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Autopsy Room : A Potential Source of Infection at Work Place in Developing Countries

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Abstract: Forensic pathologists/Autopsy surgeons and the forensic medicine personnel assisting to conduct an autopsy who come in direct contact with the body fluids, soft tissues of the dead and skeletal remains in different stages of decomposition, are at a continuous risk of acquiring various kinds of infections including blood-borne viral and other bacterial infections. However, limited data are available regarding these occupational risks to the persons who are usually exposed to dead bodies in the autopsy rooms. With the existing and growing HIV epidemic and high seroprevalence of hepatitis virus, safety becomes an issue not only relevant to the team performing the autopsy, but also has direct implications regarding the protection of the environment. Prevention strategies including immunization, exposure avoidance by the use of universal precautions and proper infrastructure in the autopsy rooms can go a long way in preventing the occupational hazards of the autopsy rooms.

Key words: Autopsy, postmortem examination, forensic pathologist, autopsy surgeon, autopsy-room

INTRODUCTION

The autopsy room has always been a potential source of infection and the autopsy surgeons/forensic pathologists and other persons engaged directly or indirectly in conducting postmortem examination are at greater risk of exposure to blood-borne viruses and other infections including human immunodeficiency virus, hepatitis B, hepatitis C, hepatitis D and G viruses, non-A, non-B hepatitis, tuberculosis, Creutzfeldt Jakob disease, herpes, hantavirus pulmonary syndrome, smallpox, human T-cell lymphotropic virus type I and infections from other pathogenic organisms[1-12]. Throughout the world, the frequency of consent autopsies has substantially declined over the previous decades, from approximately 50% of all hospital deaths in 1950 to less than10% in 1995[13]. One of the main reasons for this decrease is the increased risk of occupational exposure to dangerous pathogens among the forensic pathologists[14]. Many studies have confirmed that with the cessation of life, certain pathogenic bacteria are released, which if left unchecked, may prove hazardous to the personnel dealing with them. Moreover, after death, there is neither the reticulo-endothelial system nor the blood-brain barrier to restrict the translocation of micro-organisms and the pathogens translocate themselves unrestricted within the dead body[15].

Quite often, the dead bodies brought for postmortem examination, are of unknown background and as such the risks of infection from these bodies are also unknown. Prevalence of deadly infections in individuals such as drug abusers, who are liable to meet violent unexplained deaths and the existence of social and ethical pressures which restrict the availability of information, combine to create significant risk for postmortem examination room worker[16]. A study from Dublin has reported the prevalence of human immunodeficiency virus HIV and hepatitis C virus HCV among injecting drug users to be 1.2 and 61.8% respectively[17]. According to a report, contaminated injections caused an estimated 21 million hepatitis B virus (HBV) infections, 2 million HCV infections and 260,000 HIV infections accounting for 32, 40 and 5% respectively of new infections for a burden of 9,177,679 disability-adjusted life years between 2000 and 2030[18]. According to another study, the baseline seroprevalence of (HIV), (HBV), (HCV) and Cytomegalovirus (CMV) infection were 0%, 21.7, 1.4 and 43.4% respectively[19].

Furthermore, the forensic medicine personnel often work on dead-bodies that are in various stages of decomposition where a detailed dissection of the tissue is often essential in order to establish the identity and/or the cause of death[12]. Whatever the stage of human remains, the potential for exposure to pathogens from the tissues or body fluids is always there and despite infection control precautions and availability of hepatitis B vaccines, these workers remain at risk for acquiring blood-borne viral infections. The common occupational hazards likely to be encountered in an autopsy room include infections, toxicity and radiation.

Infections: Infections in autopsy room may be acquired by one or more of the following routes: (a) A wound

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resulting from an object contaminated with blood or body fluid or needle-stick injury. (b) Splash of blood or other body fluid onto an open wound or area of dermatitis. (c) Contact of blood or other body fluids with mucous membranes of the eyes, nose or mouth. (d) Inhalation and ingestion of aerosolized particles. Streptococcal sepsis, tuberculosis, blastomycosis, AIDS, hepatitis B and C, rabies, tularemia, diphtheria, erysipeloid fever and certain viral hemorrhagic fevers are some of the serious infections that can be transmitted through these routs. Many of these have proved to be fatal[20-26].

It has long been recognized that the dissectors, observers and other persons in close proximity to an autopsy are at a high risk of contracting infectious diseases from the dead bodies. Studies in British clinical laboratories between 1970 and 1989 established that the highest rate of laboratory- acquired infections was in autopsy workers[27]. It has been reported that resident doctors working in pathology sustained a percutaneous injury with a blood exposure in1 in 11 autopsies whereas the experienced pathologists in 1 in 55 autopsies[28]. Scalpel blades made majority of these cuts. However, many other objects such as broken glass, needle fragments, bone pieces, and fragmented projectiles can injure the autopsy personnel[29]. Weston and Lober[30] *et al.* have documented that approximately 8% surgical gloves get punctured during autopsy and about 1/3rd of these remain undetected by the pathologist, thus causing any pre existing hand injuries to be bathed in infectious blood for a prolonged period of time.

Hepatitis B virus is the most transmissible of the blood-borne viruses, though at present, transmission is preventable by vaccination[2]. Infection with hepatitis B virus can produce a chronic infection that places the individual at risk of death from chronic liver disease or primary hepatocellular carcinoma. Damage induced by the virus increases susceptibility to other liver ailments, which can prove fatal. The long incubation period of 6 to 24 weeks often masks the association between the event of infection and the onset of symptoms[31]. Increased risk of hepatitis B virus infection has been found among health care workers especially those having frequent contact with blood and/ or exposure to needles or sharp instruments[32]. Among the health care workers, the prevalence rate has been reported to increase with duration in the profession reaching 30% for those who have worked for 20 or more years as compared to 5% among persons of comparable age in the general population[33]. Among the physicians, pathologists have been recognized as a high-risk group for occupationally acquired hepatitis B virus (HBV) because of their exposure to blood[34]. The prevalence of HBV, HCV and HIV infection is higher in the cases examined by forensic autopsy population than by general duty doctors as they constitute a higher percentage of drug addicts, particularly the intravenous users[35]. According to the study, hepatitis B was found to be positive in 8.8% in the technicians who were in direct contact with blood during profession.

Another study reported that in the period 1985-1988, there were 16 cases of occupationally acquired hepatitis B among the UK health care workers, but with the increase in awareness and availability of vaccination, the comparatively recent period showed decline in the occupationally acquired hepatitis B virus[2]. Surveillance of forensic medicine personnel or health care workers suffering sharp injuries suggests that the overall chance of acquiring infection by this route is about 5%, although if the contaminating blood contains 'e' antigen (HBeAg), the risk of infection may be as high as 30%[35]. Li *et al*[36] and Plessis *et al*[37] reported frequency of hepatitis B prevalence at about 23 and 8% respectively in forensic autopsy performers. This virus is about 100 times more transmissible than HIV as blood borne as well as by aerosol.

Hepatitis C virus infection is responsible for the majority of cases of parenterally transmitted Non-A, Non-B hepatitis and is known to produce a persistent infection that is often associated with chronic liver disease[38]. The transmission of hepatitis C virus is associated with direct percutaneous exposure to blood such as through transfusion of blood or blood products; transplantation of organs from infectious donors and sharing of contaminated needles among injection drug abusers[39]. Persons associated with postmortem examination and other health care workers experiencing needle stick injuries are at a countable risk of acquiring hepatitis C infection. Surveillance data from the CDC Sentinel Countries study show that 3% of the reported cases of acute hepatitis C are associated with the needle stick injuries[40]. The incubation period for acute hepatitis C following accidental needle stick has been reported to average 6- 7 weeks but may range from 2 to 26 weeks[40].

Hepatitis D virus is found in the patients with hepatitis B virus and can cause chronic liver disease. In addition to blood, hepatitis D virus is also found in serum-derived fluids such as wound exudates; however its presence in other body fluids i.e. semen, saliva and faeces has not been reported. Hepatitis G virus infection can be found in both symptomatic and symptomatic acute viral hepatitis, but its exact role in human liver disease is not yet clearly understood[41,42]. Hepatitis G is transfusion associated and presumably contractible through inadvertent contact during autopsy although no casual relationship between infection and actual hepatitis has been shown[43].

The first reports of Acquired Immune Deficiency Syndrome (AIDS) were published in literature in 1981. These reports described a cell immunodeficiency with no identifiable cause. This deficiency caused the development of a variety of opportunistic infections and malignancies, many of which are extremely rare. Later, cause of the syndrome was found to be a retrovirus (HTLV-III), which is now known as the human immunodeficiency virus. In a brief time, AIDS cases were recognized among hemophiliacs, transfusion recipients and injection drug users from diverse geographic locales around the world[44, 45]. Soon after the first AIDS case was registered in the Indian state of Tamil Nadu in January 1986, a National AIDS committee was constituted. The nature and magnitude of the danger posed by AIDS to the world can be gauged by the reports that, it is killing six persons every minute worldwide; the figure is said to be rising every hour. The latest data of UNAIDS reveal that while over 0.4 million people are infected with AIDS today, 0.28 million people have already succumbed to the disease. Estimated 14,000 new infections occur everyday in the world. As on December 31st 2001, India had 3.86 million AIDS patients[46].

Body fluids responsible for transmitting the HIV include blood, semen, vaginal secretions, breast milk, and cerebrospinal, peritoneal, amniotic, pericardial and synovial fluids. Other fluids such as saliva, tears, urine are not implicated in the transmission of HIV unless they contain sufficient and visible blood[47]. The greatest concern remains the dead body of undiagnosed patient. The HIV is of low infectivity as compared with other blood-borne viruses such as hepatitis B and C. Deep injury, visible blood on the device causing the injury, injury with a needle used in a vessel, and injury with hollow-bore needle (compared to a solid needle) all increase the likelihood of a larger inoculum of blood entering the recipient. Other factors such as penetration of a needle through a latex glove (which may have wiping effect) also alter the risk of transmission[2]. The first case of occupationally transmitted HIV infection was reported in the medical literature in 1984[48]. In the surveillance conducted by CDC, at least 54 health care workers in the USA have had HIV infection developed after occupational exposure[49]. Postmortem samples have been reported HIV positive in about 6 to 15% cases[5]. The risk for infection among medical and laboratory personnel including mortuary workers is considered as low but resembles the rates for single contact heterosexual transmission[50]. Infection risk due to needle prick is estimated at 0.3 to 0.5%. HIV does not survive for long periods with drying but postponement of autopsies in known AIDS cases does not eliminate risk of contamination by HIV. According to a report, viable HIV was isolated from blood obtained 16 days after death.[51]

Performing autopsies on persons who have died of Viral Hemorrhagic Fever (VHF) poses even greater risk. Many pathologists and their assistants have died of autopsy transmitted Ebola, Marburg and Lassa hemorrhagic fevers[52]. However, none of these persons were reported to be injured during dissection.

Infectious aerosols are composed of air borne particles aproximatley1-5 μm in diameter, which can remain suspended in air for long periods of time. When inhaled, they cross the upper respiratory passages and reach the pulmonary alveoli[53]. Aerosols are generated by aspirators, oscillating saws and water hoses, when applied to the dead bodies, even compressing and dissecting the lungs can give rise to infectious aerosols[54]. One of the most common organisms to be transmitted through this route is *Mycobacterium tuberculosis*. Others include rabies, plague, meningococcemia, Q fever, and anthrax.

Autopsy is an exceptionally efficient method of transmitting tuberculosis from the dead body to those present in the autopsy room. The risk for infection does not vary with the distance from the autopsy table. Exposures as brief as 10 minutes in the autopsy room have resulted in transmission[55]. It has been documented that autopsy exposure is far more infectious than exposure during life and it is not unusual for tuberculosis to remain undetected until a patient dies[56]. In a study of hospitals in Dundee, Scotland, 50%of autopsied active tuberculosis cases were unrecognized before autopsy[57]. In a country like India, where tuberculosis is still the most fatal respiratory disease affecting the lower socioeconomic group and where unidentified vagabonds constitute an appreciable percentage of the autopsy population, the percentage of unrecognized tuberculosis cases is substantially very high, as compared to the more developed countries. Out of 300 million people infected with *Mycobacterium tuberculosis* in India, 12 million are supposed to be that of active *tuberculosis*[58].

Airborne droplets usually from the sputum positive case transmit tuberculosis. The groups at higher risk include autopsy workers and persons involved in histopathological preparations from fresh material. According to a study, medical students washed their hands in a sink contaminated with *M. tuberculosis* and contacted the infection. The infection was most probably caused by inhalation of an aerosol created as the water was run into the sink[55]. According to another study, the postmortem room workers were infected during the autopsy procedure; the infection was most probably contracted by the aerosol particles generated by an oscillating saw[59]. Instances of *tuberculosis* outbreak caused by multi-drug resistant M. tuberculosis have increased in the recent past[60] thus sounding the alarm bells for autopsy room workers as well as those

who are exposed to it in professional capacity. Embalming itself has been shown to produce active tuberculosis aerosols. Embalmed bodies have yielded active *M. tuberculosis* for as long as 60 h after fixation[61].

Concerns about the possible transmission of rabies to forensic personnel are not all surprising. Being a public health problem, data from the WHO indicate that about 30,000 people die of rabies in India which accounts for about 81 % of global report of 37,000 deaths annually[62]. The virus has been detected in human tracheal secretions, saliva, nasal swabs and human tissues. According to a report, an autopsy on a patient having unknown meningoencephalitis was conducted in New York and was later found to have died of rabies when routine histopathological slides of brain tissue were reviewed approximately 2-3 weeks after death. Then after diagnosis, the post exposure prophylaxis was administered to 55 persons including 5 members of the autopsy team[63].

Toxicity: Formaldehyde is the most common toxic agent to affect the autopsy personnel. It is highly volatile and causes irritation of the eyes, mucous membranes and skin[64]. According to the Occupational Safety and Health Adminstration,[65] exposures to this chemical of 0.75 PPM for 8 h and of 2 PPM for 15 min is the safe limit. The odor threshold for formaldehyde is between 0.1 to 1 PPM. Therefore the ability to smell the substance generally means that the person is exposed to a concentration, which exceeds the occupational standard. Long-term exposure to the substance has also been associated with an increased risk for all cancers, particularly the cancer of lung[66].

Forensic pathologists and their technicians may be exposed to cyanide when performing autopsies on persons who have died after ingesting this substance[67]. The risk is maximum, when the stomach is exposed during autopsy because in the acidic environment of the stomach, the cyanide salts are converted to highly volatile hydro cyanic gas[68]. In cases of Aluminum/Zinc phosphide ingestion deaths also, the risk of similar inhalation exists as fatal phosphine (hydrogen phosphide) gas is released in the stomach. Phosphine causes toxic symptoms at a concentration of approximately 2 ppm[69]. Organo-phosphates (e.g., Malathion and Parathion) fumes may cause toxicity on inhalation, while opening the stomach[70]. Certain nerve gas agents are organo-phosphorus compounds (Tabun, Sarin). These can penetrate heavy rubber gloves and aprons and be absorbed through the skin. Hence bodies contaminated with these agents should first be thoroughly washed with water or 5% hypochlorite solution[71].

Radiation: Autopsy workers may be exposed to radioactive materials from a body exposed to therapeutic or diagnostic procedures. Cases of pathologists receiving excessive radiation after autopsying such bodies have been reported[72]. The extent of radiation exposure is dependent on the dose administered to the patient, type of radiation emitted, the radio nucleotide used, the exposure time and the protection gear worn by the autopsy personnel. Rubber gloves reduce β-radiation very much, but not the δ-radiation from the isotopes[73].

Autopsy precautions: Although the agent-specific degrees of risk have been clearly established for bio-medical and microbiologic laboratories, the same standards have not been well laid down for the autopsy room. However the safety standards developed for the various clinical and investigative laboratories can be broadly applied to the mortuaries[74]. Standard universal precautions are meant to apply to blood, semen and vaginal secretions as well as to cerebrospinal, synovial, pleural, peritoneal, pericardial and amniotic fluids but they do not apply to faeces, nasal secretions, sputum, sweat, tears, urine and vomitus unless they contain visible blood[7].

Entry to postmortem examination room should be restricted except for the experts and workers who are trained in handling the infected material.

The experienced persons should preferably conduct the postmortem examination because it has been shown that the risk of accidental exposure is greater among the inexperienced.

Immunosuppressed or immunodeficient individuals and individuals who have uncovered wounds, weeping skin lesions or dermatitis should not perform the autopsy.

The autopsy room should be of a size sufficient to accommodate the workload without overcrowding and the design of the room and equipment should be such as to permit free movement and easy and thorough cleaning and disinfection of autopsy tables, dissecting surfaces, floors, walls etc.[16] and creating an atmosphere in which work is done more safely.

Proper personnel protection involves personal protective equipment, engineering, work practices, etc. The protective gear used and the procedures followed so as to protect the health care workers were formerly termed Body Substance Isolation Procedures or Universal Precautions. Recently, these precautions were combined into Standard Precautions, which were developed to reduce the transmission of all pathogens from moist body substances[75]. The principles of Bio Safety[74] as suggested by CDC against most blood borne pathogens are listed at Table 1 whereas Table 2 lists the principles for protection against agents transmissible in aerosol form.

Table 1: Principles of bio safety level 2

Suitable for work with agents of moderate potential hazard to personnel and the environment:

- Personnel are trained in hazard identification and work procedures.
- Access to work area is controlled and limited; hazard signs are displayed.
- Extreme precautions with sharps are observed.
- Special equipment may be used to contain or control chemical fumes, splatters, or biological aerosols.

Emphasis on safe practices and procedures

- Restrictions on smoking, eating, and drinking in the autopsy area are enforced to reduce ingestion potential.
- Gloves, gowns, and aprons are worn.
- Other personal protective equipment is worn as needed (e.g., to protect mucous membranes).
- Hand washing after removal of gloves and before leaving the work area.
- Instruments and work surfaces are decontaminated and cleaned.
- Waste is decontaminated or processed for incineration.
- Samples are labeled (including hazard warnings) and contained for transport to other locations.

Policy issues include

- A qualified person provides supervision.
- Immunizations are offered (e.g., HBV); medical services are available.
- Standard operating procedures (with bio safety issues addressed) are developed.

Facility requirements include

- The location is away from public areas; doors are lockable.
- Consideration is given for directional inward airflow without re-circulation to other areas.

Table 2: Principles of bio safety level 3

Suitable for work with indigenous or exotic agents that can cause serious or potentially lethal disease as a result of exposure by the inhalation route:

- Personnel receive specific training in handling materials (potentially) infected with pathogenic and potentially lethal agents.
- Competent scientists who are experienced in working with such agents provide supervision.
- Localized containment or ventilation devices are used to contain or control fumes, splatters, or biologic aerosols.
- Special engineering controls and appropriate personal protective clothing and equipment are used (including respirators).

In addition to the principles of Bio-safety Level -2

- Additional medical surveillance procedures might be applicable (e.g., periodic TB skin testing, serum collection and testing).
- Biohazard warning signs indicating suspect agents and necessary precautions are displayed.
- All personnel demonstrate proficiency in the practices and procedures specific to the nature of the hazard

Facility requirements include

- A separate room is recommended; otherwise, only persons involved with the specific autopsy are allowed in the room; and the room doors are lockable.
- Exhaust from the autopsy room is directed to the outside.
- Access to a personal shower is available close to the autopsy room.
- Interior surfaces of the walls, floors, and ceilings are constructed for easy cleaning and decontamination.
- Floors should be monolithic and slip resistant.

Autopsy workers need to be protected from blood borne and aerosol transmissible pathogens. To protect the eyes, skin, and mucous membranes, all persons in the autopsy room should wear a surgical gown with full sleeves, surgical cap, and some type of goggles and shoe covers. Persons dissecting should wear double gloves. Surgical gloves may mitigate the risk from splashed body fluids and will prevent the persons involved in dissection from contacting their face and nose with soiled hands. They however do not protect them from inhaling airborne contaminants[76]. Although light surgical style facial masks may also be used in the mortuary, these are not an adequate substitute for a respirator when working with potentially infectious material. For example, in case of tuberculosis infection, surgical masks have proven insufficient, in such cases, wearing of N-95 respirators should be made mandatory[53]. These mask like respirators are designed to filter about 95% of particles that are 1µm in diameter. Their use should be considered for all

autopsies because it is frequently impossible to determine the risk for an aerosolized pathogen before an autopsy.

The Health Services Advisory Committee[16] recommends that 10% formalin should be introduced into the lungs after appropriate microbiological specimens have been taken and before the lungs are examined[16].

The procedures like bone cutting or chiseling should be avoided with oscillating/rotating saw which are most likely to cause splashes of blood and aerosolization of infected particles in case of tuberculosis. In case of plague and hantaviruses, the guidelines center around two critical issues[11]: (a) Avoiding aerosol droplets or particulate of rodent excreta and direct inoculation from infected tissues and (b) Decontamination with a disinfecting product recommended by the CDC i.e. Lysol, a 10% solution containing chlorine bleach, or some other biphenyl compounds.

Taking utmost precautions while dissecting the bodies can decrease the risk of autopsy-transmitted infections. Personnel performing dissections must be careful with sharp instruments like scalpels, needles, etc[77]. They must also be aware of the possibility of encountering other sharp objects like broken glass, splintered bone fragments, and projectile pieces. They should thoroughly and immediately wash any skin surfaces that are contaminated with blood or other potentially infectious body fluids to prevent infecting themselves. After the autopsy is complete and the gloves are removed, it is essential to thoroughly wash the hands as unapparent defects may appear in the gloves during use and may lead to contamination.

Any paper waste, sponges, waste tissue, soiled clothes and similar materials should be treated as

standard hospital red bag waste and incinerated[78]. Afterwards, the table surface should be cleaned with appropriate liquid chemical.

Vaccination is currently recommended for all health care workers who are regularly exposed to blood and other body fluids. It can significantly decrease the risk of occupational exposure to the pathogens[78]. However, a substantial number of autopsy workers in the developing countries are not immunized on account of lack of awareness and/or resources.

Autopsy personnel should have baseline blood tests and tuberculin skin test at the time of employment and a periodic retesting should be undertaken at regular intervals.

All the exposed personnel should have access to appropriate health – care facilities at the earliest.

The autopsy rooms should be separated from the administrative part of the mortuary. Separation prevents the employees and other persons not participating in the Postmortem examination from being exposed to various pathogens[79].

Disinfectants or sterilizing agents:

- The instruments used for postmortem examination should be placed in a plastic container with 0.5 sodium hypochlorite solution before cleaning.
- Instruments that can be autoclaved should be sterilized in 1% gluteraldehyde for at least 10 min.
- Aluminum and stainless steel are damaged by hypochlorite and should be decontaminated with 2% aqueous gluteraldehyde solution.
- 10% formaline solution is found effective against all kinds of viruses and is recommended for the disinfection of instruments, tables and other surfaces after the postmortem examination of HIV and viral hepatitis infected person.
- 1-2% soluble phenolics are recommended against bacterial pathogens including *M. tuberculosis*.
- In a case of Creutzfeldt Jakob disease, prolonged soaking in sodium hydroxide solution is recommended.

What should be done if an injury occurs?:

- In case of needle stick injury, remove gloves and thoroughly wash the hands or the other affected part of body under running tap water.
- Factors that increase the risk of disease transmission viz., deep injury, visible blood on the injury device, procedure involving a device being placed directly in a blood vessel (e.g. a hollow bore needle) should be duly considered.
- Exposed mucous membranes should be flushed with water for at least 15 min.
- Eye exposure should be treated by emergency eyewash for 15 min or rinsed with saline eyewash solution.
- Information should be given to the authorities and an appropriate medical advice should be sought.
- Scheduled blood tests should be got done for serological status of HBV and HIV.

CONCLUSIONS

High prevalence of various infectious diseases in the population poses a great risk of occupational hazards to the forensic pathologist/autopsy surgeon and other staff involved in the postmortem examination. They may be exposed to a wide variety of infectious

agents such as HIV, Hepatitis B, *C, viruses, Mycobacterium tuberculosis,* etc. Other hazards include toxic chemicals like formalin, phosphine gas and organophosphates, etc. Furthermore, practically, it is almost impossible to know the medical status (whether HIV/HBV/*Tuberculosis*, etc, present or not) of each and every deceased person. It is therefore prudent to consider all the dead bodies to be potential carriers of infection and follow the Universal Precautions, while conducting autopsy on them. Proper assessment, personal protective equipment, appropriate autopsy procedures and infrastructural modifications can substantially reduce the risks of occupational health hazards in the autopsy rooms. Accordingly, periodic training and education in safe postmortem procedures, prevention of sharp's injuries and other kinds of exposures should be imparted to the forensic personnel regularly. They should be aware of the potential transmission of these infections and the use of preventive measures. Non-availability of the vaccination for some of these deadly infections alerts that avoidance to such an exposure is the only prevention by the use of universal precautions while at work.

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