

Management of Needlestick Injuries

A House Officer Who Has a Needlestick

David K. Henderson, MD, Discussant

DR REYNOLDS: Dr J is an intern in internal medicine at a large academic residency program. At 2 AM on a call night in the cardiac intensive care unit (CCU), a 70-year-old patient was brought to the unit after having experienced an out-of-hospital cardiac arrest due to ventricular fibrillation. The patient's medical history was not known; he lives with his sister, who reported that he had not seen a physician in approximately 40 years.

Dr J was involved in resuscitation efforts in the CCU along with several other clinicians. While attempting to place a central line and sewing with a curved needle holder, Dr J had a needlestick. The needle was a solid-bore needle; the stick did not draw blood. After handing over the procedure to another team member, Dr J scrubbed and rinsed the site of injury. His supervising resident directed him to go to the emergency department (ED) to be seen under the hospital's needlestick protocol.

In the ED, a nurse trained in the protocol spoke to an infectious disease fellow by telephone and then saw Dr J. She assessed his vaccination history and drew baseline blood work for hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV) antibodies. The nurse told Dr J to take lamivudine/zidovudine combination tablets and gave him his first dose in the ED approximately 2 hours after the needlestick.

Dr J's blood was drawn for serologic testing.

DR J: HIS VIEW

We had admitted a patient to the CCU who was post-ventricular fibrillation and needed a central line. I had a small curved needle and a curved hemostat because there was no normal needle driver available. I proceeded to clip the needle in the end of the hemostat and passed it to my other hand to tie off. As I passed the hemostat, the needle clipped my glove and my skin. I notified my fellow and resident, who both decided to send me to the ED. I then disposed of the sharp and tried to force bleeding. I waited in triage for about

Since its identification in 1985, human immunodeficiency virus (HIV) has challenged several aspects of health care delivery. Because HIV is a blood-borne infectious disease, from the early days of the epidemic, concern was raised about risks of occupational exposures and infections among health care workers. Despite the development of highly active antiretroviral therapy, which has effectively modulated HIV into a chronic disease in many settings, risks of occupational infection with 3 blood-borne pathogens remain in the health care workplace. Using the case of a house officer who has a needlestick during a resuscitation attempt, prevention of needlesticks including universal precautions and postexposure management of occupational HIV, hepatitis B, and hepatitis C exposures is discussed.

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2 hours. They took my vitals and the ID [infectious disease] fellow talked to them over the phone. They decided to start me on Combivir, which I assume was based on the unknown status of the patient and the fact that it did get my skin. So we started with 1 dose of Combivir in the ED and got consent from the patient's family [for HIV testing] since he was nonresponsive.

I did have some side effects, but it's tough to say whether it was side effects from the medication or because it was an overnight shift, especially because I felt tired and run-down to begin with. I had a little gastrointestinal upset but nothing that was unbearable. They gave me metoclo-

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pramide to go with the Combivir to try and stem the side effects, since I was going back to the floor. I didn't feel great, but it wasn't that miserable.

To prevent the stick, there are a few things I probably would have to do either mechanically or based on the equipment. For some reason there were no regular needle drivers in the CCU, and I am not accustomed to suturing with a curved hemostat. It is a little trickier to use and wasn't ideal for this procedure. I feel there could've been more appropriate equipment available to use. Another thing was that it was late and I was probably sloppy in terms of technique. As I do more procedures, I develop a more consistent method on how to go about doing every step of every procedure. So I believe some of it was quality control within myself and some of it was quality control in terms of having the right kind of equipment.

The experience in the ED was interesting, as I was seen only briefly by a physician. There was a nurse and a nursing student, and I felt like they were a little bit intimidated because I was questioning a lot of what was going on. They didn't have someone higher come in to answer my questions. I wasn't resistant to anything, but I just wanted a little more information about the protocol. I was also surprised that the ID fellow didn't come in to see me. I shouldn't have expected the ID fellow, but I didn't know if someone from the ID team was in house or not. I was unsure whether protocol is to just prescribe Combivir to every needlestick that comes through, without actually assessing or figuring out what had happened or figuring out what kind of injury it was. If it was a different kind of a stick, I think I might have felt differently. If it was a high risk, a large hollow bore, or a lot of blood exposure, I think I'd have a harder time dealing with the little things throughout the day, especially seeing other patients.

AT THE CROSSROADS: QUESTIONS FOR DR HENDERSON

How many needlesticks and body fluid splashes occur yearly among health care workers? What are the risks of HIV seroconversion with sticks and splashes of various types, from known HIV-positive and unknown-serostatus sources? How does this risk compare with the risks of occupational infection with HBV and HCV? How can health care workers and health care institutions reduce risks of occupational exposures? What are the first actions a health care worker should take if an occupational exposure occurs? How should occupational exposures to blood-borne pathogens be assessed and managed and to whom should prophylaxis be offered? What is the scientific rationale for offering post-exposure antiretroviral chemoprophylaxis for HIV exposures? What medical regimens are effective in lowering these risks? What are the adverse effects? What are the best counseling practices for health care workers who have had occupational exposures? What recommendations do you have for Dr J?

DR HENDERSON: In this article, the GRADE system is used to describe the quality of evidence that supports the statements.¹ This system of grading ranks clinical evidence using the following scheme:

- A. High quality: Further research is very unlikely to change confidence in the estimate of effect.
- B. Moderate quality: Further research is likely to have an important impact on confidence in the estimate of effect and may change the estimate.
- C. Low quality: Further research is very likely to have an important impact on confidence in the estimate of effect and is likely to change the estimate.
- D. Very low quality: Any estimate of effect is very uncertain.¹

EPIDEMIOLOGY AND RISK

How many needlesticks and body fluid splashes occur yearly among health care workers?

Despite the implementation of strategies designed to reduce risks of occupational exposures to blood-borne pathogens, exposures associated with risks of transmission of blood-borne pathogens continue to occur commonly in US health care settings and in both developed and developing countries.²⁻⁴ Porta and colleagues⁵ estimated that more than 400 000 parenteral exposures to blood occur annually among US health care workers, and more recently, investigators from the Centers for Disease Control and Prevention (CDC) used data from US surveillance hospitals to estimate that more than 380 000 such exposures occur annually.⁶ Irrespective of the precise number of exposures, these data suggest that nearly 1 of every 10 US health care workers has a needlestick exposure each year.⁶ Underreporting of exposures remains a distinct problem, even in institutions that provide easily accessible reporting systems.⁷⁻¹¹

What are the risks of seroconversion associated with sticks and splashes of various types, from both HIV-positive and unknown-serostatus sources?

More than 20 longitudinal studies provided data that helped investigators estimate the transmission risk associated with discrete occupational exposures to blood from patients infected with HIV (summarized by Henderson¹² and Ippolito et al¹³). In these studies, health care workers who had occupational HIV exposures were tested for HIV antibody at or near the time of exposure and then periodically to detect serological evidence of infection. The combined data from these studies provide an estimate of the average risk of HIV transmission associated with percutaneous exposures of 0.32%, or approximately 1 infection for every 325 documented exposures to blood from HIV-infected individuals (summarized by Henderson¹²). Although fewer studies address the risk associated with mucosal exposures, pooling data from those that assessed this risk results in an average risk estimate of approximately 0.03% (ie, approximately 1 infection for each 3300 mucous membrane exposures to

blood from HIV-infected individuals).¹⁴ For comparison, the risk of occupational infection after parenteral exposure to blood from source patients who have HBV infection with circulating e antigen has been estimated to be between 19% and 37%.^{15,16} Similarly, pooling the data from several longitudinal studies designed to measure the magnitude of risk of occupational infection with HCV following parenteral exposures to blood from HCV-infected source patients produced an estimated infection risk of 1.9% per exposure (A).¹⁷

Assessing risks associated with exposures to blood from patients whose blood-borne pathogen status is unknown, such as occurred in Dr J's case, is more challenging. Decisions about subsequent evaluation and treatment of health care workers who have source-unknown exposures should be based on a careful risk assessment, including the clinician's best assessment of (1) the probability of HIV or other blood-borne pathogen infection in the source patient (eg, making an epidemiological risk-benefit assessment of the likelihood of exposure to a blood-borne pathogen based on patient location, patient demographics, known prevalence of infection in the geographic area, presence or absence of risk factors for infection, etc), (2) the infection risk associated with the type of exposure incurred, and (3) the risks of postexposure treatment for the exposed health care worker. Often, source-unknown exposures are associated with negligible transmission risks; thus, no treatment is indicated. At my institution, treatment is initiated for such source-unknown exposures only in instances in which the risk assessment suggests that the infection risk outweighs the risks associated with prophylaxis. In such instances, treatment is initiated but may be discontinued if test results or other relevant data become available.

Although these "average risk" estimates for occupational infection are useful in evaluating populations of exposed persons, such estimates may not accurately reflect the risk associated with a specific occupational exposure. Several factors are known or assumed to influence occupational risk, including the characteristics of the exposure (eg, parenteral, mucous membrane, deep, superficial), the exposure inoculum, and the exposed worker's immunological response, among many others.

Viral inoculum relates both to the viral concentration in the material to which the health care worker is exposed as well as to the volume of the exposure. Laboratory studies of needle-stick exposures have shown that exposure volume increases with needle size and depth of penetration and, not surprisingly, that hollow needles are associated with higher inocula than comparably sized solid suture needles.^{18,19} With respect to viral concentration, the source material may vary by several orders of magnitude, depending on the stage of the source patient's blood-borne pathogen infection as well as the efficacy of the source patient's therapy. The circulating viral burden (ie, number of circulating viral particles) is likely among the most important predictors of transmission risk.²⁰⁻²² For HIV, the circulating viral burden is highest during the initial stage of infection (ie, near the time of seroconversion) as well as in advanced (ie, preterminal) stages of the illness.

Perhaps the best available data concerning factors associated with risk of occupational HIV infection come from the retrospective case-control study of percutaneous occupational exposure to HIV conducted by investigators from the CDC.²³ Their study identified 4 exposure characteristics associated with increased risk of occupational infection: deep (as opposed to superficial) exposure (odds ratio, 15; 95% CI, 6.0-41), the presence of visible blood on the injuring device (odds ratio, 6.2; 95% CI, 2.2-21), prior placement of the injuring device in a vein or artery (odds ratio, 4.3; 95% CI, 1.7-12), and presence of preterminal disease in the source patient (ie, the source patient died within 2 months of the exposure) (odds ratio, 5.6; 95% CI, 2.0-16).²³ Each of these factors is likely a surrogate marker for inoculum. Dr J's exposure had none of these high-risk features.

Data suggest that the immunological responses of the exposed health care workers affect blood-borne pathogen transmission, although this is perhaps less well characterized. Several investigators have suggested that the relatively low rate of HIV transmission may, at least in part, be due to aborted infection, a concept that has been clearly demonstrated in studies of uninfected sex workers,^{24,25} in studies of sexual partners of infected persons,²⁶⁻²⁸ in studies of children born to HIV-infected mothers,²⁹ in a few studies of patients who were inadvertently exposed to blood from infected patients during the provision of health care,³⁰ and in studies of occupationally exposed but uninfected health care workers.³¹⁻³³ Many of these studies demonstrate HIV-specific cell-mediated immune responses among patients who did not develop HIV infection despite documented exposures. Similarly, studies of a point source epidemic of HCV infection suggest that a substantial fraction of exposed patients spontaneously cleared the infection.³⁴ These individuals developed cellular immunity against HCV but did not have antibody directed against HCV.³⁴ Although the precise role of human cellular immune responses in host defense against low-inoculum blood-borne pathogen challenges is incompletely understood, the observations from the studies cited herein are consonant with the hypothesis that the cellular immune system may well be a contributing determinant of exposure outcome.

PREVENTION

How can health care workers and health care institutions reduce risks of occupational exposures?

Standard Precautions, developed and recommended by the CDC in 1996,^{35,36} were based on the CDC's original Universal Precautions guidelines³⁵ and were designed to prevent health care workers from having direct contact with blood and certain other fluids containing blood that have been associated with blood-borne pathogen transmission. The basic tenets of Universal/Standard Precautions are outlined in the BOX.

Several studies assessed the efficacy of Universal/Standard Precautions in preventing occupational exposures.³⁸⁻⁴⁰ Factors associated with the efficacy of these programs in reducing exposures include comprehensive training,

Box. Summary of the Components of Universal Precautions^a

Universal precautions should apply and be used consistently for all patients and relevant specimens.

Precautions apply to the following specimens: blood, bloody body fluids, semen, vaginal secretions, tissues, cerebrospinal fluid, synovial fluid, pleural fluid, peritoneal fluid, pericardial fluid, and amniotic fluid.

Appropriate barrier precautions should be used routinely to prevent skin and mucous membrane exposure, whenever contact with blood or other body fluids is anticipated.

Gloves are required for touching blood and body fluids, mucous membranes, or nonintact skin of all patients; for handling items soiled with blood or body fluids; and for performing vascular access procedures.

Masks and protective eyewear or face shields are required when droplets of blood or other body fluids might be generated that could contact mucous membranes.

Gowns are required when splashes of fluids might be anticipated.

Hand washing is required both after contamination with blood or other body fluids as well as immediately after gloves are removed.

Precautions should be taken to prevent sharps injuries during procedures and during cleaning of instruments.

Needles should never be recapped, purposely bent or broken, or removed from disposable syringes.

Disposable syringes and needles, scalpels, and other sharps should be placed in puncture-resistant containers for disposal; these containers should be placed as close as practical to the area where sharps are being used.

Mouthpieces, resuscitation bags, or other ventilation devices should be available wherever their need can be anticipated.

Health care workers who have exudative lesions or weeping dermatitis should refrain from all direct patient care.

^aSummarized from the Centers for Disease Control.^{35,37}

ensuring adherence to the guidelines, and ongoing communication about the circumstances of exposures with both managers and front-line workers. Reducing occupational exposure will, of necessity, reduce occupational infections with blood-borne pathogens.

Strategies that may be associated with injury prevention include avoiding unnecessary needle use, avoiding unnecessary insertion of intravenous catheters, use of needleless or protected needle infusion systems, use of safer needles (eg, needles that can be resheathed without placing the operator at risk of exposure, needles with blunted tips), and use of puncture-resistant sharps disposal containers.⁴¹⁻⁴⁴

Similarly, institutions should develop strategies for preventing exposures during more invasive (eg, interven-

tional and operative) procedures. The prevention principles are the same. For example, the least invasive surgical approach that can provide the desired patient outcome generally will be associated with the least risk of occupational exposure and infection. Fiberoptic techniques usually pose a lower risk of injury and blood exposure than do more invasive surgical approaches. Similarly, when patient safety permits, alternatives to needles and other sharp implements should be used to minimize exposure risk (eg, use of tape skin closure, staples, tissue glue, electrocautery).⁴⁵⁻⁴⁷

Studies have demonstrated that the use of so-called safer devices has been associated with reductions in intraoperative exposures. For example, a multicenter study demonstrated that the estimated odds of having an injury with a curved suture needle were reduced by 87% when only half of the suture needles used were blunted.⁴² Surgeons interested in operating room safety also advocate the “no-touch” technique that emphasizes the use of instruments, rather than hands, for retracting and exploring tissue; they also do not allow hands of 2 or more operators in the operative field simultaneously; they prohibit hand-to-hand passage of sharp instruments; and, in instances in which such instruments must be directly passed, the hand-off is orally announced prior to instrument passage. Other strategies that have been advocated to reduce intraoperative blood exposures include routine double gloving^{31,48-54}; reinforcement of surgical gloves in the areas of the thumb, index, and middle fingers of the nondominant hand^{45,55-57}; and use of gloves that increase the thickness of the barrier between a patient and a clinician. In Dr J’s case, he was using a curved hemostat as a needle holder. Curved hemostats are not designed as needle carriers and the emergent use of this device in this urgent setting may have increased the risk of exposure. In my own view, the emergent nature of the clinical situation may also have contributed increased risk.

MANAGING EXPOSURES**What are the first actions a health care worker should take if an occupational exposure occurs?**

Once the safety of patients for whom the exposed worker is caring can be ensured, the exposed worker should wash the wound or skin site that has been in contact with blood or body fluids with soap and water, which is just what Dr J did.^{58,59} Exposed mucous membranes should be flushed with tap water and eyes exposed to potentially infectious material should be flushed with sterile water or a commercial eye irrigant when available or, alternatively, with tap water. Antiseptics can be used to flush the wound, but they are not known to reduce the incidence of infection, and decontamination should not be delayed until antiseptics can be obtained. The exposed worker should next notify his or her supervisor about the exposure and then report the exposure to the institution’s occupational medicine service. The immediate management of these occupational exposures should be given high priority and treated as urgent, if not

emergent, circumstances. In my view, all health care institutions should have processes for reporting and managing these exposures that are available 24 hours a day, 365 days a year, and are easily accessed. Clinicians charged with managing these exposures must understand the importance of rapid assessment and administration of chemoprophylaxis, when appropriate.

How should occupational exposures be assessed and managed and to whom should prophylaxis be offered?

When an exposure is reported, the first priority is to evaluate the risk of infection and the need for immediate wound care and prophylactic treatment. If infection status of the source is not already known, the source of an occupational exposure should be evaluated for HIV as well as for HBV and HCV infections. Testing of the exposure source should be performed with urgency. In most facilities, conventional screening tests (eg, HbsAg, anti-HCV, HIV enzyme immunoassay [EIA]) can be completed quickly. If the source patient is found to be infected with HBV, the patient's circulating viral burden should be determined by directly measuring viral DNA. Previously, e antigen testing has been relied on, but the identification of patients with very high circulating viral burdens who are infected with so-called precore mutants that cannot make e antigen render this test much less reliable than directly measuring viral DNA.⁶⁰ For HIV exposure, a US Food and Drug Administration–approved rapid HIV antibody test is an acceptable alternative. Positive rapid test results should be confirmed by EIA, and positive EIA results should be confirmed by Western blot. A negative conventional EIA result is sufficient to exclude an HIV diagnosis unless the source patient has clinical evidence of primary HIV infection or HIV-related disease. If the source cannot be tested or if the source is unknown, the probability of blood-borne pathogen infection should be assessed using available clinical, epidemiological, and laboratory information.^{58,61,62} In the case of Dr J's exposure, little was known about the source case's risks or health history.

The evaluation of the exposed health care worker should include assessment for tetanus immunity (and administration of a tetanus, diphtheria, and acellular pertussis booster, if indicated), preexisting blood-borne pathogen infection, medication use for potential drug interactions, and any underlying medical conditions or circumstances that could influence decisions about or choice of chemoprophylaxis regimens. As part of this evaluation, pregnancy testing should be offered to all women of childbearing age.

TREATMENT

What is the scientific rationale for offering postexposure immunoprophylaxis or chemoprophylaxis?

Management of occupational exposures to HBV and HCV is discussed in detail elsewhere.^{17,63} In 2011, most US health care workers have been immunized with the hepatitis B vaccine and, based on vaccine efficacy data, between 93% and 95%

are protected.⁶³ In the unusual instance in which a susceptible health care worker has an occupational exposure to blood, the worker should receive primary immunization, irrespective of the probability that the source patient was HBV-infected. In instances in which the source patient is HBV-infected, 1 dose of hepatitis B immune globulin (HBIG) (0.06 mL/kg) should be administered concurrently with the first vaccine dose to provide passive protection until vaccine-induced antibody appears. Passive HBIG prophylaxis should be given as soon as possible after exposure and within 24 hours, if possible. If the health care worker refuses vaccination, a second dose of HBIG should be administered 1 month following the exposure. Follow-up for susceptible health care workers should include a hepatitis panel (HBsAg, HBsAb, and anti-HBc) and liver enzyme measurement 6 months after exposure and at the time of the third dose of vaccine (A).^{58,63}

In managing treatment of health care workers who have had occupational exposures to HCV, my institution tests the exposed health care worker at the time of exposure for antibody to HCV and for HCV RNA (by polymerase chain reaction [PCR]), then monitors exposed workers at periodic intervals (at a minimum every 2 months) both for anti-HCV and for HCV RNA by PCR. An individual found to have reproducibly positive results by PCR is referred to the hepatology service for follow-up and management. The hepatology team follows the patient up for a minimum of 2 additional months to see if the worker spontaneously clears the infection.³⁴ If the infection does not resolve, the worker is treated for acute HCV infection as described by Jaeckel et al.⁶⁴ The role of the newly marketed HCV protease inhibitors in this setting is as yet undetermined, though these agents theoretically could play significant roles in prophylaxis and/or early treatment of occupationally exposed or infected health care workers.

The rationale for the administration of postexposure chemoprophylaxis for occupational exposures to HIV is based on (1) current scientific understanding of the early events in HIV pathogenesis; (2) biological plausibility of pharmacologic intervention; (3) studies of the safety and efficacy of antiretroviral prophylaxis in animal models; (4) clinical trials demonstrating efficacy of HIV chemoprophylaxis in other clinical settings; and (5) clinical and epidemiological data from clinical experience with antiretroviral chemoprophylaxis.¹²

Detailed descriptions of both the early events occurring following HIV exposures as well as the early events in the pathogenesis of HIV infection are beyond the scope of this discussion; however, the past decade has witnessed the development of data that suggest that postexposure intervention is both practical and achievable. These data suggest that productive HIV infection occurs in a sequence of events involving capture and subsequent infection of dendritic cells prior to the handoff to susceptible T cells.^{65,66} Each step in this sequence provides a potential target for antiretroviral intervention. These data also provide biological plausibility for chemoprophylactic intervention. Based on current

understanding, one can reasonably postulate that an anti-retroviral chemoprophylactic effect might occur by limiting the proliferation and dissemination of virus when the virus is still relatively localized, allowing for a cellular immune response resulting in viral clearance.⁶⁷

Antiretroviral chemoprophylaxis has been shown to be effective in several animal models of retrovirus infection. Some animal models evaluating antiretroviral chemoprophylaxis have demonstrated chemoprophylactic efficacy.⁶⁸⁻⁷² Assuming that such models are relevant to occupational HIV transmission prevention (a broad assumption), current recommendations for the administration of antiretroviral chemoprophylaxis maximize the potential for postexposure treatment efficacy.

Studies of the administration of antiretrovirals to humans in different clinical settings have also demonstrated the potential for postexposure chemoprophylaxis efficacy. An early prospective controlled trial demonstrated that zidovudine administration to HIV-infected mothers and their offspring reduced the risk of HIV transmission to the child by nearly two-thirds.⁷³ Two additional studies of the vertical transmission risk found that administration of antiretrovirals to only the newborn (eg, true postexposure prophylaxis) also resulted in a substantial reduction in vertical transmission.^{74,75}

Perhaps the most compelling piece of indirect evidence suggesting efficacy of antiretroviral chemoprophylaxis is the CDC's retrospective case-control study of health care workers who had exposures, matching workers who became infected with those from the CDC's longitudinal needlestick study who had exposures but did not become infected. In that study, post-exposure treatment with zidovudine was associated with an 81% reduction in the risk of infection.^{23,76} Despite the limitations of study design, that study provided among the most compelling epidemiological evidence that zidovudine afforded protection to exposed health care workers.

Antiretroviral chemoprophylaxis for occupational exposures to HIV has been in common use in the United States since the late 1980s.⁷⁷ Over the past decade, the numbers of occupational HIV infections reported to the CDC have decreased steadily,^{12,78} presumably because of several factors, including less aggressive case finding and decreased passive reporting to public health authorities; broad-scale implementation of standard precautions; administration of highly active antiretroviral therapy to HIV-infected source patients, lowering their viral burdens and reducing the likelihood of hospitalization and invasive diagnostic procedures; and use of postexposure antiretroviral chemoprophylaxis for occupational exposures.

What medical regimens are effective in lowering these risks? What are the adverse effects?

Several factors influence the selection of antiretroviral drugs for prophylaxis regimens: (1) the type of exposure and the estimated risk of HIV transmission associated with the exposure; (2) the probability that drug-resistant virus strains are currently circulating in the source patient and are likely

to be present in the inoculum; (3) the safety profile and likelihood of health care worker adherence to proposed treatment regimens; and (4) cost. Several antiretroviral agents from at least 6 classes of drugs are available for the treatment of HIV disease.^{58,79-81} These agents include nucleoside reverse transcriptase inhibitors, nucleotide reverse transcriptase inhibitors, nonnucleoside reverse transcriptase inhibitors, protease inhibitors, integrase inhibitors, and cell-entry/fusion inhibitors.

The *basic regimen* currently recommended by the CDC for postexposure prophylaxis includes either a combination of zidovudine and either lamivudine (which was the combination that Dr J received) or emtricitabine or a combination of tenofovir and either lamivudine or emtricitabine (TABLE).⁸² All of the regimens recommend treatment for 28 days for a known exposure to a HIV-positive source or for a high-risk exposure to an unknown source, based at least in part on animal studies that demonstrate that short courses are less effective.⁶⁹ These CDC guidelines are now nearly 5 years old (a revision is under way). More recent publications suggest that the newer combinations are much better tolerated, both in ongoing treatment trials^{83,84} as well as in 1 study of nonoccupational postexposure prophylaxis.⁸⁵ Combinations of antiretroviral drugs are more effective than single agents for treating established HIV infection; however, no data demonstrate that combinations of drugs are more effective for prophylaxis than a single agent. Combination therapy is offered as a hedge against viral resistance. One modeling study suggested that unless antiviral resistance in the community (ie, source patients) exceeded 15%, a 2-drug option was superior to 3 drugs from the perspectives of adverse effects, regimen efficacy, and cost.⁸⁶ In my opinion, the likelihood is high that revised guidelines will recommend a standardized 3-drug regimen for clarity.

The CDC advocates use of an *expanded regimen* (ie, adding a third agent to the basic regimen) for exposures for which the risk of HIV infection is increased.^{23,82} In the 2005 recommendations, the CDC listed the lopinavir-ritonavir (Kaletra) combination as the preferred third agent for the expanded regimen.⁸² Other ritonavir-boosted protease inhibitors will likely be equally as effective (Table). As noted herein, Dr J's exposure was characterized as low risk, so the decision to recommend standard dual combination therapy (ie, zidovudine plus lamivudine)⁸² was consonant with the existing guidelines (A).

Although nevirapine has been used historically for post-exposure prophylaxis, this agent has been associated with serious and sometimes life-threatening toxic effects in this setting and is not recommended.⁸⁷⁻⁸⁹

Gastrointestinal adverse effects (nausea, vomiting, and/or diarrhea), malaise or fatigue, and headache have consistently been the most commonly reported adverse effects associated with postexposure prophylaxis, occurring in 40% to 70% of recipients (Table).^{90,91} Adverse effects associated

with postexposure antiretroviral chemoprophylaxis are similar to those observed in HIV-infected patients and are generally reversible. Fortunately, most symptoms can be managed both proactively and symptomatically (eg, acetaminophen for headache and myalgia, antiemetics for nausea, and antimotility drugs for diarrhea). Clearly, the 3-drug regimens have been associated with more adverse effects than the 2-drug regimens; however, the newer combination treatments have been associated with far fewer adverse effects than the traditional 3-drug regimens. Drug-drug interactions occur commonly with administration of protease inhibitors; all other drugs currently being taken by the exposed health care worker (particularly those metabolized hepatically) should be carefully assessed.

COUNSELING

What are best counseling practices for health care workers who have occupational exposures?

The emotional impact of an occupational exposure should not be underestimated, particularly immediately following the exposure.^{92,93} Institutions must have plans in place to provide access to supportive counseling by clinicians who have experience with the special medical and psychological needs of exposed persons. Counselors must be able to provide clear, concise, easily understandable information about exposure risks and about the known risks and potential benefits of postexposure chemoprophylaxis. Because the exposed individual is initially likely to be preoccupied, the counselor should be patient and prepared to answer the same questions repeatedly.

Health care workers who have experienced occupational exposures are often too upset, distracted, or confused to make immediate decisions about chemoprophylaxis.

One strategy is to suggest that treatment be initiated immediately, with the health care worker having the option of discontinuing treatment subsequently. This approach often alleviates the pressure to make an immediate decision about the full 28-day course while simultaneously empowering workers to change their minds about treatment if they ultimately decide to do so. Administering the first dose of treatment as soon as possible following the exposure also likely affords the best opportunity for therapeutic efficacy.^{61,62,94}

Clinicians should emphasize the following issues when counseling exposed health care workers: (1) based on average-risk data for occupational exposures, more than 99% of exposed health care workers do not acquire HIV infection, even if no postexposure treatment is administered; (2) an exposed worker who chooses a treatment option can decide to discontinue treatment at any time; and (3) although postexposure prophylaxis has become the standard of care in the United States for occupational exposure to HIV,⁹⁵ data about chemoprophylaxis safety and efficacy are incomplete.

Health care workers who have exposure to HIV should be counseled to avoid the potential for transmission to others during the follow-up period, especially during the first 6 to 12 weeks after exposure, when seroconversion is most likely to occur.⁵⁸ Practices recommended to preclude secondary transmission include sexual abstinence or use of condoms as well as avoidance of blood and organ donation. If the exposed health care worker is breastfeeding, discontinuation of breastfeeding should be considered, especially for high-risk exposures. Modifying an exposed health care worker's patient care responsibilities to prevent transmission to patients is unnecessary.

Table. Current US Public Health Service Recommendations for Management of Occupational Exposures to HIV^a

Exposure/Regimen ^b	Regimen Components	Common Adverse Effects
HIV exposures associated with a recognized transmission risk Basic regimen	Zidovudine plus lamivudine or emtricitabine Tenofovir plus lamivudine or emtricitabine	Nausea, vomiting, diarrhea, headache, malaise, dizziness, headache, insomnia, loss of appetite
	Alternative basic regimen Stavudine plus lamivudine Stavudine plus emtricitabine ^c	Nausea, vomiting, diarrhea, headache, malaise, dizziness, headache, insomnia, loss of appetite
HIV exposures for which the nature of the exposure suggests an elevated transmission risk ^d Expanded regimen	Basic regimen plus lopinavir/ritonavir	Abnormal perioral and digital sensations, diarrhea, dizziness, headache, loss of appetite, nausea, stomach pain, dysgeusia, fatigue, vomiting, weakness
	Alternative expanded regimen Basic regimen plus 1 or more of: Atazanavir Fosamprenavir Indinavir plus ritonavir Saquinavir plus ritonavir Efavirenz ^c	See product inserts for adverse effects associated with these alternative agents

Abbreviation: HIV, human immunodeficiency virus.

^aModified from Panlilio et al.⁸² These guidelines are currently being revised. The roles of newer agents (eg, integrase inhibitors, CCR5 inhibitors) remain undetermined but are being considered for use in updated guidelines.

^bRecommended duration of treatment is 4 weeks. Follow-up recommended at 6 weeks, 3 months, and 6 months.

^cAgent(s) not recommended for use in pregnancy.

^dElevated risk associated with "deep" injuries, injury with a device placed in an HIV-infected patient's artery or vein, and injuries associated with larger volumes of blood and/or blood containing a high titer of HIV.

Counseling should emphasize reassurance, review information about the magnitude of risk, and inform the worker about institutional assurances to protect his or her medical privacy. Counselors should also be attuned to concerns of spouses, sexual partners, coworkers, family, and friends of the exposed worker.⁵⁸ Adherence to chemoprophylaxis regimens may also be enhanced if knowledgeable counselors proactively discuss the regimen, its anticipated adverse effects, and techniques effective in avoiding those adverse effects.^{96,97} Because these circumstances are associated with substantial anxiety for exposed workers, having the clinician maintain close personal contact may be beneficial and may increase adherence to the prophylaxis regimen.

RECOMMENDATIONS FOR DR J AND THE HOSPITAL

Dr J's story is typical of events that occur in emergency settings in health care institutions throughout the United States. Although his story has an optimal outcome (ie, in this instance the source patient harbored no blood-borne pathogen infections), there are lessons to be learned. My recommendations for Dr J and his institution include the following:

1. Clinicians should make an effort not to take shortcuts or use medical devices for purposes other than those for which they were intended. Finding an easily accessible, standard needle driver would have been in Dr J's best interest, even in this emergent setting; the intensive care unit should reassess its stocking pattern to ensure that appropriate needle drivers are readily accessible.

2. Although Dr J was clearly reasonably knowledgeable about the exposure, I recommend that he take some time to learn more about the epidemiology and optimal management of occupational blood-borne pathogen exposures. If another such exposure occurs, he should again be aggressive about being evaluated and treated promptly.

3. I also encourage Dr J to "spread the wealth"—to encourage colleagues to become knowledgeable about occupational risks of blood-borne pathogen infections and encourage them to report occupational exposures promptly when they occur. The resident and fellow who mandated his immediate assessment should be complimented for their appropriate management of a situation that all too often results in delayed evaluation.

4. Based on his experience, Dr J is optimally situated to work with hospital leadership, the occupational medicine program, and the infectious diseases team to help the hospital further develop a highly visible, standardized approach to the efficient, effective management of occupational exposures to blood-borne pathogens. Such an approach should include an opportunity for exposed clinicians to ask questions of an expert at the time of needlestick assessment.

5. Finally, I recommend that Dr J put these events behind him. His was a low-risk exposure. He reported the exposure promptly and was treated appropriately. As additional information was accrued, the data demonstrated that he had not been exposed to any blood-borne pathogens.

QUESTIONS AND DISCUSSION

QUESTION: I was at a meeting with a surgical program director a couple of weeks ago and he and the obstetrics and gynecology program director commented that it's often difficult to get people to report their exposures. Can you comment on underreporting and what you think we should be doing about that?

DR HENDERSON: Underreporting of occupational exposures remains a huge problem, especially among surgical staff.^{9,10,98,99} I think this problem relates both to the inadequacy or ineffectiveness of our education as well as to the reluctance of our colleagues who perform invasive procedures to understand the significance of these risks, the nature of the interventions, and the importance of reporting promptly and to take these issues seriously. Furthermore, some staff believe that reporting such exposures may jeopardize their subsequent careers because of the perception that such exposures may be viewed as technical incompetence.

QUESTION: I guess we protect our patients more than ourselves, but it sounds like we should be mounting a campaign to get all health care workers to report exposures and figure out why the exposures happened and what interventions might prevent them.

DR HENDERSON: That strategy has really worked well in my own institution and has substantially reduced the number of exposures that occur. In fact, during the last week of November 2010, the physician who runs our occupational medicine service called me to say that he had just seen the first occupational HIV exposure for the year. So we almost made it through an entire year without 1 such reported exposure. In my view, evaluating these exposures systematically, as you suggest, provides great fodder for classic performance improvement work.

QUESTION: Does the time between exposure and reporting and treatment matter?

DR HENDERSON: Certainly, the time to treatment does matter. "The sooner, the better" is a good rule of thumb, but there is no magical threshold of time. The 2001 CDC guidelines state that postexposure treatment should be administered as soon as possible; for example, within 2 hours (which was about the amount of time it took Dr J to get a first dose). Regulatory agencies unfortunately became fixated on the 2-hour window, and the 2-hour recommendation developed a life of its own. The data from animal models suggest that treatment within 24 hours is effective; nonetheless, my mantra is "as soon as possible." Earlier is clearly better, and if an institution has a fluid mechanism for completing the evaluation efficiently, strategies can easily be developed to get these drugs administered in a timely fashion.

Conflict of Interest Disclosures: The author has completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest and none were reported.

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