

Personal Protective Equipment for Occupational Safety and Ocular Health - A Review

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Abstract

Encountering ocular injuries at the workplace is very common. Of the total amount of work-related injuries, 10 - 20% will cause temporary or permanent vision loss. If safety eye wears are not worn, if safety eye doesn't fit in our eyes or if we don't provide appropriate protection by their application it might badly harm eyes and/or reduce visual comfort. Eye being one of the most important parts of human being, which is continuously subjected to trauma and hazards, should be protected in every way possible be it in home or work place with proper use of Personal Protective Equipment (PPE). It is defined as "all equipment which is intended to be worn or held by a person at work which protects them against one or more risks to their health and safety". Let's wisely select PPEs and use PPEs for ocular and vision preservation.

Keywords: Personal Protective Equipment; Ocular Injuries; UV Protection; Goggles; Face Shield

Introduction

Personal protection must be considered in the context of control methods for preventing occupational injuries and various hazards. Injuries and disease transmission via eye-route is not uncommon. A study has shown a high incidence (45%) of blood and body fluid splashes found on protective glasses and masks [1] which urges eye protection as an important measure to control and prevent disease transmission. So, personal protective equipment for eyes is as important as that for any organs in the body.

Personal Protective Equipment (PPE) is defined as "all equipment (including clothing affording protection against the weather) which is intended to be worn or held by a person at work which protects them against one or more risks to their health and safety". PPE would include such things as hard hats, eye protection, safety harnesses, life jackets and safety footwear [2]. PPEs are a precautionary step that prevents contact with infectious agents by creating a barrier between potentially infectious agents and the practitioner. Eight types of PPEs have been listed by European Directive [3] and they are:

1. Head protection, like Helmets; Hard hats; Bump Caps; Guards; Accessories.
2. Hand protection, like gloves and gauntlets; wrist cut off nets.
3. Eye and face protection, like Safety glasses and goggles; Eye and face shields; Eyewear accessories; Over specs; Visors.

4. Respiratory protection, like breathing apparatus; full face or half mask respirators; powered respirators; protective hoods; disposal face masks; detectors, monitors.
5. Hearing protection, like Earplugs and defenders; Noise meters; Communications sets; Acoustic foam.
6. Foot protection, like Safety boots and shoes; Anti-static and conductive footwear.
7. Body protection, like Life jackets; Clothing for specific weather conditions; High-visibility clothing; Harnesses, and others.
8. Height and access protection, like Fall-arrest systems; Body harnesses; Lowering harnesses; Rescue lifting; Energy absorbers, and others.

Encountering eye injuries at the workplace are very common. More than 2,000 people injure their eyes at work each day. Of the total amount of work-related injuries, 10 - 20% will cause temporary or permanent vision loss [4]. If we don't wear the safety eyewear, if safety eye doesn't fit in our eyes or if we don't provide appropriate protection by their application it might badly harm eyes and/or reduce visual comfort [5]. It is estimated that 90% of them were preventable if these workers had been wearing appropriate eye protection [4]. These statistics related to eye injuries warrant the need for total eye protection. Eye injuries may occur anywhere, with anybody and by anything.

Eye injuries can happen through a variety of means. Most eye injuries occur when solid particles such as metal slivers, wood chips, sand or cement chips get into the eye [6]. The common causes for workplace eye injuries are projectiles including dust, concrete, metal, wood and other particles. Other possible sources include biological discharges, chemicals like splashes and fumes and radiation especially visible light, ultraviolet radiation, heat or infrared radiation, and lasers. Smaller particles in smokes and larger particles such as broken glass also account for particulate matter-causing eye injuries. Blunt force trauma can occur to the eye when excessive force comes into contact with the eye. Chemical burns, biological and thermal agents, from sources like welding torches and UV light, also contribute to occupational eye injury [7]. Some working conditions include multiple eye hazards, continuously rendering them prone to eye injuries and diseases.

Eye care services cannot be an exception for eye-related hazards. For eye care specialists, the common source of infection may include blood-borne pathogens like hepatitis and HIVs, or those from body and body fluids including mucous membranes like conjunctival discharge, pseudo-membranes, pus, hypopyon, etc. With the evolution of laser as diagnostic and prophylactic treatment for various eye conditions, both the eye care specialist and the patient are at major risk for radiation hazards, if slight precaution is overlooked. Vano., *et al.* has reported that lens injuries can occur to the interventionist and other medical staff if proper radiation safety precautions are not employed [8]. The specialist is prone for development of early cataracts, while the patient party are prone to hazards due to improper handling of instruments during innervation like corneal burns during laser peripheral iridotomy, macular hole during pan-retinal photocoagulations, or pseudo-hole formation during syringing and probing. Recently, eye as a possible route for transmission of 2019-nCoV was suspected when Dr. Wang Guangfa of Perking University was diagnosed with coronavirus following an acutely inflamed left eye [9]. With this anecdotal report, the need of eye protection in the ongoing pandemic has been stressed upon. The fact that exposed mucous membranes and unprotected eyes increased the risk of coronavirus transmission suggests that exposure of unprotected eyes to 2019-nCoV could cause acute respiratory infection [10].

Eye hazards are also experienced by prescription spectacle users, especially those belonging to the pediatric population. Children are quite "heavy-handed" with their spectacles [10]. Children are always engaged in acts that are unexpectedly hazardous, and their eye-glasses can be expected to endure much abuse [11]. They are subjected to trauma and allergies associated with frame and lens materials. If glass material is used for lens, especially for high powers, during the act of play, these lens may get broken and the glass pieces may injure the eyes. Poorly fitted nylon cord frames are subjected to rough handling. Also, pediatric patients are sensitive to certain materials, thus

if hypo-allergic materials like titanium are not used, frame material can be a possible source of eye hazards. Improper bridge fitting may rest the entire weight of frame into the crest. This may not only be painful, but also can cause a permanent ridge to be formed as it causes adipose tissue to breakdown as the child is still developing [12].

The most typical eye protection against external factors (e.g. radiation, dusts and droplets), is a natural protective mechanism of a human eye. The thin layer of slightly oily lachrymal fluid produced by the conjunctiva protects the human eye against pollution and infections. However, this natural protection is often insufficient in both everyday life and work environments. Since, the eye and face are often under-protected and overexposed, the eye's natural protective mechanism is not sufficient all the time. Moreover, people tend to underestimate the risk of eye injury.

Though the importance of eye protective equipment is well understood, their use in health and other occupations has not flourished as much as the other PPEs. Employees may neglect to wear eye and face protection or remove their PPE before it is safe to do so. One of the leading reasons for lack of utilization of eye protectors is inaccessibility; the right equipment isn't readily available when people need it, therefore people tend to work without protecting their eye. Also, even if PPEs are used people tend to complain about it. Common complaints by user include improper fitting. Most of them refrain using PPEs as it makes them look unattractive. For goggles and safety glasses in particular, a major problem is the equipment fogging up, causing the wearer to periodically remove it and clean off moisture. In spite of properly fitted PPEs, inadequate training for its utilization is a hindrance. If the user does not know when and how to use PPE; how to put it on, adjust it, and take it off; and how to properly test, store, maintain, and dispose of the equipment, there is no meaning of wearing an eye PPE. For selecting the most suitable eye and face protection the following elements should be considered [11]:

- Ability to protect against specific workplace hazards.
- Should fit properly and be reasonably comfortable to wear.
- Should provide unrestricted vision and movement.
- Should be durable and cleanable.
- Should allow unrestricted functioning of any other required PPE.

Eye injuries at workplace or hospitals can be avoided by the use of proper eye PPE. The first step in preventing eye injuries is to identify any hazards associated with the injury, then eliminate the risk those hazards create. If the risk cannot be eliminated the risk should be minimized by substitution, isolation, or adding engineering or administrative controls. Lastly, appropriate selection of eye-ware is needed. Some of the available safety eye-ware are:

- Non-prescription and prescription safety glasses: Although safety glasses may look like normal dress eyewear, they are designed to provide significantly more eye protection due to which the lenses and frames are much stronger than regular eyeglasses. Safety glasses must meet standards of the American National Standards Institute (ANSI). These protective eyeglasses have safety frames constructed of metal or plastic and impact-resistant lenses. Side shields are available on some models.
- Goggles: These are tight-fitting eye protection that completely cover the eyes, eye sockets and the facial area immediately surrounding the eyes and provide protection from impact, dust and splashes. Some goggles will fit over corrective lenses. Like safety glasses, safety goggles are highly impact-resistant. In addition, they provide a secure shield around the entire eye and protect against hazards coming from any direction. Goggles can be worn over Prescription glasses and contact lens
- Face shields: Face shields are intended to protect the entire face or portions of it from impact hazards such as flying fragments,

objects, large chips, and particles. When worn alone, face shields do not protect employees from impact hazards. Face shields can be used in combination with safety spectacles or goggles, even in the absence of dust or potential splashes, for additional protection beyond that offered by spectacles or goggles alone.

- Laser safety goggles: These specialty goggles protect against intense concentrations of light produced by lasers. The type of laser safety goggles chosen should depend upon the equipment and operating conditions in the workplace. Laser eyewear should be selected to protect against the specific wavelength of light generated and with a sufficient Optical Density (OD) for the given laser power.
- Absorptive lenses: Lenses can be clear, tinted, photochromic or polarized. Each type offers various levels of ultraviolet protection, including no protection (even when coloured). Absorptive lenses can help in improving the visual comfort either by increasing the transmittance or by decreasing the reflections. If a person is subjected to long term UV exposure, he must wear sunglasses labeled 100% UV protection with a wraparound style so that rays don't enter through the sideways of the protective wear.

The choice for PPE depends upon the occupation and potential hazards that a personal might be exposed to during their work. For medical personnel, the main need of PPE is to block transmission of contaminants from blood, body fluids, or respiratory secretions. They are exposed to biological hazards. All personal protective equipment (PPE) that is intended for use as a medical use must follow The FDA's regulations and should meet applicable voluntary consensus standards for protection. This includes surgical masks, N95 respirators, medical gloves, and gowns. During any radiological investigation or therapy, the medical doctor should wear appropriate PPE against radiation hazards which mostly includes protective eye wear.

Occupations including welding are subjected to injury and radiation hazards. The intense light associated with welding operations can cause serious and sometimes permanent eye damage if operators do not wear proper eye protection. Wearing fire resistant eye and face shield will protect from: Radiation, flying particles, debris hot slag, sparks, intense light irritation and chemical burns. To protect against fumes and oxides, appropriate oxygen respirators can be used. Fire resistant ear muffs should be worn to protect against excessive sound. Moreover, the entire body should be covered with fire resistant apron, boots and glove for protection against fires, burns, radiations. Dark clothing works best to reduce reflection under a face shield.

Engineers and construction workers who are mostly exposed to physical hazards should have a full physical protection PPEs. There are so many potential hazards at a construction site, and personal protective equipment (PPE) is one of the workers' primary lines of defense. Some common classes of hazards at construction sites with risks that can be mitigated with appropriate PPE include electrical, fall, chemical, harmful dust, struck-by, penetration, caught-in and caught-between, rollover, and heat. Hard hats are essential at most construction sites. They protect against head injuries related to swinging or falling objects, striking the head against something, or accidental head contact with an electrical hazard. For foot protection steel-toe boots should be worn on site that protect against crushed toes due to heavy or falling equipment or materials. Different types of work gloves are best suited to particular tasks and risks at construction sites. For example, there are heavy-duty leather and canvas gloves for protecting against cuts and burns, welding gloves for welders, heavy-duty rubber gloves for working with concrete, insulated gloves with sleeves for working with electric hazards, and chemical-resistant gloves for working with chemical agents. Workers should protect their full legs, full arms and torso against cuts, scrapes, burns, and other superficial injuries with thick, flexible work pants and shirts. And finally, for face and/or eye protection, Safety glasses or face shields should be worn whenever there is a danger of flying debris or harmful dust getting in the eyes. Cutting, grinding, welding, chipping, and nailing are some activities that necessitate protective eyewear. Along with basic safety glasses, some other protective wear for the face include welding shields, chemical splash goggles, and dust goggles. Reflective/high-visibility garments like brightly colored and/or reflective jackets, vests, or other upper-body clothing is important for worker visibility.

Traffic police working outdoors are exposed to hazards like impact due to RTA (Road Traffic Accident), long term UV exposure, dust and debris and rarely electric and chemical injury from naked electric wires and molten gaseous matters. Though hard hats may not match with their daily uniform, they should be worn for head protection. Safety glasses and goggles should be worn to protect against thermal and physical hazards. Side shields provide protection from indirect impacts as well. Absorptive glasses, especially photochromic glasses can be worn to protect against long term UV exposure from sunlight. Polaroid glasses can cut off annoying reflections from pitched roads. Like in construction and engineering work, reflective jackets and high reflectivity garments must be worn for their visibility especially during low lightening conditions like night time.

Agricultural workers also suffer from farm injuries every now and then. Many farm injuries can be prevented or their impact reduced if farmers wore proper personal protective equipment. Farmers who wear head protection like bump caps and hard hats when performing everyday tasks such as building, demolishing or repairing structures; operating and repairing machinery; felling or trimming trees; and when entering or exiting buildings with low door clearances, reduce head injury incidences. They should wear eye protection like safety glasses and goggles, face shields when grinding feed, handling chemicals, harvesting crops, haying, and doing shop work such as drilling, grinding or sawing. Safety protective foot wares also should be worn.

Personal protective equipment are also important for emergency responders and recovery workers, particularly those responding to natural disaster and chemical (including oil), biological, radiological and nuclear events, firefighting, and emergency medical personnel. These consist of a Self-Contained Breathing Apparatus (SCBA) and a totally encapsulating chemical-protective (TECP) suit, protective body-ware like gloves, boots, hats, suitable clothes, respiratory, and eye protection are also required.

Protective eye-ware for children is different from those of adults. Their facial contours are quite different from adults and, importantly, are still developing; hence they require special frames designed for them, not the small adult one [8]. Since safety is the primary concern during pediatric dispensing, children's frames should be strong; solidly built, be they plastic or metal. High quality spring temples are a good option. The advantage is that, when hit from the side, the spring takes much of the shock, instead of transferring all of it to the side of the nose. The material chosen should be hypo-allergic like titanium. Silicone-based rubber frames are useful for some babies and children who require indestructible frames. The material is such that it is light and pliable and any frames made from this will not have metal hinges, thereby reducing the chances of facial injury. Young children can be fitted with light metal frames with curl side.

As eye-route transmission has been established as a possible method for COVID-2019, the ongoing pandemic, eye protection must not be ignored. Eye protection should be prioritized during activities where splashes and sprays are anticipated, which typically includes aerosol generating procedures or during activities where prolonged face-to-face or close contact with a potentially infectious patient is unavoidable. Eye protection should be shifted from disposable to re-usable for optimizing the supply of eye PPEs during ongoing pandemic. Therefore, preferential use of powered air purifying respirators (PAPRs) or full-face elastomeric respirators which have built-in eye protection should be considered. Appropriate cleaning and disinfection should be done between users if goggles or reusable face shields are used.

Conclusion

In conclusion, eye being one of the most important part of human being, which is continuously subjected to trauma and hazards, should be protected in every way possible be it in home or work place. While we use sunscreen to protect our skin from sun damage, why not use protective spectacles to protect our eyes as well?

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