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Original article

ASSESSMENT OF OCCUPATIONAL RISK EXPOSURES AND THE DEGREE OF IMPLEMENTATION OF STANDARD PROTECTIVE EQUIPMENT AMONG MEDICAL PERSONNEL

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ABSTRACT:

Knowledge and application in practice of hygienic and epidemiological standards and the algorithm for post-exposure prophylaxis of blood-borne infections are decisive for their reliable prevention.

Aim: Assessment of participants' knowledge and behavior regarding hygienic and epidemiological standards and awareness regarding the algorithm for post-exposure prophylaxis of medical personnel for hepatitis B, hepatitis C and human immunodeficiency virus infection.

Materials and methods: the period is March 2024-March 2025. 164 respondents working in the Emergency Department of the University Hospital "St. George" - Plovdiv participated in the survey.

Results: mean age is 39.4 years (SD = 13.0). Approximately 32.3% are men, 82.3% report wearing gloves for each patient, and 80,5% are vaccinated with HBV. The prevalence of occupational incidence was 45.7% (n = 75).51.3% reported "2 ", 28.2% reported "1 ", 12.8% reported "3 ", 5.1% reported ">5 ", and 2.6% reported "5 ".Among the 73 participants with available data, post-incidence measures included washing the wound/stab site with soap and water and disinfection (65.3%), testing for Hepatitis B/C (26.7%), and testing for HIV (5.3%)

Conclusion: Only knowledge and compliance with a strict anti-epidemic regime and hygienic-epidemiological standards will ensure a safe working environment and prevention of blood-borne infections.

Keywords: risk exposures, standard protective equipment, prevention,

INTRODUCTION

The risk of work-related accidents and the acquisition of blood-borne infections is a serious occupational problem that medical staff face in their daily work. Given the specific nature of their work (rapid response times, handling of needles and various other sharp and cutting instruments, direct contact with blood and other biological fluids), emergency medical services personnel have emerged as one of the most at-risk medical professional groups in this aspect. Among the common pathogens that can be transmitted by blood, we should mention Hepatitis B (HBV - up to 30%, if not vaccinated), C (HCV - about 1.8-6 %) and Human Immunodeficiency Virus (HIV - about 0.3%) [1, 2, 3].

The percutaneous inoculation is considered to be an occupational exposure risk - cuts from contaminated sharps, needle sticks, contact with blood on injured skin or mucous membranes or blood in the conjunctiva, improper disposal of sharps, inadequate use of personal protective equipment (PPE) [4, 5].

In the Republic of Bulgaria, the emergency medical services are organized to provide accessible, effective, and high-quality medical care to the population. Although there is a need to comply with specific measures to ensure employees' health is well known, the incidence of morbidity among employees and their awareness of potential risks have not been systematically and comprehensively studied nationwide. [4].

Awareness of risky incidents and the correct behaviour in case of risky exposures, as well as the proper and continuous use of personal protective equipment and post-exposure prophylaxis, are decisive for their reliable prevention [5, 6].

Aim:

Assessment of participants' knowledge and behavior regarding hygienic and epidemiological standards and awareness regarding the algorithm for post-exposure prophylaxis of medical personnel for hepatitis B, hepatitis C and human immunodeficiency virus infection.

MATERIAL AND METHODS:

We conducted an anonymous one-year long survey for the period from March 2024 until March 2025. Our focus was on the employees in the emergency department of the University Hospital "St. George" -Plovdiv, 164 of whom responded to a specially designed questionnaire.Twelve single-answer questions were asked to gain insight into the employees' level of awareness about applying standard preventive measures, the frequency of occupational exposure risks, proper measures after an incident, and other factors that may present a potential hazard to the employees' health, etc.

Statistical Methods

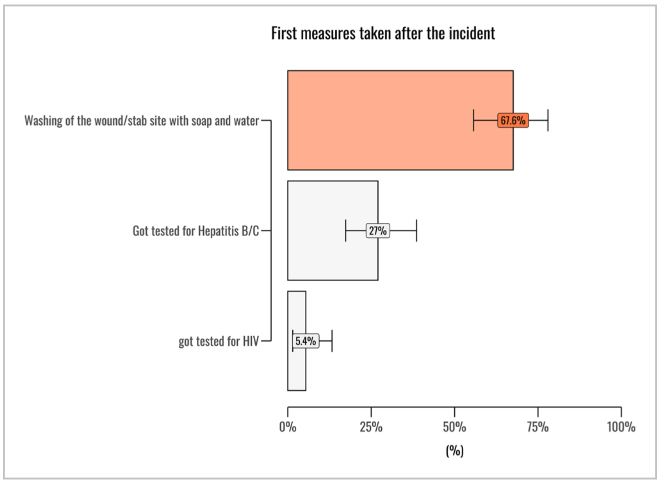
This cross-sectional study evaluated factors associated with occupational incidents (e.g., needlestick injuries or exposures) among 164 emergency care specialists. Data were collected on participants' age, gender, work experience, glove use for every patient, incidence occurrence, number of incidences per year, use of personal protective equipment at the time of incidence, measures taken post-incidence, hepatitis B virus (HBV) vaccination status, knowledge of the post-exposure algorithm, and preferred first contact person following an incidence. Statistical analyses were performed using R software (version 4.4.3) with the tidyverse, broom, gtsummary, and car packages. Descriptive statistics included means and standard deviations for continuous variables (e.g., age) and proportions for categorical variables (e.g., gender, glove use). Two logistic regression models were constructed using the glm() function with a binomial family to estimate odds ratios (ORs) and 95% confidence intervals (CIs), computed via the broom package. Model 1 assessed predictors of incidence occurrence - age, gender, work experience, glove use, vaccination status, and algorithm knowledge using data from all 164 participants, with no missing values for these variables. Model 2 examined predictors of multiple incidences (2 vs. 1 per year) among the 75 participants reporting an incidence, defined by recoding the number of incidences per year into a binary outcome.

RESULTS

Study Population Characteristics

The study cohort comprised 164 emergency care specialists with a mean age of 39.4 years (SD = 13.0). Approximately 32.3% were male, 82.3% reported wearing gloves for every patient, and 80.5% were vaccinated against the hepatitis B virus (HBV). The prevalence of occupational incidence was 45.7% (n = 75). Work experience was distributed as follows: 45.7% with 5 years, 25.6% with 5–15 years, and 28.7% with >15 years. (Fig. 1.)

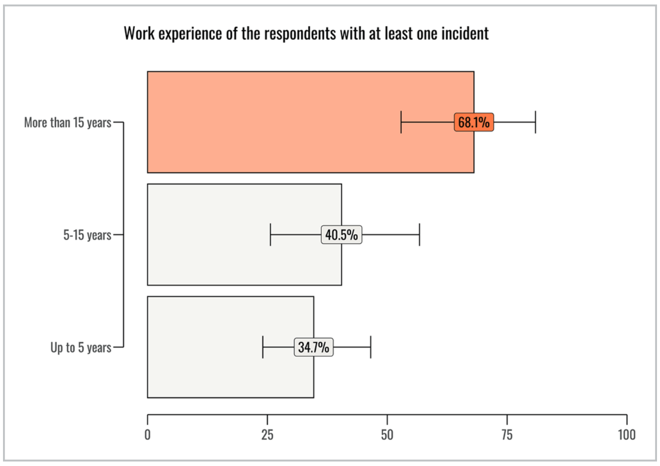
Fig. 1. First measures taken after the incident.



Descriptive Analysis

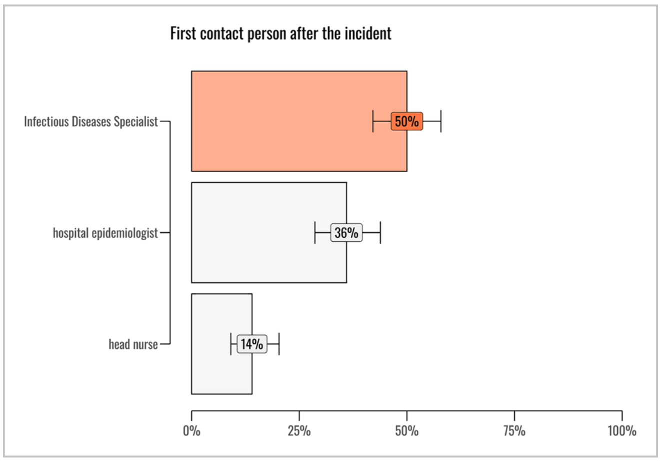
Among the 75 participants reporting an incidence, the annual number of incidences was distributed as follows: 51.3% reported "2 ", 28.2% reported "1 ", 12.8% reported "3 ", 5.1% reported ">5 ", and 2.6% reported "5 ". Among the 73 participants with available data, post-incidence measures included washing the wound/stab site with soap and water and disinfection (65.3%), testing for Hepatitis B/C (26.7%), and testing for HIV (5.3%) (Fig. 2.)

Fig. 2. Work experience of the respondents with at least one incident.



The primary contact person post-incidence (n = 75) was the hospital epidemiologist (42.7%), followed by an Infectious Diseases Specialist (41.3%) and head nurse (16.0%). (Fig. 3.)

Fig. 3. First contact person after the incident.



Cross-tabulations revealed that 21.9% of unvaccinated participants reported an incidence compared to 51.5% of vaccinated participants. Among those not wearing gloves for every patient, 62.1% experienced an incidence, versus 42.2% of consistent glove users. Chi-square tests indicated a significant association between vaccination status and incidence (^{2} = 7.96, df = 1, p = 0.005) and a borderline significant association with glove use (^{2} = 3.03, df = 1, p = 0.082). A weak positive correlation was observed between age and glove use (Pearson's r = 0.14, p = 0.068).

A summary table (Table 1) highlighted significant differences by incidence status. Median age was higher among those with an incidence (46 vs. 31 years, $p < 0.001$), and vaccination rates were elevated (90.7% vs. 71.9%, p = 0.003). Work experience distribution showed a significant difference (p = 0.001), with a greater proportion of participants with >15 years' experience reporting an incidence (42.7% vs. 16.9%). Glove use differences were borderline significant (76.0% vs. 87.6%, p = 0.052), while gender differences were not statistically significant (p = 0.5).

Table 1. Summary of Characteristics by Incidence Status.

Characteristic	**No Incidence**, N = 89	**Incidence**, N = 75	**p-value**
Age (years)	31 (26, 44)	46 (31, 55)	<0.001
Male gender	31 (34.8%)	22 (29.3%)	0.5
Work experience			0.001
up to 5 years	49 (55.1%)	26 (34.7%)	
5–15 years	25 (28.1%)	17 (22.7%)	
more than 15 years	15 (16.9%)	32 (42.7%)	
Glove use for every patient	78 (87.6%)	57 (76.0%)	0.052
HBV vaccination	64 (71.9%)	68 (90.7%)	0.003

Prediction Modeling of Incidence Occurrence

A logistic regression model was fitted to predict occupational incidence occurrence among the 164 emergency care specialists.

Table 2. Logistic Regression Results for Incidence Occurrence.

Variable	**Odds Ratio**	**95% CI**	**p-value**
Intercept	0.06	0.01–0.40	0.004
Age (per year)	1.09	1.03–1.16	0.003
Male gender (ref: Female)	1.5	0.68–3.39	0.316
Work experience: 5–15 years (ref: ≤5 years)	0.3	0.09–0.96	0.048
Work experience: >15 years (ref: ≤5 years)	0.56	0.11–2.67	0.465
Glove use for every patient (ref: No)	0.21	0.07–0.56	0.003
HBV vaccination (ref: No)	2.45	0.95–6.95	0.075
Algorithm knowledge (ref: No)	1.15	0.55–2.37	0.714

Consistent glove use was significantly associated with reduced odds of incidence (OR = 0.21, 95% CI: 0.07–0.56, p = 0.003), reflecting a 79% decrease in odds relative to inconsistent use. Age exhibited a significant positive association (OR = 1.09 per year, 95% CI: 1.03–1.16, p = 0.003), indicating a 9% increase in odds per year. Work experience of 5–15 years was associated with significantly lower odds of incidence compared to ≤5 years (OR = 0.30, 95% CI: 0.09–0.96, p = 0.048), while >15 years showed no significant difference (OR = 0.56, 95% CI: 0.11–2.67, p = 0.465). HBV vaccination status showed a borderline significant association (OR =2.45, 95% CI: 0.95–6.95, p = 0.075). Gender (male vs. female: OR = 1.50, 95% CI: 0.68–3.39, p = 0.316) and knowledge of the post-exposure algorithm (OR = 1.15, 95% CI: 0.55–2.37, p = 0.714) showed no significant association. Variance inflation factors indicated no multicollinearity among predictors (all GVIF < 5). The model's pseudo R^2 was 0.17, indicating moderate explanatory power.

Prediction Modeling of Multiple Incidences

An initial logistic regression model including vaccination status and PPE use to predict multiple incidences (≥2 vs. 1 per year) among the 75 participants reporting an incidence was unstable due to quasi-complete separation and missing PPE data (n = 73), and thus abandoned. A simplified model (n = 75) examined age, gender, work experience, and glove use.

Table 3. Logistic Regression Results for Multiple Incidences.

Variable	Odds Ratio	95% CI	p-value
Intercept	1.05	0.09–13.1	0.968
Age (per year)	1	0.93–1.08	0.922
Male gender (ref: Female)	1.22	0.38–4.15	0.737
Work experience: 5–15 years (ref: ≤5 years)	1.26	0.25–6.48	0.775
Work experience: >15 years (ref: ≤5 years)	2.97	0.42–23.8	0.282
Glove use for every patient (ref: No)	1.11	0.31–3.86	0.864

No predictors reached statistical significance. Compared to the reference category of d"5 years of work experience, neither 5–15 years (OR = 1.26, 95% CI: 0.25–6.48, p = 0.775) nor >15 years (OR = 2.97, 95% CI: 0.42–23.8, p = 0.282) showed a significant difference in odds of multiple incidences. Age (OR = 1.00 per year, 95% CI: 0.93–1.08, p = 0.922), male gender (OR = 1.22, 95% CI: 0.38–4.15, p = 0.737), and glove use (OR = 1.11, 95% CI: 0.31–3.86, p = 0.864) were also not significantly associated. The model's pseudo R^2 was 0.05, indicating limited explanatory power.

DISCUSSION

The World Health Organisation [7] estimates that unsterilized syringe use causes between 8 and 16 million cases of hepatitis B, 3 to 4.7 million cases of hepatitis C, and 80,000 to 160,000 cases of HIV each year.

According to a prospective survey study, 'A Safer Place to Work', needlestick and sharps injuries cause 17% of incidents involving National Health Service (NHS) staff. These injuries are also the second most common cause of injury, after handling and moving (18%).The central blood-borne infections that should be of concern regarding needlestick injuries are the viruses that cause hepatitis B and hepatitis C. [8].

Worldwide, there are three million exposures annually. Thus, needlestick injuries account for 40% of hepatitis B, 40% of hepatitis C and 4.4% of HIV infections among health professionals. HIV-related deaths claim the lives of 1,000 healthcare professionals annually. The efficacy rate of HBV immunization is 95%. However, over 80% of healthcare personnel are still unvaccinated in many regions of the world [9].

The US Centers for Disease Control and Prevention (CDC) estimates that hospital employees in the US sustain 385,000 needlestick and other medical sharps injuries [10]. Other authors estimate the annual rate in the United States to be somewhere between 500,000 and 800,000 [11].

According to [12], there are approximately 100,000 needlestick injuries in the UK and 500,000 in Germany per year. Given the research on underreporting of medical sharps injuries, the epidemiology of these injuries may be higher. For example, a comprehensive study conducted in the United States of America revealed that 58% of medical sharps injuries went unreported, but other studies put the figure at 90%.

One of the known occupational hazards for health care workers is injuries from medical sharps. Approximately 2 million HBV, 900,000 HCV and 170,000 HIV infections among healthcare workers worldwide are caused by medical sharps injuries each year [13]. Many Asian and African countries are concerned about these blood-borne diseases because of their severe consequences, which can include permanent illness, disability, and even death [14].

Each year, 3 million healthcare professionals worldwide are exposed to blood-borne pathogens through percutaneous procedures; 90% of these cases occur in underdeveloped countries [13].

Injuries from medical sharps and needle sticks are common among healthcare professionals. 75.6% of 352 health care workers in Iran who participated in a descriptive, cross-sectional study reported having experienced at least one needlestick injury during the year [15].

Despite the significant risk of occupational exposure to HIV among health care workers in busy maternity wards, a retrospective study conducted in South Africa to determine the prevalence of needlestick and sharps injuries revealed that 21% of respondents had been subjected to sharps injuries. [16]

A USA's national examination of occupational hazards in emergency medical services, published in 2023, reported that among 13,218 respondents, any occupational injury in the past 12 months was experienced by 27% of the sample. Of these, only 2% involved accidental needle injury [17]. The same study concluded that the work-related hazards are associated with demographic characteristics such as age and sex, and workplace characteristics such as agency type and level of certification. The results showed that common mitigation efforts were not widespread, but when present, they were associated with lower odds of reporting occupational hazards.

Similar results were reported earlier, in 2015, when it was reported that among 966,082 shifts, 4382 employees and 950 outcome reports, only 2.1% were related to needle injury. This three-year long study concluded that shift length is associated with increased risk of occupational injury and illness in this sample of emergency medical services shift workers - risk of occupational injury and illness was lower for shifts ≤8h in duration compared with longer shifts (ranging from >8h to 24h) [18].

In contrast, the results from our survey show that at least one injury caused by a sharp object was reported by 45.7% (n = 75). Any post-incident measures were reported by 73 responders.These results are disturbing. As expected, consistent glove use was significantly associated with reduced incidence odds, a 79% decrease relative to inconsistent use. Authors referred the sharps-related injuries to the patient visits count and identified a higher frequency in incidence in the academic medical centre (20.3 per 100,000 patient visits) versus the community sites (5.9 per 100,000 patient visits). The study observed the type of instrument causing the injury: 73.7% were caused by straight needles, 17.0% were caused by suture needles, 4.7% by scalpels and 4.7% by other sharp objects. [19]

Some authors report that increased age, but not increased experience in Emergency medical services, is associated with lower odds of experiencing work-related hazards, indicating that there may be some unknown protective indicator that also increases with age [17].

Unlike these reports, our survey concluded that age exhibited a significant positive association with incidence occurrence, indicating a 9% increase in odds per year. Work experience of 5 - 15 years was associated with significantly lower odds of incidence compared to 5 years, while >15 years showed no significant difference. In parallel, we observed a weak positive correlation between age and glove use.

Naghavi SH, et al. [20] performed a survey of post-traumatic stress disorder in trainee doctors with previous needlestick injuries. They report that 54% of the participating doctors sustained at least one needlestick injury during their training, and 38% of the injuries were not reported to the occupational health or emergency departments.

The different medical facilities demonstrate a significant variation in employees' training and re-training, safety procedures, and reporting standards [19]. It was observed that the voluntary nature of reporting may lead to underreporting [19]. This highlights the necessity of a unified approach to PPE use, standardization of manipulation procedures, reporting guidelines and strict and mandatory post-injury measures.

Dorevitch S, et. al [21] observed that measures to prevent the infections' exposures can reduce risk, but compliance is low, particularly for those involving changes in the behaviour of emergency physicians (such as not recapping needles).

Minimizing the risk of infections and prevention

1. Pre-exposure immunoprophylaxis, as well as post-exposure immunoprophylaxis – especially for Hepatitis B – for those born before 1992, it is important to get vaccinated, because after this year, the vaccine became part of the Immunisation Calendar of the Republic of Bulgaria! All those who were vaccinated more than 10-15 years ago are recommended to be examined and monitored for the intensity of their immunity! [4].

It is recommended that education about the risk of infection from occupational exposure to blood be enhanced during training and periodically during internship. Ongoing training and information should be provided for both qualified medical and non-medical personnel, trainees, temporary and foreign workers. Effective education programmes are needed to reinforce prevention and compliance with post-exposure management.

Each health care facility is required to develop a program to prevent exposure to blood-borne infections (BBIs), including the provision of post-exposure prophylaxis (PEP) to health care personnel who come into contact with them. [22, 23, 24, 25, 26, 27]

Personal protective equipment has a barrier function and is essential to ensure a high level of protection. The benefit of wearing personal protective equipment is twofold - it protects patients and medical staff. [28, 29, 30,31].

CONCLUSION:

Ensuring healthy and safe working conditions for medical personnel requires the existence of a plan-programme in each medical facility and the observance of the algorithm of behaviour in case of occupational exposure to blood-borne viral infections. Preventive measures to protect workers in high-risk environments and adherence to the existing regulatory framework for safe work techniques and blood-borne infection risk management are essential for successful control.

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