

ORIGINAL RESEARCH

Evaluation of occupational exposure in healthcare workers via a trio-strategy of pre-KAP survey, educational intervention, and post-KAP survey

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Abstract

Background: Occupational exposures in form of sharps injury, splashes are common among healthcare workers (HCWs). There is a need to identify associated risks and provide focused training sessions accordingly. Knowledge, Attitude and Practices (KAP) survey has emerged as an effective tool to measure impact of trainings. In this study we are evaluating the impact of occupational safety training among health care workers via pre and post KAP surveys.

Aims: To estimate the prevalence of self-reported occupational exposures and evaluate the risk factors associated with it. To assess the impact of single educational session on healthcare workers.

Methods: All exposures based on self-reporting were recorded and evaluated. Impact of education on HCWs was evaluated via a Trio strategy of pre-KAP, followed by educational session and post- KAP assessment surveys.

Findings: The prevalence of self-reported occupational exposure was found to be 3.88%, most commonly in nurses (27%) and primarily during blood sample collection (19%). Detailed data was compiled for risk factor analysis. Significant improvements ($p < 0.001$), in knowledge, attitude and practices were recorded with 33.6%, 19.1% and 26.7% respectively, after the educational session.

Conclusion: Focused and multiple educational sessions are required to increase reporting of exposure events and consolidation of knowledge, positive attitude and good practices in HCWs.

Keywords: KAP survey; Health-care workers; educational session; BBPs; Occupational exposure; Trio strategy; Risk factors

Received: 8 November 2023; Accepted: 23 March 2025; Published: 9 May 2025

This study identifies the prevalence of occupational exposure associated with healthcare workers (HCWs) at their work place and the factors primarily responsible for exposure risk, which compromise the safety of healthcare personnel during duty hours. It also emphasizes an utmost need of sequential educational interventions, which will help the HCWs to understand the factors responsible for their exposure to occupational hazards. In this study, we have also evaluated the occupational exposure via the trio-strategy, which includes pre- and post-assessment of knowledge, attitude, and practice (KAP) surveys prior to and after educational intervention, which will help in providing safe occupational health practices in hospital settings.

Background

The Occupational Safety and Health Administration (OSHA) defines *occupational exposure* as reasonably anticipated skin, eye, mucous membrane, or parenteral contact with blood or other potentially infectious materials that may result from the performance of HCW's duties (1). In 2022, the highest prevalence was observed in the Southeast Asia Region (46.9%), followed by the Western Pacific (44.4%), while the lowest prevalence was reported from the European Region (35.2%) (2). Among all types of occupational exposures, needlestick or sharp injuries pose the greatest threat to the healthcare professionals, at least one event of accidental needlestick or sharp injury is reported by 32.4–44.5% of HCWs each

year globally (3). The risk of infection of the exposed person from a single needlestick injury (NSI) by a contaminated needle is maximum for Hepatitis B Virus (HBV) ranging between 10 and 30%, followed by Hepatitis C Virus (HCV) ranging between 1.8 and 10%. Although Human Immunodeficiency Virus (HIV) seems to be the most dreaded infection among HCWs, the risk of HIV infection is least, 0.3% for a single contact percutaneous puncture and 0.1% for the exposure through the mucous membrane (4).

Occupational exposures are not completely avoidable, though they can be reduced to a large extent through following standard precautions during performing hospital duties and being aware of the high-risk activities that can result in such exposures. Also standardized post-exposure management guidelines must be well known by all the HCWs in any hospital setting.

KAP of HCWs regarding transmission and risks associated with blood-borne pathogens (BBPs), prevention, and immediate management in case of exposure needs to be urgently strengthened for the safety of our HCWs. Educational intervention is an effective tool to improve KAP of HCWs toward occupational exposure. Assessments based on the KAP survey have been carried out by few studies across India (5–8); however, to completely assess the impact of education, there is an utmost need of a post-assessment after the educational intervention. Previous research has consistently demonstrated significant deficiencies in HCWs' KAP concerning NSI prevention. Many HCWs, particularly those in training, lack awareness of the potential risks associated with NSIs and the crucial importance of adhering to standard precautions. Furthermore, inadequate training and supervision can contribute to unsafe practices, such as needle recapping, which significantly elevates the risk of accidental exposure to BBPs. These studies have identified a discrepancy between theoretical knowledge and actual practice, underscoring the urgent need for comprehensive educational interventions. Authors have emphasized the pivotal role of training and education in reducing the incidence of occupational exposure to Blood-borne virus (BBVs), as well as increasing the reporting rate of such incidents and ensuring appropriate follow-up for exposed HCWs.

This study aims to find out the prevalence and risk factors associated with occupational exposure with special reference to evaluation of educational intervention on HCWs by a pre-assessment KAP survey and a post-assessment KAP survey.

Methodology

This study was conducted in two parts according to the study objectives:

Study part I – Prevalence measurement and risk factor evaluation

This was a prospective observational study that included 1,623 HCWs performing hospital duties during the time period of 1 year 8 months (January 2021 – August 2022). All the self-reported occupational exposure incidents that included exposure to blood or other infectious body fluids via percutaneous or splash injury were recorded, and a complete evaluation of incidences, exposed HCWs, and their respective sources who gave consent to participate was performed in terms of demography, cause, associated risk factors, relevant prior history, history of current event with details of immediate post-exposure measures, etc. (9). HCWs who had occupational exposure to non-blood tinged, potentially non-infectious body fluid, or exposures involving clean needles were excluded from this study.

Rapid diagnostic tests (RDTs) of all the exposed and source (if known) were performed for initial screening. HBsAg was detected using a lateral flow immunoassay (Trustline HBsAg Rapid Test), and anti-HCV was detected using a double antigen lateral flow immunoassay (Trustline HCV Ab Rapid Test). For HIV, a third-generation rapid test (Tulip HIV QualPro Rapid Test Kit) was used to detect total HIV-1 and HIV-2 antibodies.

Subsequently, enzyme-linked immunosorbent assays (ELISAs) were performed for confirmation. HBsAg was detected using a solid-phase ELISA (Qualisa HBsAg) employing high-affinity agglutinating sera. Anti-HCV was detected using a microwell ELISA (Qualisa Microwell Enzyme Immunoassay) targeting conserved antigenic segments of HCV core. Finally, a fourth-generation ELISA (Qualisa Microwell Enzyme Immunoassay HIV 4.0) was used to detect antibodies to HIV-1/2 and HIV-1 p24 antigen.

All the exposed HCWs were followed-up at 3 weeks, 6 weeks, and after 6 months as per standard guidelines. Anti-HBs Ab titer was performed in exposed who did not provide history of prior vaccination (10–12).

Study part-II: Educational sessions along with pre- and post-KAP surveys

A group of HCWs was enrolled based on convenience sampling for educational sessions, which included 116 nurses. Due to then prevailing situations of COVID-19 pandemic, the nursing staff of the institute was overworked and unavailable for the study. Hence, a convenience sampling was done, and staff from all the departments were enrolled based on availability. However, the participants who enrolled for the pretest were kept same as those for the educational session and the posttest. Three educational sessions were conducted including 25–50 participants per session. Focused and interactive

educational sessions of 90 min, on prevention and management of occupational exposure due to BBPs, were taken. Entire survey included a pre-assessment KAP survey, an educational session, followed by a post-assessment KAP survey (using the same questionnaire as used for pre-assessment and conducted on the same participants 3 months after their respective educational session). Impact of educational session was evaluated by comparing results of pre- and post-KAP assessment surveys done on participants.

KAP questionnaire preparation

The questionnaire consisted of four sections, which included a total of 25 questions regarding demographic details of participants (eight questions), knowledge (eight questions), attitude (five questions), and practices (four questions) related to occupational exposure due to BBPs, which were designed based on recommended guidelines (9, 11, 12). Selection of questions was done after a thorough review of available literature and the study population involved, so that during analysis, meaningful conclusions can be drawn from the generated data.

Data processing and analysis

Descriptive data are presented as number or mean $\pm$ standard deviation (SD) as appropriate. Data collected were entered into a computer-based spreadsheet for analysis using SPSS statistical software (version 20).

KAP assessments were scored by weighing each correct answer as one point; therefore, the range of score for knowledge was (0–8); similarly, the range for attitude score was (0–5), and for practice score was (0–4) (13). The total pre-assessment score of each participant in each of the three sections was calculated separately. A mean pre-score of each section, KAP was calculated evaluating all the 89 responses in these sections.

The difference between the mean scores of each section in preassessment and post-assessment was calculated separately, and a *P-value* was calculated to evaluate whether this difference was significant ($P < 0.05$).

Results

Study Part I – Evaluation of demography, risk factor, management, and follow-up of exposed HCW ($n = 63$)

Demographic evaluation of exposed HCWs

This study was performed on a total of 1,623 HCWs of our institute, who were actively involved in giving patient care and laboratory testing, out of which 63 HCWs self-reported the occupational exposure event. Therefore, the prevalence shown by this prospective study was 3.88% (63/1,623). Out of the 63 exposed HCWs, we were able to follow-up 53 exposed HCWs. Demographic analysis

showed that the mean age of exposed HCWs was 27.5 years (SD ± 5.6 years), showing no gender predilection, as there were 32 males (51%) and 31 females (49%). The most

Table 1. Analysis of exposed HCWs in terms of demography and exposure event

	N	Percentage
1. Demographic evaluation of exposed ($n = 63$)		
a. Age distribution		
≤ 33 years	55	87.3
> 33 years	8	12.7
b. HCW group		
Doctors	11	17.5
Nurses	17	27
Trainees	17	27
Technicians	2	3.2
Housekeeping staff	16	25.4
2. Exposure analysis ($n = 63$)		
a. Place of exposure		
Medical departments	17	27
Surgical departments	16	25.4
Sample collection center	14	22.2
ICU	6	9.5
Others	10	15.9
b. Site of exposure		
Index finger	28	44.4
Thumb	18	28.6
Hand	11	17.5
Others	6	9.5
c. Side of the body involved ($n = 62$, one splash injury involved both hands)		
Left	39	61.9
Right	23	36.5
d. Procedure during which injury occurred		
Blood sample collection	12	19.0
Delivering medications through venous route	10	15.9
Random blood sugar	4	6.3
Venous cannulation	4	6.3
Others	9	14.3
Recapping	8	12.7
Left at patient bedside or not discarded after use	13	20.6
Cleaning improperly disposed-off waste	3	4.8
e. Instrument of injury ($n = 61$, two were splash injuries)		
Wide bore needle	31	50.8
Injections	14	23.0
Solid sharps	5	8.2
Unknown	11	18.0
f. Time taken in reporting		
Within 24 h	40	63.5
> 24 to ≤ 48 h	16	25.4
> 48 h	7	11.1

ICU, Intensive Care Unit.

commonly involved HCW groups were nursing staff (27%, $n = 17$) and short-term trainees, enrolled in patient care courses in the institute (27%, $n = 17$). The ward attendants, sweepers, and Bio-medical Waste workers, who though are not directly involved in patient care, accounted for one-fourth (25.4%, $n = 16$) of exposed cases (Table 1). Table 1 gives the complete analysis of all the 63 exposure events in terms of demography and exposure events

Exposure analysis

Each exposure event was analyzed by a preformed exposure proforma provided to exposed HCWs. The exposure events were most commonly seen in medicine departments (26.9%, $n = 17$), followed by the surgical departments (25.4%, $n = 16$), sample collection center (22.2%, $n = 14$), and intensive care units (9.5%, $n = 6$). Sharp injuries accounted for majority of occupational exposures (96.83%, [61/63]), and only two cases of splash injury were reported (3.2%, [2/63]). Most exposures occurred during the procedures (61.9%, $n = 39$), where the most common activity was the blood sample collection (19%, [12/63]), followed by delivering medications through intra-venous route (15.9%, [10/63]). Another 33.3% ($n = 21$) of the exposures resulted from sharps left after use (21.3%, [13/61]) and recapping of needles after use (13.1%, [8/61]). Furthermore, 4.9% (3/61) exposed HCWs had injuries because of the used needles, which were not disposed in sharps bin. Among sharps, hollow bore needles alone caused more than half of the injuries in HCWs (71.4%). It has been seen that most of the exposed HCWs had injury on the left side of the body (61.9%, $n = 39$) compared to the right side, with index finger being most commonly injured (44.4%, $n = 28$). A majority of cases reported incidences from day shifts 82.5% (morning and afternoon shifts, $40 + 12 = 52$). 40 out of 63 (63.5%) HCWs reported exposure within 24 h of the incidence (Table 1).

Post-exposure management and follow-up

Out of 63 cases of occupational exposure, a total of 53 HCWs completed immediate and long-term follow-up

Table 2. Immediate post-exposure measures and vaccination status of exposed HCWs. ($n = 53$, the number of HCWs who completed the immediate and long-term followup)

	N	Percentage
a. Immediate post-exposure management		
Washed with soap and water	17	32.1
Washed with water and used sanitizer	14	26.4
Used only sanitizer	22	41.5
b. Vaccination status		
Completely vaccinated	22	41.5
Incomplete vaccination	31	58.5

after the exposure. Immediately after the exposure, majority of exposed workers, 41.5% (22/53), applied sanitizer as a first step, while 32.1% (17/53) washed hands with soap and water, and 26.4% of HCWs washed hands with water and later applied hand sanitizer. Surprisingly, squeezing was practiced by more than half of the exposed HCWs, 56.6% (30/53). Most of the exposed HCWs (73.05%, [46/53]) wore gloves while performing their duties. Vaccination status of 53 exposed HCWs was evaluated, and 41.5% (22/53) gave their history of complete vaccination. Out of 53 HCWs, nurses ($n = 9$, 40.9%) and doctors ($n = 7$, 31.8%) were the highest among vaccinated exposed HCWs (Table 2). Table 2 gives details of immediate post-exposure measures, followed by exposed HCWs and vaccination status of the exposed HCWs.

Evaluation of sources

Out of 63 exposed cases, the respective sources could be traced for 43 cases (68.3%). Out of 43 identified sources, eight (12.7%) were infected with HBV, while four (6.5%) were infected with HIV and HCV each. However, post-exposure prophylaxis for HIV was taken by 2 exposed HCWs. Another two HCWs who were exposed to HBV and recorded low titer along with a history of incomplete vaccination were given Hepatitis B Immuno-globulin (HBIG) and a full course of HBV vaccination.

Study part-II: Educational sessions along with pre- and post-KAP surveys

Three educational sessions were conducted along with the preassessment KAP survey where 116 nursing staff actively participated; however, only 89 participants attended the post-assessment KAP survey. Out of the 27 participants who could not appear for the posttest, the majority were unable to do so because they were either quarantined or were on duties. Some of these individuals, however, did not show up for the posttest because, we assume, they were unable to recognize the significance of both the posttest and these educational sessions. These 27 participants who did not appear for the posttest were excluded from further analysis. The mean age of participants was 32 years (standard deviation ± 6.5 years) with female preponderance of 60.7% (54/89).

KAP assessment of individual participants for knowledge (0–8), attitude (0–5), and practices (0–4) was done by the scoring method. The total mean score of participants' knowledge was 1.416 (standard deviation ± 1.15) during the pretest, which improved to 4.101 (standard deviation ± 1.99) after the educational session, showing a maximum mean difference of 2.68 ($P < 0.001$). However, the comparison of pre- and post-assessment of attitude toward occupational safety and assessment of practices followed to prevent occupational exposure or practices done after

Table 3. Mean scores of pre- and post-assessments along with mean difference

Parameters	Scores				Mean difference in pre- and posttest	Percentage change after educational session	P
	Pretest mean	standard deviation	Posttest mean	Standard deviation			
Knowledge	1.416	± 1.15	4.101	± 1.99	2.68	33.5	0.001
Attitude	2.371	± 1.13	3.326	± 1.16	0.955	19.1	0.001
Practice	1.843	± 1.05	2.91	± 0.98	1.067	26.7	0.001

Note. N = 89.

Table 4. Assessment of knowledge, attitude, and practices of HCWs before and after a single educational session

Knowledge parameters	Pretest (n)	Pretest (%)	Posttest (n)	Posttest (%)	Change in Knowledge (%)	P
Definition of occupational exposure to blood-borne viruses	7	7.8	31	34.8	27	< 0.001
Viruses transmitted	25	28.1	41	46.1	18	0.0489
Maximum risk of transmission	27	30.3	64	71.9	41.6	0.0001
Time period within which baseline test of the source and exposed HCW be performed	12	13.5	22	24.7	11.2	0.0863
Availability of PEP is for which virus/es	5	5.6	44	49.4	43.8	< 0.001
Golden time period for the initiation of PEP for HIV	11	12.6	60	67.4	54.8	< 0.001
HIV-PEP duration	34	38.2	59	66.3	28.1	0.0095
When should the antibody titer be checked after complete vaccination for Hepatitis B	5	5.6	44	49.4	43.8	< 0.001
Attitude parameters	Pretest positive attitude (n)	Pretest (%)	Posttest positive attitude (n)	Posttest (%)	Change in attitude (%)	P
Occupational exposure should be reported	74	83.1	88	98.9	15.8	0.2714
Do you think occupational exposure is preventable	29	32.6	50	56.2	23.6	0.0181
Following standard precautions can reduce risk of occupational exposure	27	30.3	51	57.3	27	0.006578
All medical staff should undergo a preassessment to check their knowledge about prevention and management of occupational exposures	13	14.6	34	38.2	23.6	0.0021
Are you comfortable in treating HBV/HCV/ HIV positive patients	67	75.2	73	82.0	6.8	0.6121
Practice parameters	Pretest good practice (n)	Pretest (%)	Posttest good practice (n)	Posttest (%)	Change in practices (%)	P
Follow standard precautions while performing duties in the hospital	51	57.3	66	74.2	16.9	0.1655
Not recap needle after use	37	41.6	69	77.5	35.9	0.0018
Discard sharps into sharp disposal bins	56	62.9	72	80.9	18	0.1573
Post-exposure measure after an exposure/ contamination	20	22.5	55	61.8	39.3	< 0.001

Note. N = 89.

an exposure showed moderately significant mean score differences of 0.955 ($P < 0.001$) and 1.067 ($P < 0.001$), respectively. Table 3 shows all the pre- and posttest means of KAP, as well as their mean differences and percentage change along with a P -value.

Also, the improvement in KAP parameters of each participant was assessed for number of correct answers in each parameter attempted by 89 participants before and after an educational session and was analyzed. For example, if, out of 89 participants in the knowledge parameters, the definition of occupational exposure was answered correctly by seven (7.8%) participants during preassessment, while 31 (34.8%) participants answered correctly after an educational session, an improvement of 27% was seen in this specific question. Table 4 represents question-wise analysis of all the individuals in the pre- versus post-assessment format, along with the percentage improvement in number of participants correctly answering the questions. Based on the aforementioned calculation, we found that educational session had the greatest impact in terms of knowledge of golden time period for the initiation of HIV-Post-exposure prophylaxis (PEP) (54.8%, $P < 0.001$); however, least impact was seen in the knowledge of time period within which baseline tests of exposed and source should be performed (11.2%, $P = 0.0863$) (Table 4). A significant change of 27% in the attitude of HCWs was seen, for believing that following standard precautions can reduce the risk of exposure. Also, a positive change of attitude, after the educational session, was recorded among participants regarding the role of assessment of occupational risks before joining institutes (23.6%; $P < 0.0021$) and also in believing that the occupational exposures are preventable (23.6%; $P < 0.0181$). Improvements in practices after the educational session

of following correct measures after any exposures and in recapping needles after use were significant with a percentage increase of 39.3% ($P < 0.001$) and 35.9% ($P < 0.0018$), respectively.

Overall, it has been seen that the highest improvement after an educational session was in knowledge parameter, in comparison to attitude and practice, with an average increase of 33.6, 19.1 and 26.7%, respectively (Table 3).

The KAP survey also identified that the main reason for underreporting was the lack of guidance about whom to report the exposure incident, as almost one-third ($n = 30$, 33.7%) of the HCWs during the KAP survey had mentioned it. Furthermore, 28.1% of HCWs ($n = 25$) considered exposure as insignificant. Also, according to HCWs, the main factor that attributed to the occupational exposure event was the inability to follow standard precautions, followed by high patient load (Table 5). Table 5 lists all the factors that were considered responsible for occupational exposure and the reasons for not reporting an exposure event, by the participants.

Discussion

Globally, the prevalence of occupational exposure is quite varied, and this variation in the data is mostly governed by the methods used for data collection, differences in study designs, and study populations. Most of the studies have calculated prevalence, using questionnaires assessing the details of exposure, based on recall of the incidence by the HCWs. A high rate of prevalence ranging from 25 to 59.0% in India (14–17) and an even higher prevalence ranging from 27 to 65.3% (18–21), from international studies have been thus reported. In the present study, we calculated the prevalence of occupational exposure based on self-reporting of exposure events, and a prevalence of 3.88% in a duration of 1 year was observed. This huge gap between the prevalence reported by using a questionnaire-based approach versus a self-reporting approach highlights extreme under-reporting of exposure events.

The age predilection to occupational exposure is toward younger age group (less than 33 years), which was quite similar to other studies (22, 23). Nursing staff was the most commonly affected group (27%), as they are the most actively involved HCW-group in patient care. Many studies across India and elsewhere have reported that nurses are the high-risk group for occupational exposures (24–26). Another high-risk population were short-term trainees (27%), enrolled under various courses in the institute. This can be attributed to the fact that these young students were not well educated or trained in terms of risks of occupational exposures in healthcare settings (27). Surprisingly, about one-fourth, 25.4%, of total exposures occurred in the housekeeping staff, though they are not directly involved in patient care. This has also been seen in another Indian study where 16.59% cases occurred

Table 5. Factors responsible for occupational exposure and reasons for not reporting an exposure event

	N	Percentage
Factors causing occupational exposure		
Inability to follow standard precautions	33	37.1
High patient load	18	20.2
Carelessness	14	15.7
Long duty hours	11	12.4
Flaws in training	7	7.9
Lack of safety devices	6	6.7
Reasons for not reporting an event		
Don't know whom to report	30	33.7
Insignificant exposure	25	28.1
Reflects poorly on job	17	19.1
Not infectious	10	11.2
Not important	7	7.9

Note. N = 89.

in housekeeping staff; however, lower number of cases, 3.2%, were reported by a study done in Saudi Arabia (24, 26). These high numbers in the present study indicate lack of skills and knowledge in the HCW-groups directly dealing with patients, as a very high percentage, 20.6%, of exposed HCWs got stuck by the devices left after use. These numbers were low as compared to 54.03% and 30% cases reported by similar studies conducted in India (14, 24) but were very high when compared to studies conducted in Saudi Arabia (5.5%) and Iran (3.3%) (26, 28). Education and training of HCWs, especially in low- and middle-income countries, is extremely important for bringing a change in this practice of not discarding sharps after use.

Wards are the most active work areas with maximum patient loads, and this study noted maximum number of the exposures in wards. This outcome was in accordance to various studies reporting similar findings (24, 26). The largest number of injuries reported during the use of sharp instruments, 61.9%, which indicate that clinical procedures are high-risk activities for exposures, and almost similar results were obtained in various other studies, done in India and abroad (14, 16, 29, 30). Majority of the injuries from sharps were from hollow bore needles, 50.8%, similar to other studies. Injuries from such needles are high risk as a large amount of blood can be present inside the bore. Training of HCWs leads to be more cautious while working, and using an appropriate Personal Protective Equipment (PPE), which can help reduce risk from such sharps (24, 31). Detailed evaluation of exposures identified that the most common site of injury is the index finger of left hand as it is the most vulnerable part while performing any procedures. Similar results were also observed by a study done in North India (23).

Timely reporting of events to the infection control staff is of utmost importance during exposure. In our study, 63.5 and 11.1% of cases got reported within 24 h and >48 h, respectively; however, a previous study from India showed that 32% of cases were reported within 20 min, while 100% of the cases were reported within 24 h (31). This finding indicates lack of awareness in the HCWs involved in our study, which necessitates comprehensive educational sessions.

As an immediate post-exposure measure, only 28.6% of the exposed HCWs followed washing the injury with soap and water; a study from Iran reported similar figures of 21.4%, and still lower figures of 7.1% were reported by another study conducted in India. Squeezing is a common wrong practice, which further allows the infection to become deeper; in our study, more than half of the exposed HCWs (56.6%) practiced squeezing to promote bleeding. In studies performed by Joukar et al. and Goel et al., 21.1 and 62.4% of the exposed HCWs practiced squeezing, respectively (23, 28). The

vaccination status of HCWs in the present study was extremely low, 41.5%, when compared with the results of similar studies from India and other southeast Asian countries (24, 26, 30, 31). A good majority of the exposed HCWs in this study were students, who had recently joined the healthcare services and were not vaccinated against HBV, leading to such low rates of vaccination in total. However, among the exposed nurses, 76.8% were vaccinated, which is in line with other studies from India, but lower when compared to studies from abroad (26, 31). Recapping has also been stated as the most common practices leading to sharps injuries, like in a study done by Jaggi et al., where recapping accounted for 37% of cases (24); however, in the present study, injuries resulting due to recapping were quite low, 12.7%. Despite HCWs being at very high risk of exposures to BBVs, studies worldwide have shown a suboptimal level of knowledge regarding the prevention and post-exposure management of an occupational exposure (15, 23).

The KAP followed by HCWs regarding occupational safety has been studied all over the world to assess factors governing occupational exposure; however, the use of KAP survey to assess the impact of educational intervention has been done by very few studies globally. The pre-KAP survey followed by an educational session and a post-KAP survey, an approach adopted in the present study, appears to be a good sequential way to assess the HCWs regarding any improvements after the educational intervention.

A study conducted in India evaluated the knowledge of nurses and interns regarding occupational exposure, where the percentage of participants answering correctly in both groups remained <65%; however, higher rates of knowledge were reported from Ethiopia, where 81.6% of HCWs had adequate knowledge (8, 32). The pre-education knowledge of participants in the present study was very low when compared to other studies from India or abroad (4, 7, 8, 33). The main reason for this difference could be the lack of any prior educational or training sessions received by these participants. The analysis of each question in different sections of KAP assessment has been done only in few studies and in a study by Li et al. the maximum improvement of 15.8% was seen in the knowledge of factors responsible for increased transmission risk during an exposure (34), whereas in the present study, maximum improvement was seen in the knowledge of golden time period for the initiation of HIV-PEP (54.8%) ($P < 0.001$).

Only few studies are documented, which assessed the effect of educational training of HCWs to reduce the prevalence of occupational exposure so far (34–36). The data analysis in these studies is based on entirely different scoring system and, hence, is not directly comparable. A study from Saudi Arabia showed an improvement of

37.12% in knowledge score (26), very similar to our study, which showed an improvement of 33.6%. In a study from Nepal, the knowledge and practices were measured as mean deviation, and significant differences in the pre- and post-intervention tests of mean knowledge and practices were recorded (36). Another study from China calculated the scoring rate of pre- and post-surveys and concluded a significant increase in all the three parameters (34). Studies carrying out a KAP assessment have mostly reported that the HCWs have significant improvement in positive attitude toward occupational exposure prevention (8, 32). This was quite similar to the current study where significant positive change of 27% was seen in their attitude toward the fact that following the standard precautions can prevent occupational exposures. In the present study, maximum improvement was seen in the practice of not recapping the needles after use (39.5%), which simulates a study from China (34).

KAP surveys have also been used to identify the factors leading to occupational exposure, which include lack of regularly applying standard precautions, not using proper disposal techniques and also lack of training sessions (36, 37). In this study, 37.1% of the participants identified *inability to perform standard precautions* as the main factor leading to occupational exposure.

An evaluation of the causes of under-reporting in this study showed *unawareness of HCWs regarding whom to report* (33.7%) as the main cause, followed by 28.1% of the HCWs thinking that the exposure was insignificant. A similar study by Jain et al. reported that 38.1% of HCWs were unaware that exposure events need to be reported, and another 15.9% did not know whom to report (15). Surprisingly, Khelgi et al. reported that the majority of participants in their study did not think that the exposure was important, although 40% of them knew whom to report an event (37). Also, a study from Nigeria showed that 1.4% of their doctors and 2.2% of their lab technicians did not believe that wearing gloves provides protection from exposures (38). Fear of stigma associated with exposure has also been identified in HCWs. A study by Madhavan et al. showed that 8.5% of participants had a fear of stigma, and another 3.2% were embarrassed to report the event (8). In our study, 17% of the participants did not report exposure due to the fear that it will reflect poorly on their job. Educational sessions should also be planned to address such issues in beliefs of HCWs and should try to inculcate positive attitudes in HCWs. Numerous global studies underscore the significance of ongoing educational interventions to mitigate occupational hazards among HCWs. Strategies to enhance awareness may include comprehensive induction training for newcomers, leveraging special events to reinforce key messages, and organizing workshops, seminars, and interactive sessions. Senior healthcare

professionals can play a pivotal role in fostering a culture of safety by serving as role models and undergoing regular training.

While KAP surveys have been widely used to assess baseline KAP related to occupational exposure risks, their utility in evaluating the impact of educational interventions is limited. This study uniquely employs a pretest and posttest design to assess the effectiveness of a trio-strategy educational intervention in improving HCWs' KAP.

Despite our best efforts, this study is not without limitations. We acknowledge the fact that although a pre-run of the questionnaire is of utmost importance, we were unable to do it, and this is one of the lacunae of our study. It should have been done because pre-run of the questionnaire helps in eliminating any ambiguous or confusing questions and also helps in increasing the validity and reliability of the data produced using it.

Conclusion

Occupational exposure is a hidden iceberg, which needs to be identified at the ground level for the safety of HCWs. Education is the only tool that will reduce these exposures, which can become a life-long misery to exposed HCWs, who provide noble services. In this study, educational intervention with pre- and post-KAP surveys proved that educational sessions can significantly improve the KAP of HCWs. However, we saw this improvement was not 100% after a single educational session, and still many areas need improvement. Hence, there is an urgent need of sequential educational sessions, which should be evaluated every time with pre- and post-KAP surveys to reduce the risk of occupational exposure and provide a safe environment to our HCWs.

Ethical approval

All procedures were performed in compliance with relevant laws and institutional guidelines, and ethical clearance from the institutional ethical committee was taken prior to the commencement of this study (IEC No. 138/20).

Conflict of interest and funding

The authors declare no conflict of interest. The authors have not received any funding or benefits from industry or elsewhere to conduct this study.

Ethical considerations

This work has been approved by the Institute Ethical Committee of Dr Ram Manohar Lohia Institute of Medical Sciences, Lucknow, India, where this study was performed, and the subjects gave informed consent for the work.

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