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Risk Consulting Alert

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Risk of Respiratory Diseases in Dental Care Personnel

A recent report published by the Centers for Disease Control and Prevention (CDC) identifying a cluster of Idiopathic Pulmonary Fibrosis (IPF) among dentists and dental technicians working in a Virginia clinic serves as a reminder of the occupational health hazards faced by dental professionals. They also reinforce the need for proper precautions and safety measures. This is especially true as the dental care industry introduces technological advances in materials, equipment and processes, which may in turn bring new, and as yet, undefined exposures.

As with other healthcare disciplines, the focus on patient health, safety and comfort among dental personnel can obscure their awareness of the health and safety hazards they face in their daily work activities. Recognizing the risk of exposure to toxic chemicals and infectious agents is the first step to taking the necessary precautions to prevent occupational illnesses.

Fortunately, many of the same methods and techniques used to protect patients from harm, also provide effective protection for dental practitioners when used correctly and consistently. This Loss Control Alert describes some of the health hazards and risk factors associated with respiratory diseases, and the prevention and control measures available to protect dental personnel from inhalation exposures.

Occupational Lung Diseases among Dental Personnel

The prevalence of occupational lung diseases among dentists, dental technicians, and dental laboratory workers has been documented in medical and scientific literature in the U.S. and other countries. Pneumoconiosis, a fibrotic disease resulting from exposure to dust composed of silica (quartz), and also from metals, asbestos, and composites, is higher than that found in the average population. The long latency period between initial exposure and appearance of the disease, which may extend beyond 30 years in the case of some fibrotic diseases, complicates the identification of the cause or causes. That is why constant protection against exposure is the best preventive strategy.

Idiopathic Pulmonary Fibrosis

IPF is a chronic, progressive fibrotic lung disease with no known cause. It is usually treated with drug therapy or a lung transplant. IPF has a poor prognosis, and those who contract it have a median survival time of three to five years post-diagnosis .

The CDC publication, Morbidity and Mortality Weekly Report (MMWR), reported on the Virginia cases in the March 9, 2018 issue. A dentist being treated for IPF at a specialty clinic learned that other dentists had been treated for the same condition and alerted the CDC. Their subsequent study found that between 1996-2017, out of almost 900 patients treated for IPF at the same clinic, eight were dentists and one was a dental technician. Information on potential exposure at work was obtained from reviewing patient records and interviews with one surviving patient. Dental workers diagnosed with IPF at the Virginia clinic were over-represented by 23 times compared to their percentage of the total US resident population in 2016 .

IPF Symptoms

Symptoms of IPF are characterized by progressive dyspnea, non-productive cough, throat clearing, phlegm production, and shortness of breath. However, not all IPF patients presented similar responses to standard respiratory function tests. Levels ranged from normal to severe restriction. Patients also had different smoking histories.

Occupational Respiratory Hazards

Dental personnel are exposed to many types of aerosols generated by dental procedures, devices, and material processing techniques. The potential to generate and inhale aerosols is greatest in processes that involve rotational grinding or polishing, use of air polishers and ultrasonic scalers, air turbine drills, water droplet emission, and mechanical manipulation.

Aerosols with reported respiratory toxicity include silica, cobalt, chromium, molybdenum, and indium from polishing dental prostheses, mercury from amalgams, alginate used for dental impressions, asbestos paper to line crown molds for casting, X-ray developing solutions, and composite materials such as polyvinyl siloxane and methacrylates in lining materials. Advances in dentistry have replaced some of these legacy methods with new procedures and materials. Nanocrystalline hydroxyapatite cements, bioactive glass, and new composites used for 3-D printing crowns, and implants by deposition or milling are tested for cytotoxic effects on epithelial tissues in the oral cavity, but have not been fully tested for potential inhalation hazards.

Viral and bacterial pathogens from patient blood and saliva can aerosolize in the form of droplets or be emitted by contaminated instruments such as suction devices and saliva ejectors, posing a risk of disease transmission among dental workers and their patients. In addition, ultrafine particles emitted from electrocautery and laser tools as surgical or laser smoke from tissue dissection and cauterization can be inhaled during oral surgery.

Preventing and Controlling Inhalation Exposures

Preventing and controlling exposures can be achieved through engineering controls, safe work practices, and personal protection. Engineering controls constitute the first line of defense to limit overall exposure to potentially harmful aerosols. Their main benefits are that they do not require individual actions, and that they can remove a substantial portion of the hazard. The second line of defense, safe work practices (SWP), function by reducing the individual's exposure to the hazard through their own behavior. SWPs are more effective when the bulk of the hazard has already been removed by engineering controls, and when they are consistently applied. The last line of defense is personal protective equipment (PPE), which is intended to control residual risk that remains after the two previous control measures have been adopted.

Engineering Controls

Local exhaust ventilation (LEV) is the most effective means of reducing the risk of exposure to potentially toxic materials or infectious agents. LEVs capture the emission at the point of generation keeping it from reaching the breathing zone of the exposed individual. Two examples of LEVs used in dental clinical practice are low-volume evacuators, such as saliva ejectors, and high-volume evacuators (HVE) like suction mirrors or suction tips.

Saliva ejectors are not very effective as exhaust ventilation systems. They are designed primarily to control pooling water in the patient's mouth. The vacuum pumps typically do not have a high enough flow rate to capture aerosols ejected by high speed rotational or air polishing instruments.

HVE suction devices are much more effective. They cover the point of particle generation and are attached to evacuation systems capable of drawing upwards of 100 cubic feet per minute of air. In some states, they are required for ultrasonic and air polishing procedures as part of infection control measures, and the CDC is studying similar requirements for the U.S. Tests show that HVEs can have a capture efficiency of 90% to 98% of emitted aerosols. However, performance in the clinical environment is not the same as in controlled testing conditions. HVEs require that the dental hygienist continuously maintain the device in the patient's mouth within 6 to 15 millimeters of the point of aerosol generation whenever the ultrasonic tip or air polisher is being used.

Oral surgery LEVs use local smoke evacuators connected to electrosurgery probe tips to capture the laser smoke at the source and convey it to ultrafine particle filters that scrub the exhaust air before returning it to the operating room.
LEV systems are also used separately from direct patient care on laboratory equipment that generates aerosols. Glove boxes for polishing investment castings for crowns and implants made by 3-D printers function as enclosures to isolate the particle emission source from the work environment. The same principles of adequate air velocity, volumetric flow rate, hood capture velocity, and duct static pressure apply to all LEV systems designed to transport particles away from the point of generation and protect the individual from exposure.

Equipment maintenance is essential to ensure that LEV systems work effectively. Evacuator vacuum lines can become clogged with debris or biofilm, reducing flow rate and capture efficiency. Conversely, low static pressure conditions even under normal air flow can cause backflow and potential contamination. Regular air flow and static pressure testings by qualified technicians are necessary to verify that the system is working within optimal parameters.

Safe Work Practices

SWPs can reduce the risk of exposure to aerosolized particles and droplets when performing dental procedures. The area of highest aerosol concentration is within a 36-inch radius around the patient's face. Dental clinicians and hygienists often must work within this zone. Implementing SWPs, such as work flow pre-planning, training on work procedures, using HVEs efficiently, and task rotation can help to reduce overall time of exposure and limit proximity to airborne particles. Oral irrigation during drilling or polishing tasks wets the particles being produced to form larger, heavier agglomerates and reduce aerosol emissions. The vacuum system's pressure gauge and suction velocity should also be checked daily to ensure it is working properly.

Personal Protective Equipment (PPE)

The need to work very close to the patient in clinical settings presents challenges to reducing exposures to harmful aerosols and infectious agents. These working conditions require the use of PPE even after engineering controls and SWPs have been implemented.

Standard Precautions issued by CDC for dental personnel in clinical procedures were primarily intended to guard against bloodborne pathogens (BBPs), such as Human Immunodeficiency Virus (HIV), Hepatitis B Virus (HBV), and other infectious diseases. But these precautions are also effective against particulate aerosols that pose an inhalation hazard. The minimum level of PPE recommended in standard precautions consists of latex or nitrile gloves, face mask, protective eyewear, face shield, and gown. These measures are required by the Occupational Safety and Health Administration (OSHA) to protect dental workers from exposure to BBP. OSHA calls them "universal precautions," and requires their use when performing dental procedures that are likely to generate sprays or splashes of blood, body fluids, or aerosolized particles that result in a risk of BBP exposure.

Respiratory Protection

The most important item of PPE for preventing inhalation exposure is a well-fitting face mask that covers the mouth and nose. Face shields are barrier devices not intended or designed for respiratory protection and should only be worn in combination with a mask underneath.
OSHA requires face masks to be approved by the National Institute of Occupational Safety and Health (NIOSH), a branch of CDC. Most health care masks marketed as surgical, medical or dental masks do not offer an adequate level of protection against aerosols, which are particles with an aerodynamic diameter of 10 micrometers (µm) or smaller, and do not meet NIOSH's criteria for tight-fitting respirators. A comparison of nine models of health care masks concluded that they have a wide range of bacterial and particulate filter efficiencies, do not fit properly, and do not meet the minimum NIOSH requirements for respiratory protection.

NIOSH-approved masks are called particulate filtering respirators, or filtering face-pieces, and are classified as N-95, N-99 or N-100 for their percent efficiency to filter a 0.3 µm particle (i.e. N-95 offers 95% efficiency). Particulate filtering respirators do not offer protection against gases or vapors - that requires a respirator with replaceable cartridge filters designed to adsorb the specific types of volatile chemicals or gases present in the air.

All NIOSH-approved filtering face pieces have two straps, one fits around the neck and the other around the back of the head. Both straps must always be worn correctly in order to provide a tight fit against the face. For the same reason, these masks may only be worn on a smooth or clean-shaven face. Many face masks have an adjustable soft metal bar at the bridge of the nose to close air gaps, and some models have one-way exhalation valves to help exhaled breath and moisture exit the interior of the mask.

It is essential to take proper care of all PPE to achieve the optimal level of protection. Filtering face pieces are considered disposable respirators and must be replaced when they lose integrity, shape or filtering efficiency, particularly in high humidity environments or when used in activities that generate moisture. A change-out schedule must be established based on the particular conditions of use. Some studies recommend that dental personnel replace face masks every 20 minutes to one hour to prevent aerosolized liquids from soaking through the material to the interior of the mask. In some non-clinical settings, face masks may have a longer lifespan before they need to be replaced. However, there may still be other forms of wear or contamination of the interior surface that limit usable life. Leaving the face mask hanging while not in use, for example, exposes the interior to dust or metal particles; storing it under heavy objects can deform the shape and affect the tight fit. For practical reasons, filtering face pieces are usually replaced at least once a day.

OSHA considers filtering face piece respirators to be one component of a Respiratory Protection Program (RPP) that also requires medical evaluation, selecting the appropriate respirator, fit testing, personnel training in the respiratory hazards present in the workplace, and in the use, care, and limitations of the assigned respirator, and recordkeeping. The OSHA RPP rule has some exceptions when masks are worn by employees under voluntary use conditions.

Summary

Respiratory illnesses are a recognized occupational hazard in the dental profession. Although the specific causes of the recently reported cases of IPF in dentists and dental technicians have not been conclusively established, the severity of this disease, combined with the long latency period of most pulmonary fibroses, speaks to the need to take abundant precautions to minimize the potential risk to dental personnel. The continued technological advances in dental care materials and equipment, particularly in composites, bioactive materials, and nanoparticles, which while tested for cytotoxic effects, are not similarly evaluated for inhalation toxicity, represents a gap in our understanding of their potential health risks. Preventing and controlling exposures to all types of particulate and biological aerosols through engineering controls, safe work practices, and respiratory protection is the best strategy to reduce the hazards in dental practice.

Resources and References

Additional information is available from the following resources and references:

- Centers for Disease Control and Prevention. Guidelines for Infection Control in Dental Health-Care Settings - 2003. MMWR 2003;52(RR-17).
- Centers for Disease Control and Prevention. Morbidity and Mortality Weekly Report. Dental Personnel Treated for Idiopathic Pulmonary Fibrosis at a Tertiary Care Center. MMWR March 9, 2018: Vol. 67(9).

- US Department of Labor, Occupational Safety and Health Administration. Safety and Health Topics: Dentistry. http://www.osha.gov/SLTC/dentistry/index.html.
- US Department of Labor, Occupational Safety and Health Administration. 29 CFR Part 1910.1030. Occupational exposure to bloodborne pathogens; needlesticks and other sharps injuries; final rule.