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Original Article

Biosafety at autopsy: Analysis of hepatitis B, hepatitis C, and HIV transmission risks

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Abstract

Aim: This study aimed to demonstrate, through serological testing, that healthcare workers involved in forensic autopsies are at risk for HIV, hepatitis B, and hepatitis C viruses, and to discuss the necessary precautions for infection control in light of the literature.
Materials and Methods: After completion of the forensic autopsy, two separate 5 ml blood samples were taken from the thigh regions of the corpses in gel tubes with yellow caps, with the written consent of the relatives of the deceased. The blood samples were analyzed for HBsAg, anti-HCV, and anti-HIV 1/2 levels using the Roche Cobas E601 device in the microbiology laboratory of the Research and Training Hospital of Gaziosmanpaşa University Faculty of Medicine, employing the electrochemiluminescence method.
Results: The study included 197 cases who underwent autopsy in Tokat and Kayseri provinces. The blood samples collected were analyzed for HBsAg, anti-HCV, and anti-HIV 1/2 levels. In the serological tests performed, HBsAg positivity was detected in 6 cases (3.04%) and anti-HCV positivity in 1 case (0.50%), while anti-HIV 1/2 positivity was not detected in any cases.
Conclusion: A risk assessment should always be carried out before the autopsy. Depending on the emerging risk and the biosafety level determined, protective measures should be taken. In cases where a risk assessment cannot be performed, biosafety principles should be strictly followed, and the bodies should be transferred to appropriate autopsy centers if necessary.

Keywords: Autopsy, biosafety, infection, risk analysis.

INTRODUCTION

Occupational infectious diseases are becoming increasingly important for healthcare workers. These diseases, caused by work-related injuries, can cause significant harm to the individual and their environment [1]. Autopsy rooms, particularly as work environments, are potential sources of contact with infectious agents [2]. Healthcare workers and other personnel performing autopsies are at serious risk of infection from direct contact with blood and body fluids, soft tissue, and bone structures during autopsies or from being in communal areas [2,3]. Many different infectious agents contribute to this risk, especially Human Immunodeficiency Virus (HIV), hepatitis viruses (hepatitis B, C, D, G), Mycobacterium tuberculosis, prions, Bacillus anthracis, Clostridium tetani, meningococcal and streptococcal bacteria, rabies virus, Crimean-Congo hemorrhagic fever virus, and other viral hemorrhagic fever pathogens [2]. The mortality rate of most diseases caused by these pathogens is exceptionally high [4].

Infection can be transmitted through needles used during autopsy, injuries from sharp objects contaminated with blood, contact with infected blood or body fluids on the mucosa, and

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inhalation of airborne particles [2]. To protect against the risk of infection, a risk analysis before the autopsy, the use of personal protective equipment, proper technical equipment in the autopsy room, and correct autopsy techniques are crucial. If the necessary protective measures are not taken during the autopsy, infectious diseases can be transmitted to the staff and, consequently, to the general public. In cases where the diagnosis of an infectious disease is not known prior to the autopsy, the risk of infection increases even further. The seroprevalence of HIV, hepatitis B, and hepatitis C virus infections has been reported to be higher in autopsy cases than in the general population. It has been emphasized that the principles of biosafety in autopsies should be mandatorily applied to protect the health of employees [4].

This study aimed to demonstrate, through serological testing, that healthcare workers involved in forensic autopsy procedures are at risk of contracting HIV, hepatitis B, and hepatitis C viruses, and to discuss the precautions that should be taken to protect against infection, in line with the literature.

MATERIAL AND METHOD

Study Design

Before the start of the study, approval was obtained from the Tokat Gaziosmanpaşa University School of Medicine Ethics Committee (decision number 83116987-027, date: 07.01.2016). Informed consent was obtained from the relatives of the deceased who agreed to participate in the study.

Cases who underwent autopsy between January 2016 and January 2017 in the province of Tokat and Kayseri were randomly selected and prospectively analyzed. The demographic characteristics of individuals who underwent autopsy, including their education level, marital status, known diseases, and drug, alcohol, and cigarette use, as well as their history of surgical procedures, were recorded using information from their families and the hospital's registration system.

Cases whose relatives did not agree to participate in the study, whose deaths were no longer a source of infection, and those who had died more than two weeks prior were not included in the study.

Evaluation of Cases

After the completion of the forensic autopsy, two separate 5 ml blood samples were taken from the thigh regions of the corpses in gel tubes with yellow caps, with the written consent of the relatives of the deceased. The blood samples were analyzed for HBsAg, anti-HCV, and anti-HIV 1/2 levels using the Roche Cobas E601 device in the microbiology laboratory of the Research and Training Hospital of Gaziosmanpaşa University Faculty of Medicine, employing the electrochemiluminescence method. The following reference values were used:

- **HBsAg:** <1 COI negative, ≥1 COI positive
- **Anti-HCV:** <0.9 COI negative, ≥1 COI positive
- **Anti-HIV 1/2:** <0.9 COI negative, ≥1 COI positive

StatisticalAnalysis

Descriptive analyses were performed to determine the general characteristics of the study groups. Data on continuous variables were presented as mean ± standard deviation and median, with minimum and maximum values, while data on categorical variables were given as number (%). The SPSS 22.0 program was used for data analysis, and percentage analyses were carried out. Statistical significance was accepted as $p<0.05$.

RESULTS

The study analyzed 197 cases that underwent forensic autopsies in the province of Tokat. Of these, 151 (76.6%) were male and 46 (23.4%) were female. The mean age of the cases was 44.7 years (SD: 21 years). The youngest case was 1 year old, and the oldest case was 88 years old (Figure 1).

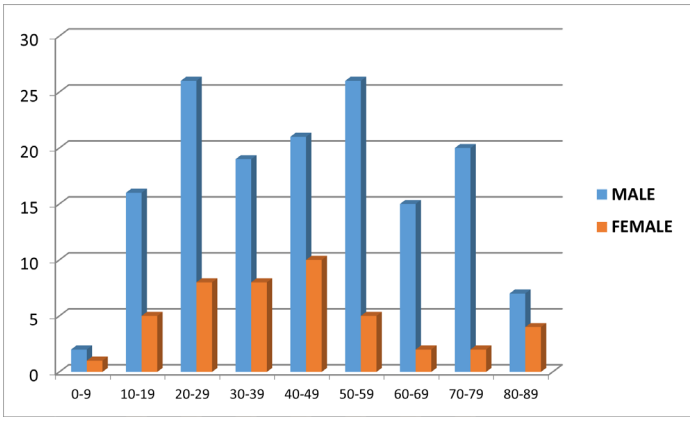

Figure 1. Age distribution by gender

When examining the educational status of the cases, 119 (60.4%) were primary and secondary school graduates, 31 (15.7%) were high school or equivalent graduates, 19 (9.6%) had a university degree, and 28 (14.2%) had no education.

Regarding drug, alcohol, and cigarette use, 12 cases (6.0%) had a history of drug use, 33 cases (16.7%) had a history of frequent alcohol use, and 97 cases (49.2%) had a history of smoking.

When evaluated in terms of surgical history, 41 cases (20.8%) had undergone major surgery, 55 cases (27.9%) had tooth extractions, 14 cases (7.1%) had received blood or blood product transfusions, 10 cases (5.0%) had tattoos on their bodies, and 3 cases (1.5%) were routinely on dialysis.

In terms of living environment and familial infection, 4 cases (2.0%) had hepatitis B carriers in their family. The number of cases with one or more chronic diseases, as indicated by the relatives of the deceased, was 69. When these diseases were classified, 29 (42.0%) had cardiovascular disease, 27 (39.1%) had an endocrine system disease, 12 (17.3%) had a nervous system disease, 10 (14.4%) had a respiratory system disease, 8 (11.5%) had mental and nervous disorders, 6 (8.6%) had malignant diseases, 5 (7.2%) had urinary system diseases, 1 (1.4%) had a hematological disease, and 1 (1.4%) had a gastrointestinal system disease.

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Serological tests revealed HBsAg positivity in six cases (3.04%) and anti-HCV positivity in one case (0.50%), while anti-HIV 1/2 positivity was not detected in any cases. Table 1: The lowest HBsAg value in the seropositive cases was 2122 COI, while the only detected anti-HCV value was 39.12 COI. All HBsAg-positive cases (n=6) were male, and the anti-HCV-positive case was female. Three of the HBsAg-positive cases were construction workers; the other cases were teachers, drivers, and shopkeepers. The anti-HCV-positive case was a housewife. Other risk factors are listed in Table 2.

Table 1. Seropositive cases

	HbsAg	anti-HCV	anti-HIV	Total
Seropositivity	n=6 (3.04%)	n=1 (0.5%)	0	n=7 (3.55%)

Table 2. Risk factors

	HbsAg positive n=6	anti-HCV positive n=1	anti-HIV positive n=0	All cases n=197
Drugs	0	0	0	12 (6%)
Alcohol	2	0	0	33 (16.7%)
Major surgical procedure	1	1	0	41 (20.8%)
Tooth extraction	0	1	0	55 (27.9%)
Blood transfusion	0	0	0	14 (7.1%)
Hemodialysis	0	0	0	3 (1.5%)
Tattoo	0	0	0	10 (5%)
Household infection	0	0	0	4 (2%)
History of infection	0	0	0	0
Other	0	0	0	0

DISCUSSION

The results of our study show that cases who underwent major surgery, tooth extraction, and alcohol consumption were associated with the presence of hepatitis B and hepatitis C.

The main components of the current approach to health and safety at work include worker participation, expert support, worker information, worker training, the protection and prevention approach, and risk assessment [5,6]. Risk assessment consists of two basic steps: First, the hazard must be defined. For example, sharp-edged tools and materials used in procedures that cause physical injury during autopsy are a source of danger. At the same time, known/unknown sharp objects such as metal caps and filaments found under the skin or inside the body can cause injury during autopsy. An ICD used to treat malignant tachyarrhythmias, which is inserted into the body and generates 20-40 joules of electricity, is a potential autopsy hazard [7]. While unexploded projectiles retain their hazard potential due to heat and vibration, fragmented projectile cores can cause minor injuries [8]. Corpses contaminated with radioactive substances for diagnostic or treatment purposes or in industrial areas before death are potential radioactive sources [9]. Chemical substances are another hazard for autopsy personnel. Formaldehyde, used in tissue preservation, can cause symptoms such as irritation of the eyes, mucous membranes, and skin. It is a long-term risk factor for all types of cancer and has a cumulative effect on lung cancer [10,11]. Other hazards include poisoning from pesticides such as organophosphates and metal phosphides, cyanide poisoning, and poisoning from gases used in chemical warfare such as tabun and sarin [4]. In addition, infections that can occur, for example, from the needle of a syringe used during the autopsy, from injuries with sharp objects such as scalpels contaminated with blood, from splashes of infected blood or body fluids on mucous membranes, and inhalation of airborne particles, pose a serious risk [2].

Cases have been reported in which individuals have died as a result of hepatitis B as an occupational disease [12]. In addition, the incidence of transmission of hepatitis B through sharps injuries or needlestick injuries is about 30% [13]. HBsAg positivity was analyzed in 2888 blood samples of patients from urban and rural areas in Diyarbakır, Şanlıurfa, Batman, and Mardin provinces, and the incidence was reported to be 7% [14]. In a study conducted on 1095 samples in Tokat province, the frequency of HBsAg positivity was reported as 5.5%, and in another comprehensive study conducted in Ankara on 61,786 samples, a similar rate (5.58%) was found [15,16]. In a study conducted on 38,505 blood samples from hospital outpatients in İzmir province, the HBsAg positivity rate was 6.5% [17]. Inci et al. found HBsAg positivity of 3.9% in a study conducted on 21,865 blood samples in the province of Artvin [18]. In the Sayhan study, the HBsAg frequency in the

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preoperative evaluation of 994 patients was reported as 1.5%, while this frequency was reported as 2% in the study by Aydın et al. [19,20]. As shown in the studies conducted, the frequency of HBsAg positivity varies between 1.5% and 7% throughout Turkey, and the rate of 3.04% found in our study is consistent with the values in our country.

The incidence of transmission of hepatitis C through sharp objects or needlestick injuries is about 3% [21]. In a study conducted by Yıldırım et al. on 1095 samples, the incidence of anti-HCV positivity was reported to be 2.1% [15]. In a study conducted on 38,505 blood samples, the frequency of anti-HCV positivity was 1.3%. In another comprehensive study conducted on 60,507 blood samples from patients and blood donors presenting to the Ankara outpatient clinic, the frequency of anti-HCV positivity was 1.5% [16,17]. Recent studies have found seropositivity rates of 0.85%, 0.95%, 0.62%, 1.9%, 1%, and 1.5% [18,21-26]. Although the seropositivity rate in our study (0.5%) is slightly below the national average, we believe similar rates can be achieved in studies with larger sample sizes.

Tokars et al. reported that 4 (0.36%) of 1,103 healthcare workers who had percutaneous contact with HIV-infected blood showed seroconversion [27]. In a multicenter study conducted in Italy, 1,534 healthcare workers who had come into contact with HIV-infected blood percutaneously or via the mucous membranes were included in the study. As a result of the follow-up, the seroconversion rate was found to be 0.10% after percutaneous exposure and 0.63% after mucosal exposure [28]. In Ankara, serological analysis of 57,247 blood samples from patients and blood donors showed anti-HIV seropositivity of 0.087% [16]. A comprehensive study conducted on 34,666 samples found anti-HIV positivity of 0.04% [17]. Serological tests performed by Kocazeybek et al. on 229 corneal transplant donors showed seropositivity for hepatitis B and hepatitis C, but no anti-HIV positivity was found [29]. Considering the HIV seropositivity rates in national studies, it was only natural that no positivity was found in our study of 197 cases. This situation does not exclude the fact that HIV is a source of risk at autopsy. Other sources of risk, hepatitis B and hepatitis C, have been detected serologically in autopsy cases, and cadavers are a source of risk to medical staff.

Among inexperienced autopsy personnel, injury-related percutaneous blood contact occurs in 1 in 11 autopsies, compared to 1 in 55 autopsies among more experienced personnel [4]. In some studies on occupational exposure to blood and body fluids in healthcare workers, the rate of sharps injuries in surgeons was 1.3-15.4%, while the rate of mucocutaneous blood contact was reported to be 6.4-50.4% [30,31]. In a similar study, 95% of all percutaneous injuries were reported to be caused by needlesticks and 3.6% by scalpel cuts [32]. The nature of injuries is different in those who perform autopsies. People are exposed to incisions rather than needle sticks. Most of these incisions occur when the scalp is opened. In addition, about 8% of surgical gloves are punctured during autopsy, which can result in existing lesions on the hand coming into contact with infected blood during prolonged use [4]. Therefore, there is a risk of infection from injuries that occur during autopsy.

The second step in risk assessment is determining the degree of risk the hazard poses. The greater the probability of the event or situation occurring and the more serious the consequences, the higher the risk. There are various methods for risk assessment. The "5x5 method" is the simplest and most widely used among these methods. It can also be easily applied to any situation. This method is based on a formulation that evaluates the frequency of occurrence of the event and the severity of the consequence by ranking them from one to five according to specific criteria (Table 3). Based on the data obtained from this method, five different risk levels are determined for the hazard in question, such as "insignificant," "low," "medium," "high," and "unacceptable," and appropriate measures are taken [5]. Let us consider the possibility of cutting or stabbing injuries during the autopsy. If the use of cutting and stabbing tools occurs daily due to the autopsy process and if they are used carelessly, the risk is unacceptable because there is a possibility of contracting a fatal and serious disease such as hepatitis and AIDS due to the injuries. If the risk is unacceptable or a high-risk situation occurs, the necessary precautions should be taken to prevent this situation.

Table 3. Risk assessment table "5X5 method"

5X5 method		Severity of the result				
		1. Accident without damage/injury	**2. Minor injury requiring first aid**	**3. Requires at least 3 days of rest**	**4. Severe injury or illness**	**5. One or more fatal accidents**
Frequency of occurrence	**1. Once a year**	Meaningless	Low	Low	Low	Moderate
	2. Every three months	Low	Low	Low	Moderate	Moderate
	3. Once a month	Low	Low	Moderate	Moderate	High
	4. Once a week	Low	Moderate	Moderate	High	High
	5. Every day	Low	Moderate	High	High	Unacceptable

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However, the "5x5 method" cannot always be used for risk assessment. In such cases, attention should be paid to many parameters, such as the transmission route, the severity of the infectious agent (non-toxic/non-pathogenic, pathogenic/lethal), the concentration of the agent, the physical condition of the environment (technical construction, air flow, inlets, and outlets), the protective equipment, the training and behavior of the personnel, the factor for which there is limited information, and the technical materials used. The more these factors play a role, the higher the risk and the more precautions must be taken [33]. Because HIV and the hepatitis B and hepatitis C viruses are pathogenic and blood-borne, the morbidity and mortality rates and the spread of the diseases (hepatitis, AIDS), the transmission of infections (hepatitis B, hepatitis C, HIV) during the autopsy procedure is highly risky.

Following the risk assessment, the appropriate biosafety level for the autopsy is determined and performed under these conditions. In environments where there are pathogens that can be transmitted through blood and body fluids, such as the infectious pathogens in our study, second-degree biosafety level measures are sufficient, while in environments where there are pathogens that can be transmitted through the air, such as the tuberculosis pathogen, third-degree biosafety level measures are required. In addition, in environments where there is a risk of transmission of pathogens such as the Ebola virus, which causes a high mortality rate and for which there is no vaccine or treatment yet, and Nairovirus (Crimean-Congo hemorrhagic fever pathogen), which is more common in Tokat, Sivas, and Yozgat regions of our country, fourth-level biosafety conditions should be provided.

CONCLUSION

In cases where forensic autopsies are performed, medical personnel involved in the autopsy are at high risk of contracting hepatitis B, hepatitis C, and AIDS.

Since it is not always possible to access medical records, we consider it appropriate to exercise extreme caution in the use of personal protective equipment to minimize the risk of infection in all cases, especially for those with a history of major surgery and alcohol or drug use.

Conflict of Interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Ethical Approval
Approval was obtained from the Tokat Gaziosmanpaşa University School of Medicine Ethics Committee (decision number 83116987-027, date: 07.01.2016).

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