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Increased Occupational Exposure to Body Fluids in Healthcare Workers During the COVID-19 Pandemic: A Retrospective study from 2013 to 2022

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ABSTRACT

Background: Healthcare workers (HCWs) are at risk of body fluids' exposure. **Objective:** The objective of this study was to study the incidence of occupational body fluid exposures in HCW at a tertiary hospital and largest coronavirus disease 2019 (COVID-19) center in Mexico. **Methods:** Data on sociodemographics, exposure factors, and vaccination status were collected from questionnaires of HCWs self-reporting exposures (January 2013-December 2022). Hepatitis B and C virus (HBV and HCV) and human immunodeficiency virus (HIV) serology data were retrieved from the laboratory platform. Descriptive statistics and variable associations were analyzed. **Results:** Four hundred and eighty-two exposures occurred, 311 in women (64.5%). Exposure incidence was 19.09/1000 person-years; 80% were percutaneous; and 20% were splashes. Median age of exposed HCWs was 21 years (standard deviation = 9.65). Nurses were the most exposed (n = 172, 35.6%), mainly in patients room (n = 223, 46%). About 40.5% of HCW had protective antibody titers to HBV surface antigen (anti-HBs). Self-reported vaccination status and protective anti-HBs titers had poor concordance (kappa = 0.02). One hundred and ninety-seven HCW required HIV post-exposure prophylaxis (40.8%) with no seroconversions. Exposures were highest in 2020 (78 cases, p = 0.001 vs. all years). **Conclusion:** A high proportion of HCW lacked protective anti-HBs titers. Increased occupational exposures during the COVID-19 pandemic underline the need for standard precautions, HBV immunization, staff training, and post-exposure protocols to enhance pandemics preparedness. (REV INVEST CLIN. 2025;77(2):55-66)

Keywords: Blood-borne pathogens. Body fluids. Human immunodeficiency virus. Hepatitis B virus. Hepatitis C virus. Occupational exposure of healthcare personnel.

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INTRODUCTION

Healthcare workers (HCWs) are exposed to blood and other body fluids during their work. Consequently, they are at risk of infection with blood-borne viruses. Following occupational exposure, the risk of infection may vary with factors such as the pathogen involved, the type of exposure (percutaneous or mucous membrane contact), the type of sharp instrument, the amount of body fluid involved in the exposure, and the viral load of the source patient[1]. Most cases are attributed to three blood-borne viruses, specifically, the human immunodeficiency virus (HIV), hepatitis B (HBV), and hepatitis C (HCV)[2]. Among the 35 million HCWs worldwide, about 3 million experience percutaneous exposures to blood-borne pathogens each year, 2 million of them to HBV, 0.9 million to HCV, and 170 000 to HIV. These injuries may result in 15 000 HCV, 70 000 HBV, and 500 HIV infections. More than 90% of these infections occur in developing countries[3]. The probability of acquiring a secondary infection from a biological accident involving fluids from seropositive patients is as high as 30% in the case of HBV, 1.8% in HCV when the exposure is percutaneous, and 0.3% when the exposure is mucosal. The probability for HIV is 0.3% in percutaneous exposure and 0.09% in mucosal exposure[4].

The National Institute of Respiratory Diseases (INER) is part of the tertiary healthcare institution network in Mexico and serves as a national referral center for respiratory diseases, receiving patients from across the country. The INER is also a training center for healthcare students (a term used here to encompass medical residents, undergraduate medical interns, and other health science students), as well as for healthcare professionals, and has a specialized clinic for the care of people living with HIV, named the Center for Research in Infectious Diseases (CIENI). Considering that as of March 23rd, 2020, the INER was transformed into the largest coronavirus disease 2019 (COVID-19) facility for severely ill patients in Mexico; here, we recorded occupational exposures to body fluids before, during, and after the pandemic period.

The objectives of this study were to determine the incidence of occupational exposures to body fluids and the percentage of HCWs with protective antibody titers to HBV surface antigen (anti-HBs) at the INER. In addition, the study aimed to assess the distribution of occupational exposures across sociodemographic variables and job positions, to identify hospital areas with the highest frequency of exposures, analyze common injury mechanisms, assess the percentage of exposures with positive sources for HIV, HBV, and HCV, determine the requirement of post-exposure prophylaxis (PEP) among workers, assess vaccination coverage for HBV, and evaluate the concordance between prior vaccination status and protective anti-HBs titers.

METHODS

Study population

This retrospective, cross-sectional, and observational study was conducted at the INER. The study was reviewed and approved by the Research Ethics Committee and the Research Committee of the INER (Approval No. C03-23). Data on the exposed worker's demographics, job category, work area, HBV vaccination status (recalled shots received in adulthood), exposure details (date, hospital area, type of fluid, causative object, and mechanism), and HIV PEP when indicated, were collected from questionnaires administered during the clinical consultation following the exposure. In addition, HBV, HCV, and HIV serology results for both the exposed worker and the source patient, along with follow-up data on seroconversion, were obtained from the virology diagnostic laboratory (VDL) platform of the CIENI. This study included HCWs who attended infectious disease consultations between January 2013 and December 2022, and underwent serological testing for HIV, HBV, and HCV at the VDL.

Preventive measures

The measures implemented at the INER to prevent occupational exposure to body fluids include staff training in standard precautions, such as washing hands after direct contact with patients, safe collection and disposal of sharps, the use of barrier materials (e.g., gloves, masks, eye protection, gowns, and covering cuts and abrasions), cleaning up spills of body fluids, using safe systems for hospital waste management and disposal, and vaccination against HBV[5].

Immunocompetent adults who had vaccine-induced anti-HBs levels of ≥ 10 mIU/mL 1-2 months after

having received a complete HBV 3-dose vaccine series were considered seroprotected and deemed vaccine responders[6].

The presence of total (immunoglobulin M and immunoglobulin G) antibodies to the HBV core antigen (anti-HBc) was considered indicative of previous or ongoing infection with HBV within an undefined time frame, as immunization against hepatitis B through vaccination does not result in the development of anti-HBc[7].

Statistical analysis

We performed descriptive statistics including frequencies and percentages for qualitative variables. For quantitative variables, we computed means and standard deviations (SD). The kappa index was used to evaluate the concordance between self- reported vaccination status and protective anti-HBs titers. Comparisons of the number of exposures that occurred in 2020 versus other study years were performed using the X^2 test. Statistical tests were two-sided, and $p \leq 0.05$ were considered statistically significant. Statistical analysis was executed utilizing the R programming language and R software version 3.4.3 (2017).

RESULTS

Characteristics of the study population

During the period between January 2013 and December 2022, a total of 482 exposures of HCWs to body fluids were reported at the INER. Of those, 311 occurred in women (64.5%) and 171 in men (35.5%). The incidence of occupational exposure to body fluids during the study period was 19.09/1000 person-years. The median age of the population studied was 21 years, (SD = 9.65), with a minimum of 17 years and a maximum of over 60 years. When dividing this group by decades into age intervals of 17-21 years, 22-29 years, 30-39 years, 40-49 years, 50-59 years, and 60 years and older, we found that most exposures occurred in HCWs aged 22-29 years (n = 311, 52.7%) followed by those aged 30-39 years (n = 171, 35.5%). During the pandemic contingency, the INER hired workers for a limited period to fulfill temporary institutional needs (short-term staff), but most accidents (n = 348, 72%) occurred among permanent workers (staff). Throughout the study period, exposures were more frequent among nurses (n = 172, 35.6%), medical residents (n = 113, 23.5%), and physicians (n = 111, 23%). A total of 384 exposures were percutaneous (80%), and 97 exposures (20%) were due to splashes. In a single HCWs, it was not specified whether the type of exposure was percutaneous or by splash. The most frequently involved instrument was the syringe needle or catheter, accounting for 259 cases (67.4%). During 2020 and 2021, this frequency increased to 80% and 80.4%, respectively (Table 1). A total of 197 HCWs required PEP for HIV (40.8%). The average time elapsed between the occupational exposure to body fluids and the initiation of PEP was 17.6 h. None of the HCWs exposed to body fluids experienced seroconversion for HIV, HBV, or HCV during the follow-up.

The diagnosis of the source patient was unknown in 111 cases (23%); HIV infection was confirmed in 129 source patients (26.7%); HBV infection was confirmed in 18 source patients (4%); HCV infection was confirmed in 3 source patients (0.6%); and COVID-19 was confirmed in 96 source patients (20%).

The number of HCWs at the INER varied throughout the study period. Considering that physicians, nurses and medical residents had the highest exposure to body fluids, table 2 shows the proportion of individuals exposed within these three populations for each study year. The lowest number of exposures and the lowest incidence occurred in 2017 (Fig. 1), involving 4 physicians (2.2%), 9 nurses (1.7%), and 15 medical residents (2.2%), which, respectively, constituted 0.2%, 0.4%, and 0.7% of the entire population of HCWs at the INER. The year with the highest incidence was 2014, although the highest number of exposures occurred in 2020, when a total of 25 physicians (8.3%), 35 nurses (2.3%), and 7 medical residents (3.6%) were exposed, which, respectively, represented 0.7%, 1.0%, and 0.2% of the entire population of HCWs at the INER.

Vaccination coverage for hepatitis B at the National Institute of Respiratory Diseases

On the initial questioning about vaccination status for HBV, 354 HCWs reported having received at least one dose of HBV vaccine in adulthood, in addition to the vaccination administered in the 1st year of life (73.4%).

Table 1. General characteristics of the healthcare workers included in the study

n = 482	2013		2014		2015		2016		2017		2018		2019		2020		2021		2022		Total	
Exposures by gender	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Female	34	67.0	36	59.0	26	65.0	23	68.0	22	69.0	21	51.0	28	57.0	48	61.0	49	83.0	24	65.0	311	64.5
Male	17	33.0	25	41.0	14	35.0	11	32.0	10	31.0	20	49.0	21	43.0	30	39.0	10	17.0	13	35.0	171	35.5
Age	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
17-21 years	2	4.0	8	13.0	2	5.0	4	12.0	2	6.5	3	7.0	4	8.0	4	5.0	3	5.0	1	3.0	33	6.9
22-29 years	19	37.0	32	53.0	19	47.5	16	47.0	18	56.0	24	59.0	24	49.0	42	54.0	33	57.0	26	70.0	253	52.7
30-39 years	14	27.0	10	17.0	14	35.0	8	23.0	8	25.0	8	20.0	14	29.0	19	24.0	14	24.0	8	21.0	117	24.3
40-49 years	11	22.0	5	8.0	1	2.5	2	6.0	1	3.0	3	7.0	5	10.0	7	9.0	6	10.0	1	3.0	42	8.8
50-59 years	3	6.0	4	7.0	4	10.0	2	6.0	2	6.5	2	5.0	1	2.0	4	5.0	1	2.0	0	0.0	23	4.8
Over 60 years	2	4.0	1	2.0	0	0.0	2	6.0	1	3.0	1	2.0	1	2.0	2	3.0	1	2.0	1	3.0	12	2.5
Employment status	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Staff	33	65.0	39	64.0	24	60.0	23	68.0	18	56.0	23	56.0	26	53.0	71	91.0	54	91.0	37	100.0	348	72.0
Short-term staff[a]	18	35.0	22	36.0	16	40.0	11	32.0	14	44.0	18	44.0	23	47.0	7	9.0	5	9.0	0	0.0	134	28.0
Occupation	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Physician	2	4.0	3	5.0	11	27.5	5	15.0	4	12.5	10	24.5	18	36.7	25	32.0	16	27.0	17	46.0	111	23.0
Healthcare student[b]	20	40.0	24	40.0	13	32.5	10	30.0	15	47.0	12	29.0	8	16.3	7	9.0	3	5.0	1	3.0	113	23.5
Nurse	17	33.0	24	40.0	10	25.0	11	32.0	9	28.0	12	29.0	14	29.0	35	44.5	24	41.0	16	43.0	172	35.6
Administrative	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Laboratory[c]	1	2.0	2	3.0	0	0.0	2	6.0	2	6.2	0	0.0	2	4.0	1	1.5	7	12.0	0	0.0	17	3.5
Technician[d]	3	6.0	1	1.0	1	2.5	1	3.0	0	0.0	4	10.0	4	8.0	1	1.5	1	1.5	0	0.0	16	3.4
Housekeeping	5	9.0	2	3.0	3	7.5	1	3.0	2	6.2	1	2.5	2	4.0	8	10.0	8	13.5	3	8.0	35	7.0
Other	3	6.0	5	8.0	2	5.0	4	11.0	0	0.0	2	5.0	1	2.0	1	1.5	0	0.0	0	0.0	18	4.0

(Continues)

Table 1. General characteristics of the healthcare workers included in the study *(continued)*

n = 482	2013		2014		2015		2016		2017		2018		2019		2020		2021		2022		Total	
Hospital exposure area	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Patient's room	22	43.0	39	64.0	14	35.0	12	35.0	11	35.0	23	56.0	23	47.0	36	46.0	24	41.0	19	51.0	223	46.0
Outside patient's room[e]	8	16.0	1	2.0	1	2.5	4	12.0	1	3.0	0	0.0	0	0.0	5	6.0	4	7.0	2	6.0	26	5.4
Emergency area	5	10.0	9	15.0	4	10.0	2	6.0	8	25.0	5	12.0	4	8.0	18	23.0	10	17.0	6	16.0	71	14.7
Intensive care unit	2	4.0	4	6.5	5	12.5	3	9.0	3	9.0	2	5.0	4	8.0	6	8.0	5	8.5	2	6.0	36	7.5
Operating room	5	10.0	2	3.0	6	15.0	4	12.0	1	3.0	6	14.0	8	17.0	1	1.5	2	3.0	3	8.0	38	7.9
Blood bank	1	2.0	1	2.0	0	0.0	1	3.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3	0.7
Laboratories	1	2.0	2	3.0	2	5.0	1	3.0	2	6.0	0	0.0	1	2.0	1	1.5	5	8.5	0	0.0	15	3.1
Pathology	1	2.0	0	0.0	1	2.5	0	0.0	0	0.0	1	3.0	1	2.0	0	0.0	0	0.0	2	5.0	6	1.3
Other	6	11.0	3	4.5	7	17.5	7	20.0	6	19.0	4	10.0	8	16.0	11	14.0	9	15.0	3	8.0	64	13.4
Type of exposure	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Splash	10	19.0	12	20.0	11	27.5	13	38.0	11	34.0	14	34.0	13	26.5	3	4.0	3	5.0	7	19.0	97	20.0
Percutaneous	41	81.0	48	80.0	29	72.5	21	62.0	21	66.0	27	66.0	36	73.5	75	96.0	56	95.0	30	81.0	384	80.0
Syringe needle/catheter	20	48.8	30	62.5	16	55.2	14	66.7	14	66.7	18	66.7	24	66.7	60	80.0	45	80.4	18	60	259	67.4
Lancet	14	34.1	12	25.0	2	6.9	1	4.8	1	4.8	0	0.0	3	8.3	2	2.7	1	1.8	0	0.0	36	9.4
Solid needle	3	7.3	2	4.2	8	27.6	4	19.0	5	23.8	3	11.1	2	5.6	4	5.3	4	7.1	2	6.7	37	9.6
Scalpel	1	2.4	1	2.1	2	6.9	0	0.0	1	4.8	0	0.0	4	11.1	4	5.3	1	1.8	4	13.3	18	4.7
Other sharp instrument[f]	3	7.3	3	6.3	1	3.4	2	9.5	0	0.0	6	22.2	3	8.3	5	6.7	5	8.9	6	20.0	34	8.9
Diagnosis of source patient	**n**		**n**		**n**		**n**		**n**		**n**		**n**		**n**		**n**		**n**		**n**	**%**
Unknown	17		9		13		6		9		6		10		20		17		4		111	23.0
HIV infection	17		22		15		8		14		16		19		5		3		10		129	26.7
HBV infection	6		1		3		0		0		0		1		1		0		6		18	4.0
HCV infection	0		1		0		1		0		1		0		0		0		0		3	0.6
Pneumonia	9		27		11		10		13		7		14		11		1		3		106	22.0
Tuberculosis	3		0		0		2		2		5		3		0		2		1		18	4.0
Empyema	1		3		1		1		0		1		0		0		0		0		7	1.5
Cancer	1		5		5		2		0		2		2		0		0		6		23	4.8
Other	10		11		5		9		6		11		16		4		3		2		77	16.0
COVID-19	0		0		0		0		0		0		0		45		36		15		96	20.0

(Continues)

Table 1. General characteristics of the healthcare workers included in the study *(continued)*

n = 482	2013		2014		2015		2016		2017		2018		2019		2020		2021		2022		Total	
HBV vaccination	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Reported HBV vaccination[g]	32	48.0	35	56.0	28	53.0	23	56.0	21	54.0	30	58.0	39	72.0	67	84.0	47	73.0	32	86.0	354	73.4
Had protective anti-HBs titers[h]	34	52.0	28	44.0	25	47.0	18	44.0	18	46.0	22	42.0	15	28.0	13	16.0	17	27.0	5	14.0	195	40.4
PEP	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Required	22	43.0	24	39.0	21	52.5	9	26.0	17	53.0	15	37.0	26	53.0	34	44.0	20	34.0	9	24.0	197	40.8
Not required	29	57.0	37	61.0	19	47.5	25	74.0	15	47.0	26	63.0	23	47.0	44	56.0	39	66.0	28	76.0	285	59.2
Time from exposure to PEP initiation (hours)	26.1	11.9	13.1	18	11.8	18.7	20.7	15.8	19.2	16.3												

[a]Short-term staff refers to employees hired for a limited period to fulfill temporary institutional needs.
[b]The term "healthcare students" encompasses medical residents, undergraduate medical interns and other health science students.
[c]Laboratory: individuals processing biological samples.
[d]Technicians: trained professionals performing specialized tasks, such as inhalation therapy technicians (respiratory care), physical therapists (mobility recovery), and laboratory technicians (blood and tissue analysis).
[e]Outside patient's room refers to hospital hallways and the nursing station.
[f]Other sharp instrument refers to materials not strictly related to the clinical setting, such as iron sheets, blood sample glass tubes, microscope slides, cover slips, and razors.
[g]Healthcare workers who self-reported having received the complete HBV vaccination on initial interrogation.
[h]Healthcare workers who had antibodies to HBV surface antigen (anti-HBs) of ≥ 10 mIU/mL were considered to have protective titers against HBV infection.
HIV: Human Immunodeficiency Virus; HBV: hepatitis V virus; HCV: hepatitis C virus; INER: National Institute of Respiratory Diseases; PEP: post-exposure prophylaxis.

Table 2. Proportion of healthcare workers exposed per study year

Year	Total HCW	Physicians				Nurses				Healthcare students*			
		Total	Exposed		Proportion of total HCW	Total	Exposed		Proportion of total HCW	Total	Exposed		Proportion of total HCW
	n	n	n	%	%	n	n	%	%	n	n	%	%
2013	2008	171	2	1.2	0.1	491	17	3.5	0.8	403	20	5.0	1.0
2014	2045	170	3	1.8	0.1	511	24	4.7	1.1	529	24	4.5	1.1
2015	2062	172	11	6.4	0.5	518	10	1.9	0.5	579	13	2.2	0.6
2016	2059	174	5	2.9	0.2	517	11	2.1	0.5	460	10	2.1	0.5
2017	2098	179	4	2.2	0.2	527	9	1.7	0.4	680	15	2.2	0.7
2018	2085	178	10	5.6	0.4	526	12	2.3	0.6	615	12	1.9	0.6
2019	2092	182	18	9.9	0.9	526	14	2.7	0.7	655	8	1.2	0.4
2020	3487	301	25	8.3	0.7	1505	35	2.3	1.0	195	7	3.6	0.2
2021	3729	431	16	3.7	0.4	1524	24	1.6	0.6	137	3	2.2	0.1
2022	3574	383	17	4.4	0.5	1397	16	1.1	0.4	414	1	0.2	0.1

*The term "healthcare students" encompasses medical residents, undergraduate medical interns and other health science students.
HCW: health care workers.

However, serology tests indicated that only 149 (30.9%) had protective anti-HBs titers, while 205 did not. Among the 128 HCWs who reported not having received complete HBV vaccination, 46 (35.9%) had protective anti-HBs titers, and 82 did not. Thus, according to the baseline serology test, a total of 195 (40.5%) HCWs at the INER had protective anti-HBs titers due to previous vaccination, while 287 (59.5%) did not. A low concordance was observed between self-reported vaccination status and protective anti-HBs titers (kappa = 0.02). In addition, none of the exposed HCWs had anti-HBc antibodies, indicating no previous or ongoing HBV infection.

Occupational exposures to body fluids significantly increased in 2020

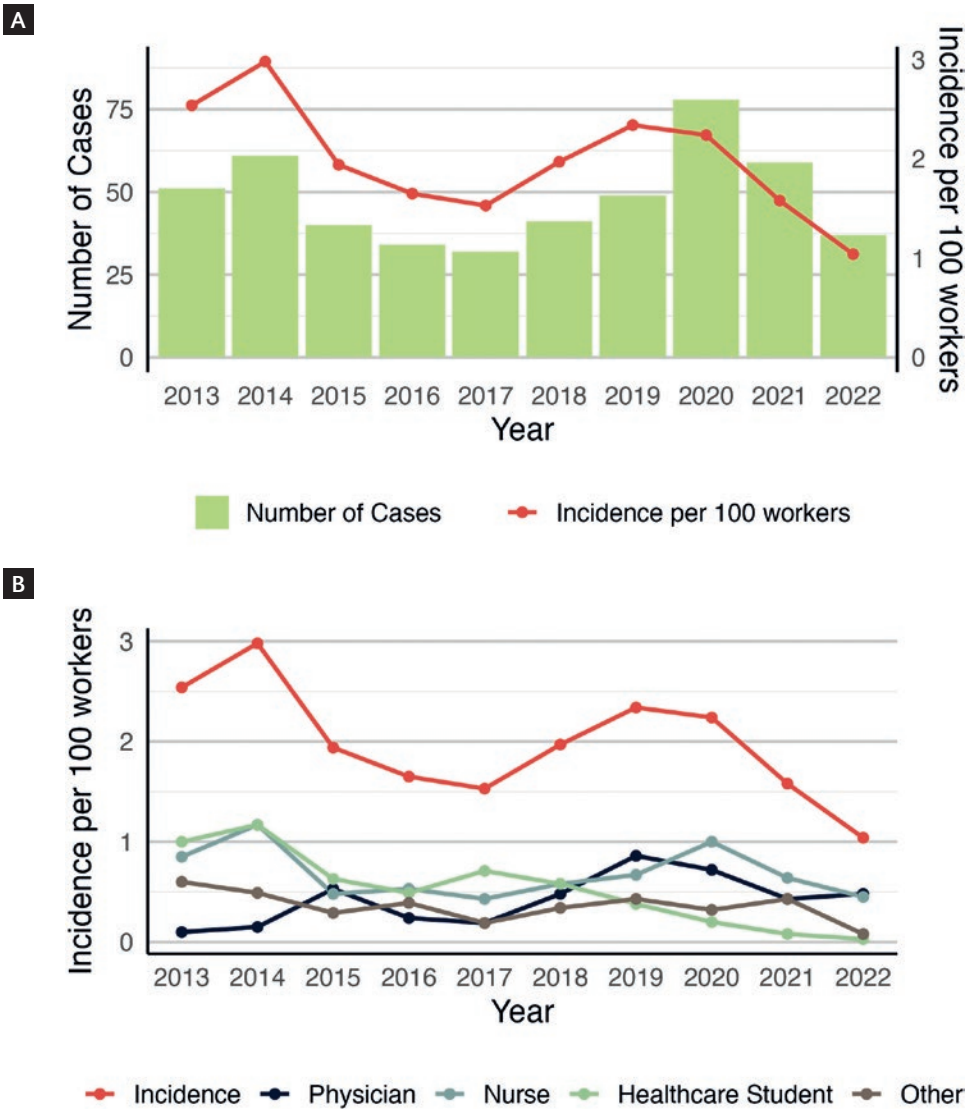
In this study, we were able to register the number of occupational exposures to body fluids before, during, and after the pandemic period. Before the pandemic, there was a stable level of cases observed. However, during the pandemic period, there was a significant increase in the number of cases. This upward trend coincided with a substantial increase in the hiring of short-term staff (Fig. 1). Subsequently, as the situation stabilized, cases began to gradually decrease, eventually returning to levels like those observed before the onset of the pandemic. Thus, the rise in the hiring of short-term staff may have contributed to the increased number of cases. In 2020, there was a statistically significant increase in occupational accidents compared to previous years ($p = 0.001$), with the highest number of exposures among nurses ($p = 0.005$) and physicians ($p = 0.005$) in relation to other years (Table 3).

The hospital areas with the highest frequency of occupational exposures during the study period were the patient's room (n = 223, 46.3%), followed by the emergency area (n = 71, 14.7%), and the operating room (n = 38, 7.9%). In 2020, the areas with the greatest frequency of exposures remained the patient's room (n = 36, 46.2%) and the emergency area (n = 18, 23.1%), with only one exposure (1.3%) occurring in the operating room (Fig. 2).

DISCUSSION

Several studies have reported occupational exposures to body fluids among HCWs during the pre-pandemic period, with only a few studies conducted during the pandemic and post-pandemic periods[8,9]. However, to our knowledge, this is the first study exploring

Figure 1. Occupational exposures to body fluids from 2013 to 2022. **A:** the red line indicates the incidence per 1000 person-years. Bars show the total number of healthcare workers per year at the INER. **B:** incidences per job area during the study period are depicted in colored lines. The term "Other" refers to administrative personnel, lab personnel, technicians and housekeeping.



occupational exposure to body fluids across all three periods. The incidence of occupational exposure to body fluids at the INER was 19.09/1000 person-years, which is lower to what has been reported in other developing countries[10].

We found that 40.5% of the studied population had protective anti-HBs titers due to previous vaccination, which was lower than expected, as 73% reported having received at least one dose of the HBV vaccine in adulthood. Hepatitis B vaccination is recommended during infancy in most countries. The World Health Organization advises a three-dose schedule, with the first dose at birth, followed by doses at 1 and 6 months of age[11]. In Mexico, the Universal Vaccination Program follows a similar schedule, with the first dose administered at birth and subsequent doses at 2, 4, 6, and 18 months of age[12]. Despite that the degree of protection depends on the production of anti-HBs antibodies, and that these levels decrease over time[13], booster doses are not routinely recommended in immunocompetent individuals since immunity conferred by the primary vaccination series remains effective for at least two decades[14]. While some guidelines suggest booster doses every 5-10 years for high-risk individuals or for those with declining antibody levels,

Table 3. Comparison between occupational exposures to body fluids in 2020 versus other study years

Exposure	2020	2013	2014	2015	2016	2017	2018	2019	2021	2022
Exposed HCW	78	51	61	40	34	32	44	46	59	37
Non-exposed HCW	3409	1957	1984	2022	2025	2066	2041	2046	3670	3537
p		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Exposed nurses	35	17	24	10	11	9	12	14	24	16
Total exposures per year	78	51	61	40	34	32	44	46	59	37
p		0.001	0.005	0.001	0.001	0.001	0.001	0.001	0.0025	0.001
Exposed physicians	25	2	3	11	5	4	10	18	16	17
Total exposures per year	78	51	61	40	34	32	44	46	59	37
p		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.005	0.001

Comparisons of the number of exposures that occurred in 2020 versus other study years were performed using the X^2 test. Statistical tests were two-sided, with $p \leq 0.05$ considered statistically significant. HCW: health care workers.

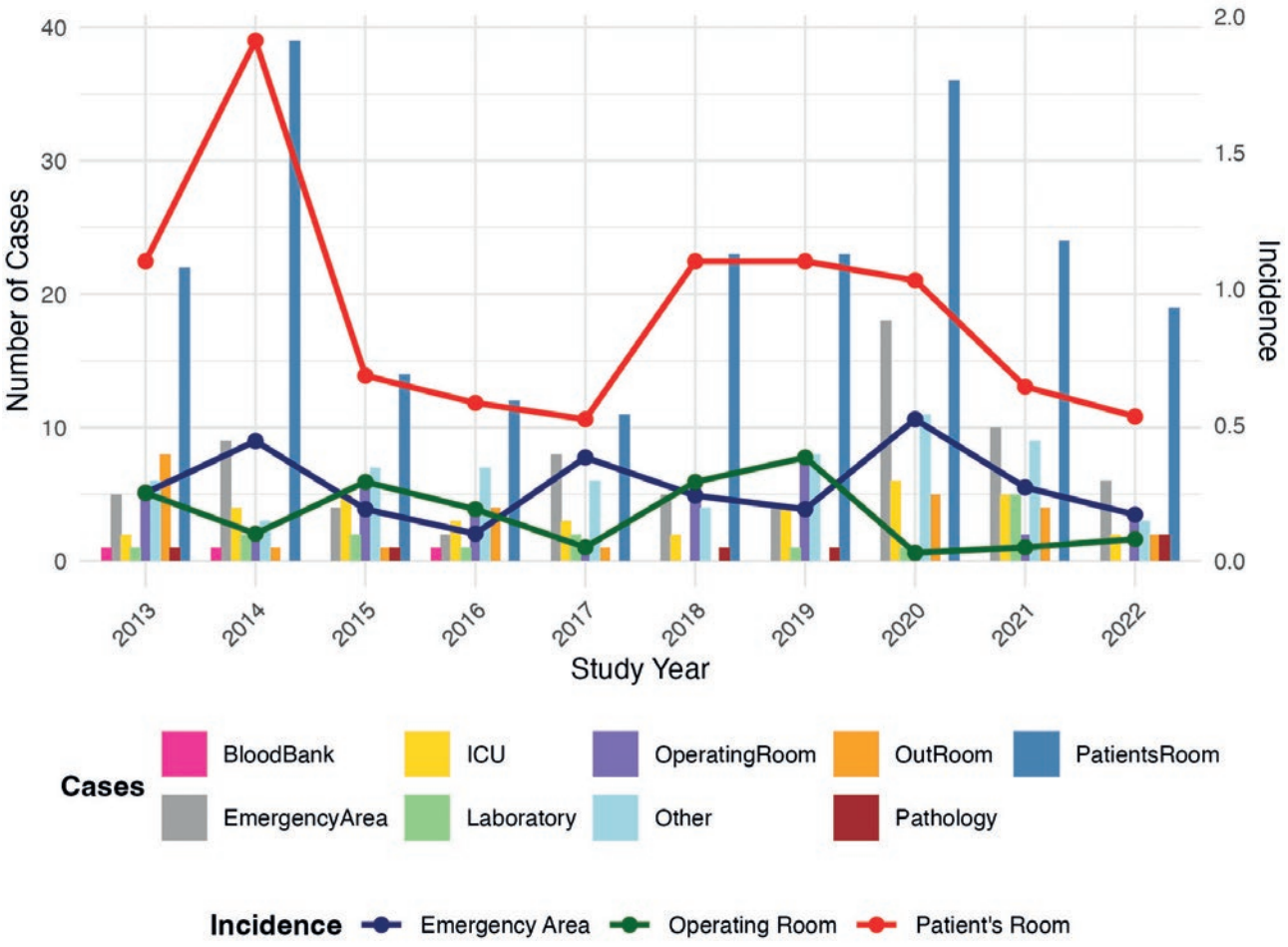
other studies indicate that additional doses may not be necessary if protective anti-HBs titers are maintained[15]. At the INER, the HBV vaccine was unavailable for several years due to nationwide shortages. On resumption of vaccination, only one or two doses were administered to eligible individuals. HCWs recalled receiving a single dose, but precise dates were often uncertain, or they may have received only one dose when a complete schedule was warranted. Consequently, there was a low concordance between self-reported vaccination status and the quantified antibody titers conferring protection against HBV infection.

Our results align with those of previous studies indicating that young nurses experience the highest frequency of occupational exposures to body fluids, with medical residents and physicians being the subsequent most affected groups[9,10,16]. Exposures were more frequent in women because nurses were predominantly female. In accordance with previous reports, we found that percutaneous incidents accounted for the highest proportion of occupational exposures to body fluids, with puncture accidents being the most common[17].

The INER serves as a national referral center for respiratory diseases, where some patients who present with respiratory symptoms may receive their initial diagnosis of HIV. This accounts for the high proportion of HIV infections and pneumonia observed among the source patients, as well as the high demand for PEP among HCWs. Fortunately, none of the exposed workers experienced seroconversion for HIV, HBV, or HCV during follow-up. This outcome was likely due to timely serological diagnosis, access to medication, and professional care and follow-up. In Mexico, current regulation stipulates that all healthcare facilities must have the resources to manage occupational exposure incidents, ensuring timely access to PEP[18]. The institutional PEP protocol for occupational exposures to HIV, HBV, and HCV was applied to workers involved in accidents[5]. Briefly, the risk of infection with these viruses was assessed, and if deemed necessary and feasible, HIV, HBV, and HCV serology was requested for both the source patient and the injured worker, and HIV PEP was initiated if indicated[19,20]. Referral to the infectious diseases consultation was made on the first working day. All injured workers were closely monitored, provided with 24-h counseling and assistance, and the exposure was centrally reported. The absence of HBV immunoglobulin in Mexico renders HBV PEP unfeasible. PEP is not recommended for HCV, as the transmission risk in HCWs is very low, and highly effective and safe therapies achieve near 100% eradication[2].

In 2020, the INER was entirely converted to exclusively admit severely ill patients with COVID-19. A substantial proportion of these patients required intensive care, and there was a significant hiring of short-term staff due to the vulnerability of staff over the age of 60, many of whom had comorbidities and were allowed to stay at home. Furthermore, the

Figure 2. Occupational exposures to body fluids by hospital area. The red line indicates the incidence per 1000 person-years. Bars represent the total number of cases reported annually, categorized by hospital area, from 2013 to 2022. ICU: intensive care unit; out room: hospital hallways and the nursing station.



implementation of personal protective equipment, including double or even triple layers of gloves, masks, goggles, and gowns, presented challenges for sample collection and syringe manipulation, leading to markedly reduced visibility due to fogging. Poor visibility, insufficient experience of short-term staff, burnout, work overload, fatigue, and the intensive care required by severely ill patients, have all been associated with percutaneous exposures in HCWs[17,21-23]. In this context, there was an increase in needlestick injuries involving syringes and catheters. In many cases, the infection status of the source patient could not be documented, leading to the assumption that the infectious agent was SARS-CoV-2.

In healthcare settings, most occupational exposures can be prevented. Strategies to protect HCWs include: (1) standard precautions; (2) implementing routine screening of anti-HBs titers followed by vaccination as needed, or administering universal HBV immunization early in a HCWs career according to the 0, 1-2, and 6-month schedule, followed by documented protective anti-HBs titers[6]; (3) providing personal protective equipment and training staff on its correct use; and (4) implementing post-exposure management, which includes following guidelines, educating and communicating with staff, providing HIV PEP for high-risk exposures, and analyzing surveillance data[3,17]. Although the highest incidence was observed in 2014, the greatest number of exposures occurred in 2020. Thus, the increased hiring of short-term staff during the COVID-19 pandemic may have contributed to the rise in cases. Although we could not directly assess this in the present study, special working

conditions during the COVID-19 pandemic—such as nervousness, uncertainty, and the use of additional PPE (e.g., double gloves, which could affect the handling of sharp objects, and eye protection, which could blur vision due to excessive sweating caused by nervousness)—may have contributed to a higher frequency of accidental exposures in hospitalization areas. The year with the lowest number of exposures and lowest incidence was 2017, which coincided with the initiation of courses on standard precautions for new resident physicians. This suggests that these precautionary measures may have temporarily reduced occupational exposures. The hospital areas with the highest frequency of occupational exposure during the study period were the patient's room, followed by the emergency area and the operating room. However, in 2020, only a few exposures occurred in the operating room, likely due to the cancellation of elective surgeries as a result of the INER's conversion to a COVID-19 treatment center.

The main limitation of our study is its retrospective design. Another limitation was that exposures to body fluids were self-reported, potentially leading to underreporting. In addition, this study was conducted at a tertiary healthcare institution serving as a national referral center for respiratory diseases, so the study results may not be representative of other health centers in Mexico. An important limitation of the study was that we were unable to perform a logistic regression model or any other statistical analysis to assess the risk associated with occupational exposure to body fluids. Since the information for this study was collected from the database of HCWs who self-reported exposure to body fluids, we lacked data on the population who did not report accidents during the study period; thus, no control group could be used for comparison. In addition, due to the retrospective nature of the study, we were not able to assess the impact of specific circumstances associated with the COVID-19 pandemic, such as mental health, on the number of accidental exposures. Finally, information on previous HBV vaccination was also self-reported, which may introduce recall bias.

We observed a high rate of exposure to body fluids in a setting where HCWs had lower-than-expected HBV vaccination coverage, resulting in a smaller proportion of them with protective anti-HBs titers. This finding underscores the need to strengthen vaccination programs at the INER, including maintaining an up-to-date registry of vaccination dates and doses. We recommend revising the vaccination policy at the INER to improve coverage, enhance staff protection, and reduce the risk of transmission within the hospital environment. There is no unified guideline for administering booster doses based on anti-HBs levels after primary vaccination, and greater consensus is needed on post-vaccination monitoring and booster dose strategies. Different approaches for protection against HBV infection through booster doses include either measuring anti-HBs titers and administering booster doses as needed to maintain protective immune memory; providing booster doses if protective anti-HBs levels are not detected 1 month after primary vaccination or a previous booster dose; or administering booster doses periodically to all vaccinated individuals without measuring anti-HBs titers[24]. Establishing institutional protocols based on the resources and capabilities of each institution could improve HBV vaccination control among HCWs.

In conclusion, our findings highlight the importance of maintaining and promoting standard precautions, HBV immunization protocols, staff training on personal protective equipment, and post-exposure management protocols. The significant rise in the number of exposures observed during the COVID-19 health contingency should be considered in the design of the preparedness measures for future pandemics. During health emergencies, tertiary healthcare hospitals often become pivotal centers for managing severe cases. Ensuring that the staff receives comprehensive and up-to-date training on these protocols is essential. In addition, establishing robust monitoring and reporting systems for exposure incidents, along with developing programs to support staff health and well-being—including preventive measures and psychological support—is crucial. Administering HBV immunization early in a HCWs career is particularly important.

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