ENVIRONMENTAL VISION

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Environmental Vision is that discipline that is concerned with the interaction of the visual system with our environment. It encompasses aspects of maximizing visual performance and protecting the eyes from environmental hazards. Environmental vision incorporates the visual assessments of patients/workers taking into account their specific visual requirements at home, work, and play. Assessments can begin with the visual history at the optometric examination by a practicing optometrist or with a workplace assessment of the visual tasks of workers by an occupational vision consultant.

This chapter will provide an overview of environmental vision to illustrate eye and vision threats in our environment and procedures used to protect us from these threats. Additionally, strategies will be reviewed to illustrate how doctors and office personnel can help modify patient behavior to help reduce eye injury and illness. Case studies will next be presented to put these principles into a daily practice scenario to illustrate how primary eyecare providers can best serve the environmental vision needs of their patients.

Eye Injury Databases

While the eyelids, tear system, boney orbit, and reflex mechanisms provide protection from many natural and artificial hazards in our environment, the eyes continue to be at risk of injury throughout our daily lives. Dust, flying particles, and both sharp and blunt objects are several hazards which can inflict damage and cause temporary or permanent loss of vision. As with any public health problem, the first step in remediation is to measure and analyze the extent of the problem. Eye injury databases exist to help document the number of eye injury cases per year. However, it is extremely difficult to determine: 1) what percent of all eye injuries are identified, 2) the seriousness of the cases, and 3) the exact population at risk for these injuries. Without this information, it is difficult to determine the overall extent and nature of eye injuries or how effective an injury prevention program can be. In spite of these shortcomings, eye injury databases provide useful information upon which to build prevention efforts. Within the United States, the three main eye injury databases are the National Electronic Injury Surveillance System (supported by the U.S. Consumer Product Safety Commission), Survey of Occupational Injuries and Illnesses (compiled by the Bureau of Labor Statistics), and the U.S. Eye Injury Registry.

National Electronic Injury Surveillance System

The Consumer Product Safety Commission of the U.S. Government sponsors the National Electronic Injury Surveillance System (NEISS). Injury numbers collected through NEISS provides a national probability sample of injuries associated with consumer products from across the United States and its territories. Patient information is collected within participating NEISS emergency rooms for patients seeking care involving consumer products. The number of documented injuries within this limited number of hospitals is statistically modified into a national projection. It is important to remember that the documented injuries were not necessarily "caused" by the consumer product, but that the injury was associated with the product's use. [The NEISS estimates provide only the number of injuries treated in emergency rooms, therefore underestimating the total number of injuries associated with a given product. Injury cases treated by private providers or in clinics are not included in the estimates.] By summing the injuries associated with different products, an estimate of a general class of injuries (e.g. sporting activities or home and garden activities) can be obtained for certain body parts.

Recent estimates from related products have been condensed into product categories by Prevent Blindness America. Although the NEISS data does not specify the extent of injury, we must assume that the injury has significant severity because the patient sought treatment within an emergency room facility. NEISS data is available online at http://www.cpsc.gov/LIBRARY/neiss.html. These estimates show that over 40,000 eye injuries treated in emergency rooms occurred in the United States in 2000 from sporting activities.[1] As these estimates represent injuries treated only in emergency departments, it is logical to assume that the 40,000 number considerably underestimates the actual total.[2] A similar number of eye injuries associated with lawn and garden products has also been found. Clearly, the large number of eye injuries each year is putting vision at risk for a large number of our patients.

Survey of Occupational Injuries and Illnesses

The Occupational Safety and Health Act of 1970 requires all employers in the United States to keep records of work-related injuries, illnesses, and deaths. Businesses of 10 or fewer employees, however, are usually exempt from this requirement. Data from these records can then be used to implement safety and health programs within individual companies or generally across different industries. Rules regarding this record keeping are available online at http://www.osha.gov/recordkeeping/handbook/index.html#1904.02.

A summary of eye injury data is presented in Table 1. An advantage of the OSHA database (from which Table 1 is extracted) is that **rate data,** taking into account both worker population and number of workdays, is provided within the estimate[3] (e.g. 7.3 eye injuries/10,000 workers/year). The severity of the injuries is not provided; however injuries must meet the general recording requirements of death, days away from work, restricted work or transfer to another job, medical treatment beyond first aid, or loss of consciousness.

Table 1. Eye Injuries/Illnesses Involving Days Away From Work

Number / 10,000 Workers / Year

Type of Industry	**Rate**
All Private Industry	3.5
Natural Resources and Mining	7.3
Construction	7.3
Manufacturing	5.8
Trade, Transportation, Utilities	3.7
Information	1.0
Financial Activities	1.6
Professional and Business Services	1.4
Education and Health Services	1.7
Leisure and Hospitality	3.1

*Bureau of Labor Statistics 2007
http://www.bls.gov/news.release/osh2.t07.htm

US Eye Injury Registry

The US Eye Injury Registry (http://www.useironline.org) is a voluntary, medical-provider reported database which began in 1988. Its stated goals are:

1) To promote descriptive epidemiology of eye injuries, facilitating both analytical epidemiology research and development of preventive strategies.
2) To allow data collection on treatment outcomes.
3) To propose clinical trials to identify best treatment modalities.
4) To develop and implement utilization of an Ocular Trauma Scoring (OTS) system to make eye injury assessment consistent and accurate, aiding both prognostication and management.
5) To disseminate information regarding eye injury prevention and management to both the public and professional community.

This registry documents serious eye injuries which the examining provider believes to have a “likelihood of resulting in permanent structural or function damage to the eye and/or orbit.” Table 2 summarizes the “causes” of over 16,000 serious eye injuries that have been compiled by USEIR since 1988.

Table 2. Sources of Reported Serious Eye Injuries

REPORTED SOURCE	
Blunt Object	31
Sharp Object	18
Motor Vehicle Crash	9
BB/Pellet Gun	6
Fireworks	5
Hammer on Metal	5
Nail	5
Guns	5
Falls	4
Explosion	3
Other	8
Unknown	1

US Eye Injury Registry 1988 to 2007, n = 16,364

While the voluntary reporting nature of this registry limits the completeness of the injury numbers, it does provide very useful information on the specific activities that are associated with injuries causing vision loss. For example, their data show that 67% of all serious eye injuries involving fireworks are from bottle rockets. Additionally, the data show that bystanders are more often injured than the individual igniting the bottle rocket. This data support the implementation of bottle rocket bans across the United States or, alternatively, a program to advertise the need for wearing eye protection devices when fireworks are used.

Occupational Eye Safety Programs

The Occupational Safety and Health Administration (OSHA) is the primary government agency which oversees workers' health and safety in the United States. OSHA has both educational and enforcement responsibilities. It sets safety regulations with which employers must adhere and has enforcement officers to ensure regulations are being observed. OSHA provides extensive information online for employers, safety personnel, workers and other interested parities. Eye and face protection information is available at http://www.osha.gov/SLTC/eyefaceprotection/index.html. Many of their "eTool" programs can be used by eyecare providers to help educate workers and industrial safety personnel on the "why's and how-to's" of eye safety.

OSHA regulations require employers to "ensure that each affected employee uses appropriate eye or face protection when exposed to eye or face hazards from flying particles, molten metal, liquid chemicals, acids or caustic liquids, chemical gases or vapors, or potentially injurious light radiation." The regulations further specify that side protection is required when there is a "hazard to flying objects." Additionally, the eye protection devices must comply with ANSI Z87.1-1989 *American National Standard Practice for Occupational and Educational Eye and Face Protection*.[4] This standard addresses the performance and marking requirements for eye and face protectors used for industrial applications.

General standards for eye and head protection in the United States began with the edition of the Z2 standard in 1922.[5] This standard was developed from safety requirements prepared by the War and Navy Departments and the National Bureau of Standards. Numerous revisions to this initial standard have taken place over the years. In 1961, the Z2 committee structure was divided into three separate committees overseeing Industrial Eye Protection (Z87), Industrial Respiratory Protection (Z88) and, Industrial Head Protection (Z89). The newest edition of the ANSI Z87.1 was completed in 2003, although a new version was due out in 2009.

In spite of the efforts of OSHA, the ANSI Z87.1 committee, safety professionals and others, the most recent estimates show that, on average, 2000 occupational eye injuries requiring medical treatment occur every workday.[2] The *causes* of these injuries are varied. Often workers are simply not wearing the personal protective equipment at the time of the injury. For other injuries the protective device may not provide sufficient angular coverage.[6] Because OSHA considered this a significant factor, it changed its rules in 1994 to **require** (instead of recommend) side protection for safety eyewear in all environments where a flying particle hazard was present.

Only rarely does an injury occur due to a failure of the eye protective device. This illustrates the important role of primary eye care providers in occupational eye safety. Practitioners must constantly remind patients of the benefits of eye protection in certain environments and should help workers choose the appropriate eyewear to provide the proper protection for the specific task.

As part of the personal protective equipment (PPE) selection process, OSHA requires the employer to survey the work environment to identify hazards. This allows safety personnel to recommend sound engineering controls to help eliminate risk of injury. Additionally, it allows for better PPE selection that is based on the actual risk of injury. In ANSI Z87.1-2003 (the 2009 version is pending) a process is proposed to accomplish the hazard assessment in an efficient manner.[5] Sources of hazards (impact, heat, chemical, dust, glare, or optical radiation) should be identified in a survey of the work area. Hazards should be analyzed to determine the proper course to provide maximum worker safety. This may involve isolating a manufacturing process within an isolated portion of the plant to limit exposure and will certainly involve identifying the proper personal protective equipment required for the operation. Experienced workers and supervisors can be interviewed to help determine the best course of action to provide for a safe work environment. Periodic reassessment of work areas and accident records should be accomplished to determine suitability of previous actions.

Eye Safety in and Around the Home

Although the industrial workplace is often viewed as the most dangerous environment for which many of us are exposed to eye hazards, home and recreational activities account for many serious eye injuries. For cases reported to USEIR, 40% of serious eye injuries happened in and around the home.[7] Only 13% were listed as industrial settings. This same percentage (13%) was found for injuries in sporting activities and for injuries on our streets and highways. This illustrates the importance of educating everyone of the importance of using safe practices where eye safety is a concern.

While industrial safety eyewear may be adequate for many activities around the home, sports and recreational activities often require eyewear with greater robustness. In baseball, for example, protective eyewear must be capable of withstanding an impact from a baseball thrown or hit at speeds approaching 100 miles per hour. The American Society for Testing of Materials (ASTM) is the standards-developing organization for sports eye protectors. Table 3 lists those sports for which standards have been written and are available for which eye protectors designed for and tested to protect the eyes from the specific hazards of the sport. As an example of the ASTM testing process, in addition to having to meet realistic optical standards, sports eye protectors must show impact robustness for expected impacts. Eye protectors for racquet sports must not only withstand a ball impact traveling at realistic velocities but must also withstand a racquet impact. As the eye protectors are mounted on a standard headform, the impacts must not fracture the “frame” or lens and must not dislodge the lens back toward the eyes. Additionally, the frame and lens must not show signs of impact with the orbital area of the headform. Eye protectors meeting ASTM standards should clearly state this fact on the protector box or hangtag. It is important for athletes to look for this information when purchasing a protector for their specific sport. Many protectors are now available with prescriptive correction to allow all patients the opportunity to participate with eye protection in almost all sporting endeavors.

Table 3. Eye Protectors for Specific Sports

Eye Protection for Selected Sports Racket Sports, Women's Lacrosse, Basketball, Baseball, and Soccer	ASTM Standard F803
Eye Protective Devices for Paintball Sports	ASTM Standard F1776
Skier Goggles and Faceshields	ASTM Standard F659
Eye Protectors for Field Hockey	ASTM Standard F2713

The role of the primary eye care provider is to educate patients and/or parents of the eye hazards we all face in our daily lives and the need for wearing task specific eye protection and to ensure those protectors are readily available for purchase. Industrial safety eyewear should be recommended for use in the home workshop or for yard-work activities. For sports and recreation, ASTM approved devices should be recommended for the specific sports for which patients are participating. Also, wearing the recommended protector does not guarantee that no eye injury can occur; however, USEIR data show that for their reported serious eye injuries, glasses were known to be worn only 5% of the time.

The importance of wearing eye protection around the home and with sports and recreational activities is also recognized through the Healthy People 2010 initiative of the Surgeon General of the United States.[8] In objective 28-9, the goal was to significantly increase reported use of eye protectors around the home and during sports and recreational activities compared to the reported values from 2000.

Electromagnetic Radiation

The human visual system is most sensitive to a small portion of electromagnetic radiation (EMR) that we term "light." The sensitivity of vision to this small portion of the spectrum is a result principally of the selective transmission of the structures of the anterior eye and of the precise absorption spectra of the photopigments within the outer segments of the rods and cones. We specify light as that portion of the spectrum with wavelength from 380 to 780 nanometers.

For our natural source of light (our sun) the EMR which reaches the earth's surface is principally within the ultraviolet, light, and infrared portions of the spectrum (see Table 4). While exposure to these wavelengths are generally safe and are required for vision, excessive exposure to the radiation in any of these three bands can cause damage either with acute exposure to high intensity or with chronic exposure to lower intensity.

Table 4. Regions of Electromagnetic Radiation (nm)

Ultraviolet Radiation	
Vacuum Ultraviolet	10 to 100
Ultraviolet C	100 to 280
Ultraviolet B	280 to 315
Ultraviolet A	315 to 400
Visible Radiation (Light)	380 to 780
Infrared Radiation	
Infrared A	780 to 1400
Infrared B	1400 to 3000
Infrared C	3000 to 10^6

It is important to remember that the emission of EMR is a discontinuous process. Electromagnetic radiation is emitted in small packets of energy termed quanta. The energy within a single quantum of electromagnetic radiation is directly proportional to the radiation frequency. As wavelength and frequency are inversely related, the shorter the wavelength of radiation, the more energy there is per quantum. As EMR is also absorbed in whole quantal units, the wavelength of EMR is a very important factor in determining damage potential for exposure. Generally, the shorter the wavelength of EMR, the greater is the damage potential to human tissue. This, of course, varies depending upon the absorption spectrum of the tissue, as only that energy that is absorbed will cause damage. Energy that is transmitted through a tissue will not cause damage as there has been no transfer of energy. It is useful, therefore, to study the transmission properties of the eye to determine which wavelengths have the most potential for damaging specific tissues.

The cornea heavily absorbs UV radiation below 290 nm. Transmission then increases gradually through 360 nm. The crystalline lens absorbs most ultraviolet that is transmitted by the cornea. The retina is exposed to visible radiation and to infrared radiation through 1400 nm.

The wavelength of incident radiation is an important component in assessing the risk of EMR damage potential. Ham et al. explained solar retinopathy as predominantly a photochemical damage mechanism.[7] With shorter wavelengths there is sufficient energy per quantum to break chemical bonds within the retina and cause damage to various cellular structures. With longer wavelengths the energy per quantum is insufficient to cause this type damage. With longer wavelengths, the injury mechanism is primarily thermal in nature. Photochemical effects typically show a relatively sharp long wavelength cutoff (when energy per quantum is no longer sufficient to break chemical bonds). Additionally, photochemical reactions show intensity – exposure duration reciprocity. The same effect can be found with high intensity exposure of short duration or with lower intensity exposure with a prolonged duration. This raises the possibility of chronic exposure to low level EMR as a causative agent for injury disease. A lifetime of exposure may place an individual at risk for cataract or retinal degeneration during the later years of life.

Several population based studies have investigated the effects of various portions of the solar spectrum on various ocular conditions. These studies completed comprehensive interviews that attempted to determine both the total length of sun exposures and the times of day associated with those exposures. Ultraviolet A versus ultraviolet B versus visible light exposure outdoors is generally dependent upon latitude, time of day outdoors, the type of spectacle lenses (if glasses were worn), and the use of hat/visor or sunglasses. The values of total lifetime exposures for these various EMR components were next compared to the presence or absence of various ocular anomalies later in life.

Chesapeake Bay Watermen Studies[9,10]

This study examined the relationship between exposure to sunlight and senile cataract, age-related macular degeneration, pterygium, and climatic droplet keratopathy in 838 watermen who work on the Chesapeake Bay. The annual ocular exposure was calculated from the age of 16 for each waterman by combining a detailed occupational history with laboratory and field measurements of sun exposure.

Conclusions:

1. There is no association between nuclear cataracts and ultraviolet B exposure or between cataracts and ultraviolet A exposure.
2. There is an association between exposure to ultraviolet B radiation and cortical cataract and posterior subcapsular cataract.
3. In phakic subjects, even with high levels of sunlight exposure, there is no evidence of increased risk of age-related macular degeneration associated with UVB or UVA exposure.
4. High levels of exposure to blue or visible light may cause ocular damage, especially later in life, and may be related to the development of age-related macular degeneration

Salisbury Eye Evaluation Study[11]

The SEE Study evaluated the association between ocular exposure to UVB radiation in sunlight and lens opacities in a population-based cohort of 2,520 older adults, not just high-risk occupational groups such as the Watermen study.

Conclusions:

1. There is an association between ocular exposure and increasing odds of cortical opacity
2. This association also exists among African-Americans.
3. Analyses of the ocular dose by each age group after the age of 30 years showed no vulnerable age group, suggesting that damage is based on cumulative exposure.

Blue Mountains Eye Study[12]

The Blue Mountains Eye Study in Australia was a population-based assessment of visual impairment and common eye diseases of 3,654 adults aged 49-97. Eye conditions were assessed by taking a series of photographs of the eye that were graded using standard protocols.

Conclusions:

1. Sunlight exposure was associated with a higher risk of posterior subcapsular cataract.
2. There is no consistent pattern of association between sunlight-related factors and age-related macular degeneration incidence, except that persons with very fair skin might have an increased risk of geographic atrophy.
3. A protective association between skin sensitivity to sun damage and neovascular age-related macular degeneration could be the result of confounding by sun-avoidance behavior among persons sensitive to sunburn.

Beaver Dam Eye Study[13,14]

The Beaver Dam Eye Study was designed to discover causes of common eye diseases that cause visual impairment in an aging population. It enrolled 3,583 persons aged 43-86 years.

Conclusions:

1. After adjusting for other risk factors, men who had higher levels of average annual ambient UVB radiation were 1.36 times more likely to have more severe cortical opacities than men with lower levels.
2. UVB exposure is not associated with nuclear sclerosis or posterior subcapsular opacities in men.
3. There is no association with cataract and UVB exposure for women, who were less likely to be exposed to UVB.

4. The amount of leisure time spent outdoors in summer was significantly associated with early age related macular degeneration.

Summary of Solar Radiation Pathology

Solar radiation causes or contributes to certain ocular and adnexal pathology. There is convincing evidence of a causal relationship between solar ultraviolet radiation (UVR) and cortical cataract, cutaneous melanoma, squamous cell carcinoma and basal cell carcinoma. There is a probable causal relationship between solar UVR and ocular melanoma, pterygium and pinguecula, and conjunctival neoplasm. While UVR is often implicated in age-related macular degeneration, there is not sufficient evidence to determine whether it is a cause. There is some evidence that the "blue hazard" portion (400-500nm) of the visible spectrum might be related to age-related macular degeneration.[15] Gallagher and Lee,[16] and McCarty and Taylor[17] provide an excellent overview of research findings to date. Additional information is provided by the National Eye Institute [http://www.nei.nih.gov] and the Centers for Disease Control and Prevention[http://www.cdc.gov].

Behavior Modification

Prevention of injury or disease is a major component of public health principles. Modification of behavior to lessen risk of injury or disease has long been a public health tenet; however, it is often difficult to convince individuals to change behavior to lessen risk of injury or disease. Examples of risky behavior are the wearing of seat belts or cessation of smoking. All understand that this behavior is "risky;" however, many individuals do not have the right mind set to change behavior.

Individuals often claim "I have not worn a seatbelt since I was a kid and I've never been injured!" While this is probably a true statement for that single individual, it shows a lack of understanding of the notion of risk and how proper behavior can lessen that risk. Certainly, not all individuals that fail to use a seatbelt will be injured in an accident. Truly, a serious traffic accident is a relatively rare event; however, when it does occur, serious injury or death is often a result. Individuals must recognize that a lifetime of safe behavior is required to ensure that the protection (i.e. wearing a seatbelt) is present when the catastrophic event occurs where the protective device can make all the difference.

In order to change attitudes and modify behavior, health care practitioners must address several aspects of their patients' perceptions. The same techniques can be used for many different aspects of health. The Health Belief Model[18,19] was developed in the early 1950s to modify patient perceptions. This technique has been used in health-related behavior modification in many different arenas. Examples include cessation of smoking, seatbelt use with driving, yearly mammograms, and use of eye protection.

The Health Belief Model addresses 4 aspects of patient perceptions to help turn risk-reduction behavior into a habitual activity. The 4 elements of the model are:

a. Perceived Susceptibility
b. Perceived Severity

c. Perceived Benefit, and
d. Perceived Barriers.

These elements will be reviewed using the case of not wearing eye protection during industrial activities as the risky behavior that requires modification.

Perceived Susceptibility

An important first element is to help patients realize that they are at risk. It is now reported that perhaps 2000 occupational eye injuries requiring treatment occur on average every day across the United States. While not all of these injuries are serious, it does illustrate that the eyes are at risk for many occupational activities. Whether hammering, grinding, sawing, working with chemicals, or being exposed to dust and grit, the eyes can be injured seriously enough to affect vision.

Injured workers often express thoughts like “I never thought it would happen to me,” or, “protection is not really required for this operation.” Safety officers and eye care professionals must help workers recognize that while the rate of eye injuries may be relatively low, the longer an individual works at a given job, the time of exposure will continue to grow; thus, the greater the chance of an injury.

Individuals are more likely to recognize their own susceptibility if someone they know is injured. Whether it is a well known co-worker, a friend of a friend, or a well known actor that has been injured, if an individual can relate personally to an injury the more likely the individual will say that “it can happen to me!” Practitioners can help workers gain this familiarity by privately relating incidents about injuries their own patients have experienced on a one-on-one basis during an annual examination or during an annual safety talk at a local manufacturing plant. Having a worker provide his or her own story of injury is equally effective. Having workers recognize that they are at risk of injury is the important first step to the continual wearing of eye protection on the job.

Perceived Severity

Understanding the potential for a serious eye injury is the second step in the Health Belief Model process. Even though workers may recognize that an eye injury can occur, workers may still choose to not wear protection. They may feel that if an injury occurs, it will be superficial and will heal quickly. A related comment may be “A little dust in the eye never hurt anyone!” Workers must be educated on the fragileness of the global and ocular structures. A small cut to the cornea can result in total vision loss with sufficient scarring or infection. Having workers “visualize” the change in their lives as a result of a serious injury can also be effective. Losing vision can affect employment opportunities and driving licensure, not to mention the overall quality of life.

Showing workers pictures of serious injuries or having an injured individuals relate the changes in their lives that occurred as a result of injury can help drive home this point. Eye injuries can be serious and can affect almost all aspects of our lives. Often it is this aspect of safety presentation that workers will remember the longest. Understanding the fragileness of the eyes and the meaningfulness of vision to our everyday lives is an important aspect of decreasing eye and vision risk by making the wearing of eye protection a habit and not an afterthought.

Perceived Benefit

In order to make a meaningful change in behavior, workers must also recognize that wearing safety glasses and other eye and face protection can provide protection to help eliminate eye injuries. No one will wear a device that is perceived as being useless in terms of protection, or even worse, is felt to contribute to the severity of an eye injury. It is often heard a worker say, "If it's going to happen, it's going to happen. There is nothing I can do about it." Of course, this is not true concerning the wearing of the proper device which meets the correct eye-safety standard. Industrial eyeglasses are required to meet the ANSI Z87.1 standard for eye and face protection. Rigorous testing is used to ensure frames and lenses are designed to meet anticipated workplace hazards. Since 1994, OSHA has mandated the wearing of sideshields on safety spectacles when flying particles are a workplace hazard. Modern day lenses of polycarbonate or Trivex® material will withstand a substantial impact without breaking. When flying particles are a hazard, the ANSI Z87.1 standard requires lenses to be capable of withstanding impact from a ¼" steel ball traveling at 150 ft per second. If a higher energy hazard is present, goggles or a faceshield can be used to provide even greater protection from impact.

Illustrating the toughness of eye safety material is one method used to help convince workers of the benefit of safety eyewear. Firing a BB pistol round at a polycarbonate lens in a safety chamber is a common occurrence at safety exhibits. Also, through its Wise Owl Club, Prevent Blindness America illustrates the benefits of eye safety equipment by recognizing those individuals that have been "saved" by eye safety wear. Showing a worker injured by a chemical splash is one recent case. The worker had burned skin across his cheeks and forehead, but showed normal skin around the eyes shaped in a typical chemical goggle pattern.

Perceived Barrier

Overcoming the perceptive barriers to safe and comfortable use of safety equipment is the final step in the Health Belief Model program. Workers can say, "Sure, I am more safe with the glasses, but they interfere with my work. My vision is blurred and they are uncomfortable." This step is difficult to overcome with simple rhetoric. Eye care practitioners realize that it often takes several days or weeks to become accustomed to new spectacles, especially for first time wearers; however, with proper design and adjustment it is only the rare adaptation process that exceeds one or two weeks. This illustrates the importance of quality frames that will retain fitting adjustments made by experienced technicians with the availability of periodic adjustments as required. If eyewear remains uncomfortable with daily wear, there is always the risk that eyewear will not be worn at the exact moment it is needed.

Understanding the concepts of the Health Belief Model will help personnel in industry design a safety program to ensure the prescribing and wearing of the proper safety equipment for each individual work task. These concepts are also useful within a private practice or clinic to educate patients on the need for eye injury prevention practices at home.

CASE STUDIES

I. Patient 1 – Office Worker

A. History

A 46-year old female Caucasian accountant presented with a chief complaint of intermittent blur at near, especially while using the computer. A vocational history includes that she is an avid tennis player and enjoys many other outdoor activities including typical home maintenance tasks. She has worn soft contact lenses for many years to correct simple myopia. She reports comfortable wear of the lenses, including no symptoms of dry eye even after many hours of computer use. She has a family history of macular degeneration (mother) and cataract (grandfather).

B. Environmental Considerations

After refraction and careful measurement of working distances, we discussed with the patient the multiple options including multifocal and monovision contact lenses, separate single vision spectacles for distance and near, segmented and progressive traditional and occupational spectacles. We discussed the importance of protecting the eye from impact injury while playing tennis and home activities, especially while mowing, trimming and while using any hand and power tools. We also discussed protecting the eyes from solar radiation, especially with the presence of other risk factors of macular degeneration including family history, race, and gender. We discussed the role of antioxidants in reducing the progression of age-related eye disease.

C. Plan

The patient opted to continue single vision distance soft contact lenses with UV absorption for most of her daily activities, including tennis. Occupational progressive spectacles were prescribed for wear over her contact lenses in the workplace and while performing other near tasks. Despite understanding the risks, the patient believes that spectacle eyewear reduces her performance while playing tennis. However, she agreed to wear tinted Z87 wraparound eye protectors while working in her yard, and clear protectors with indoor home maintenance. The patient will consider a monovision contact lens approach for social activities. The patient will continue with her normally healthy diet that includes many leafy green vegetables, and will confirm that her daily multivitamin contains the appropriate eye nutrients including Vitamins A, C, E, zinc, lutein and zeaxanthin.

II. Patient 2 – Monocular Visually Impaired Patient

A. History

A 52-year old male African American auto worker presented for a routine eye and vision examination, requesting that his “safety eyeglass order form” be completed so that he can return it to his safety officer at work. He advises that the vision in his left eye has been bad since a work-related injury in 1984, and has religiously worn safety glasses on the job ever since. He reports his vision as clear with present glasses, but has some difficulty performing occupational tasks that are near but overhead. He installs engine components from both above and below the vehicle at working distances between 16” and 40,” and must read fine detail part numbers from inventory sheets. He began wearing corrective lenses at age 45, but now wears Straight-Top 28 multifocals full time at work and when doing close work at home. He spends most weekends bass fishing with his son and plays city-league basketball two evenings a week during the winter months. He has a family history of adult-onset diabetes, hypertension and glaucoma.

B. Environmental Considerations

Upon examination, best visual acuity was found to be 20/20 OD, 20/80 OS with slight hyperopic correction and a +2.00 add OU. Ocular health examination was normal, although a prominent pinguecula was present nasally in each eye. We advised the patient that he would likely benefit from occupational lenses that incorporate near correction in both the lower and upper portion of the spectacle lens. We discussed that while he has been diligent about eye safety in the workplace, there are other aspects of his lifestyle that should be considered. We discussed the environmental aspects of fishing, including protecting the eye from damage related to fishing lures and direct and reflected solar radiation, as well as the comfort and visual performance benefits of polarized lenses to reduce reflected glare from the water. We also discussed the relatively high number of eye injuries of basketball players and the importance of protecting his fully functional eye at all times. We discussed the importance of annual general medical and eye examinations, especially because of his functional monocularity and increased risk of glaucoma, diabetes and hypertension due to his race and family history.

C. Plan

We completed his safety glasses order form recommending polycarbonate lenses with occupational segments. We advised that his dress eyewear should be made with lens material equivalent or superior in impact resistance to that of 2mm polycarbonate or Trivex® material. For fishing, we prescribed wrap-around polarized polycarbonate sunglasses that block 99+% of UV radiation. For basketball, we prescribed ASTM F803 approved sports goggles. We advised him that he should use his work-provided Z87 safety glasses for home maintenance activities.

III. Visual Performance Assessment – Hospital Kitchen

A. History

At the completion of her annual examination, a patient reported that her on-the-job duties as a Registered Dietician at a local hospital included overseeing the operation of the hospital kitchen. The kitchen was tasked with providing one specific menu for three meals to each of their 900 patients each day. Each patient received one of 8 differently designed menus depending upon the patient age and medical diagnosis. -The patient would circle food options in the categories of appetizers, breads, fruits, beverages, entrees and desserts. The patient reported that the kitchen received numerous complaints each day that the wrong food was delivered to several patients and that warm and/or cool foods had reached room temperature by the time of their delivery. The patient felt there were vision issues that were not addressed in the kitchen and she asked for help to increase kitchen efficiency and accuracy. The hospital did not want to get the reputation in the community that their food service was sub-standard.

B. Environmental Considerations

A site visit to the hospital kitchen revealed that the individual menus would be mounted vertically above a food tray on a rotating conveyor belt. Workers would stand at six different locations (corresponding to the six food categories on the menu). A worker would read each menu as it passed his/her station and place the appropriate food item on the patient's food tray. The kitchen was tasked with preparing trays for all 900 patients within a 90 minute window for each meal. Measurements of the menu letter size (mean letter height = 2.25 mm) and worker viewing distances (mean viewing distance = 87.5 cm) show a visual acuity demand of 20/35. Inspection of the printing also showed less than ideal letter contrast. Additionally, the menus were illuminated with a 9-watt, warm white fluorescent bulb chosen to provide incandescent-like light to the food on the conveyor providing only 22 ft-cd of illumination.

C. Plan

The first step is to ensure all workers are corrected fully in order to efficiently perform this visually demanding task. It was recommended that each of the kitchen workers receive a pre-employment visual examination and receive, as required, eyewear designed for individual visual abilities taking into account task working distances and directions. The second step is to maximize visibility of the menus themselves. Several authors have shown that reading is most efficient when print size is 2 to 3 times acuity threshold[a,b,c]. Therefore, increasing print size slightly to 20/45 to 20/60 size should increase visibility. Additionally, letter quality can affect visibility especially when letter size is near threshold level. It was recommended that a new printer be used for the menus to increase letter contrast. An increase in light level should also improve performance as this is a task with small detail and medium contrast. By switching from the specialized incandescent-like fluorescent lamps to cool white lamps, task illumination was increased from 22 ft-cd to 35 ft-cd. (Note: Although the color of the cool white lamps was not ideal for food “presentation,” this was not a negative factor for these kitchen workers that were concerned only with reading the menus and placing the proper food item onto the proper tray.) A final recommendation was to organize each of the 8 menus in similar fashion to reduce the need for visual search by each kitchen worker. Workers needed to find the proper menu section for their workstation as the various menus moved past. By setting a standard menu design, the menu section for each workstation would be found more efficiently by workers. Alternatively, color coding each food item category would add redundancy and further improve visual efficiency for the workers.

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