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Research Article

Occupational Hazard (Hepatitis B & C)

Abstract

Hepatitis B and C are considered as an important health hazard among health care workers (HCWs). These blood borne infections can be transmitted either from HCW to a patient or vice-versa. Both viruses are known to cause hepatitis, cirrhosis and hepatocellular carcinoma. Among these two blood borne infections, HBV is usually more stable in the external environment and is more infectious as compared to HCV. HBV is associated with an average risk of 30% after having a potential exposure to the infected blood as compared to HCV, which is associated with a lower risk of 3%. Though, universal precautions should be undertaken at different clinical setups but still occupational exposure to these blood borne viruses does occur. However, due to the availability of effective vaccination and post exposure prophylaxis against HBV, incidence has decreased tremendously over the past few years. Among different categories of health workers, surgeons, nurses and dentists are at a higher risk as they tend to come in intact with patient's blood and body fluid during various interventions and surgeries. The present chapter describes in detail about the current situation of HBV and HCV as a potential health hazard along with management and treatment guidelines.

Introduction

HBV and HCV – Important occupational health hazard

Health care workers (HCWs) refer to all the people who are involved in delivering health care services, this includes doctors, nurses, students, trainees, laboratory staff and mortuary attendants, who have direct contact with patients , their blood, body fluids and their surrounding environment. Due to the nature of their work, they are at risk of acquiring various health hazards. Among the biological hazards, infectious agents such as Human immunodeficiency virus (HIV), tuberculosis (TB), Hepatitis, Pandemic influenza A (H1N1) are a major threat to the HCWs, if proper biosafety precautions are not adopted. Apart from these biological hazards, HCWs are also exposed to several other hazards such as chemical hazards (glutaraldehyde, ethylene oxide), physical hazards (noise, radiation), ergonomic hazards (heavy lifting), psychosocial hazards (shift work, violence and stress), fire hazards and electrical hazards.

HCWs too need safe working environment and health protection as those workers involved in occupations associated with health hazards such as mining and construction. HCWs are engaged day and night in patient care and tend to ignore their own health. HCWs are often considered as "immune" to injury and illness and are often expected to sacrifice their well-being for the sake of their patients. However, for providing high quality of care to the patients, safety of HCWs is of prime importance. In this chapter, health hazards associated with blood borne pathogens mainly Hepatitis B virus (HBV) and Hepatitis C virus (HCV) are discussed. Another important blood borne viral infection is HIV, the awareness of which is good among the HCWs, but knowledge about HBV and HCV as an occupational health hazard is still not widely prevalent among HCWs. Therefore, in this chapter several important facts about HBV and HCV epidemiology among HCWs, management and treatment guidelines along with preventive strategies have been discussed.

In a health care facility, flow of infectious agents is bidirectional i.e. from patients to HCWs and vice-versa. Thus, good infection control practices are essential to limit such infections. These may range from simple hand washing to use of more sophisticated personal protective equipment (PPE) depending upon on the nature of threat from the surrounding environment and the mode of transmission of infection. However, universal precautions should strictly be followed in the health care facilities, but sometimes the compliance is not stringent owing to the increased workload, lack of resources in terms of labor and infrastructure. It is commonly perceived that due care should be exercised only while handling samples from HBV, HCV and HIV infected patients. The HCWs should understand that at any time point a hospital may have a large pool of asymptomatic patients who harbor the pathogens but are asymptomatic for the same. Hence, all patients and samples should be treated as potentially infectious. Also, apart from ongoing awareness on antibiotic stewardship policy and infection control practices, awareness about HBV and HCV as an important occupational health hazard is also essential. Policies for the management, reporting and treatment of accidental exposure of HBV and HCV should be made available in all health care facilities and universal vaccination against hepatitis B should be made compulsory in all the health care settings.

If a HCW is a carrier of HBV or HCV, he or she may be liable to transmit these blood borne infections to patients. Therefore, proper screening and annual health work ups of HCWs should also be advised. To prevent the needle stick injuries, proper education about the use and disposal of needles and syringes should be taught at the basic student level so that the chances of acquiring infection by HCWs are minimized.

The Centers for Disease Control (CDC) estimates that about 600,000 to one million needle stick injuries occur each year. Unfortunately, about half of these needle stick injuries go unreported (CDC, 2007) [1,2]. HHBV, HCV and HIV are the potential well recognized blood borne viruses. Worldwide they are also the leading cause for chronic hepatitis, cirrhosis and hepato-cellular carcinoma (HCC) [3,4] which draws the attention to take steps for establishing

comprehensive knowledge, prevention and care. Occupational health and safety is an important issue because apart from being responsible for high rates of associated morbidity and mortality, these infections cause significant psychological impact. An estimated 100,000 people die from occupational illnesses, while about 400,000 new cases of occupational diseases are diagnosed every year [5,6].

Epidemiology

Agent, host and environment

Agent: HBV and HCV are known to cause hepatitis, but both the viruses differ in their basic characteristics, clinical features, and treatment options. Despite the fact that both the viruses are from different families, viral hepatitis caused by them is indistinguishable based on clinical symptoms. Both the viruses are present in blood and many other body fluids, including tears, saliva, semen, and vaginal secretions. The viruses have affinity for hepatocytes and they interfere with the functions of the liver during their replication. They are the main cause for hepatic decompensation, cirrhosis and hepatocellular carcinoma. HCC represents approximately 4% of all new cancer cases worldwide and HBV is responsible for >50 % of HCC cases [7], while HCV contributes to another 25% of cases [8].

Thus, it is essential to have a brief idea about both the viruses before the occupational health hazard associated with them can be detailed out.

HBV: HBV is a DNA virus belong to *Hepdnaviridae* family. It is 42nm in diameter, enveloped virus having icosahedral symmetry. However, it is a DNA virus, but still it has a high rate of mutations similar to that of RNA or retroviruses due to viral polymerase mistakes associated with the additional step of reverse transcription, necessary for genetic material replication. At its surface, hepatitis surface antigen (HBsAg) is present. Viral capsid is formed by core proteins and carries viral genomic material and polymerase [9]. The circular DNA of HBV is partially double stranded and encodes for four open reading frames (ORFs): PreC/C encodes for hepatitis B e antigen (HBeAg) and core protein (HBcAg), P for polymerase (reverse transcriptase), S for surface proteins and X for transcriptional and trans activator protein [10,11]. The diagnostic backbone of HBV infections are serological and molecular techniques for the detection of specific antigens/antibodies and virus DNA respectively.

HCV: It is an enveloped single stranded positive sense RNA virus belonging to *Flaviviridae* family. The glycoproteins E1 and E2 are embedded in the envelope. Apart from structural proteins (E1 and E2), several other non-structural proteins aNS2, NS3, NS4A, NS4B, NS5A and NS5B are also encoded by the virus. Based on the genetic differences between HCV types, it is classified into seven genotypes (1-7), several subtypes and quasispecies. The virus has high rates of mutation and no commercial vaccine is available for prevention. Thus, strict adherence to universal precautions is the key to prevention among HCWs.

Routes and risks of transmission: Both HBV and HCV transmitted parenteral and are capable of causing both acute as well as chronic hepatitis. HBV is mainly transmitted through contact with blood and body fluids of an infected person. Whereas, most common route of transmission of HCV is through unsafe injection practices, inadequate sterilization of medical equipment and transfusion of unscreened blood and blood products [12,13]. If a HCW has been vaccinated against hepatitis B virus, there is no risk of acquiring HBV infection if adequate immunity has been developed following vaccination. However, in an unvaccinated individual, the risk from a needle stick injury ranges from 6% to 30% depending upon status of hepatitis e antigen of the source individual. Whereas, risk is approximately 1.8% (range 0-10%) from needle stick injury exposed to HCV-infected blood. After blood splash, risk is known to be minimal but HCV infection has been reported after such episodes. HIV carries the minimal risk of 0.3% after a needle stick injury, though it is the most commonly known virus among general HCWs.

In a nutshell, the probability of transmission of HBV and HCV infection depends upon the route of exposure, concentration of infectious virions in the infected body fluids and volume of infected material transferred [14]. Transmission may result from percutaneous or mucous exposure to infected blood and body fluid. The various body fluids implicated in transmission of HBV and HCV infection are pleural fluid, peritoneal fluid, amniotic fluid, synovial fluid and cerebrospinal fluid (CSF). However, faeces, nasal secretions, tears, vomitus are not considered potentially infectious unless they contain blood. HBV and HCV do not penetrate intact skin and airborne transmission does not occur [15]. Significant exposure is defined as an exposure of a person to potentially infected blood and body fluids in his/ her work place. The exposure is not always significant, it is considered significant only if there is a potential for infection like percutaneous injuries, splashes on mucus membranes and contact with abraded or damaged skin. Some exposures (such as contact with clothing) are not significant because there is no potential for infection.

The concentration of HBV in blood and body fluids varies from few to 10^9 virions/mL. The highest concentration has been documented in those individuals in whom virus is actively replicating and are positive for hepatitis e antigen. The concentration in body fluids such as saliva and semen is 1000 to 10,000 fold lower as compared to that found in blood [16,17]. HBV is stable at room temperature for ≥7 days, resistant to drying, simple detergents and alcohol. As concentration of HBV may be high in blood and body fluids, contamination of surfaces/equipment may lead to transmission through inapparent modes, such as exposure through non-intact skin [18]. However, inactivation of HBV can be achieved by using intermediate level disinfectants such as 0.1% glutaraldehyde and 500 p.p.m. free chlorine from sodium hypochlorite [15,19].

HCV RNA concentration is relatively stable in serum of patients with chronic infection. HCV is generally present in the range of 10^5 – 10^8 genome equivalents/mL [20]. Although, HCV has been detected in saliva, semen and other body fluids, but these are not believed to be efficient vehicles of transmission [14,21]. There is a lack of literature on survival, disinfection, sterilization and disinfection procedures because of the non-availability of cell culture system. A recent study suggests that dried plasma of HCV infected patient is infective up to 16 hours at room temperature [18]. However, in liquid environment at lower temperature, the infectivity of HCV can be detected up to 5 months [22]. However, epidemiological data has shown that

environment contamination is not the major route of transmission [23]. Conventional sterilization procedures such as steam autoclave or chemical germicides with intermediate level of disinfection are sufficient for inactivating HCV [19].

Global burden: Approximately, 240 million people are chronically infected with hepatitis B and 6,86,000 people die every year due to complications associated with hepatitis B such as cirrhosis and liver cancer [12]. However, global burden of HCV is less as compared to HBV and it corresponds to 130-150 million people who are suffering from chronic hepatitis C infection. Mortality associated with HCV is more or less similar to that of HBV associated deaths and 7,00,000 people are expected to die each year from hepatitis C related diseases [13]. Thus, high burden among general population is an important contributing factor that increases the pool size of reservoir. This further increases the chances of acquiring an infection by HCW due to accidental exposure to blood and blood products.

Host

From patients to health care workers (occupations): Health care is one of the fastest growing sectors of economy. Increasing number of available advanced treatment options across the globe has led to an increase in recruitment of HCWs. Approximately, 18 million HCWs are employed only in US and women represent 80% of the work force [24]. Providing a health care is a team effort and different types of HCWs provide health care facilities such as physicians, surgeons, nurses, technicians, dentists, laboratory workers etc. All are at an increased risk of getting exposed to potentially infected blood and blood products. Those who are involved with invasive procedures are at higher risk and transmission through needle stick injuries is the most common route of transmission of HBV and HCV among HCWs.

Surgeons are exposed to sharps and complex instruments daily as part of their routine procedures. Literature reflects that the surgeons are at the highest risk and the reported exposure ranges from 38% - 87.4% in various studies [25-27]. A review has reported that the surgeons in U.S. are victim of one–fourth of the total annual occupational injuries. In majority of the cases, injury with suture needle and blades has been implicated. Various reasons for increased injuries among surgeons include:

- Lack of appropriate operating equipments.
- Lack of proper assistance during surgery either due to less staff available or untrained new staff.
- Inexperienced surgeons, those who lack the required surgical skills to conduct safe procedures.
- Lack of adherence to sharp safety policies.
- Consultants and senior surgeons who were found to spent more time in OTs and also involved in teaching.
- Lack of time, work overload with inadequate breaks from the operating room.

Moreover as a part of the surgical culture it is the patient first at all cost, and when an accident occurs in the operating room, the surgeon's first inclination is to continue with the operation and complete it. It has also been observed that surgeons might be reluctant to report the accidents for fear of being barred from further practices. A French study estimated that the surgeons experience 0.8 injuries per 100 h of operating time, or 210 injuries throughout their career, resulting in a 6.9% lifetime risk of contracting hepatitis C [28]. CDC has reported that the use of instruments rather than hand and blunt-tip suture needles during surgical procedures can significantly reduce suture-related percutaneous injuries during operations.

Medical students of final and pre-final year being overenthusiastic and less experienced also have reported high percentage of exposure ranging from 27% - 71% [29,30].

The frequency of percutaneous and mucocutaneous exposure in dental professionals is more than other occupations, associated with invasive procedures. Approximately 2 million dental health care professionals worldwide are exposed to the blood as well as saliva of the patients, increasing the probability of transmission of infection. The dentists are 3-10 times more prone to HBV than the general population, while the risk of HCV is only slightly higher [31]. Seroprevalence of HBV is 9% and HCV is 1.4% in dental professionals [32]. Literature has reported up to 85% exposure among [3], the dentists due to small field for work with frequent patient movement and proximity to sharp instruments. The fingers are the most commonly affected followed by thumb and then the hands. The common instruments causing injury are needles (anaesthetic/local), [4,32,33] drilling instruments, endodontic files and lab knife. The occupational exposure rates have shown different trends in the review studies, a study done between 1986-1995 [34], among U.S. dentists including residents, hygienists, assistants and oral surgeons have shown a steady decline in percutaneous injuries over a period of 10 years. Same trend was noticed in different studies from Brazil, 60% PCI in 2012 which was > 85 % in 2005 & 2006. However another study done by New York University College of Dentistry in 1987-1997 [32], reported exposures to blood and other potentially infectious materials as 6.5 per year in 1987-88 which increased to 50.6 in 1990 and 79.3 in 1995-97, the rise may be due the increased awareness regarding the reporting of occupational exposure. The steadily decline reported may be due to the compliance of infection control practices, awareness and hep B vaccination. Barriers like gloves, masks, eye wear and a good suction should be used to prevent occupational exposure. Percentage of PCI reported from India ranges from 50%-77% [35-37] which is greater than that reported worldwide 25%-50% [37]. It was evaluated that increased percentage of injuries were reported in dentists which had less than 10 years of experience[3], in teaching clinics [32], among students[32] and among those who do not use dental assistant [33]. In spite of number of awareness programs like use of PPE, safe handling of instruments and use of safety syringes, a study [4], at dental university reported that the rate of injuries increased among students over a 13 year period, possibly due to low awareness and casual attitude of the students. Questionnaire literature [32,33] shows that the maximum injuries occur post-procedure while cleaning up the instruments. Azad et al. [33], has reported that >90% of injuries are avoidable if appropriate measures are taken like proper PPE, single handed needle recapping adoption, withdrawal of the needle

after palpation of retro molar area, handling of single instruments at one time rather than multiple ones, use of safety syringes etc.

Globally there are around 19.3 million nurses [38], who are at high risk of occupational hazards. Nursing as an occupation has a high level of stress which increases the probability of accidental injuries. Eljedi et al. [39], have reported that nurses are 4.27 times more at risk than other medical professionals and Aluko et al., in a study among HCWs have reported 57.6 % of exposure in nurses [5]. One study among HCWs from Central America reported higher HBV infection among nurses (30%) and nonprofessional staff (34%) than among physicians. Indian studies [40,41] have also shown similar results. The majority of the cases occurred due to the needle stick injury in 45.5% to 94.5% cases [5,39]. The probability of a needle stick injury among nurses in a Poznan [42], study group was 28.0% per year, and it was 0.8/nurse/year in a US study [43]. More hazards were reported in nurses posted in surgical wards, OT's, and emergency units. Like other professional students, nursing students are affected more [2,39]. The majority of NSIs were self-inflicted during recapping [2,5,43] others were during removing needles, placing them in overfilled containers etc.

Laboratory technicians are exposed to the blood samples either during sample collection or processing them in laboratory. Little literature has been published among laboratory technicians with varied results. Shoaei et al. [44], have observed that in spite of the fact that 30% - 70% of the laboratory technicians had abrasions, cuts and history of body fluid splashing, majority of them did not develop both HBV & HCV after an average of 10-15 years of work. This may be because they are not directly involved in invasive procedures or the viral load may be less in samples of blood and body fluids in case when exposure occurred. Indian literature have reported injury rate to be 29.2% from Tamil Nadu and 66.7% from Kolkata though the seroconversion rate was not evaluated in these studies. Maximum injuries were reported among the new staff, during odd hours of working i.e. late nights or early morning and improper and careless handling of the instruments.

Bio-medical waste is an inevitable by-product of the hospitals on the daily basis. Its proper disposal and maintenance of clean environment is the ethical responsibility of hospital administration. Out of the total waste generated only 10%-25% of it is considered infectious. This infectious waste poses serious threat during collection, transportation and disposal, by causing injuries with sharps and needles and splashes on eyes and face with liquid waste. The literature regarding the exposure among waste handlers is limited as they are less educated, do not report exposure and often overlook their injuries. The limited literature from both developed and developing countries report significant exposure among waste handlers. The global prevalence in waste handlers is reported to be high i.e. 41.8% - 67.5%, this may be due to their lower education status and low awareness about the risk of infection acquisition. They often handle overfilled containers, proper disposal guidelines are not followed, and transportation of waste containers is done without the use of heavy duty gloves especially in resource poor settings. A study from Ethiopia compared the HBV & HCV positivity rates between medical waste handlers and non-medical waste handlers, HBV & HCV positivity rate was 6% & 1% among medical waste handlers and 1% & 0% among non-medical waste handlers (NMWH), the difference being significant. Another study from Ethiopia reported 6.3% HBsAg and 47.6% anti-HBcAg, in medical waste handlers which was significantly higher compared to NMWHs (0.8% and 31.7%) [45]. A study from UK reported that all waste handlers reported frequent splash or droplet contamination while handling waste sacks, they also reported at least 40 incidents of injuries among waste handlers [46]. A study from India reported that among all the hospital staff, 15.1 % of injuries was in waste handlers alone. Erdem Y et al. [47], concluded that inappropriate disposal of waste was associated with as high as 80% of these injuries. Apart from inadequate training, supervision, and support with regard to infection control, limitation of resources and workload pressures in developing countries contribute to high prevalence of accidents among them. This group of HCWs require periodic 'refresher training' apart from 'induction training' programs regarding waste handling and disposal.

Few studies have reported injuries in other hospital staff also, Hashmi et al. [48], has reported 6.3% of injuries among laundry workers and Jayanath et al., have reported 15% exposure in cleaning staff and 1.7% in other categories of staff involved in patient care [49].

Apart from risk to health care workers, occupational hazard also includes transmission of infection from the infected health care worker to the patients. This has long been identified and there are number of published cases of transmission of HBV infection from HCW to patient [50]. The first case series was published in 1969 when eleven patients were suspected to have possibly acquired infection from an infected nurse, who was not aware of her HBV infection. This report was followed by more than 50 publications of HBV (HCW to patient) transmission till date. Various health care workers involved were oral surgeons, dentists, obstetrician, gynecologist, general surgeons and orthopedic surgeon. They are divided into "high transmitter risk" which include surgeons, operating room nurses, intensive care (ICU) staff, interventional radiologists, and emergency department staff. All the other healthcare occupations are generally considered as to "below transmitter risk" [1]. HCW to patient transmission was defined as either confirmed, probable and possible transmissions.

Others at risk include the people working in the emergency response team or working as a public safety personnel. Apart from needle stick injuries, other sharp injuries, mucous membrane exposure and skin exposures also contribute towards transmission of HBV and HCV among HCWs. In addition to the use of sharp devices, percutaneous injuries in EPINet hospitals, associated with certain work practices such as activities after use and prior to disposal, such as item disassembly, disposal-related activities and recapping a used needle [51]. According to the Occupational Safety and Health Administration (OSHA), "occupational exposure means reasonably anticipated skin, eye, mucous membrane, or parenteral contact with blood or other potentially infectious materials that may result from the performance of an employee's duties" [52].

Over the past few years, substantial efforts have been made to prevent HBV transmission among HCWs by immunization [27,53,54]. However, among those who are susceptible in the absence of post exposure prophylaxis, the risk is 37% to 62% and 23% to 37% if the source patient is HBeAg is positive and negative respectively [54].

Majority of infections among HCWs occurred before the implementation of vaccination and post exposure prophylaxis. There has been a tremendous decrease in HBV infections among HCWs during last decade. This decrease has been attributed to implementation of standard precautions, use of safety devices along with hepatitis B vaccination among HCWs and post exposure prophylaxis.

The average rate of getting sero-converted after an exposure from the source patient is relatively low for HCV and it corresponds to 1.8%. The prevalence of antibody to HCV among HCWs in US is relatively similar or even lower as compared to levels of antibodies present in general population. As currently no vaccine is available, thus strict adherence to standard precautions is recommended.

From HCWs to patients: Infectious agents can also be transferred from HCWs to patients and nosocomial infections transferred by contaminated hands of HCWs are well documented and hand washing is recommended to prevent such infections. Apart from this blood borne infections have also been documented, which were transferred to patients seeking health care facilities from an infected HCWs. Thus, it is both ways that infection could be transmitted either to a patient or HCW.

Most of the reports have been published prior to 1990s, before the widespread use of barrier precautions and vaccination against HBV. These investigations have documented varying rates of transmission from ≤1% to 13% with most reported cases to less than ten [27].

U.S. estimating the prevalence of HBV infection in HCWs reported that the infection is approximately four times higher than in general population [55]. Literature from various countries regarding the prevalence of HBV among HCWs is reported to range between 1%- 16%.

Published literature documented 50 outbreaks in which 48 HBV infected HCWs (39 surgeons) transmitted infection to approximately 500 persons. Few cases of HCV (8) and HIV (3) have also been reported that resulted in transmission from infected HCWs.[56] Such risk of infection results from exposure prone procedures associated with surgical specialties such as obstetrics and gynecology, orthopedics, cardiothoracic surgery. However, some reports also documented that skin lesions in HCWs such as exudative dermatitis, bleeding lesions or cuts can also transmit HBV infections among care seekers. Besides, screening of HCWs, efforts should be made to develop technology that can be used to perform minimal invasive surgery. Other things such as use of blunt suture needles, improved instruments and reinforced gloves should be implemented so as to reduce the risk of transmission. However, in the pre vaccination era the incidence of HBV in HCW was >300/ 100,000 population in 1985 and it was reported to be < 50/ 100,000 population in the year 2000. This steep decline is mainly due to the mandatory hepatitis B vaccination, catch-up adolescent vaccination, and partly due to the increased awareness among HCWs.

There are only few reports pertaining to transmission of HCV from HCWs to patients. The incidence of HCV is higher among less developed nations. The prevalence of hepatitis C is lowest in Northern European countries, including Great Britain, Germany and France (<2%) as compared to Asian and African countries (≥ 3%) and it is highest in Egypt (>10%)which is due to the reuse of syringes during a schistosomiasis eradication program in the 1960s and 1970s [8]. The mode of transmission across the globe is uniform and mostly involves exposure to contaminated needles or syringes. However the rate of infection after accidental percutaneous exposure to hepatitis C virus (HCV) varies and it is estimated to be between 0.2%–10%, corresponding to the HCV endemicity in that particular area.

The seroprevalence of HCV in healthcare workers across the globe lies between 0.2%- 5.4% [57]. It is more in developing countries as the most common mode is occupational related while in developed nations it is injection drug use. CDC reported that the incidence of anti-HCV seroconversion in U.S. after accidental percutaneous exposure from an HCV-positive source is 1.8% and that too occurred only from hollow-bore needles as compared with other sharps. In India it was reported to vary between 1.2%- 5.7% [58]. The increasing rate of hepatitis C virus (HCV) infection globally, in the community will be directly proportional to the increased risk of occupational exposure among healthcare workers.

Most instances are not associated with exposure-prone invasive procedures [59]. In US, majority of the reported episodes are related to narcotic abuse by the HCWs, which led to transmission of HCV to subsequent patients [60,61]. Outside US, where substance abuse is not considered as a major problem among HCWs, transmission rates have been found to be low (≤0.6%) [62-65].

Environment: Health care setting: HBV and HCV infected individuals represent reservoir of infection and could lead to cross contamination of HCWs hands, medications and environment surfaces. HBV and HCV transmission has been documented in various health care settings and examples are enumerated as below:

Outpatient settings: (from patient to patient) Transmission of HBV and HCV in outpatient settings have been reported from New York, Oklahoma and Nebraska from 2000 to 2002. Transmission mainly occurred indirectly from patient to patient after exposure of injection equipment to contaminated blood from the source patient, unsafe injection practices, primarily reuse of syringes and needles or contamination of multiple-dose medication vials [66]. In the developing countries, burden of HBV and HCV due to use of unsafe therapeutic injections is huge, amounting for >21 million new cases of HBV infections and approximately 2 million new hepatitis C cases annually worldwide [67]. Thus, outbreaks in both developed and developing nations raised the questions about non-adherence to fundamental infection control practices, aseptic technique for preparation and administration of parenteral medications [21]. For investigating an outbreak and to track a source patient, well established epidemiological study is required along with documentation of genetic relatedness of virus isolates.

Long term dialysis care: Patients requiring long term dialysis care are also prone of acquiring blood borne infections as care involves long-term and repeated vascular access in an environment that is shared among different patients. However, use of vaccination against HBV and infection control practices have decreased the incidence, but occasional outbreaks are still being reported in dialysis set-ups.

In developed nations, most of the cases where patient to patient transmission have been reported are not related to haemodialysis but are found to be associated with unsafe injections and diabetic care practices. Such practices may result in contamination of multiple-dose vials or of equipment used for blood sampling and flushing of intravenous lines [21,68-74].

Acupuncture: Deficiencies related to proper disinfection of acupuncture needles have also been documented to be the cause of transmission of HBV [75,76].

Weight reduction clinic: around 60 patients acquired HBV infection at weight reduction clinic due to repeated use of medications by a jet injector device [77].

Dermatology clinic: HBV cases have reported due to poor hand hygiene and unsafe injection practices involving multiple-dose anaesthetic vials in dermatology clinic also where syringes reused in individual patients were refilled through a needle that remained in the vial [78].

However, few cases of HCV transmission have been reported with ambulatory care in Australia and Italy. Due to the contamination of the multiple-dose an aesthetic vial, HCV transmission occurred to one patient who was undergoing endoscopic procedure [79]. In Italy, during two consecutive pharmacokinetic trials, 15 of 29 volunteers became infected with HCV, possibly as a result of contamination of multiple-dose heparin vials used for maintaining intravenous catheter in each individual [80,81].

Thus, in literature enormous reports have been documented where HBV and HCV are considered as a health hazard for HCWs and patients. Various policy makers have formulated management and treatment guideline, which are discussed below:

Current Guidelines for management and treatment

Employers should frame written protocols for immediate reporting, evaluation, counselling, treatment, and follow-up of occupational exposures. Exposure control plans should also be outlined and the facilities for its implementation should be available during all the working hours of the hospital. Exposure should be immediately reported not only for the management but also for the evaluation of preventive measures.

Immediately after an accidental exposure the puncture site should not be squeezed, in fact, the wound should be allowed to bleed freely and washed with soap and water, mucous membranes should be flushed with water and all the contaminated clothing should be removed. If the exposure is significant then the source is evaluated for the risk factors like - history of high risk sexual behaviour (men having sex with men, multiple sexual partners, sexual partner is intravenous drug abuser or infected with HCV or HBV), patient from highly endemic area or had history of blood transfusion before 1990.

Serologic testing of the source patient for HBV, HCV and HIV is the most reliable method to assess risk of exposure and should be strongly encouraged. If the source refuses to be tested, Mandatory Blood Testing Act, 2006 should be followed. If the source is unknown or untestable, the circumstances under which exposure occurred should be considered along with the prevalence of HBV, HCV, or HIV in the population group. Testing of needles and other sharp instruments is not recommended. In addition to the source, exposed person should also be investigated for baseline serological investigations for HBV, HCV and HIV irrespective of whether or not prophylaxis is indicated. Liver function tests are also important for baseline testing because without baseline data, any future claim for compensation for occupationally acquired blood borne illnesses could be jeopardized. Repeat HCV and HBV testing at 3 months and 6 months is advised if the baseline sample is negative.

Exposure should be quickly evaluated and should be notified to the concerned authority of the institute so that risk of infection can be evaluated timely to start the treatment at earliest without any delay. Post exposure counselling of the victim is an essential part of the management. It has been noticed that the health care workers become extremely anxious post exposure. These psychological issues may extend its effect on their daily routine work, personal relationships, mental stress which sometimes may lead to depression and isolation. They are basically concerned about the transmission of virus to their partners, maternal-foetal transmission is the matter of concern in those who are either pregnant or planning pregnancy. A report has also been published mentioning the therapeutic abortion post exposure [82,83]. To avoid all these anxiety sequels it is important to counsel the victims regarding the post exposure prophylaxis, probability of acquiring infections, preparation of future follow ups and required management.

Post exposure prophylaxis recommendation

Post exposure the source should be evaluated for all the three major blood borne viral infections. The probability of acquiring infection is maximum with hepatitis B followed by C and then HIV. Among them hepatitis B is the only virus with effective vaccine and immunoglobulin. Guidelines for PEP depend on the vaccination status of the exposed person and serological status of the source.

- SUSCEPTIBLE – (never got vaccinated or previously infected) – Hepatitis B immune globulin (HBIG) + hepatitis B vaccine series.
- VACCINATED - (responder i.e. taken complete course of hepatitis B vaccine with anti-HBs > 10mIU/ml) – do not require PEP, irrespective of the status of the source.
- VACCINATED - (non-responder i.e. taken complete course of hepatitis B vaccine with anti-HBs < 10mIU/ml) – if the source is HBsAg positive either one dose of HBIG with HBV vaccine series or 2 doses of HBIG is recommended, first as soon as possible and the second one month later. If the source is HBsAg negative HBIG is not required.
- UNVACCINATED OR INCOMPLETELY VACCINATED – if the source is positive or unknown then – Hepatitis B immune globulin (HBIG) + hepatitis B vaccine series should be given. If the source is negative, the vaccination is recommended as per the prescribed schedule.

Both HBIG and the first dose of the hepatitis B vaccine post exposure should ideally be administered within 24 hours of exposure.

HBIG should not be given after 14 days of exposure. The HBV vaccine series has three dose regime and it should be given at 0, 1 to 2 months, and 6 months. Hepatitis B antibodies should be obtained 1 to 2 months after completion of the third dose of the vaccine. In the occupational setting, prophylactic doses of hepatitis B immunoglobulin (HBIG) initiated within 1 week following percutaneous exposure to HBsAg-positive blood provides an estimated 75% protection from HBV infection. Increased efficacy of post-exposure efficacy of the combination of HBIG and the hepatitis B vaccine has been evaluated in perinatal period and similar approach may also be useful in occupational setting as well. Moreover, health care workers are at continued risk for HBV exposure, thus hepatitis B vaccination should also be given along with PEP.

There is no PEP for exposure to hepatitis C. Baseline antibody titers and liver function test should be done and then followed at 3 and 6 months. HCV RNA levels should be monitored periodically. It is established that the risk of acquiring infection is very low, approximately 50% of the symptomatic patients clear the virus spontaneously. Moreover, those who acquire acute infection have high rate of progression to chronic infection. Many studies have been published regarding the outcome, of the infection when the patient was treated with antivirals in acute phase, though there are no specific conclusive guidelines still majority of the clinical trials reflects that if hepatitis C infection is treated during the acute phase it is associated with high sustained virological response (SVR) rates ranging between 75% and 100% [84-87]. Acute infection is defined as – detectable HCV RNA levels (an FDA-approved quantitative or qualitative NAT with a detection level of 25 IU/mL or lower should be used to detect HCV RNA) with negative HCV antibody diagnosed within 6 months of exposure to hepatitis C virus. Further, it was suggested that the treatment should be initiated within 12 weeks of exposure, to effectively decrease the transmission and to prevent chronic HCV infection. The exposed person should be counselled for the risk of infection, post exposure illness reporting: like fever, abdominal pain, jaundice after hepatitis B or C exposure, secondary spread and PEP compliance and regular follow up.

Prevention being the best policy therefore steps should be taken to reduce the needle stick injuries through:

1. Adequate education of healthcare workers about handling sharps and samples,
2. Management should ensure the availability of suitable sharp disposal containers and safety cannulas.
3. Rationalization/avoidance of unnecessary procedures,
4. Appropriate healthcare worker workload and adequate staff–patient ratios (excessive tiredness and work-related stress are clearly associated with higher rates of needle stick injury).
5. Appropriate health management and follow-up systems for staff, including appropriate counselling about hepatitis B and C virus and HIV infection.
6. Appropriate vaccination program for healthcare workers, especially hepatitis B vaccination, to prevent further reports with blood borne diseases.

The combined efforts by administration, doctors, nurses, technical staff and the supporting staff of the hospital may help to reduce the risk of infection with these blood borne viral infections.

Prevention

Various initiatives that are essential for the decline in the incidence of occupational exposure include:

- Implementation of standard precautions.
- Availability of proper sterilization equipment's.
- Implementation of universal work precautions.
- Appropriate biomedical waste management.
- Proper arrangement of managements of accidents e.g. Spill kits etc.

Standard precautions were introduced by the CDC's Hospital Infection Control Practices Advisory Committee (HICPAC) in 1995. They introduced the concept that all blood and body fluids, secretions, excretions (except sweat) and tissues of all patients should be considered as potentially infectious and precautions should be used for the care of all patients irrespective of their infection status. The core elements of standard precautions are:-

- Hand washing after contact with patient. Hand hygiene is the simplest way to prevent infections. Last year on 15th October 2015, global hand washing day was celebrated. At various hospitals 5 moments of hand washings should be displayed so as to educate the HCWs. These are the key moments when HCW should perform hand hygiene [88].
- To prevent mucocutaneous contact, barrier precautions are advised (e.g., gloves, gowns, and facial protection)
- Sharp instruments and devices should be handled with care. Minimal manual manipulation should be done. As per CDC and Exposure Prevention Information Network (EPINet) [89], sharps-related injuries decreased 31.6% during 2001-2006 in non-surgical hospital settings following the Needle stick Safety and Prevention Act of 2000) [51].
- Disposal of sharp items should be done in puncture resistant containers.
- Cleaning the organic material before disinfecting is essential for adequate results especially for devices like endoscopes, cystoscopes, dental instruments etc. that poses risk of patient-to-patient transmission.

These are the infection control practices; breach in them is the major cause for transmission of infection among patients through HCWs. After the introduction of these standard precautions, several investigators have assessed their efficacy. Doebbeling BN et al. [90], found that alone standard precautions are suboptimal as percutaneous injury and mucocutaneous blood exposure are related to frequency of sharp handling and inversely related to routine standard-precaution compliance. Long before the concept of standard precautions, CDC in 1987 introduced universal health precautions to transmission of infection from patient to HCW and vice versa. Universal precautions

initially focused on prevention of exposure and HBV immunization and subsequently it included PPE and BWM.

Spills of blood and blood-contaminated body fluids in the work place are not uncommon, and they pose potential hazard to all the workers in that area. Spill management kit containing PPE absorbable material and appropriate disinfectant should be readily available. Soon after the spill, workers should leave the area until the aerosols settle down. Spill should be properly covered with a disinfectant and should be cleaned immediately by a person taking universal precautions. Disposable towels or some absorbable material should be used first to remove visible material followed by decontamination of an area under consideration with an appropriate disinfectant. Only Environmental Protection Agency (EPA) approved disinfectant should be used in a particular concentration as prescribed for a particular contact time. However, if EPA approved disinfectant is not available, 1:10 to 1:100 solution of hypochlorite (household bleach) may also be used [91]. Improperly managed biological waste may results in the adverse effect on the hospital environment causing risk in both patients and HCWs. Though all the waste generated has to be disposed of, but the procedure is different for the infectious and non-infectious waste, among the infectious waste, disposal of sharps and other infectious material also varies. Therefore color coding of the disposal containers is recommended, which has been made simple and easy enough, to be understood by the less educated supporting staff of the hospital also. The key feature of proper management is the segregation of the waste at the place of generation only. This also helps the waste handlers to be aware of the containers containing sharps and infectious material, calling them to be more cautious. Waste to be disposed should be properly packed and labelled. Administration should mark separate transportation paths for the waste in the hospital premises to the place of disposal to avoid accidents causing injury.

HBV is the potential vaccine preventable carcinogenic virus. Vaccine against HBV was first available in 1981, it was a plasma derived vaccine containing highly purified 22nm HBsAg particles inactivated through a combination of urea, pepsin, formaldehyde and heat. Though immunogenic with good results still the transmission of blood borne pathogens was not completely ruled out. Therefore in mid 1980s a recombinant vaccine containing HBsAg expressed in HBV transfected yeasts (i.e. Saccharomyces cerevisiae), the so-called "second" generation hepatitis B vaccine, with > 90% protective antibody response were commercialized. This new recombinant DNA hepatitis B vaccine offered the potential for its unlimited production, with excellent safety and efficacy.

CDC recommends HBV vaccination to all the health care workers, followed by hepatitis B surface antibody (anti-HBs) status. Appropriate protective levels are when the serum antiHBs ≥10 mIU/mL, if the levels are not adequate, revaccination is advised. Still if the protective levels are not attained even after the three dose series of second vaccination schedule, HBV surface antigen (HBsAg) and HBV core antibody (anti-HBc) testing is advised to determine whether the HCW is previously or chronically infected.

This vaccination was recommended since 1982 to all the health care workers. In 1990 a survey was done at U.S. hospitals to know the vaccination status of the HCWs and it was estimated that only 46% of the high risk workers had received immunization. The survey concluded that the major reason for this low coverage is the high cost of the vaccine [92,93]. Following this, in 1991 HCWs who anticipated to be in contact with blood and body fluids was provided with HBV vaccination at no cost. Subsequent surveys reflected that the vaccination coverage had increased to > 80% from various centers [94].

Conclusion

The delivery of health care has the potential to transmit HBV and HCV among HCWs and patients. In developing countries where resources are limited are more prone for such infections as compared to developed nations. In developed nations, widespread use vaccination against HBV among HCWs and general population has led to a significant decrease in HBV infection rates in recent years. Moreover, strict compliance with infection control practices and universal precautions also led to decrease in blood borne infections. However, HBV and HCV is considered as an occupational health hazard among few health care settings in developed nations, which require further assessment of the problem and implementation of specific preventive measures in such settings such as ambulatory health care settings. On the other hand, in developing countries, education should be imparted to medical students, staff and doctors at various health care setups so that adequate preventive measures can be taken. Universal immunization among general population and HCWs should be implemented along with availability better infrastructure. Thus, in an era of advanced medical care, health care provider as well as health care seeker should be free from fear of getting blood borne infections.

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