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Acute work-related hazardous eye exposures in a health care environment – An observational study from a tertiary care hospital in South India

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Purpose: Healthcare workers (HCW) are exposed to numerous occupation-related eye hazards. We studied the epidemiological distribution, risk factors, and severity of acute work-related hazardous exposure/infection (WRHEI) to the eyes of HCW in a tertiary healthcare institution in Southern India. **Methods:** In this prospective observational study, we included HCW who reported acute WRHEI between February 15, 2017 and August 14, 2017 from a total 11,628 HCWs (staff and students). Each HCW underwent a comprehensive eye examination. Information regarding WRHEI was collected by a structured questionnaire. Statistical analysis was performed using SPSS Version 20.0. **Results:** Cumulative incidence of acute WRHEI in 6 months was 0.8%, 95% CI (0.64–0.96). Among the 94 reporting WRHEI, 82 (87.2%) were staff and 12 (12.8%) students. Mean age was 31.53 ± 8.39 years and 65 (69%) were females. Exposures were reported more commonly among nurses (25.5%), followed by technicians (18%), and housekeeping staff (15.9%). Infectious eye hazards accounted for 50%. Noninfectious eye hazards included exposure to chemicals (28%) and blood and body fluid (8%). Among them, awareness regarding personal protective equipment (PPE) and its usage was present in 44.6 and 27.6%, respectively. Multivariable logistic regression analysis showed that HCWs working in clinical areas (adjusted odd's ratio (AOR): 3.23, 95% CI: 1.12–9.34) and not wearing glasses (AOR: 3.72, 95% CI: 1.33–10.34) had a significantly higher risk of acute WRHEI. **Conclusion:** Cumulative Incidence of WRHEI eye was 8 per 1000 in 6 months. Infectious conjunctivitis is half the burden followed by chemical exposures. Awareness regarding eye safety and usage of PPE was low.

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Eye hazards to healthcare workers (HCWs) include biological, physical, and chemical injuries, as well as exposure to infections through the ocular surface. Literature on occupational hazards to personnel in the health sector is limited.[1,2] Studies on hazardous exposure to the eyes of health workers are even more scarce.[3] Few reports in specialties such as dentistry and orthopedics exist. To the best of our knowledge, there are no reports on acute work-related hazardous exposure/infection (WRHEI) to the eyes of all workers in a health system. The objective of this study was, therefore, to study the incidence of acute WRHEI among all HCWs. The modes of injury, risk factors, availability and use of personal protective equipment (PPE), sickness absenteeism, and treatment cost were also studied.

Methods

This was a prospective observational study conducted in a tertiary care teaching hospital in South India. Institutional Ethics and Review board approval was obtained, and the study conformed to the Declaration of Helsinki (IRB Min No 10358). The study period was from February 15, 2017 to August 14, 2017. Any staff or student who reported an acute hazardous exposure or injury to the eye at work was included in the study. Postgraduate trainees were considered as staff.

Our institution is a tertiary care hospital and training center for medical, nursing, and allied health professionals with a total strength of over 11,000 staff and students. It has a dedicated Staff Student Health Services (SSHS) that has been operational since 1960s. Health care is provided free of cost to staff and students. The Ophthalmology department is located on a separate campus, around 3 km from the main hospital. The SSHS, Emergency department (both located on the main campus), and the Ophthalmology department were considered as the first point of contact in case of work-related hazardous eye exposure.

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Posters with pictorial information about the types of work-related eye injuries and exposures, and place and whom to report to, including contact numbers were widely displayed in the hospital and in the medical college. Information was also provided on the institutional webpage and letters were sent to all the heads of units, departments, and the occupational health team. A structured questionnaire was designed, pilot-tested, and finalized to collect demographic information and details of the injury from all reporting personnel.

At presentation, first aid was given to the HCW at the first point of contact, depending upon the hazard, and the principal investigator (PI), an ophthalmologist was informed. Those sustaining a splash: chemical/blood and body fluid (BBF)/BBF with chemical were given thorough eye irrigation with normal saline or ringer lactate or balanced salt solution for 15–30 min and assessment of pH was done before and after for chemical splashes.[4,5] Those exposed to BBF were screened and followed up for blood-borne viruses (BBVs) according to standard guidelines.[6] Informed consent was obtained and questionnaire administered by an ophthalmologist (PI or on-call) who then examined the patient comprehensively within the first half-hour after presentation either at the first point of contact or at the ophthalmology department. This included an assessment of best-corrected visual acuity (BCVA) using Snellen's chart, anterior segment examination using torchlight, and slit lamp, intraocular pressure measurement by Goldmann applanation tonometer or Tonopen where appropriate. Posterior segment examination was done by fundus biomicroscopy using either 90 Diopter lens or by direct/indirect ophthalmoscopy.

In case of chemical injury or splash, the extent of the injury was assessed and classified using Roper Hall's classification and treated according to standard guidelines.[7,8] In case of blunt trauma and foreign body, the extent of the injury was classified using ocular trauma score and treated.[9,10] Corneal and conjunctival foreign bodies were removed under topical anesthesia using either a cotton bud or 26 gauge needle.[11] Those with infectious conjunctivitis were classified into bacterial and viral conjunctivitis and treated with appropriate topical eye drops.[12] Lid, hand hygiene, and fomite care were taught. All participants were followed up in the eye hospital Outpatient Department, with the PI, and follow-up was based on the type and extent of injury. We contacted and included HCWs who presented with acute WRHEI to eye, but failed to report to the study, from the day's list of emergency presentations at the first points of contact after obtaining the required consent.

For the purpose of this study, we defined *Health Care Worker (HCW)* as a staff or student working in clinical/paraclinical areas. *Clinical HCWs* included doctors, nurses, etc., who were in direct contact with patients. *Paraclinical HCWs* included those working in laboratories and *nonclinical areas,* i.e., offices, libraries, cash counters, and housekeeping (sweepers and attenders)**.** *Work-related exposure or WRHEI (work-related hazardous exposure and infection*) was defined as acute exposure at the workplace to the eye with BBF, chemicals, injury with either blunt or sharp objects, a foreign body or infectious conjunctivitis. *Work environment* included the employer's premises and other locations where employees were engaged in work-related activities or were present as a condition of their employment excluding institutional recreational facilities. *Infectious WRHEI* was defined as an acute presentation consistent with symptoms of infectious conjunctivitis including redness, swelling or stickiness of eyelids, foreign body sensation, pain, itching, watering, or discharge. Place of exposure for infections was difficult to determine. History of contact was elicited from the HCW presenting with conjunctivitis. However, we included all respondents presenting with conjunctivitis, as a majority of them reside in institutional campus/hostel and it was hard to separate home from work premises. Second, depending on the carrier/immune status of individuals, others in the family/hostel may manifest earlier than the staff, who may have carried the infection in the first place. Even if the infection was not contracted at the workplace, they were now likely sources for spreading it to other coworkers and needed attention. *Noninfectious WRHEI w*as defined as exposure of the eyes to chemicals, BBFs, injury with blunt or sharp objects, and foreign bodies. For exposure to BBF and chemicals, direct splash to the eye was recorded as such and those to the face but not definitely to the eye were considered as "*near misses."*

Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 20.0 (Armonk, NY, USA: IBM Corp). Associations of demographic and clinical variables with WRHEI were determined by using Chi-square test and Fisher's exact test, as appropriate. Incidences between groups were compared by Two-proportions test. Risk factors were assessed using Logistic Regression analysis. A P value < 0.05 was considered statistically significant.

Results

A total of 11,628 individuals (9,575 staff and 2,053 students) were eligible for the study. The flow of the study is represented in Fig. 1. During the study period, 94 individuals presented to either point of first contact. Cumulative incidence of WRHEI in 6 months was 0.8% (95% CI 0.64–0.96). Cumulative Incidence among staff and students was 0.86% and 0.58% respectively. This difference was not statistically significant. The mean age of HCWs reporting WRHEI was 31.53 ± 8.39 years. The demographic and work-category distribution details are given in Table 1a and b.

HCWs with less than 10 years of experience in the institution reported significantly higher incidents of WRHEI (72.3%), compared to those with more than 10 years ($P < 0.0001$). Among staff, WRHEI was commonest in the clinical areas as shown in Fig. 2. Students were excluded from the area of work analysis as they were usually rotated in various clinical and paraclinical postings during their training. Infectious conjunctivitis was the commonest WRHEI 47 (50%), followed by chemical splashes at 28%. The distribution of all WRHEI is shown in Fig. 3.

The types of chemicals, to which the HCW's eyes were exposed, are given in Table 2. Among the 32 HCWs reporting chemical splashes, 59% had not followed the recommended first-aid measures or standard protocol by Occupational Safety and Health at the place of injury.[4,13] Further, 22 (68.75%) were from disinfectants which included cresol (Lysol), formalin, cleaning acids like hydrochloric acid (Harpic), sodium hypochlorite, glutaraldehyde (Cidex), hydrogen peroxide, and alcohol-based disinfectants (Sterillium). All chemical injuries in our study were Roper Hall Grade 1. Six (18.75%) were due to chemicals mixed with BBF; of these, four had splash with formalin contaminated with Hepatitis C positive blood. All HCWs were seronegative at the end of follow-up. All those

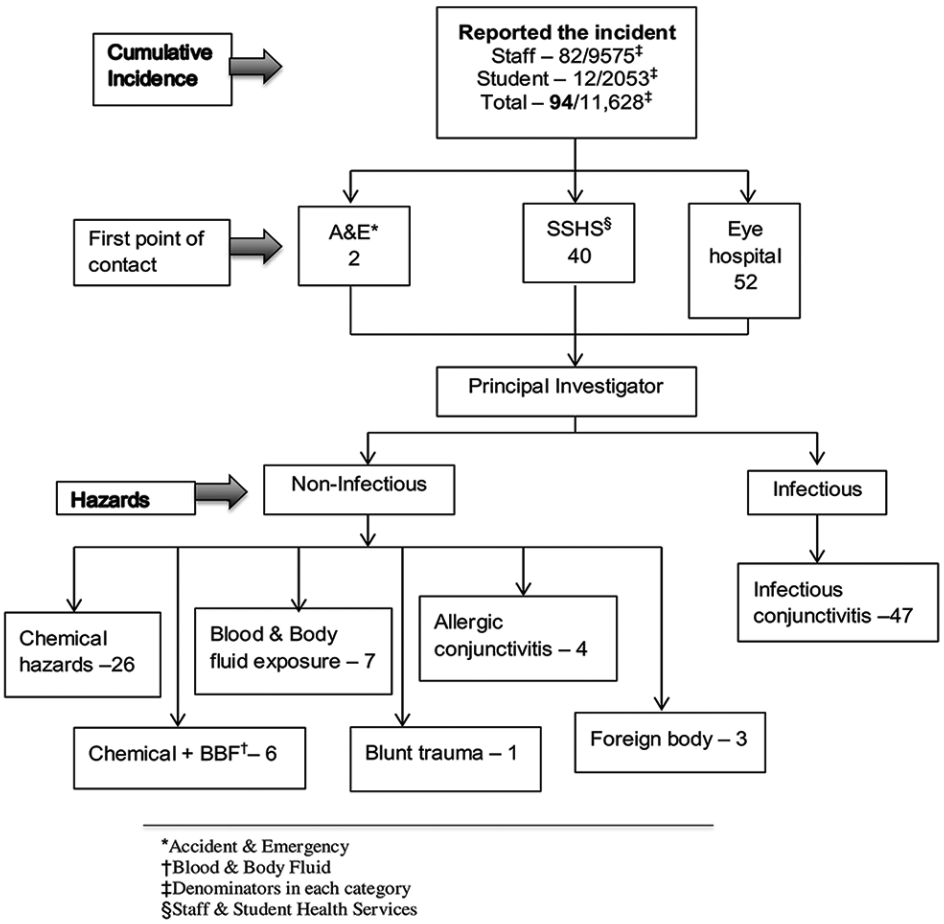

Figure 1: Flow chart of work-related hazardous exposure and infection (WRHEI) study

exposed to BBFs had a direct splash to the eyes and none were near misses. One case of blunt trauma, one corneal, and two conjunctival foreign bodies were reported. None of the above led to loss of vision. Eight of the 47 personnel (17%) who were exposed to a noninfectious hazard reported having had a similar incident in the past at the workplace.

Contact history with a person with conjunctivitis recently at the workplace was reported by 11 (23.4%), 11 (23.4%) had contact at home, 4 (8.5%) had a history of visiting an eye hospital for other reasons within the previous week before developing symptoms, 5 (10.7%) reported to have contact from other places like hostels, and 16 people (34%) did not know the source of infection. Of these, five (12%) participants developed nummular keratitis, and their vision improved to normal after treatment.

In the noninfectious category, 43/47 (92%) HCWs reported within 24 h of the incident. On the other hand, the mean time to report conjunctivitis symptoms was 3.79 ± 3.53 days. Of the 47 HCW with noninfectious WRHEI, 21 (44.6%) responded that they were aware of PPE availability. Further, 15 (31.9%) said it was readily available for use, but only 13 (27.6%) responded that they used PPE regularly at the workplace. One-third of the respondents (14/47) reported that PPE was well fitting, but only one (2.1%) responded that the PPE used was appropriate and easily usable for a particular task involving hazardous exposure.

BCVA in the eye with WRHEI at the time of injury was better than 6/18 in all the 94 patients. Of the total presenting with WRHEI, 29 (31%) had refractive errors of whom 25 (86%) were regular spectacle users. Four respondents had preexisting eye morbidity, one each of corneal dystrophy, primary open-angle glaucoma, corneal scar, and allergic conjunctivitis. There were no systemic comorbidities in (76/94) 81% of the respondents.

Working in clinical areas and not wearing glasses emerged as significant risk factors in univariate analysis and remained so after adjusting for confounding as shown in Table 3. Overall, sickness absenteeism ranged between 0 and 24 days (mean 2.26 ± 3.39). Specifically, for those with the noninfectious WRHEI, the mean number of days was 0.75 ± 0.94, and that for infectious conjunctivitis was 3.38 ± 2.96. The mean cost incurred as a result of WRHEI was INR 643.22 ± 749.23. The cost of treatment (indirect and direct) ranged from a minimum of INR 178.80 in simple conjunctivitis to INR 3215 for blood splashes which required BBV screening and follow-up for the same.

Discussion

In this study on HCW in a tertiary care institution, the 6 months Cumulative incidence of WRHEI was 8/1000 and, therefore, an annual incidence would be at least 16 per 1000. To the best of our knowledge, there are no published reports on WRHEI among HCW in tertiary care settings from India. A Finnish

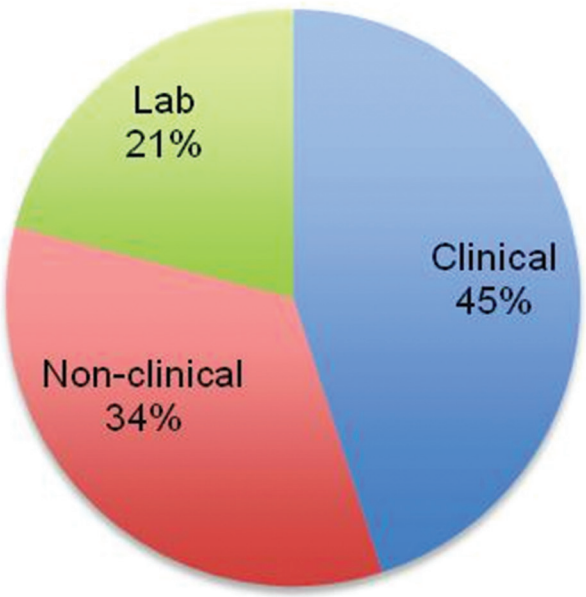

Figure 2: Pie chart showing the distribution of work-related hazardous exposure and infection (WRHEI) by area of work,(*n*=82)

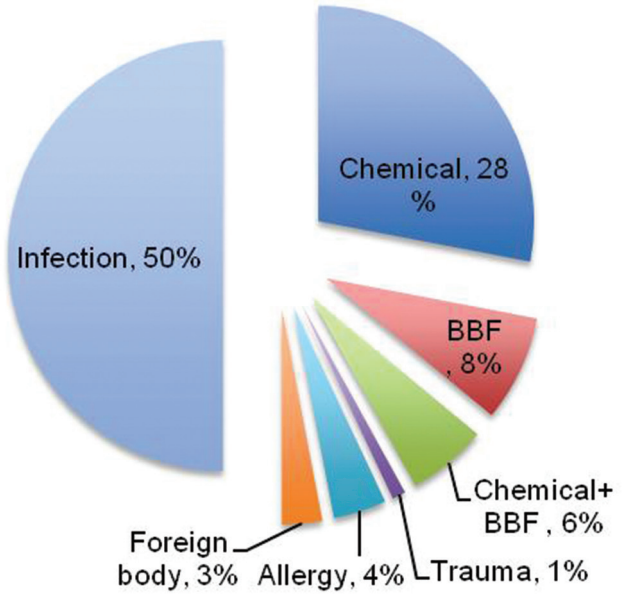

Figure 3: Pie chart showing the distribution of work-related hazardous exposure and infection (WRHEI) based on the type of hazard

Table 1a: Demographic details of HCW† who reported work-related hazardous exposure and infection (WRHEI) (*n*=94)

Demographic variable	Frequency	Percentage
Health care worker		
Staff	82	87.2%
Student	12	12.8%
Age group (years)		
≤20	8	8.5%
21-30	41	43.5%
31-40	30	32%
41-50	14	15%
>50	1	1%
Gender		
Male	29	31%
Female	65	69%

†Health care worker

Table 1b: Professional details of HCW† who reported WRHEI‡ (*n*=94)

Demographic variable	Frequency	Percentage
Category		
Consultant	2	2.1%
Postgraduate	8	8.5%
Intern	2	2.1%
Nurse-Medical	18	19.1%
Nurse-Surgical	6	6.4%
Technician	17	18%
Housekeeping	15	15.9%
Medical student	6	6.4%
Nursing student	2	2.1%
Allied health sciences student	2	2.1%
Research fellows	5	5.3%
Others	11	12%
Total no of years in the institution*		
≤5 years	38	40.4%
6-10 years	30	31.9%
11-15 years	9	9.6%
16-20 years	12	12.8%
21-25 years	3	3.2%
>25 years	2	2.1%

*This includes years of study and work in the institution. †Health care worker, ‡Work-related hazardous exposure/infection

study reported the mean annual incidence of eye injuries among agriculture workers as 3.46 per 10,000 and in construction workers as 5.28 per 10,000.[14] The Cumulative incidence of noninfectious WRHEI was 4 per 1000 in 6 months in our study, which suggests that HCWs are at higher risk compared to other industries.

The mean age of HCWs in our study was comparable to that reported from a teaching hospital setting in Nigeria 34.6 ± 7.88 years.[15] However, a majority of our respondents fell within the 21–30 years category, a decade younger than the Nigerian study (31–40 years). This could be attributed to the fact that we included undergraduate students as well because trainees in health care are also at risk of WRHEI. There was a preponderance of female HCWs (69%) in our study, like in that reported by Nigerian study (56.8%) and a study done in the Republic of Costa Rica (61%) on work related injuries in hospital employees.[15,16] This reflects the higher proportion of females in many health care facilities particularly among nurses, which was similar to the observation in a study by Kermode *et al*.[17] among HCWs in a rural health setting in India.

Nearly half (37/82, 45%) of the study respondents belonged to the clinical group. Our study found that occurrence of injury was significantly higher among the clinical group (56.1%),

Table 2: Distribution of chemical exposure (*n*=32)

Chemical splash (32 incidents)	Frequency	Percentage
Type of chemical		
Disinfectants	16	50%
Anesthetic agents	6	18.75%
Injectable drugs	1	3.13%
Others	3	9.37%
Disinfectant and blood and body fluids	6	18.75%

Table 3: Association of risk factors with acute WRHEI using multivariate logistic regression analysis

Risk factors	Adjusted odd's ratio (AOR)	Confidence interval (CI)	*P*
Age	0.99	0.94-1.04	0.59
Gender	0.71	0.28-1.79	0.47
Not wearing vs wearing glasses	3.72	1.33-10.38	0.01
Clinical vs paraclinical	3.23	1.12-9.34	0.03

whereas paraclinical HCW (65.9%) were more prone to infections. However, there were no reports in literature for comparison.

Of all WRHEI in our study, 13.8% were due to exposure to BBF with or without chemical additives. This was comparable to the study among personnel at a dental school in Bologna, Italy, where 7 (11%) of the 63 reported BBF exposures, involved splash to the eye.[18] Kermode *et al*.[17] reported 37% of health workers had at least one mucocutaneous exposure to BBF. However, there are no studies quantifying BBF exposure to the eyes among all work-related eye hazards.

In our study, chemical splashes comprised a quarter (28%) of all WRHEI. There are no reports with eye hazards alone to make comparisons. The study done in Costa Rica among healthcare personnel showed that workers exposed to chemicals had a higher rate of work-related injury (RR 1.36) as compared to nonexposed workers.[16] Another study done on occupational health hazards among HCWs in Kampala, Uganda, estimated that chemical spills can contribute up to 10% of all occupational hazards.[19] Eight of the 47 (17%) who had been exposed to a noninfectious hazard in our study reported having had previous such incidents at the workplace, which suggests that there is a risk of recurrent injury, which needs to be addressed.

Half (47/94) of our participants reported an infectious WRHEI. Two-thirds (66%) reported within 3 days of developing symptoms. A study done among students at Dartmouth showed that annual attack rates among 3,682 undergraduate and 1,378 graduate students were 18.7 and 2.5% respectively. The mean duration of symptoms at reporting was 5.9 days (range, 1–43) in comparison to our study, which had a mean reporting time of 3.79 ± 3.53 days.[20] A study from Kampala in healthcare facilities reported that all infections accounted for 7.5% of work-related hazards in 100 (50%) respondents.[19] The mean number of sick days was 2.26 ± 3.39 in our study, which was lesser as compared to a Brazilian study among nursing staff, which reported an average of 3.17 days.[21]

A study done on ocular trauma in South India found that trauma was responsible for unilateral blindness in 39 out of 824 subjects and majority were traumatic incidents (461, 55.9%) occurring at the workplace.[22] Though none of the HCWs developed loss of sight in our study, the nature of injuries suggests that it is possible if adequate precautions are not taken.

Awareness about PPE availability (44.6%) and regular usage (27.6%) was low in our study in contrast to the study among HCWs in Nigeria, where 55.5% used PPE during various procedures.[23] Only 38.4% responded as having had training of any sort on PPE usage. This highlights the need for regular training. A case-control study done in Ethiopia showed that lack of training put workers at a higher risk of occupational injury, and health and safety training remained a significant predictor of occupational injury (AOR 1.85, 95% CI (1.17, 2.91).[2] Wearing spectacles was protective in our study, acting as a barrier against physical and chemical hazards. Alani *et al*.[24] and Ansari *et al*.[25] concluded in their studies that PPE usage must be advocated to protect from microscopic splatter that may be missed by the naked eye.

There was no available literature to compare cost analysis for work-related eye hazards. Though HCWs in our study availed benefits of free health services, average direct cost per individual for the institution may vary and may not be comparable with other public and private health care settings.

The strengths of this study are that it was done at a large tertiary care hospital with a comprehensive SSHS. All HCW with WRHEI underwent complete eye examination by an ophthalmologist, making for accuracy in recording. As for the limitations, the study was conducted over a limited time period of 6 months. Further, while efforts were made to contact HCWs who may have missed reporting to the first points of contact, we cannot fully rule out underreporting. This study was conducted in 2017 (pre-COVID-19 era). However, with the current pandemic, adherence to PPE use among HCWs in clinical areas would have changed, which may indirectly affect the prevalence of work-related eye hazards. We could also expect higher compliance rates of PPE usage in future research.

Conclusion

There is at least a definite burden 8/1000 of acute work-related hazards to the eye among tertiary HCWs in a six-month period. Students are as much at risk as are the staff. Infectious conjunctivitis contributed to 50% and chemical splashes make up nearly 28% of all reported WRHEI. Awareness regarding PPE usage was low and deserves attention. WRHEI does contribute to sickness absenteeism, which can be prevented by appropriate measures. There is a considerable direct and indirect cost for care with both noninfectious and infectious exposures. Appropriate preventive measures need to be taken to address these issues. Generalizing our findings to other healthcare institutions should be done with caution, as they may not have services such as mandatory training and SSHS in place.

Considering the dearth of literature in this regard, this study has helped us to identify the nature and burden of hazards and its implications in terms of sickness absenteeism, cost to the employer, appropriateness of PPE, and awareness among HCW

to develop the necessary interventions to ensure eye safety for HCW in a tertiary care setting.

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Conflicts of interest

There are no conflicts of interest.

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