

Eye Safety in Dentistry

By Marie T. Fluent, DDS, CDIPC

Eye safety is personal to me. In 2012, over the course of a few months, I was rendered blind in my left eye. This led to a premature, completely unanticipated, and personally devastating end to my capacity to practice dentistry.

After shedding many tears, I sold my beloved clinical practice and looked for something to do. I am fortunate that the medical condition that took the sight in my left eye has so far left my right eye unscathed. Over time, I was also blessed to learn that some annoying clichés, such as

“when one door is closed, others are opened,” really are true.

So, while I did not lose my vision in an occupationally related event, with one remaining functioning eye, I am exponentially more aware of the daily splendors of sight, and dramatically more vigilant in taking steps to protect my vision. Relevant to the following, I am also passionate in my commitment to do what I can to protect these precious windows to the world for others. Through this article, I share essential considerations for clinical practice to protect eyesight for our patients, team members and ourselves.

Background

Ocular injuries are prevalent in occupational settings. NIOSH (the National Institute of Occupational Safety and Health) estimates that each day about 2,000 U.S. workers sustain a job-related eye injury that requires medical treatment. About one-third of these injuries are treated in hospital emergency departments, and more than 100 of these injuries result in one or more days away from work.¹

Ocular hazards in dentistry

Not surprisingly, members of the dental team are exposed to numerous eye hazards during their workday. While performing dental care and laboratory procedures, dental personnel are exposed to bloodborne pathogens and other flying debris such as tooth materials, dental materials, chemicals, prophy paste, pumice, and on occasion, broken dental instruments and burs. Studies have shown that debris may hit the eyes of dental personnel at a speed of 60 miles (96 km) per hour.² And, since the focal distance of most dental personnel to the operative field ranges from 14 to 18 inches,³ there is simply no time to protect one's eyes with reactive protective measures. In addition to flying particles and bloodborne pathogens, clinical care-related hazards include blue light irradiation and laser light rays, if performing laser dentistry.

While involved in non-clinical care tasks, the dental team is at risk of exposure to additional hazards. During cleaning and disinfection protocols, instrument reprocessing, and processing analog radiographs, the dental team is exposed to numerous chemicals, detergents, enzymatic solutions, acidic dental materials, and chemicals used for developing and fixing X-ray films. These chemicals and solutions may accidentally splash into the eyes of the worker without warning or time to react. Thus, dental personnel must rely upon protective eyewear during

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Proper eyewear — Optimal protective eyewear provides comfort, excellent optics, anti-fog lenses, and high-impact resistance that meets ANSI Standard Z87.1.

patient care activities and other tasks likely to generate splashes or sprays of blood, body fluids, chemicals, flying debris, and potentially injurious light radiation.

Agencies that impact protective eyewear

As our nation's premier public health agency, the Centers for Disease Control and Prevention recommends that protective eyewear with side shields or a face shield are worn by dental health care personnel during procedures and patient care activities likely to generate splashes or sprays of blood or body fluids.

The Occupational Safety and Health Association (OSHA) publishes standards to protect employees from safety.⁴ The American National Standards Institute (ANSI) publishes occupational and Educational Personal Eye and Face Protection Devices standards. The ANSI/ISEA Z87.1 Standard helps ensure that personal eye and face protection devices provide the necessary protection from impact, non-ionizing radiation, and liquid splash exposures. The Z87.1 2020 update addresses product innovations and continues focus on product performance and harmonizing with ISEA standards. ANSI Standards emphasize the importance of wearing the proper protection for the specific job performed or "matching the protector to the hazard."

The bottom gap in eyewear

The route of entry into the eyes of dental personnel may be from a frontal approach, where debris may travel perpendicular to a practitioner's face; sideways, where debris may travel tangential; or through a gap formed between the bottom profile of the protective eyewear and top edge of the mask — referred to as a "bottom gap."⁵ This gap is a breach in modern medical masks and has been researched and noted by NIOSH. Subsequently, NIOSH has worked with ANSI to propose new regulations for protective eyewear. This new Standard, ANSI/ISEA Z87.62-2021, is the first federal guidance to standardize eye and face protection against bloodborne pathogens and debris. While this new Standard is not all-encompassing (as it does not assess aerosolized pathogens), its purpose is to prevent exposure to wearers' eyes and face caused by sprays, blood, body fluids, and other potentially infectious materials in all health care environments. Remarkably, this is the first industry effort to standardize eye and face protection used in occupational settings where the presence of spray and biological hazards pose a risk.⁶

Eyewear worn by patients during dental care

Patients, too, are exposed to bloodborne pathogens,



No gaps — Ideal protective eyewear as shown above, closes "the bottom gap" — the gap formed between the lower profile of the eyewear and top edge of the mask.

flying debris, and instruments accidentally dropped during dental care. As OSHA exists to protect employees, this agency does not provide standards for patient protection. CDC Guidance for patient eye protection is minimal and states that “protective eyewear for patients shields their eyes from spatter or debris generated during dental procedures.”¹²

Unfortunately, compliance with patient eye protection is variable. One study polled dental team members to inquire whether patients routinely wear protective eyewear during clinical care. The self-reported conclusions were that only 18.66% of team members provide patients with protective eyewear all the time; 6.66% most of the time; 54% sometimes; and 20% never.⁷

Emergency eyewash stations

OSHA Standard 29 CFR 1919.115(c) provides standards for eyewash stations. According to this Standard, eyewash equipment must be available for emergency use when eyes may be exposed to injurious materials. This eyewash station should be installed within a 10-second walk from the hazard, and the temperature should be well-tolerated by employees. In other words, temperature extremes should be avoided. When an ocular exposure occurs, the eyes should be flushed for a minimum of 15 minutes. Then, the employee should be evaluated by qualified medical personnel to pursue whether further treatment if necessary. In addition, ANSI Standards state that “plumbed eyewash stations should be visually inspected and activated every week.”⁸

Blue light hazards

All persons are exposed to blue light radiation in everyday life. While a natural source of blue light is from the sunlight, excessive blue light in the range of 380 to 500 nm is becoming more prevalent in our daily lives, from electronic devices, computers, streetlights, headlights on automobiles, and others.⁹ Dental personnel are exposed to additional sources of blue light during the workday. These sources include the operatory light, LED headlamps on loupes, and LED light curing units. One study reported that 53% of dentists use LED headlamps for more than five hours per day, and another study reported that dental personnel spend 240 hours per year curing restorations.¹⁰

Photochemical damage may occur to the retina caused by short-wavelength electromagnetic radiation in the 400-500 nm range, and accumulates over the lifetime. The most damaging wavelength is 415-455,¹¹ which is the wavelength of most dental curing lights. This may cause damage to the light-sensing cells (photoreceptors) in the retina and is implicated in retinal degenerative diseases such as age-related macular degeneration (AMD). Interestingly, when eyes are exposed to UV-A radiation, such



Side shields — Protective side shields prevent debris from entering the practitioner’s face from a sideways direction and should always be worn during procedures and patient care activities likely to generate splashes, sprays or flying debris.

as natural sunlight, a person will automatically squint their eyes or look away. Yet, with blue light exposure, the narrow band of light does not evoke a similar protective aversion response .

LED curing lights

LED curing lights now dominate the market for light curing procedures, and dentists report spending 57.5% of their working day placing light-cured restorations. LED curing lights emit blue light in the 430-480 nm wavelength range, and modern curing lights are becoming more intense. Some light curing units may deliver as much as 5,000 mW/cm² of irradiance — intense enough to cause soft tissue burns and or thermal damage to the tooth.¹¹ While the American Conference of Governmental Industrial Hygienists calculates the maximum daily exposure

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levels for blue light, the threshold for using high-powered LED curing lights is unknown.

Eye protection during light curing procedures

There are six main options to protect the eyes of dental personnel during light curing procedures: amber-shaded goggles with side protection, amber lenses incorporated into the lower portion of loupes, a shield attached to the light guide, antiglare cones that fit on the tip of the light curing unit, and amber paddles. There are advantages and disadvantages to each of these protective measures. (See Table One).

Another approach, “the look away method,” is never recommended. During this method, the operator applies the tip of the light curing unit to the restoration to be cured and then looks away while the LCU is activated. Yet, during light curing, the operator may glance at the operative field, exposing his or her eyes to excessive and intense blue light. In addition, the operator cannot accurately monitor the desired location of the light tip, which may lead toward an under-cured restoration, subsequent restoration leakage, and potential recurrent decay. Other adverse events related to LCU misplacement may include soft tissue burns and thermal damage to the pulp.

The role of the FDA

The U.S. Food and Drug Administration considers dental unit curing lights to be Class II medical devices that can pose moderate risk to patients and/or users. Light curing units and accompanying eye protection must meet approval standards before being sold in the United States. Through this process, the FDA ensures that the accompanying eye protection is effective and safe. However, eye protection may also be purchased after market. Unfortunately, eye protection not supplied by the LCU manufacturer is considered a Class I device posing low risk to the patient or user. Thus, the manufacturer of aftermarket eye protection is not required to submit proof of efficacy or safety. In other words, eye protection from a different manufacturer (or an off-market brand) may not provide adequate protection against blue light radiation from the LCU used in a practice setting.

Additional eyewear safety considerations

During instrument reprocessing, CDC recommends to “wear appropriate PPE when handling and preprocessing contaminated patient equipment,” and when cleaning and disinfecting environmental surfaces, to “establish an area outside of the operatory where PPE can be donned and doffed appropriately and safely.”¹²

Table One — Protective Eyewear Options for Light Curing Procedures

Type of Eye Protection	Advantages	Disadvantages
Orange shield attached to light guide	<ul style="list-style-type: none">• Can be adjusted to protect operator	<ul style="list-style-type: none">• Small surface area• Can't protect DDS and assistant at same time• May restrict access of the light curing unit• If using attached shield, consider additional protection for assistant or operator
Orange goggles with side protection	<ul style="list-style-type: none">• Provides optimum protection• Allows for hands-free protection	<ul style="list-style-type: none">• Inconvenient if using loupes
Antiglare cones that fit on top of LCU	<ul style="list-style-type: none">• Easy to use• Hands-free protection	<ul style="list-style-type: none">• May obstruct view/prevent view of light tip• Can increase distance between tip of curing light and restoration• Cone may easily slip from desired location and impair eye protection
Paddles	<ul style="list-style-type: none">• May provide adequate coverage for DDS and assistant	<ul style="list-style-type: none">• Requires an extra hand of assistant
“Look away” method	<ul style="list-style-type: none">• NONE!• NOT recommended!	<ul style="list-style-type: none">• User often glances at operative field• Can't monitor location of light tip

Protective eyewear for laser safety

Laser usage poses a serious risk to dental personnel and patients, as scatter radiation may lead to blindness. When utilizing lasers in dentistry, consult the laser manual to determine the protection level needed based on laser output and recommended Optical Density (OD). Select a filter whose specifications match the manual, provide the highest Visible Light Transmission (VLT), and provide laser eye protection for all clinical personnel and patients during laser use.

Considerations for eyewear selection

When selecting protective eyewear when splashes and sprays are anticipated, personal eyewear does not provide adequate protection. Instead, select eyewear that meets the ANSI Z787.1 Standard and has high-impact resistance (evidence of this certification is typically marked on the inside of the eyewear frames) and provides side protection in the form of a wraparound lens. Select a frame that offers a comfortable fit, excellent optics for visual acuity, and anti-fog and scratch-resistance lenses. Finally, when trying on protective eyewear, tilt the head upward to ensure there is no bottom gap between the lower portion of the lens and face.

In all light curing procedures, ensure that the photoinitiator within the restorative material can be cured by the wavelength distribution of the light curing unit, and ensure that the eye protection used blocks those specific wavelengths. A best practice is to use the eye protection method supplied by the manufacturer of the light curing unit. During light curing procedures, provide blue light blocking protective eyewear for the patient — especially children and patients taking photo sensitive medications.¹⁰ A clinical tip is to hold a “mock-light curing practice session” during a non-clinical time of the workday. In this scenario, both the operator and assistant may utilize the protective method to ensure that they both are protected from blue light radiation during light curing procedures from their perspective.

Conclusion

Eye safety education and training for dental personnel are essential to protect patients and the care team. Team members should be informed what to wear, where and when to wear it, and why it is important. Providing patients with the appropriate protective eyewear is recommended throughout their clinical encounters, and amber goggles during light curing procedures. ●

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About the Authors

Marie Fluent, DDS, has extensive experience and expertise as a dental infection control clinical instructor, educator, speaker, author, and consultant. Her dental career spans 35 years and includes roles as dentist, both as an associate and practice owner, infection control coordinator, office manager and dental assistant. She serves as education consultant for the Organization for Safety, Asepsis, and Prevention.



Fluent