



MEASURES TO COMBAT AND DECREASE RISK FACTORS AND OCCUPATIONAL HAZARDS IN PROFESSIONAL DENTAL PRACTICE

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ABSTRACT

The aim of this article is to discuss the health related risk factors and hazards in people involved in professional dental practice such as dentists, students, dental technicians, and others. The risk factors can be divided into physical and chemical exposure, exposure to different dental materials, improper infection control, work patterns and mental stress. The harm caused by these factors and prevention is discussed in this article. Also there should be awareness among the concerned people about the prevention and management of these factors.

KEYWORDS: Occupational exposure; Occupational hazards; Risk management.

INTRODUCTION

Occupational hazard is defined as a risk to a person in his working environment. Certain health hazards are associated with all occupations. It may vary from minor injuries or mild allergic reactions to fatal accidents and anaphylaxis. The consequences may appear immediately or occur later in life such as delayed hypersensitivity reactions. According to World Health Organization the term "hazard" refers to an inherent property of an agent, or situation having the potential to cause adverse effects when an organism, system, or population is exposed to that agent.^[1] "Risk" refers to the likelihood of causing adverse health effects. The degree of risk and magnitude of effects caused is determined by the extent of exposure of an individual to that risk. To promote awareness among the professionals about work hazard and how to protect themselves is the main objective of Occupational Safety and Health Administration (OSHA).

Dental professionals are exposed to many risks during work. A Norwegian survey, found that one half of the public health dentists reported occupational health complaints such as dermatoses(40%), eye, respiratory and systemic complaints (13%), and musculoskeletal problems (3%).^[2] A New Zealand study found over 40% of dental professionals affected with hand dermatoses and irritations to eyes, nose and airway at some point in their career, and women dentists experienced double the chances of allergy occurrence.^[3]

Dental professionals are exposed to many risk factors such as irritant chemicals, inhalation of vapors, dust particles, injury from high speed rotary instruments, sharp blades and inflammable materials like monomer

etc. Thermal injuries occur very often from spirit lamps, autoclaves, Bunsen burners, furnaces, boilers and curing units. Chemical allergens such as methacrylates, rubber gloves and glutaraldehyde can lead to urticaria and breathing problems such as asthma in susceptible personnels.^[4]

MATERIALS AND METHODS

An electronic data search of literature was done through PubMed and Google Scholar and all relevant reviews and studies was obtained related to dental health hazards and risks. The key words for the search was health hazards, occupational exposure, occupational hazards, risk management, chemical and physical risks, curing light hazards, noise pollution, ergonomic hazards, professional burn out and psychological stress. With the collected data and articles all the risk factors and their management has been described in this article in a detailed manner.

Types of Health Hazards and Risk Factors in Professional Dental Practice

Health hazards can be infectious, non infectious, ergonomic and psychosocial. Infectious hazards include biological agents which can come in contact due to direct or indirect exposure. Direct exposure from infectious microorganisms occur from blood from accidental cuts, wounds, needle stick injuries and inhalation of organisms. Indirect exposure occurs from bio- aerosols, bacterial contamination of casts, suction and water line units. Non infectious agents can be physical or chemical factors leading to health hazards. Physical hazards occur from trauma, burns & scalds, injuries to eyes and noise. Chemical hazards are through dental materials such as

Acrylic monomer, Alloys, Free silica particles, Alginate powder, Polishing agents, Latex gloves and Lab fumes. Potential hazards associated with using dental lasers like ocular hazards, tissue injury, inhaling the vapor emitted by the laser procedure, fire and explosion hazards etc. Ergonomic hazards occur through posture and working hours leading to musculoskeletal disorder -neck pain, back pain, shoulder pain. Psychological factors leading to psychosocial health hazards are occupational stress, professional burn out, suicidal tendency and tension related disorders.

Physical risk factors

Direct physical trauma from instruments, heat and fire injuries from heated instruments, lamps, burners and inflammable materials are commonly encountered in prosthodontics practice. Direct physical trauma usually occur due to accidental skin cuts and abrasions caused by sharp or broken instruments or high speed projectile during trimming and polishing of prostheses. Open cuts and skin abrasion can provide a gateway of entry for harmful microorganisms and toxic substances. According to a study, percutaneous injuries occur at a yearly rate of 3.4% among dentists. Prosthodontists have second highest prevalence rate of 4.5%, and pedodontists, oral surgeons, orthodontists, endodontists showed 5.5%, 2.6%, 1.9%, 1.3%, respectively.^[5]

Professional Dental practice requires regular use of Bunsen burners, spirit lamps and blow torches. Burns from bunsen burners is very common in dental colleges. Injury to the eyes and face often occurs in prosthodontics clinic from burns and sharp instruments like blades and needles. Sharps injuries commonly occur from cleaning of probes in the sterilizing room, mishandling of injection needles during recapping, and burs left in handpieces.^[6]

Grinding and polishing is done on regular basis in dental practice. This requires working with vibrating tools. These tools generally work at high frequency and it can cause direct injury to the face and upper limbs. The effects of vibration on the hand can also result in vibration syndrome^[7] or vibration white finger.^[8] Narrowing of arteries occurs in fingers and hands due to continuous vibration and can cause damage to the nerve endings. It can lead to reduced blood circulation in the fingers, reduced sensitivity of the fingers to pain, touch, vibration and temperature, blanching of finger tips.

Injury to the face

Trauma may occur to the eyes and face due to the usage of high speed rotating instruments. Such rotating instruments can generate projectiles up to 9 m/s which are often hot, sharp and infected. This may result in excessive lacrimation, pain, eye infections like conjunctivitis, corneal abrasion and blurring of the vision.^[9] More significant harm is caused by laboratory materials. methyl methacrylate monomer or pumice which contains lime and quartz when accidentally

splashed into the eye can cause severe irritation and pain in the eyes and pumice can also cause corneal abrasion.^[10]

Ocular hazards

Curing lights can also cause damage to the eyes. According to a report, the increased ocular risk occurred at about 440 nm.^[11] Increased exposure to blue light can be toxic to test animals, cellular structures, and human fetal retinas.^[12] When the blue light strikes the retina, they inhibit the formation of cytochrome-C-oxidase, which transports oxygen to photoreceptors and other retinal cells. Without cytochrome- C-oxidase, degeneration of retina occurs.^[13] There can be chronic or acute effects of blue light exposure. Cumulative exposure from blue light occurs from indirect exposure through reflection of the light from teeth surfaces and other reflective surfaces. While acute exposure results from direct exposure to the light source. Generally, the operator is exposed to 10 - 30% of the curing light.^[14] It has been reported that viewing of about 6 seconds at a distance of 30 cm (over an 8-hour workday) with high powered curing units may lead to potential ocular damage.^[15]

Hazards Associated With Use of Dental Laser Technology

a) Ocular Hazards

Potential injury to the eye can occur either by direct emission from laser or from the reflection from mirror like surfaces. Dental instruments with reflecting surface may result in tissue damage to both the operator and the patient. The use of carbonized or non-reflective instruments has been recommended during laser treatment.^[16,17] The primary ocular injury that results from a laser accident is a retinal or corneal burn. Irreversible retinal burns can result in permanent blindness by conversion of incident radiation to heat energy within a fraction of a second.

b) Tissue Damage

Laser induced damage to the skin and other non target tissue (oral tissue) can result from thermal interaction of radiant energy with tissue proteins. Temperature elevations of 21°C above normal body temperature (37°C) can produce cell destruction by denaturation of cellular enzymes and structural proteins. Clinical significance is the potential damage to deeper tissue from penetration of specific wavelengths such as the continuous wave Nd: YAG laser. Excess thermal necrosis that may not be apparent at the tissue surface can occur due to prolonged exposures of low power density from this type of laser.

c) Respiratory Hazards

A study by the National Institute for Occupational Safety and Health (NIOSH) evaluated the air that Operating Room personnel were exposed to during laser procedures and found that detectable levels of ethanol, isopropanol, anthracene, formaldehyde, cyanide and airborne

mutagenic particles were found. Inhalations of these toxic aerosols have been found to be potentially damaging to the respiratory system.

d) Combustion Hazards

Laser beam exposure can easily ignite flammable solids, liquids and gases used within the dental surgical setting. Some of the common flammable materials found in the dental treatment areas are: • Solids: clothing, paper products, plastic, waxes and resins. • Liquids: ethanol, acetone, methylmethacrylate, • Gases: oxygen, nitrous oxide, general anesthetics.

Health hazard due to noise

If the noise levels are beyond the permissible levels in a set up loss of hearing and tinnitus may occur. National Institute of Occupational Safety and Health (NIOSH), in the year 2001, included occupational hearing loss in a list of 21 priority areas for research.^[18] Exposure to a given intensity and duration of noise can be classified into acoustic trauma (few exposures, intense sound level), temporary threshold shift (temporary hearing change following exposure to noise) and permanent threshold shift (result of accumulation of exposure to noise; irreversible). According to OSHA, permanent hearing loss may occur due to exposure to 85 dB of noise, known as an exposure action value, for more than eight hours per day.^[18] Lowspeed handpieces, high-speed turbine handpieces, ultrasonic instruments, high-velocity suction, and cleaners, vibrators and other mixing devices, and model trimmers can emit sounds ranging from 66 dB to 91 dB.^[18] Dentists and laboratory technicians are exposed to such noises and they are susceptible to hearing loss.^[19] In a study, it was reported that the maximum noise level in dental offices, are very close to the limit of hearing loss (85 dB).

Chemical Health Hazards

Dentists and lab technicians are exposed to a number of synthetic and naturally occurring chemicals which include eugenol-containing materials, alloys, polymer materials, acrylic resins, ceramics, cements, sealers, etchants, hypochlorite, waxes, and elastomeric impression materials.^[20,21] Ingredients of polymethylmethacrylate resins (amines, co-polymers, such as butyl-methacrylate, plasticizing agents such as di-butyl-phthalate and inhibitor such as hydroquinone and cadmium salt) is not deleterious for the patients but poses serious problems for the technicians during packing, grinding and finishing prostheses.^[22] Dental technicians are exposed to metal fumes and grinding dust of metals such as chromium, cobalt, nickel, beryllium and gold alloys during grinding and polishing of cast dental restorations. It was reported in a study that 53 of 70 dental technicians were affected by pneumoconiosis which could be caused by dust from the processing of dental materials.^[23] Contact dermatitis and chronic granulomatous lung disease, known as chronic beryllium disease (CBD) occurs due to exposure of beryllium in form of vapors or particles.^[24] Lung carcinoma and

osteosarcoma are also associated with beryllium exposure.^[25] OSHA reported occurrence of CBD among dental laboratory technicians and advised to implement precautions to minimize exposure to beryllium-containing dust.^[26] Ceramic materials are not usually associated with health disorders but dust particles from these materials during handling, manipulating, adjusting and finishing the restorations may result in potential health problems. Inhalation of dust containing free silica or silicon dioxide particles in ceramic laboratories leads to silicosis.^[27]

Alginate powder contains many particles of less than 3 μm in diameter and greater than 20 μm in length. These particles when inhaled may prove to be a health risk (carcinogenic) over a long time span.^[28] Aerosol particles were monitored and characterized from two alginates and it was showed that 10 to 15% of the particles pose the greatest risk. With daily use of alginate in the dental office, dental personnel are exposed to health hazards.^[29] Improper handling of many impression materials result in health problems. Roberta et al. tested elastomeric impression materials for cytotoxicity, and found that polyether is more toxic than vinyl polysiloxanes.^[30]

Latex gloves used in daily practice are dusted with cornstarch powder. Starch powder result in immediate allergic reactions in susceptible individuals. Also starch particles combined with latex protein allergens become airborne and can be inhaled, or absorbed in the body by our skin.^[31] Due to these allergies, silicone, powder free gloves have been introduced which has less risk to health.^[32]

Biological Health Hazards

High-speed instrumentation resulting in spatter and aerosol dissemination. Bacterial contamination from these becomes a major health risk factor for dental professionals.^[33] The main portal of entry for infections for a dentist include epidermis of hands, oral epithelium, nasal epithelium, epithelium of upper airways, epithelium of bronchial tubes, epithelium of alveoli, and conjunctival epithelium.^[34] Research indicates that aerosols contain silica particles from the adhesive resin fillers and various other materials. The sizes of these particles ranges between 2 μm and 30 μm and the hazardous-product particle range is approximately 2.5 μm . These are implicated in many diseases as they can reach the alveoli.^[35]

Impressions soiled with blood and other infectious material are another source of infection for dentists. When poured with plaster, the microorganisms get transferred to the cast as well. The plaster dust from the infected casts gets into the respiratory tract, settles on clothes and environmental surfaces, and remains viable for a considerable time. Microorganisms such as Mycobacterium tuberculosis remains dangerous for several weeks.^[36] It was stated that impression materials can act as a carrier for spread of pathogenic bacteria and

viruses and cause cross contamination among the clinicians and laboratory personell.^[37] In a study it was reported that the pathogenic species of hospital bacteria like *Staphylococcus aureus*, *Actinobacter baumanii*, *Capnocytophaga* species, *Actinobacillus* species, *Viridans Streptococci* and *Morganella morganii* were found in every step of impression making and cast pouring.^[38]

Some other sources of infections are dental unit waterlines (DUWL), handpieces, saliva ejectors and suctions, other devices attached to air and waterlines, and radiology equipment.^[39] The threat from waterlines comes from opportunistic and respiratory pathogens such as *Legionella* species, *Mycobacterium* species, and *Pseudomonas* species. Higher titres of *Legionella* antibodies were noted for dentists.^[40]

Ergonomic Health Hazards

These are the physical factors within the environment that harms the musculoskeletal system. The risk factors of musculoskeletal disorders are repeated movements and prolonged improper body postures.^[41] According to a study, 62% of dentists reported at least one musculoskeletal complaint, 30% showed chronic complaints, 16% had spells of absence and 32% sought medical care.^[42]

There is a high risk of neck and back problems among dentists. It occurs due limited working space, and improper posture due to less visibility and accessibility in posterior areas in the oral cavity. The symptoms include low back pain, stiffness, tingling, paresthesia, and muscle weakness.^[41] An electromyographic study showed that shoulder, neck and arm muscle were placed under the most stress by routine dental work.^[43] In another study, it was reported that tooth preparation was most likely to evoke altered sensations in their upper limbs.^[44]

Repetitive, vibratory and forceful work results in Tendinopathies and Carpal tunnel syndrome. Symptoms can appear from any activity causing prolonged increase in passive or active pressure in the carpal canal.^[45]

Psychosocial Hazards

Occupational stress can occur due to uncooperative patients, work overload, mental pressure for technical perfection, dissatisfaction with the treatment is common among dentists. It was reported that the most common factors contributing to stress at work were patient demands(75%), practice management/staff issues (56%), fear of complaints/ litigation (54%) and non-clinical paperwork (54%).^[46] Women are more inclined in discussing their problems for coping stress.^[47]

Management of these health hazards

The basic goal of OSHA is to educate employers and employees about the work place hazards, risk assessment and risk management strategies.^[48]

1) For protection from blunt or broken instruments or high speed, projectile use of face shield or shatter-resistant eyeglasses with side shields, for lathes and table-top rotary devices splash guards/safety guards should be used

2) For vibration and high pitch noise ear plugs should be used.

3) Local exhaust ventilation systems, adequate fume extraction system should be installed in the clinics and laboratories for reducing chemical agents in the air.

4) Fire extinguishers should be installed in clinics to prevent incidence of fire explosion.

5) An orange shield used with the curing equipment adequately filters blue light between 350 nm to 500 nm. Apart from this, blue light filtering spectacle with side shields help to protect against reflectance and scatter.

6) For preventing laser hazard all people within the dental treatment room must wear adequate eye protection, including the patient. When selecting the protective eyewear, several factors should be considered. They are as follows.^[22]

a. Wavelength of laser emission.

b. Maximum permissible exposure limits.

c. Degradation of absorbing media or filter.

d. Optical density of the eyewear.

e. Radiant exposure limits.

f. Need for corrective lenses

g. Restriction of peripheral vision

h. Comfort and fit Optical density is one of the most important factors to consider when choosing laser eye protection.

The attenuation should be to reduce the beam exposure to the eye to relatively safe levels. Laser protective eyewear is intended to provide a level of protection that may be used to stare directly into the beam.

Highly reflective instruments and those with mirrored surfaces should be avoided since they cause damage to the non-target tissues.^[13] A wax spatula or periosteal elevator can be inserted into the gingival sulcus to serve as an effective shield when lasing soft tissue near teeth.^[25] For most applications it may be advisable to use low power time settings initially before progressing to higher and faster times. When lasers are not actually been used for treatment or if long pauses occur between use, the unit should be placed in a standby mode to prevent inadvertent firing of the laser beam. Most manufacturers provide a cover or metal hood to prevent accidental activation of the laser beam.

Physical environment in which the laser is used Laser use should be confined to controlled areas with restricted access. Use of protective laser curtains should be considered to prevent accidental exposures to passers-by. All entrances to the operating theatre should bear signboards with a removable warning that contains the words 'Danger' and 'Laser Radiation.' Highly reflective instruments and surfaces should be avoided to prevent reflection of the laser beam onto the non-target tissues.

7) For management against infectious bio aerosols, infectious body fluids, OSHA guidelines - exposure control plan, exposure control percutaneous exposures and incidents precautions, laundry procedures, mandatory hepatitis B vaccinations, housekeeping standards, and waste disposal regulations should be followed.

8) All the impression and cast should be disinfected before use by dentist and a laboratory person.

9) At least 6 minutes of rest every hour, proper ergonomic dental unit design, personalized rehabilitation exercises, stretching and regular aerobic workplace designs activity should be done to control ergonomic health hazards. Stress management workshops, deep breathing exercises, relaxation, hypnosis and desensitization techniques should be followed for coping with stress.

10) Decontamination of DUWL includes the state of the art method using ozone. Incorporation of ozone generating units into the dental treatment unit would be the logical extension of this technology. The integration of the use of ozone into a dental unit extends a system of disinfection and sterilization for DUWL into the clinical management and patient arena.^[49]

11) Heavy duty nitrile gloves to be used to prevent needle stick injury, during working with sharp orthodontic wires and while using wires for intermaxillary fixation.

CONCLUSION

The release of substances from dental materials is a prerequisite for the occurrence of adverse reactions. Research on the release of components from dental materials is scanty. In addition, a common understanding of the concept of adverse reactions from dental materials does not exist. Uncertainty also exists about which type of general symptoms results from dental materials. A high degree of uncertainty is also associated with the methods that have been used to ascertain toxic effects from dental materials. Nevertheless, contact allergy may be revealed by patch tests. However, we do lack much knowledge about the process of sensibilization by contact allergy resulting from dental materials.

Knowledge of these health hazards and familiarity is not enough for an individual to assess the potential threat. An understanding of the extent of exposure to the hazard, and strategies for minimizing the effects of occupational hazards and risks should be followed for a safe and healthy practice.

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