Just the Facts...

Beryllium Exposure & Berylliosis

Beryllium is a rare element that was discovered in 1797 [1]. In the United States, there are beryllium deposits in Colorado, New Mexico, and Utah [1]. Beryllium is a hard, gray-white metal in demand because of its lightness and tensile strength. It is used in hardening alloys in combination with steel, aluminum, and copper. Because it is nonmagnetic and transmits x-rays easily, beryllium is used extensively in x-ray tube manufacture. In the past, beryllium was also used in the manufacture of fluorescent lighting tubes; however, the recognition of ***berylliosis***, a lung disease resulting from breathing beryllium, led to its replacement in this capacity by other, less toxic compounds. Today, beryllium's main uses are in nuclear physics, in the space program, in production of fatigue-resistant alloys and heat-resistant ceramics, and as a "window" in x-ray tubes [1]. Beryllium is also found in cigarettes [3, IARC 1980].

All compounds of beryllium with the exception of the naturally occurring ore, beryl, should be considered potentially harmful, particularly if **inhaled**. Soluble beryllium compounds produce both acute and chronic toxicity. Insoluble forms, such as beryllium alloys, intermetallics, beryllium oxide, and beryllium ores generally induce effects only after prolonged exposures.

Because beryllium and its compounds can be highly toxic, exposure can lead to adverse health effects. The metal may be absorbed through the **lungs** and the **skin**, particularly if the skin is not intact. In contrast, beryllium is thought to be poorly absorbed by the gut and usually presents no hazard if ingested [1,3]. Once absorbed through the lungs or skin, beryllium may be deposited in the spleen, liver, and bones [1]. The rate of excretion of beryllium in the urine depends on how rapidly and in what form the metal has been absorbed. After it has been excreted, beryllium may persist in the liver and bones. Beryllium exposure may have local health effects, such as skin ulcers; however, the systemic changes are usually more significant.

As with any exposure, important information to assess is the **amount**, **duration** and **frequency** of the exposure to beryllium, the particular **beryllium compound** to which the person is exposed, as well as the **route of exposure**, such as inhalation, ingestion, and/or dermal). This allows an estimation of the **dose**, which is important in medically assessing the potential adverse health effects resulting from beryllium exposure.

In addition, it is important to distinguish between **acute** and **chronic exposures**, as well as between **acute** and **chronic health effects**. Most acute health effects result from relatively high exposure, sometimes only from a one-time exposure. Most chronic health effects result from repeated exposures to a chemical, sometimes at levels not high enough to make a person immediately sick.

Acute (short term) **health effects** may occur immediately or shortly after exposure to beryllium. Breathing beryllium dust or powder may cause irritation of the eyes, nose, throat, and lungs, causing nasal discharge, tightness in the chest, chest pain, cough, shortness of breath, and/or fever. Nausea, vomiting, and a metallic taste may occur [3]. Bronchitis and/or pneumonia may occur one to two days after exposure, causing pulmonary edema and death in severe cases [2]. Acute skin exposure to beryllium may cause local skin irritation and contact dermatitis [3]. Eye contact can cause irritation, itching and burning (conjunctivitis), and may occur in association with the skin and lung effects of beryllium exposure [1]. Treatment for acute beryllium exposure is symptomatic and supportive, and should include removing the person from the source of exposure. There is no specific antidote for beryllium poisoning.

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Chronic (long term) **health effects** can also occur some time after exposure to beryllium and can last for months or years. Inhalation of beryllium can cause permanent scars to develop in the lungs, a condition known as chronic beryllium disease, or **berylliosis**. Berylliosis results from repeated exposure to beryllium; only one in twenty of the most heavily exposed worker groups is affected [3] Symptoms are usually nonspecific, and may include fatigue, shortness of breath, weight loss, and poor appetite. These effects may occur months or years after exposure. In severe cases, disability and heart failure can occur [2]. Diagnosis of chronic beryllium disease requires history of exposure, compatible laboratory and pathologic findings, and quantitative tissue analysis. Medical testing may include chest x-ray, lung function tests (diffusing capacity), CT scan, and blood gas testing. Specific blood tests for beryllium include the lymphocyte transformation test, which documents sensitization to beryllium, and the beryllium antibody test, which can be useful in screening beryllium exposed workers [3]. Beryllium can be tested in the urine; however, beryllium in the urine only indicates that exposure has occurred: the level does not correlate with severity of exposure or clinical findings [3]. Specific tests for beryllium in lung and skin tissue are also available [3]. Other types of lung disease, particularly sarcoidosis, must be ruled out. Because cigarettes also contain beryllium [3, IARC 1980] and smoking may worsen respiratory conditions caused by beryllium exposure, stopping smoking would reduce the risk of developing health problems. Treatment of chronic beryllium disease, or berylliosis, is dependent on severity of the symptoms, and should include removing the person from exposure. Corticosteroids may be a useful adjunct for controlling symptoms of shortness of breath, and delaying onset of heart failure [3]. Aside from beryllium's effects on the lungs, the skin can also be affected by chronic beryllium exposure [1]. Contact with the broken skin can cause itchy **ulcers** and **lumps**, or **nodules**, to develop on the exposed part of the body after an incubation period of about two weeks. The ulcers can be chronic. Accidental implantation of beryllium metal in the skin may produce a "**beryllium ulcer**" or **granuloma**. Chronic skin granulomas can be removed surgically, and the person should be removed from exposure.

Whether beryllium compounds are carcinogenic in humans remains controversial [3]. There is some evidence that beryllium causes lung cancer in humans, and it has been shown to cause lung and bone cancer in experimental animals [2, 3]. Insufficient information is available to classify beryllium as a reproductive hazard [3]. Individual sensitization and hypersensitivity reactions to beryllium compounds, particularly beryllium fluoride, beryllium chloride, and sulfate, is also known to occur with exposure [1,3].

As described, a **medical evaluation** of a person exposed to beryllium should include a careful exposure history, review of past and present symptoms, a physical exam, appropriate testing, and treatment. However, medical tests that look for damage already done are **not a substitute for controlling exposure**. All unnecessary beryllium exposure must be avoided. Unless a less toxic chemical can be **substituted**, **engineering controls** are the most effective way of reducing exposure. The best protection is to enclose operations and/or provide local exhaust ventilation at the site of chemical release because dust control is of paramount importance to reduce the chance of inhaling beryllium. Wet, self-contained processes should be used. Beryllium preparations should be transported as liquids rather than powders. Using **personal protective equipment**, such as respirators, masks, protective eyewear, clothing and gloves, is less effective than the controls already mentioned, but is sometimes the only option to prevent exposure. Nevertheless, even with optimal controls, the concentration of beryllium in the air may be sufficient to induce hypersensitivity in some individuals [1]. The Occupational Safety and Health Administration, which adopts and enforces health and safety standards, requires employers to determine the appropriate personal protective equipment for each hazard, including exposure to beryllium and beryllium compounds, and to train employees on how and when to use protective equipment.

References:

1. Morgan WK, Seaton A. Occupational Lung Disease. 2nd Ed. W.B. Sauders Company. Philadelphia, PA. 1984. pp. 458-468.

2. Beryllium: Hazardous Substance Fact Sheet. New Jersey Department of Health and Senior Services. Trenton, NJ. July 1998.

3. Beryllium Compounds MEDITEXT.(R)- Medical Management. In TOMES CPS. Updated December 1998.