Review

Blood-borne viruses in health care workers: Prevention and management

S. Deuffic-Burban a,b,∗, E. Delarocque-Astagneau c, D. Abiteboul d,e, E. Bouvet d,e, Y. Yazdanpanah a,b,d,f

a ATIP-AVENIR, Inserm U995, Université Lille Nord de France, 152 rue du Docteur Yersin, 59120 Loos, France
b EA2694, Université Lille Nord de France, 1 place de Verdun, 59045 Lille Cedex, France
c Institut Pasteur, 25–28 rue du Docteur Roux, 75724 Paris Cedex 15, France
∗ Groupe d’Etude sur le Risque d’Exposition au Sang (GERES), Université Paris Diderot – Paris 7, UFR de Médecine – site Bichat, 16 rue Henri Huchard, 75890 Paris Cedex 18, France
d Hôpital Bichat-Claude Bernard, 46 rue Henri Huchard, 75877 Paris, France
f Service des Maladies Infectieuses et du Voyageur, Centre Hospitalier de Tourcoing, 135 rue du Président Coty, B.P. 619, 59208 Tourcoing, France

A R T I C L E   I N F O

Article history:
Received 7 January 2011
Received in revised form 15 May 2011
Accepted 18 May 2011

Keywords:
Blood-borne pathogens
Infectious disease transmission
Patient-to-professional
Professional-to-patient
Management risk
Prevention and control

A B S T R A C T

Three pathogens account for most cases of occupationally acquired blood-borne infection: hepatitis B virus (HBV), hepatitis C virus (HCV) and human immunodeficiency virus (HIV). The highest proportion of occupational transmission is due to percutaneous injury (PI) via hollow-bore needles with vascular access. We briefly review prevention and management of blood-borne pathogens in health care workers (HCWs) in developed countries. HCW compliance with standard precautions is necessary for prevention of PI. Safety-engineered devices are now being increasingly promoted as an approach to decreasing the rate of PI. Prevention of HBV transmission requires HCW immunization through vaccination against HBV. In non-vaccinated HCWs (or HCWs with an unknown antibody response to vaccination) exposed to an HbsAg-positive or an untested source patient, post-exposure prophylaxis with HBV vaccine, hepatitis B immunoglobulin or both must be started as soon as possible. Although no available prophylaxis exists for HCV, it is crucial to identify HCV exposure and infection in health care settings and to consequently propose early treatment when transmission occurs. Following occupational exposure with potential for HIV transmission, use of antiretroviral post-exposure prophylaxis must be evaluated. Patients need to be protected from blood-borne pathogen-infected HCWs, and especially surgeons performing exposure-prone procedures (EPPs) with risk of transmission to the patient. However, HCWs not performing EPPs should be protected from arbitrary administrative decisions that would restrict their practice rights. Finally, it must be emphasized that occupational blood exposure is of great concern in developing countries, with higher risk of exposure to blood-borne viruses because of a higher prevalence of the latter than in developed countries, re-use of needles and syringes and greater risk of sustaining PI, since injection routes are more frequently used for drug administration than in developed countries.

© 2011 Elsevier B.V. All rights reserved.

Contents

1. Introduction .................................................................................................................................. 00
2. Occupational risk of exposure to and transmission of blood-borne pathogens .................................................. 00
3. Preventing PI .................................................................................................................................. 00
4. HBV vaccination of HCWs ................................................................................................................. 00
5. Management of HCWs exposed to blood-borne pathogens ........................................................................... 00

Abbreviations: ALT, alanine aminotransferase; HCW, health care worker; EPP, exposure-prone procedure; HBV, hepatitis B virus; HCV, hepatitis C virus; HIV, human immunodeficiency virus; PI, percutaneous injury; PEP, post-exposure prophylaxis; SED, safety-engineered device.

∗ Corresponding author at: ATIP-AVENIR, Inserm U995, Université Lille Nord de France, 152 rue du Docteur Yersin, 59120 Loos, France. Tel.: +33 3 20 44 59 62/35128; fax: +33 3 20 96 68 62.
E-mail addresses: sylvie.burbain@neuf.fr (S. Deuffic-Burban), edelaroc@pasteur.fr (E. Delarocque-Astagneau), dominique.abiteboul@bch.aphp.fr (D. Abiteboul), elisabeth.bouvet@bch.aphp.fr (E. Bouvet), yyazdan@yahoo.com (Y. Yazdanpanah).

Tel.: +33 1 40 61 37 66; fax: +33 1 45 68 88 76.
Tel.: +33 1 57 27 78 70; fax: +33 1 57 27 77 01.
Tel.: +33 1 40 25 80 80; fax: +33 1 40 25 83 05.
Tel.: +33 3 20 69 46 16; fax: +33 3 20 69 46 15.

1836-6532/$ – see front matter © 2011 Elsevier B.V. All rights reserved.
doi:10.1016/j.jcv.2011.05.016

1. Introduction

Twenty-six different viruses have been shown to be responsible for occupational transmission in the literature. Three pathogens account for most cases due to their prevalence in patients and the severity of infections they cause: hepatitis B virus (HBV), hepatitis C virus (HCV) and human immunodeficiency virus (HIV). Pruss-Ustun et al. estimated that, in the year 2000, 16,000 HCV, 66,000 HBV and 1000 HIV infections may have occurred worldwide among health care workers (HCWs) due to their occupational exposure to percutaneous injuries (PIs).

In the present paper, we review data on management and prevention of blood-borne viruses in HCWs, focusing on HBV, HCV and HIV. For this purpose, systematic search was performed of Medline literature databases for papers published from January 1995 to March 2010 using the following search terms: health care workers, hepatitis C, hepatitis B/vaccination, HIV-1, infections/practices/utilization, equipment/re-use, personal protective equipment, infection control/standards, needle stick injuries/epidemiology, standard precautions, safety-engineered devices and post-exposure prophylaxis. We also searched for national guidelines on management and prevention of blood-borne viruses in HCWs via websites of public health institutes in specific countries (Centers for Disease Control, Health Protection Agency, CCLIN), and international guidelines via the WHO website (specifically, the Safe Injection Global Network).

2. Occupational risk of exposure to and transmission of blood-borne pathogens

Although case reports have documented transmission of these viruses as a result of splashes of blood from infected patients onto HCW mucous membranes, the highest proportion of transmission occurs through PI with hollow-bore needles for vascular access, i.e. blood-drawing and intravenous/arterial catheter. Risk of transmission is closely related to work practices. Surgeons and laboratory assistants have been identified as having the highest risk of PI. When PI occurs, the risk of HBV transmission is estimated as up to 30% in susceptible HCWs without post-exposure prophylaxis (PEP) or adequate hepatitis B vaccination. Average risk of HCV infection is estimated at 0.5%, but is considered null if exposure was to non-viremic patients. Risk of HIV infection is estimated at <0.3%.

3. Preventing PI

Preventive methods and standard precautions for protecting both HCWs and patients from infection with blood-borne pathogens include hand washing after patient contact, use of barrier precautions (e.g. gloves), minimal manual manipulation of sharp instruments/devices (e.g. avoidance of needle recapping) and disposal in specific resistant containers. Regular training sessions targeting both long-term HCWs, students and residents at high risk of injury can help to ensure compliance with standard precautions. Compliance with these precautions has reduced the incidence of occupational exposure, and therefore of PI, over time. For example, in the French national surveillance network, the incidence of occupational exposure (80% of which is due to PI) decreased from 8.9 in 2004 to 7.4 per 100 beds in 2008 (Table 1). At the same time, among overall PIs, the proportion of PIs preventable by taking standard precautions also decreased, from 52.5% in 2004 to 45.8% in 2008. However, a high proportion of PIs continue to occur in persons who do not adhere to these standard precautions: in 2008, 12.5% of PIs occurred while recapping needles; 31.2% of PIs occurred in HCWs who did not have containers for sharp device disposal. From available data, evaluating these trends is not possible in Belgium because data are pooled over 2003–2009 period. In the United States, a decrease in the incidence of occupational exposure is not noted over time. However, the surveillance is based on a few facilities (Table 1).

Although training and education remain key preventive measures for improving HCW compliance with improved standard precautions, safety-engineered devices (SEDs) (retractable syringes, needle-free intravenous systems, winged butterfly needles) are now being increasingly promoted for use in decreasing the rate of PI. Use of these devices might partly explain the decrease in the incidence of occupational exposure over time in France (Table 1). Several recent studies demonstrated the impact of SEDs on needle stick injuries. In one French hospital complex, the rate of needle stick injuries while using SEDs during phlebotomy was 4-fold lower than that with conventional devices. Procedure-specific differences in needle stick injury risk in two surveys conducted in 1990 and 1999–2000 also support this hypothesis. In the report of those surveys, the sharpest decrease in needle stick injury rate between the two surveys was observed for finger-stick-based collection of capillary blood and collection of blood for culture, two procedures for which use of SEDs has most strongly increased. However, SEDs do not exist for all type of procedures. For example, equipment for arterial blood sampling lack appropriate SEDs for protecting HCWs; thus, the rate of use of SEDs remained unchanged from 1990 to 2000. This may be related to the fact that SEDs are not suitable for these procedures, but also to cost issues. Although the cost of SEDs may represent an obstacle to their use, this drawback must be weighed against the cost of needle stick injury management and that of occupational blood-borne infections such as hepatitis B and C and HIV.

Since some studies had reported the effectiveness of blunt-tip suture needles in decreasing PIs, the American College of Surgeons issued a statement in 2005 supporting universal adoption of blunt-tip suture needles for suturing fascia. In 2008, in the US, the Occupational Safety and Health Administration, the Department of Labor, the National Institute for Occupational Safety and Health, the CDC and the Department of Health and Human Services strongly encouraged use of blunt-tip suture needles whenever feasible and appropriate. The impact of these recommendations...
on the incidence of occupational exposures will be evaluated in coming years.

4. HBV vaccination of HCWs

All HCWs in contact with patients, blood or other body secretions should be vaccinated for HBV. HBV vaccination protects HCWs not only against HBV infections but also against delta virus infections occurring only in individuals positive for HBV surface antigen.28,29 However, vaccine coverage remains disparate in western countries, and poor vaccine coverage has been reported in some countries despite recommendations.30 To ensure wider hepatitis B vaccine coverage, vaccination should be carried out, or immune status verified, very early on in the HCW career, ideally prior to beginning training, as is currently the case in France31 and as recommended by European guidelines.28 Wider vaccine coverage is likely to be achieved by a mandatory vaccination policy, as in France, although such a strategy raises ethical issues.

The HBV vaccine does not provide protective response in all fully vaccinated persons. Between 5% and 10% of healthy immunocompetent subjects do not show an antibody response to the vaccine (non-responders; HBs antibody level <10 IU/l).32 Factors associated with non-response include male sex, older age, cigarette smoking, obesity and chronic disease.33 European guidelines for prevention of HBV and HCV transmission from HCWs to patients recommend that HCWs vaccinated against HBV should have their response documented within a month by the final dose. HCWs with anti-HBs, between 10 and 100 IU, should be tested for HbsAg, but this is not imperative for administering further doses of vaccine to boost the anti-HBs response.34 Non-responders to the HBV vaccine should also be tested for HbsAg and Hbc antibodies.35,36 If negative, they should be administered up to three further doses of HBV vaccine and then have their response re-checked.35 Continuing non-responders are susceptible to HBV infection and should be screened at regular intervals or after significant exposure.

5. Management of HCWs exposed to blood-borne pathogens

The exposed site should be washed with soap and water. The potential for transmitting HBV, HCV and HIV should be evaluated based on the type of exposure and body material involved. The risk of transmission of these viruses increases with deep injuries and procedures involving hollow-bore needles.3,13 The source patient’s serostatus for antibodies against HIV, HCV and HbsAg should be obtained. If the source patient is at risk of recent HIV or HCV infection on the basis of recent exposure (e.g., in the previous 2–4 weeks), nucleic-acid based testing (e.g., HIV and HCV RNA viral load testing) should be considered for the patient source to rule out acute infection, which would confer increased risk of transmission.3 In addition, baseline HBV, HCV and HIV immune status of the exposed HCW should be available.

5.1. HBV

In previously vaccinated HCWs with known antibody response, neither PEP nor serological follow-up is recommended. In other HCWs, if the source patient is HbsAg-positive or untested, or if the source is unidentified, PEP with HBV vaccine, hepatitis B immunoglobulin or both must be started as soon as possible, preferably within 24 h after exposure and no later than one week after exposure (see Table 2 for details).38,39 If the source patient is HbsAg-negative, the HCW HBV status should be tested if unknown and vaccination should take place if necessary.

5.2. HCV

Although no available prophylaxis exists for HCV, effective treatment is available. Thus, it is important to identify HCV exposure
in health care settings so as to perform screening at the time of HCV exposure, to monitor all HCWs for HCV and to offer early treatment for cases in which transmission occurs. In HCWs exposed to viremic HCV source patients, European guidelines recommend monthly monitoring of alanine aminotransferase (ALT) activity for 4 months after HCV exposure, anti-HCV antibodies at month 6 and HCV RNA testing to confirm a rise in ALT or positive anti-HCV antibody results. However, French guidelines recently recommended HCV RNA testing in HCWs exposed to HCV two weeks after exposure, with a control of anti-HCV antibody and ALT at 1, 3 and 6 months. Early HCV RNA testing may lead to earlier detection of hepatitis C and therefore to earlier initiation of anti-HCV therapy when compared to strategies based on ALT and/or HCV antibody detection. This strategy leads to lower risk of progression to chronic hepatitis C and was recently found to be reasonably cost-effective. The American Association for the Study of Liver Diseases (AASLD) practice guidelines recommend treatment initiation in patients with acute HCV if serum HCV-RNA is not eliminated spontaneously within 12 weeks of HCV transmission. In a recent model-based analysis, we showed that early antiviral therapy with pegylated interferon within the first 2 months following transmission may decrease the risk of chronic hepatitis C occurrence by 54–68%. Nevertheless, results of this model-based analysis must be confirmed in the future.

5.3. HIV

Following occupational exposure with potential for HIV transmission, use of antiretroviral PEP should be evaluated based on the route of exposure, the material involved and evaluation of the source patient. For the route of exposure, antiretroviral PEP is recommended after PI; it should be considered after exposure of mucous membrane or non-intact skin, but should be discouraged after exposure of intact skin. Concerning the material involved, antiretroviral PEP is recommended after exposure to blood, blood-containing virus in a research laboratory; it should be considered after exposure to semen, vaginal secretions, synovial, pleural, peritoneal, pericardial or amniotic fluid and tissues; it should be discouraged after exposure to urine, vomit, saliva, feces, tears, sweat or sputum. Finally, concerning the source patient, antiretroviral PEP is recommended if the source patient is known to be HIV-infected; it can be considered if the serological status of the source patient is unknown or not available, or if there exists consent refusal; it should be discouraged if the source patient is HIV-seronegative. If the source patient’s HIV serostatus is unknown, highly sensitive rapid ELISA, including a 4th generation HIV screening assay (antigen p24), may be useful for diagnosis of HIV infection, limiting unnecessary treatment. A positive HIV test should be confirmed by western blot. If the source patient is known to be HIV-infected, the risk of transmission differs according to viral inoculum; a useful threshold for risk stratification when evaluating the potential for transmission might be a detectable load (i.e. ≥50 copies/ml). However, uncertainty exists as to whether or not transmission occurs if the source patient viral load is <50 copies/ml; thus, the question of starting PEP in these patients is subject to debate. However, in France and Switzerland, when the viral load is <50 copies/ml, stable for several months and confirmed after exposure, and if the injury was superficial, PEP is not considered.

If initiation of PEP has been decided, then current use of specific antiretroviral drugs, prior drug exposure and drug resistance of the source person should be evaluated in order to adapt the PEP regimen. It should be initiated as soon as possible, and administered for 4 weeks. PEP should be discouraged at over 72 h after exposure. PEP should be immediately accessible 24 h/day. All HCWs occupationally exposed to HIV should be clinically followed up regardless of whether or not they received PEP. European recommendations for clinical evaluation and HIV serological follow-up recommend follow-up visits and HIV testing at 6–8 weeks and three months post-exposure. In patients with PEP, compliance and tolerance must be monitored, in particular at 15 days depending on the toxicity profile of the drugs.

6. Preventing transmission from HCWs to patients

The Society for Healthcare Epidemiology of America (SHEA) has recently reviewed data on HCW-to-patient transmission. Reports of HBV, HCV and HIV transmission from HCWs to patients exist. Occupational transmission of blood-borne viruses to patients almost exclusively occurs via infected HCWs such as surgeons performing EPPs. EPPs are “those where there is a risk that injury to the worker may result in exposure of the patient’s open tissues to the blood of the worker. These procedures include those where the worker’s gloved hands may be in contact with sharp instruments, needle tips or sharp tissues (spicules of bone or teeth) inside a patient’s open body cavity, wound or confined anatomical space where the hands or fingertips may not be completely visible at all times”. In general, blood-exposed patients should systematically receive the same post-exposure follow-up and management as HCWs. For this, it is important to scrupulously report all exposure, especially that occurring in EPPs. Meanwhile, HCWs should be protected from arbitrary administrative decisions restricting their practice rights. The vast majority of HCWs infected with blood-
borne pathogens do not perform EPPs and pose no risk to patients even when infected. Restrictions would indeed be senseless and harmful.

6.1. HBV

In general, national guidelines for management of infected HCWs state that the HBV status of all medical personnel performing EPPs must be known. To prevent iatrogenic transmission of HBV, EPPs should be prohibited in HBV-infected HCWs who have HBV viremia above a specific threshold. Threshold levels above which EPPs are prohibited vary from country to country. The European consensus threshold level is 10,000 HBV DNA copies/ml, while the British threshold level is 1000 copies/ml and the Dutch threshold level is 1,000,000 copies/ml. However, with the availability of inhibitors of HBV polymerase for chronic HBV infection treatment, HBV DNA may be durably suppressed in HBV-infected HCWs. Thus, as illustrated by Buster et al., prolonged antiviral therapy for HBV-infected HCWs is a viable option instead of work restriction, provided that the level of HBV DNA is monitored regularly. This option is also likely to encourage already employed HCWs to determine their status.

6.2. HCV

Currently, no uniform guidelines exist for identification of HCV-infected HCWs who perform EPPs, nor for prevention of HCW-to-patient HCV transmission. A few countries have proposed guidelines, including the UK and the USA. In the UK, only new HCWs who will be performing EPPs, and HCWs already involved in EPPs who have suffered an accidental needle stick, are required to undergo screening for HCV antibodies. Moreover, guidelines recommend that HCWs with HCV infection not perform EPPs. HCV-infected HCWs who have a sustained virological response to antiviral therapy are allowed to perform EPPs six months after cessation of treatment. Current guidelines concerning prevention of HCW-to-patient transmission of HCV need to be improved. An alternative option to work restrictions for HCV-infected HCWs would be a therapeutic option, which would also incite HCWs to learn their status. In light of the fact that new drugs with increased efficacy will soon be available for patients with chronic hepatitis C, a therapeutic option for HCV-infected HCWs should be strongly encouraged in the near future.

6.3. HIV

The current CDC policy on infected HCWs, issued in 1991, states that HIV-positive HCWs should not perform EPPs unless they have sought counsel from an expert review panel and have been advised under what circumstances, if any, they may continue to perform these procedures. In addition, that policy states that permitted procedures should only be performed after informed consent from the patient. Some authors call for “a less restrictive national health policy regarding infected health care providers,” maintaining that the policy currently in effect is too stringent and that infected HCWs pose an insignificant risk to patients. This is probably true in HCWs receiving combination antiretroviral therapy who have a viral load <50 copies/ml.

7. Conclusion

Here we have briefly reviewed prevention and management of blood-borne pathogens in HCWs in developed countries. It is important to emphasize the fact that occupational blood exposure is of great concern in developing countries; indeed, a high proportion of worldwide occupationally acquired HCV, HBV and HIV infections occur in these countries. HCWs are exposed to patients with a higher prevalence of blood-borne viruses than in developed countries. Moreover, re-use of needles and syringes in the context of a lack of supply is not rare. Finally, HCWs are at higher risk of sustaining PIs because injection routes are more frequently used for drug administration than in developed countries, exposing them to greater risk. In addition, two-handed needle reusing and improper needle disposal remain frequent in these countries.

In response to this threat to both HCWs and patients, efforts have been made on an international level via WHO implementation of the Safe Injection Global Network (SIGN), the overall goal of which is to promote safe injection. In developing countries, in particular, data on injection practices are essential so as to adapt preventive strategies and refine training programs. It is also important to improve hepatitis B vaccine coverage; in developed countries as well, it is important to verify immunization and consequently to begin vaccination early in the career of HCWs.

Conflict of interest

S. Deuffic-Burban received grants from Roche and Janssen-Cilag. Y. Yazdanpanah received travel grants, honoraria for presentations at workshops and consultancy honoraria from Bristol-Myers Squibb, Gilead, Glaxo-SmithKline, Merck, Pfizer, Roche and Tibotec. None of the authors report any association that might pose a conflict of interest.

Acknowledgments

The authors thank Céline Ciotti and Gérard Pellissier from the Groupe d’Etude sur le Risque d’Exposition au Sang (GERES) for their valuable assistance on research data of occupational exposure in the world.

Funding: None.

Ethical approval: Not required.

References


34. Letiau 16 of marzo 2007 fixando les conditions d’immunisació de les persones visàries de l’article L. 3111-4 du code de la santé publique; 2007; Available from: http://www.legifrance.gouv.fr/legexpTexteJORF.do?reprie=true&page=1 [cited 08.03.10].


38. EASL international consensus conference on hepatitis B. J Hepatol 2003;38:533–40 [consensus statement (short version)].


