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Inhalation Injury to the Lung

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Inhalation injury occurs when a toxic gas or aerosol in the environment is inhaled at large enough concentrations to cause tissue damage. The damage might be reversible and brief, or might be chronic and perhaps irreversible. The factors which determine whether there is damage and the long term consequences include the type of chemical exposure, the duration of the exposure, prior lung damage, general health status of the victim, and the size of the particle inhaled. The symptoms and physical signs are often not specific for this type of injury, but together with the proper testing by a lung or occupational medicine physician, the likely cause is frequently found. The list of even the most common causes could be quite long, and some of these would include: ozone, nitrogen dioxide, sulfur dioxide, hydrogen sulfide, ammonia, chlorine, phosgene, mercury, cadmium, trimellitic anhydride, polymer fumes, formaldehyde, and carbon monoxide. In addition, combustion of certain materials produces toxic byproducts such as cyanide. The range of illnesses vary from mouth and throat irritation and inflammation to lung disorders such as occupational asthma, bronchitis, lung scarring such as in pulmonary fibrosis and bronchiectasis, and increased risk of cancer, among others.

The common symptoms of inhalation injury vary but are usually determined by the rapidity of the exposure and the degree of toxicity to the lining of the respiratory tract from the nose and mouth to the lungs themselves. In general, the chemicals that are irritating to the mucosa, especially when exposed in high doses, result in immediate symptoms of burning sensation in the mouth and throat. This tends to limit the exposure to the lungs in patients who can move, as they will usually run from the site and thereby possibly not breathe in enough of the chemical to seriously damage their lungs. Other gases which do not irritate the upper airways or for patients who cannot escape, there is a greater likelihood of lower airway damage. Chronic low level exposure is especially a concern with regard to lower airway damage and damage to the areas of the lung between the airways termed the interstitium. Lower airway damage and interstitial lung disease might be immediate or might be long term, possibly not becoming manifest even for weeks.

Symptoms of inhalation injury could include coughing (including coughing up blood if enough damage is done), chest discomfort, wheezing, and shortness of breath. The **cough** might be productive of phlegm but is frequently dry. If the patient does cough up blood, immediate notification of a physician or a visit to the emergency room is essential. Coughing up blood can be indicative of other very critical illnesses, such as lung cancer (the exposure being coincidental). The patient might have **chest discomfort** that can be difficult to describe and the exact location difficult to pinpoint, or it might be more sharp and intense and the location might feel more obvious especially if the throat and upper airways are involved. Certainly if the patient feels that he absolutely cannot breathe or that his throat is "closing off", an ambulance should be called immediately. **Wheezing** is often a sign of asthma (possibly being exacerbated by the toxic inhalation) but might be caused by secretions in the airways or swelling of the airways from the exposure directly. **Shortness of breath** might occur quickly at the time of exposure, or might develop insidiously over a very long period of time. It might be present only on exertion, at least early in development of the illness. It cannot be stressed enough that these symptoms are very non-specific and might represent other more or less serious illnesses, including illnesses of other organ systems such as with heart disease. There simply is no alternative to being seen by a physician. Therefore, at the very least, these symptoms should compel you to visit your physician.

On a visit to your physician he will gain insight into your disorder by discussing with you your occupational and exposure history, as well as more general topics such as family history and smoking

history, among others. He might find physical signs that would indicate that testing is necessary. Though only infrequently would physical findings be specific for one cause of inhalation injury, an exam is necessary as it might find other causes of your symptoms, determine the severity of your condition, and help guide the subsequent testing. Such testing could take the form of blood tests, pulmonary function (breathing) testing, radiological testing such as X-rays, nuclear medicine scans, and high resolution CAT scans, or even invasive procedures such as bronchoscopy for lung washings and biopsy, or an “open” lung biopsy.

Once a cause is identified, and the severity and acute versus chronic nature of the disorder is determined, then specific treatment might be appropriate. Sometimes medications should be used, either in pill form or other times as inhaled agents. Often the most important treatment is avoidance of certain environments. Only after these investigations have found the responsible agent can the risky environments be determined.

Though a review of all possibly toxic inhalation agents is beyond the scope of this article, I will detail several in particular below. Remember that there is no substitute for a visit to your own physician.

Asbestos: Exposure is predominantly from the industrial use of asbestos such as in the construction industry, ship building, and the automotive industry, though simply living in an industrial city might lead to some exposure (studies find small amounts of asbestos in up to 60% of the lungs of residents of New York City on autopsy specimens for non-related causes of death). Heavy exposure is a risk factor for multiple pulmonary problems including fibrosis (“asbestosis”) and lung cancer (especially in smokers), but many of the asbestos-related disorders typically are delayed for many years after the exposure.

Mercury: The lungs can be affected either by the vaporized form or even by absorption through the skin with the liquid form. Inhalation of the vapors can occur, for example, when a worker is confined to a closed space near a boiler. Breathing difficulties include a bronchitis or a pneumonia-like condition possibly resulting in permanent scarring. Many of the body’s other organs could be involved with a wide range of symptoms.

Polychlorinated biphenyls (PCB’s): These are chlorinated aromatic hydrocarbon compounds that can affect the lungs either by inhalation or absorption through the skin. Workers are exposed in power capacitor manufacturing and develop productive cough and restriction of the lungs on pulmonary function testing.

Results of fire exposure:

Airway burns – direct damage of the airway anywhere from the oral/nasal cavity to the lower airways by the heat itself and this could result in swelling and scarring.

Carbon monoxide poisoning – an odorless gas which is released not only in large-scale fires but other sources include faulty heaters, automobile exhaust, tobacco smoke, and paint removers. Direct contact with the lung causes swelling of the lung tissue. Absorption into the blood causes lack of oxygen delivery to the tissues since hemoglobin (the material which traps oxygen from the air and transports it to the tissues) preferentially binds to carbon monoxide rather than to oxygen.

Others – depends on the material burning but can include **cyanide** and **polyvinyl chloride (PVC)**. Cyanide is released as a byproduct of the burning of many materials and disables the body’s mechanism for using oxygen resulting in “suffocation” at a cellular level. PVC, a widely used material used for piping and for covering electric and telephone wire, and in many other manufactured products, releases hydrochloric acid gas when it is burned. This would in itself inflame only the upper airways but it can become bound to the soot aerosol and thereby also be delivered to the lung. It has been implicated as a major cause of damage to both the small and large airways. Lastly, a recent article in *The New England Journal of Medicine* (“Cough and Bronchial Responsiveness in Firefighter at the World Trade Center Site”, September 12, 2002) details the “**World Trade Center cough**” and other pulmonary complications related to the site of this disaster, though the definitive causative materials are not elucidated.

Some helpful general sources for health information on the internet:

www.intelihealth.com Harvard Medical School site: easy to read with a wide variety of information and a good search engine.

www.lungusa.org The site of the American Lung Association. I found this site to be very helpful and especially geared to patient education.

www.merckmedicus.com This site is predominantly for physician use but also has a good patient site with a search feature for *The Merck Manual for home use*.

www.nlm.nih.gov/medlineplus This site provides a wide variety of topics from the National Library of Medicine.

www.mayoclinic.com Here one finds advice from the Mayo Clinic with good patient education pages.

www.healthfinder.gov Though this site does not directly address inhalation injury, there is plenty of general information that is very easy to read and understand. The U.S. Department of Health and Human Services together with other Federal agencies developed it.

<http://www.ama-assn.org/ama/pub/category/3457.html> The American Medical Association site full of good information though might be too technical for some.

My references included:

“Occupational Respiratory Diseases”, Beckett WS, N Engl J Med, 342 (6): 406-413.

“Interstitial Lung Disease: A Diagnostic Approach”, Ragh G, Am J Respir Crit Care Med, 1995, 151:909-914.

“Cough and Bronchial Responsiveness in Firefighters at the World Trade Center Site”, Prezant DJ, Weiden M, Banauch GI, McGuinness G, Rom WN, Aldrich TK, and Kelly KJ, N Engl J Med, 347 (11):806-15.
Synopsis of Diseases of the Chest, Fraser, RS, Pare, JA, Fraser, RG, and Pare, PD, 1994, W.B. Saunders Company, Philadelphia.

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