereas HBV infection can largely be prevented with vaccination and HIV has not been documented to have been transmitted in the operating room to the surgeon, HCV infection remains a real risk. It is likely that additional unserotyped hepatitis viruses exist [63]. Additional acute infections such as with West Nile virus, coronovirus of severe acute respiratory syndrome, and the Asian avian influenza virus have a viremic phase that can pose a risk [64]. Recent evidence of transfusion-associated prion disease creates yet another potential risk [65,66]. The lassitude and indifference of recent years must be reevaluated in the context of the numerous known and unknown infectious agents that are borne in blood.

Avoidance of blood exposure is an important objective in surgical care, and it is the responsibility of surgeons to avoid exposing themselves and others in the operating room environment. We can hope that newer technology in glove design and gown barriers can provide additional protection in the future. Until that time, blood exposure is a personal health risk to the surgeon that must be avoided.

**Author Disclosure Statement**

No conflicting financial interests exist.

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