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Preventing Adverse Health Effects From Exposure To Beryllium In Dental Laboratories

Hazard Information Bulletins

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The Occupational Safety and Health Administration's (OSHA's) Directorate of Technical Support issues Hazard Information Bulletins (HIBs) to provide information about occupational hazards and/or to provide information about noteworthy, innovative, or specialized procedures, practices, and research that relate to occupational safety and health. These bulletins are not standards or regulations and they create no independent legal obligations. They are advisory in nature, informational in content, and are intended to assist employers in providing a safe and healthful workplace. Further information about this bulletin may be obtained by contacting OSHA's Directorate of Health Standards Programs at 202-693-1950.

Purpose

This Hazard Information Bulletin (HIB) is to inform employers and employees about the risk of dental laboratory technicians developing chronic beryllium disease (CBD). It also provides information on the ways in which beryllium exposures can be reduced, the type of protective equipment which can be worn to reduce exposure, and on the type of medical surveillance procedures that can be used to identify workers who may be sensitized to beryllium, or who may be in the early stages of CBD.

Background

Chronic Beryllium Disease Caused by Working With Dental Alloys Containing Beryllium: The Occupational Safety and Health Administration (OSHA) is concerned that cases of chronic beryllium disease (CBD) are continuing to occur among dental laboratory technicians working with dental alloys containing beryllium.¹ CBD is a serious lung disease that can be disabling and even fatal. CBD has been reported among dental laboratory personnel in the past (refs. 1-3), and a recent letter to OSHA indicates that these cases continue to occur (ref. 4).

Workers exposed to beryllium in dental laboratories are covered by the current OSHA Permissible Exposure Limits (PELs) for beryllium. The OSHA PELs for beryllium allow exposure to 2 micrograms per cubic meter of air (2 $\mu\text{g}/\text{m}^3$) as an 8-hour time-weighted average (TWA), between 5 $\mu\text{g}/\text{m}^3$ and 25 $\mu\text{g}/\text{m}^3$ exposure for up to 30 minutes at a time, and 25 $\mu\text{g}/\text{m}^3$ as a maximum peak limit that can never be exceeded. Several studies and reports have questioned whether the current 2 $\mu\text{g}/\text{m}^3$ PEL for beryllium in the workplace is adequate to prevent the occurrence of CBD among exposed workers (refs. 5-7, 9-14).

The Bulletin presents a case report of a dental laboratory technician who was recently diagnosed with CBD. It

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also offers information on the types of engineering controls, work practices, training, personal protective equipment and housekeeping procedures that can be used to reduce beryllium exposure and the risk of CBD to individuals involved in casting, sprue cutting, grinding, polishing and finishing of dental alloys containing beryllium. This Bulletin also provides information about a health surveillance method that can be used to identify beryllium-sensitized individuals.

Case Report

Beryllium Dental Alloy Exposure and Work Practices: A 53-year-old woman who had worked as a dental laboratory technician for 13 years was diagnosed with CBD in May 2000. From 1987 to 1995, her daily work involved sandblasting beryllium dental alloy, cutting the metal sprue from the alloy with a high-speed grinder, removing the bubbles with a hand-held electric grinder and deburrer, and setting the restoration to make sure it fit the die. While performing this work, the worker wore a surgical-type paper mask. Although a household-type wall vacuum system with movable hoses was available for cleanup, the laboratory was reported to be very dusty.

Beginning in 1996, the woman worked in a different dental laboratory, where her duties included the grinding of porcelain restorations, sandblasting, metal finishing, and polishing restorations with rouge. The dental technician also was involved in clean-up activities, which included using a household-type dry vacuum, emptying the bag daily by taking it outside and shaking it, washing the bag, and hanging it outside to dry. Shaking the bag produced a dusty cloud. Although this lab used a beryllium dental alloy, it did so much less often than the dental laboratory where this worker had previously been employed. At the second laboratory, work was performed without the use of a mask or hood. Airborne beryllium samples were not taken at either of the dental laboratories where this woman worked.

The Laboratory Technician's Awareness of the Hazards of Beryllium Exposure: The laboratory technician reportedly received no information from her employers concerning the health hazards associated with beryllium exposure. The OSHA Hazard Communication Standard (29 CFR 1910.1200) requires that manufacturers of hazardous substances such as dental alloys containing beryllium provide a copy of a Material Safety Data Sheet (MSDS) to their customers along with the beryllium dental product. MSDSs must describe the hazards posed by these substances and ways workers can be protected from exposure.

The Hazard Communication Standard also requires employers using hazardous chemicals to train workers on the hazards to which they are exposed and on how to use and work safely with the product. An MSDS for a dental alloy containing beryllium must indicate the health effects of exposure: (1) that beryllium can cause chronic beryllium disease in exposed workers; (2) that acute beryllium disease, which has symptoms resembling those of pneumonia or bronchitis, may occur as a result of exposure to beryllium. Although this form of beryllium disease is now rare, it has been reported in a single case involving the grinding of dental alloys containing beryllium (ref. 15); and (3) that beryllium is classified as a known human carcinogen by the International Agency for Research on Cancer (ref.16).

Diagnosis of Chronic Beryllium Disease and Confusion with Other Lung Disease: In 1997, the laboratory technician was diagnosed as having sarcoidosis. CBD can be mistaken for sarcoidosis when the diagnosis is based on clinical observation or x-rays alone. The worker was correctly diagnosed with CBD in May 2000. The diagnosis was based on the results of additional diagnostic procedures that identified a positive beryllium lymphocyte proliferation test result and abnormal lung pathology, physiology and function. She is currently experiencing symptoms of CBD including dry cough, decreased energy, shortness of breath after walking up one or two flights of stairs or after walking rapidly on a horizontal surface.

Identification of Dental Alloys That Contain Beryllium

Not all dental alloys contain beryllium. Dental laboratory technicians need to inquire about the contents of the alloys they are using. Information about the contents of dental alloys can be found in the MSDSs that accompany these products to the dental laboratory.² The synonyms and trade names for some beryllium-containing dental alloys and products are listed in the Appendix to this document.

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Chronic Beryllium Disease

CBD primarily affects the lungs. CBD may occur among dental laboratory technicians when they inhale dust containing beryllium when working on items such as dental crowns, bridges, and partial denture frameworks made from dental alloys containing beryllium. CBD may develop within months after initial exposure to beryllium or may have a very slow onset and not develop until years after exposure to beryllium has occurred. The amount or length of exposure to beryllium necessary to cause a specific individual to develop CBD is not known, but recent information suggests that even short exposures (weeks or months) to levels of beryllium below OSHA's PEL of 2 µg/m³ averaged over an 8-hour day may lead to CBD in some workers (refs. 5-7).

Beryllium Sensitization: Only workers who have become sensitized to beryllium are believed to develop CBD. A sensitized worker is one who has developed an allergic-type reaction to beryllium. Some workers may become sensitized within weeks or months of exposure on the job, while others may not become sensitized until after leaving a job where there has been beryllium exposure, and some workers never become sensitized. Beryllium sensitization may be detected through the use of a blood test called the BeLPT, which stands for Beryllium Lymphocyte Proliferation Test. This test measures how specific white blood cells called lymphocytes react to beryllium. Positive test results mean that a worker is sensitized. In some cases, persons with CBD do not have a positive blood lymphocyte test, but do have a positive response to beryllium using other diagnostic tests. Sensitization is believed to occur through inhalation of beryllium dusts or fumes. Particles containing beryllium that become lodged under the skin can cause skin lesions and may have the potential to induce sensitization. There are no known symptoms associated with sensitization to beryllium. It is not known whether everyone who is sensitized will eventually develop CBD, however, between 46% and 100% of surveillance-identified workers with beryllium sensitization already have CBD at the time of initial clinical assessment for the disease (refs. 6, 11, 12, 17-21). It is currently estimated that individuals with beryllium sensitization, but without CBD, have about a 10% chance per year of progressing to CBD (ref. 22).

Signs and Symptoms of Chronic Beryllium Disease: Workers with CBD may not be aware that they have the disease or may have no or only mild symptoms. Workers with clinical evidence of CBD may have one or more of the following signs or symptoms: unexplained cough; shortness of breath, especially with activity; fatigue; weight loss or loss of appetite; fever; or night sweats. Workers having CBD, but no symptoms can be diagnosed today because of advances in medical testing. Because the disease may develop slowly over a period of many years, workers may have the disease for a long time without knowing it. The individuals with CBD, who do not have clinical symptoms of disease are generally referred to as having asymptomatic CBD, or subclinical CBD.

Recommendations

Engineering Controls, Work Practices, Personal Protective Equipment And Training: The following measures can be used to reduce the exposure of dental laboratory technicians to beryllium:

1. Engineering Controls

Engineering controls are the first line of defense in employee protection. Therefore, employers should provide appropriate engineering controls and should train their workers in their use and in work practices to ensure that dental laboratory technicians exposures to beryllium are maintained below the current OSHA PELs. The following engineering controls are recommended:

- Where possible, alloys that do not contain beryllium should be substituted for beryllium-containing alloys in dental work;
- All procedures related to casting, cutting, grinding, or polishing beryllium-containing dental alloys should be conducted using properly designed and installed local exhaust ventilation;
- Vacuum systems and local exhaust ventilation systems should be equipped with high-efficiency particulate air (HEPA) filters.³

2. Work Practices to Reduce Beryllium Exposure

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The following work practices should be used to ensure that the exposures of dental laboratory technicians to beryllium are reduced:

- Substitute work practices that generate less dust, such as hand filing, for procedures that produce more dust, such as power grinding;
- Use local exhaust ventilation (hoods) properly to minimize the generation of dust and fumes when working with beryllium-containing alloys;
- Use HEPA vacuums to clean equipment and the floor around the work area;
- Prohibit the use of compressed air to clean parts or working surfaces;
- If a wet mop is used for cleaning, do not leave a film of dust on the floor after the water dries;
- Monitor employee exposures to airborne beryllium dust and fume, using personal sampling techniques on a regular basis, to ensure that beryllium exposures are below the OSHA PELs and are as low as feasible;
- Limit the number of workers who have access to areas where beryllium-containing alloys are being cast or fabricated;
- Use appropriate respiratory protection.

3. Hygiene, Clothing, Housekeeping Procedures and Personal Protective Equipment

Dusts containing beryllium can be carried into cars and taken home on the shoes, clothing, and hair of workers exposed on the job (ref. 23). CBD cases have occurred among the family members of beryllium-exposed workers. To minimize skin contact and to reduce take-home exposures and beryllium contamination of non-work areas, ensure that protective clothing is worn in areas where dental appliances and restorations containing beryllium alloy are being made. (Protective clothing includes laboratory coats, booties, and other types of garments worn over the employee's skin, hair or personal clothing.) In addition, employers should ensure that employees:

- Wash their face, hands, and forearms before eating, drinking, smoking, or applying cosmetics;
- Do not take food items, drinks, cosmetics, or tobacco products into the work area;
- Use gloves and arm sleeves to minimize skin exposure;
- Do not enter the eating area wearing protective clothing unless properly cleaned beforehand;
- Store street clothes separately from work clothes in a clean area;
- Keep their work clothes as clean as possible during the workshift;
- Vacuum their work clothing before removal (clothes must not be cleaned by blowing or shaking);
- Wipe off their shoes before leaving the work area if booties are not worn;
- Do not leave the workplace wearing protective work clothing or equipment or take it home for laundering;
- Place work clothes in a covered container at the end of the workshift;
- At a minimum, wash their hands and face before leaving the worksite; and
- If possible, shower and change into street clothes prior to leaving the facility.

4. Respiratory Protection

Recent studies suggest that exposure to beryllium at levels below OSHA's 2 $\mu\text{g}/\text{m}^3$ PEL may have caused CBD in some workers (refs. 5-7, 9-14). Therefore, even in situations where exposures may be below the 2 $\mu\text{g}/\text{m}^3$ limit, employers should consider providing their beryllium-exposed workers with National Institute for Occupational Safety and Health (NIOSH)-approved air-purifying respirators equipped with 100-series filters (either N-, P-, or Rtype as applicable) or, where appropriate, powered air-purifying respirators equipped with HEPA filters, particularly when their workers are involved in beryllium-containing alloy fabrication where dust can become airborne. Wearers of respiratory protection must be medically approved to wear a respirator and must be fit tested to ensure that the respirator they use fits properly (see OSHA's Respiratory Protection Standard, 29 CFR 1910.134). [Note: in the case report presented above, the laboratory technician either wore no mask or wore a surgical-type mask. Use of a surgical-type of mask does not provide adequate respiratory protection because it does not seal to the face or effectively filter out fine particles. Use of this type of mask provides a false sense of security and does not protect the workers from exposure to airborne beryllium fume

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or dust.]

5. Training and Information

Employers must comply with the OSHA Hazard Communication Standard, 29 CFR 1910.1200. Additional information will help employers and employees prevent exposures. The following information includes both requirements and recommendations that will help to protect employees from the adverse health effects associated with beryllium exposure. Employers should ensure that employees exposed to beryllium are trained in and have access to the following information:

- The specific nature of the operations in their workplace where exposure to beryllium-containing alloys may occur;
- Material Safety Data Sheets (MSDSs) for dental alloys containing beryllium;
- The seriousness of the lung disease (CBD) that may occur as a result of exposure;
- The signs and symptoms of CBD;
- The potential for developing lung cancer as a result of exposure;
- The importance of avoiding skin contact with dust containing beryllium;
- The engineering controls the employer is using to reduce worker exposures to beryllium-containing alloys;
- Specific work practices that should be used to reduce exposure to beryllium-containing alloys;
- The use of appropriate protective equipment, including respirators and skin protection;
- Methods that may be used to detect the presence of beryllium in the workplace, such as workplace monitoring;
- The results of any industrial hygiene sampling the employer or others have conducted for levels of beryllium in the dental laboratory;
- The availability of a blood test to determine whether an exposed worker has become sensitized to beryllium, namely, the Beryllium Lymphocyte Proliferation Test (BeLPT); and
- A copy of this Hazard Information Bulletin.

Health Surveillance Methods for Beryllium Sensitization and Chronic Beryllium Disease:

1. To the Employer

Employers should consider sending beryllium exposed laboratory technicians to a physician or other licensed health-care professional to be evaluated for beryllium sensitization or the presence of CBD. Surveillance for CBD usually begins with a blood test for beryllium sensitization (the BeLPT),⁴ plus any further evaluation considered appropriate by the health-care professional. With few exceptions, the blood BeLPT will detect a response to beryllium exposure earlier than breathing tests or chest x-rays. A confirmed positive BeLPT result means that the individual is sensitized to beryllium. It does not mean that the worker has or will develop CBD. Some individuals may become anxious after receiving information that they are sensitized to beryllium because of the uncertainty of whether or not they will develop CBD. These individuals may wish to consult a health care provider familiar with CBD for further medical evaluation and counseling.

It is widely believed that beryllium sensitization is necessary before a worker can develop CBD, although in some situations sensitization may not be shown in the blood test. The BeLPT is not routinely done in most medical laboratories; however, a health care professional may order this test from the testing laboratory or one of the medical research centers listed below. If a worker is sent to a health care professional for testing, a copy of this Hazard Information Bulletin should accompany the employee.

2. To the Employee

If you have repaired or fabricated dental appliances or restorations made from beryllium-containing alloys and have developed any of the symptoms listed below, you should inform your employer and health-care professional of your past beryllium exposure, or seek information from a health-care professional who specializes in occupational lung diseases, to determine whether you may have developed CBD:

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- Unexplained cough
- Shortness of breath
- Fatigue
- Weight loss or loss of appetite
- Fever or night sweats.

If you do not have any of the above symptoms but are concerned that you may have become sensitized to beryllium, you should inform your employer and health-care professional that you would like to be tested with the blood BeLPT. Take a copy of this Hazard Information Bulletin with you.

Blood Testing For Beryllium Sensitization:

Only the three medical research centers and the one laboratory listed below currently offer the blood test that identifies beryllium-sensitized workers. Any health-care professional with access to an overnight courier service may order this test from one of the facilities listed below. As other research centers and laboratories develop the capacity to test workers' blood for evidence of beryllium sensitization, OSHA will add them to the list.

Medical Research Centers

Cleveland Clinic Foundation
9500 Euclid Avenue, L-15
Cleveland, Ohio 44195
phone: (800) 628-6816

Division of Environmental and Occupational Health Sciences
National Jewish Medical and Research Center
Denver, Colorado 80206
phone: (303) 398-1722

Pulmonary Immunology Laboratory
Hospital of University of Pennsylvania
421 Curie Blvd.
844 BRB II/III
Philadelphia, Pennsylvania 19104
phone: (215) 573-9875

Testing Laboratory

Specialty Laboratories, Inc.
2211 Michigan Avenue
Santa Monica, California 90404-3900
phone: (800) 421-4449