Occupational Lung Disease Bulletin

Massachusetts Department of Public Health

Winter 2017

Dear Healthcare Provider,

Dr. Neil Jenkins co-wrote this Occupational Lung Disease Bulletin, during his rotation at MDPH from Harvard School of Public Health. He brought expertise in welding from a materials science and occupational medicine background, as well as involvement in welding oversight with the American Welding Society.

Remember to report cases of suspected work-related lung disease to us by mail, fax (617) 624-5696 or phone (617) 624-5632. The confidential reporting form is available on our website at www.mass.gov/dph/ohsp.

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Welding—impact on occupational health

Neil Jenkins and Elise Pechter

Welding joins metals together into a single piece by heating the surfaces to the point of melting; it is used in construction, machinery, manufacturing, jewelry, etc. The Bureau of Labor Statistics reports 3,050 welders are employed in Massachusetts, but many others weld as part of their jobs.[1,2] Welding is complex and variable—duration, method, welding and base metals, ventilation and respiratory protection all have impacts on the release of chemicals, potential absorption, and risk of lung cancer and occupational respiratory diseases.

Lung Cancer

Earlier this year, the International Agency for Research on Cancer (IARC) reclassified welding fumes as Group 1 "carcinogenic to humans" with respect to lung cancer (March, 17, 2017). Before then, IARC classified welding fumes as Group 2B "possibly carcinogenic to humans." A summary of the IARC evaluation of welding fumes can be found in the May issue of Lancet Oncology.[3]

The objective of the IARC is to identify *hazards* that are capable of increasing the incidence or severity of malignant neoplasms. The IARC classifications are not based on the probability that a carcinogen will cause a cancer or the dose-response, but rather indicate the strength of the evidence that an agent *can* possibly cause a cancer.

The IARC classifies the strength of the current evidence that an agent is a carcinogen as:

Group 1	Carcinogenic to humans
Group 2A	Probably carcinogenic to humans
Group 2B	Possibly carcinogenic to humans
Group 3	Not classifiable as to carcinogenicity
Group 4	Probably not carcinogenic to humans

In 1989, welding fume was classified as Group 2B because of "limited evidence in humans" and "inadequate evidence in experimental animals." Since that time, an additional 20 case-control studies and nearly 30 cohort studies have provided evidence of increased risk of lung cancer from welding fume exposure, even after accounting for asbestos and tobacco exposures.[3] Studies of experimental animals provide added limited evidence for lung carcinogenicity.[3] Therefore, this year, the IARC classified welding fume as a human carcinogen.

The IARC evaluation, however, does not distinguish between the various types of welding processes or metals. The carcinogens nickel and hexavalent chromium can be found in welding fume, but only when welding stainless steel. The majority of welders do not weld stainless steel. Welding emissions contain metal vapors and oxides, ozone, nitrogen oxides, free radicals, as well as chemicals from fluxes used to clean metal, or contaminants such as paint or oil on the surface metal.

Metal Fume Fever

The most common lung disorder in welders is "metal-fume fever," an acute self-limiting flu-like condition with metallic taste that starts a few hours after exposure and resolves after 24-48 hrs. Metal fume fever is caused by inhalation of zinc or cadmium fumes created when welding galvanized steels. It has also been reported in welders working with copper, bronze, brass and sometimes aluminum alloys with high levels of magnesium.

Chemical Pneumonitis

Very high levels of cadmium, chromium or nickel fumes can cause chemical pneumonitis, but this is rare. Other chemical hazards in the environment may include ozone and nitrogen oxides from arc processes, exhausts from generators and vehicles, solvents, oils, and thermal byproducts of organics that can include deadly phosgene.

Infection Risk

There is an increase in incidence and severity of pulmonary infections in welders with an excess in mortality from pneumonia. This is believed to be due to chronic chemical irritation of the airway epithelium or perhaps from a subtle immunosuppression caused by inhalation of metal oxide fume particles, or of halide salts used as welding fluxes.

Asthma

Work-related asthma has been linked to specific welding tasks. Findings from studies of asthma in welders overall have been mixed, perhaps because of the variety of chemical exposures that can occur in welding. Nickel and chromium found in stainless steels have been associated with asthma.[4] The Association of Occupational and Environmental Clinics labels stainless steel welding and gas metal arc welding mild steel as capable of causing asthma.[4-7]

Pneumoconioses

Siderosis is a pneumoconiosis from significant iron accumulation in the lungs; it is common in steel welders and is usually benign without significant changes in pulmonary function. Rarely, it may lead to pulmonary fibrosis. Chronic tin inhalation can present similarly to siderosis. Steel welding fume contains small amounts of amorphous silica but this is not the crystalline quartz associated with silicosis. Welders may work in shipyards or other environments with potential asbestos exposure, putting them at risk of asbestosis and other lung diseases. Finally, welders use grinding and machining tools; abrasives may release crystalline silica and machining may release hard metal carbides of tungsten, cobalt, titanium or tantalum creating a risk for silicosis or interstitial lung disease, respectively.[8]

Bronchitis and Chronic Obstructive Pulmonary Disease (COPD)

Welders, and others exposed to dusts, gases and fumes, have an increased rate of non-infectious chronic bronchitis (cough on most days for 3 or more months for two consecutive years).[9-11] A study of 15,919 adults in northern Europe found a dose-response trend, with elevated prevalence of bronchitis in those with high welding fume exposure.[11]

Among 9000 US nonsmokers, the proportion of work-related COPD was estimated at 31%.[12] In other studies of COPD, welding was noted as one of the specific substance leading to increased prevalence.[13]

Smoking in Welders

While welders tend to have high rates of smoking, tobacco use could not account for excess lung cancer or chronic bronchitis in studies of welders.[3,11] It is not clear

why welders have an increased smoking rate. Lower educational level and lower socioeconomic status are associated with higher smoking rates. Welders usually have high school diplomas and earn $42,000/year.[1] Anecdotally, some welders think they might as well smoke if they have to breathe in fumes all day, or they welcome a smoke-break from work. Smoking rates are strongly related to workplace smoking policies.[14] Smoking may be tolerated on construction and other outdoor jobs.

Suggestions for Welder Lung Health

Steps to reduce exposure to fumes, dusts and gases from welding will help prevent acute and chronic disease.

- Evaluate hazards and use materials/processes that are less toxic or produce less fume.
- Before welding, remove solvents and paints that can produce fumes and gases when heated.
- Use local exhaust such as hoods, extractors, vacuums, and other engineering controls to reduce fumes.
- Use good general ventilation and avoid welding in confined spaces.
- Use respiratory protection if above interventions do not sufficiently reduce exposures.
- Stop smoking. Advocate for smoke-free workplaces.

This bulletin was supported by Cooperative Agreement 5U60OH008490 from CDC-NIOSH. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of CDC-NIOSH.

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