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Beryllium exposure and chronic beryllium disease

In a study in mid-2003, E Fireman and colleagues[1] found that 6% of patients labelled as having sarcoidosis actually had chronic beryllium disease. This result highlights an ongoing problem in industry and medical practice. The proliferation of industrial uses of beryllium is resulting in an unrecognised epidemic of chronic beryllium disease, as evidenced by many epidemiological studies over the past decade.[2-8]

Occupational exposure to beryllium occurs in aerospace, nuclear, military, automotive, electronics, and telecommunications industries, in operations in metal machine shops, and in alloy applications, such as tubing for oil and gas drilling, tools and dies, jewellery, bicycle frames, and dental appliances. Beryllium is most often used as an alloy with copper, aluminum, magnesium, or nickel; the beryllium content and its attendant hazards may not be obvious to workers generating dust and fumes. Recycling of electronics, computers, and scrap alloy to recover copper also results in beryllium exposure and disease to an unknown number of workers, many of whom are unaware of the risks. Contemporary cases of chronic beryllium disease have been reported from the USA, Britain, Canada, France, Germany, Sweden, Israel, Japan, and Russia. Estimates of the number of exposed workers in the USA alone currently range from 200 000 to 800 000. By contrast, an estimated 30 000 US workers are thought to have been exposed to beryllium in the 1970s.[9]

Since the 1940s,[10] beryllium has been known to cause chronic beryllium disease, a debilitating and potentially fatal granulomatous disease that mainly affects the lungs. In 1949, the US Atomic Energy Commission established permissible exposure limits (PELs) that were applicable to their workers. Similar limits were adopted for US workers in general industry beginning in 1971.[9] The US Occupational Safety and Health Administration (OSHA) PELs for beryllium are currently: 2 μg per cubic metre of air (μg/m^3) as an 8-h time-weighted-average (TWA); 5 μg/m^3 as a ceiling limit not to be exceeded for more than 30 min at a time; and 25 μg/m^3 as a maximum peak limit never to be exceeded. Many other countries have 8-h time-weighted-averages PELs for beryllium of 1–2 μg/m^3.[1]

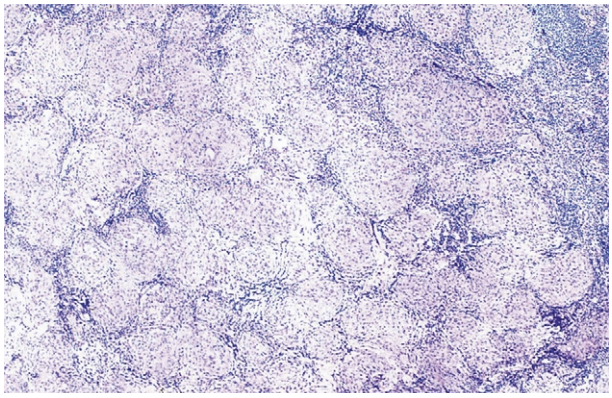
Many studies indicate that the current 2 μg/m^3 PEL for beryllium in the workplace is grossly inadequate to prevent disease occurring.[2-8] Chronic beryllium disease has been identified in workers whose average beryllium exposure levels ranged between 0·02 and 0·10 μg/m^3,[2] levels that are 20–100 times lower than the current permissible limit. Hence individuals with bystander exposures, such as secretaries, security guards, and inspectors, can contract this disease.

Also, very little cumulative beryllium exposure can cause beryllium sensitisation and chronic beryllium disease. Cumulative exposure is the product of average intensity of exposure times length of exposure—eg, 0·05 μg/m^3 × 40 days' exposure equals 2·0 μg/m^3-days of cumulative exposure. Two workers employed at a ceramics manufacturing plant,[4] who had beryllium sensitisation, had cumulative exposures of 0·04 and 0·07 μg/m^3-years, respectively. In another study,[2] chronic beryllium disease was observed in two workers, whose total cumulative beryllium exposure was only 2 μg/m^3-days, an amount of exposure allowed in 1 day under a 2 μg/m^3 PEL.

The latency period for beryllium sensitisation and chronic beryllium disease can also be much shorter than previously recognised. Although chronic beryllium disease can take more than 30 years to develop, beryllium sensitisation can occur within 2 months and chronic beryllium disease within 3 months of initial exposure.[2] In another study, 10% of workers became sensitised within 2 years of being hired.[4] In modern plants complying with the 2 μg/m^3 PEL, the prevalence of chronic beryllium disease has ranged from 2 to 15% depending on the jobs being surveyed.[3-8] With the lower disease prevalence of 2% of estimated exposed workers, 4000–16 000 undiagnosed cases of chronic beryllium disease may exist in the USA alone.

Chronic beryllium disease can be identified in both current and former beryllium workers with a well-established blood assay, the beryllium lymphocyte-proliferation test (BeLPT). This test of beryllium-specific T-lymphocyte activation identifies individuals with beryllium sensitisation.[12] Individuals must be sensitised to beryllium before chronic beryllium disease develops. Between 46% and 100% of surveillance-identified workers with an abnormal BeLPT result already have chronic beryllium disease at the time of initial clinical assessment.[3-8]

Medical surveillance with the BeLPT offers an opportunity for sensitised workers to reduce further exposure to beryllium to a minimum. Identification of beryllium sensitisation and chronic beryllium disease can help employers



Typical non-caseating granulomas seen in both chronic beryllium disease and sarcoidosis

The two conditions can be distinguished with a blood test that measures beryllium-induced T-lymphocyte proliferation.

and workers identify work sites and practices that contribute to the risk of chronic beryllium disease and lead to beneficial lowering of exposures and disease prevention.

Pathological and clinical features of sarcoidosis and chronic beryllium disease are often indistinguishable (figure). BeLPT screening assists in differentiating chronic beryllium disease from other lung diseases, particularly sarcoidosis,[13] and allows earlier intervention to slow the progression of chronic beryllium disease. Any "sarcoidosis" patient who has worked around metal dust or fumes should be offered a BeLPT.[1]

In the USA, the current OSHA standard does not define or mandate particular work practices, education of workers, or medical surveillance. A new beryllium standard is needed. Managers, many of whom still adhere to the antiquated and erroneous concept that the manufacturing and machining of beryllium-copper and other beryllium alloys is not toxic,[14] must also be educated and encouraged to substitute safer materials.

Because the 2 μg/m^3 PEL is inadequate to protect against chronic beryllium disease, OSHA indicated that it would publish a proposed regulation by December, 2001,[15] but has yet to do so. This lack of progress to protect beryllium-exposed workers is reminiscent of OSHA's failure to set a new beryllium standard to protect workers from developing lung cancer in the late 1970s.[16] At that time, a major manufacturer of beryllium complained to the government that lowering the PEL for beryllium would require them to make costly modifications in production processes, force them out of business, and thus reduce the availability of beryllium needed for national defence.[16] They further argued that the evidence for beryllium causing lung cancer in human beings was flawed and the data demonstrating cancer in several animal species were not good enough to consider beryllium a carcinogen. Efforts to promulgate a new beryllium standard were dropped. In 1993, the International Agency for Research on Cancer categorised beryllium as a human carcinogen on the basis of increased rates of lung cancer in beryllium production workers.[11]

Data on beryllium toxicity have come a long way since a 1951 *Lancet* Editorial[17] stated: "To charge such an admirable metal with having poisonous properties is about as distasteful as accusing a trusted butler of stealing the family plate." Today, evidence of the poisonous properties of beryllium and of the failure of both government and industry to adequately prevent beryllium-related illness is apparent. We have the scientific knowledge to protect the health of these workers. Regulatory agencies and producers of beryllium products must now act responsibly to arrest the problem.

PFI testified as a "fact witness" for a plaintiff a year ago on OSHA's knowledge about levels of exposure associated with chronic beryllium disease in the 1970s. Travel expenses and a fee for time to testify were provided by plaintiff's counsel. His past research has all been supported by government agencies. LSN has received honoraria and speaker's fees from universities, government agencies, and companies to lecture on the subject of the health hazards of beryllium. He and his academic institution receive research funding for studies on sarcoidosis and chronic beryllium disease from the US National Institutes of Health and CDC/National Institute for Occupational Safety and Health. He has periodically testified in US courts about the hazards of beryllium and the diagnosis of chronic beryllium disease in his patients; he does not receive personal payment for testimony.

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