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Old Cemeteries, Arsenic, and Health Safety

Widespread use of arsenic in embalming fluids began during the Civil War period.

Photos by John L. Konefes.

Embalming human remains for burial has taken a long road to its present state as an art that now minimizes health and environmental concerns of burials. Along the way, health and safety were not always considerations. From the Civil War until about 1910, arsenic was the main ingredient in the embalming fluids used widely throughout the country. Although effective, arsenic is toxic and persistent, and elemental arsenic will never degrade into harmless by-products. Progress in embalming practices during the late 1880s has left a legacy that can potentially harm the health of archeologists or cemetery workers, and impact the environment. Awareness of this potential problem is the first step in alleviating any real damage that might occur.

Arsenic embalming began as a sanitary practice and a practical means to preserve the body until burial or for transport. Considering that the alternative was ice, arsenic embalming seemed like a significant improvement. What the embalming practitioners, or undertakers, did not consider were the long-term effects of placing significant amounts of arsenic in concentrated burial areas—cemeteries.

The arsenic that endures today can pose significant danger to forensic archeologists, cemetery workers, or individuals that may be utilizing potentially contaminated groundwater supplies.

In the U.S., the widespread use of arsenic in embalming fluids began in the Civil War period. Dr. Thomas Holmes, the "father of American embalming," was engaged by the medical department of the Union Army to set up battlefield embalming stations to enable the bodies of Union dead to be returned home. Numerous embalmers were trained in these new techniques, which included preparation of embalming fluids.

Although fluid composition was often a trade secret, arsenic was the primary embalming agent because it effectively killed or halted the microorganisms responsible for decomposition. Other embalming compositions were used less frequently and contained similar toxic materials such as mercury or creosote.

At the end of the Civil War, successful embalmers returned to their hometowns and took their craft with them. This expansion of arsenic-based embalming gradually came to encompass all areas of the country.

From 1856 to 1873, six patents were issued for fluids that contained arsenic, from as little as four ounces to as much as 12 pounds of arsenic per body. Individual embalmers could also create their own formulas by going to the local pharmacy to get the necessary quantities of arsenic. The 1878 publication, *The Undertaker's Manual*, contained several embalming fluid formulas, the majority of which were arsenic based. A popular formula of the time contained about four ounces of arsenious acid (an arsenic trioxide) per gallon of water, with two or more gallons of fluid recommended for proper embalming.

Chemical embalming spread most rapidly in the 1880s, when fluids were compounded and sold commercially. Fluid compounders sent salesmen on the road to demonstrate fluid use and broaden their customer base. The salesmen provided at least rudimentary instruction in embalming techniques and helped continue the growth of chemical embalming.

The demand for chemical embalming stimulated the creation of embalming institutes or schools. Some of the earliest were the Rochester (New York) School of Embalming and the Cincinnati School of Embalming. Correspondence courses overcame geographic barriers and embalming practitioners began providing services

in every state. For example, chemical embalming in Iowa began about 1879. An enterprising young undertaker from Iowa City, Dr. William Hohenschuh, took a correspondence course from Dr. Auguste Renouard, founder of the Rochester School of Embalming. Dr. Hohenschuh spread the technique to his fellow undertakers and by 1899 there were at least 240 registered embalmers in Iowa.

Burials in the late 1800s are most likely to have used arsenic embalming practices.

Burial practices during this time period also have a bearing on problems associated with the release of arsenic. Initially, burials were primarily in wood coffins that were placed directly in the ground. Throughout the latter 1880s, use of metal burial containers, such as the Fisk Metallic Burial Case and combination metal and wood caskets, increased. In either case, no burial vaults that enclosed the coffin were used.

Embalming and metal containers added cost to funeral arrangements, and were generally only used by those who could afford them. In many cases, burial of non-embalmed persons in wooden caskets was still the only viable option. Yet embalming became increasingly affordable and popular.

Both wooden and metal caskets will eventually degrade and begin to allow contact of the embalmed remains with the environment. Arsenic, a basic element, will not change or degrade, but must remain with the remains or move into the environment. As the containers corrode, water moving downward through the soils of cemeteries can dissolve arsenic from the burials and move arsenic into the soil or groundwater. This slow spread of arsenic from numerous sources in an old cemetery can lead to serious environmental and health problems.

To understand the potential impact, assume a hypothetical cemetery in a modest sized town. It is reasonable, for the period 1880 to 1910, to assume that 2,000 people died in that time period. If half of those were embalmed with arsenic, using six ounces of fluid per person, the cemetery contains 380 pounds of arsenic. If the embalmers in the area used more arsenic, such as three pounds per person, then the cemetery would contain over one ton of arsenic. In either case, this is a significant amount of a potent, toxic material to find in the ground at one location.

In the early 1900s, arsenic use was banned from embalming. The driving force for the ban was the concern for health of embalming practitioners, and interference with autopsies after embalming had occurred.

Today, arsenic is prevalent in or near old cemeteries. Some of the most compelling evidence is the recent analysis of the remains of an embalmed Civil War soldier. The tissue sample

revealed that arsenic was present at a concentration of 28,000 parts per million, or 2.8 percent. This is firm documentation that arsenic embalmed remains can carry the arsenic residue for many years.

Evidence of elevated levels in the environment near old cemeteries is only now beginning to emerge. Limited sampling of old hand-pump wells that still exist at many smaller cemeteries has been conducted in Iowa. These wells typically access the shallow groundwater aquifer and if still functional, can provide an initial indication of arsenic presence. One problem with these old wells is that they are often located up gradient or peripheral to the burial area of interest and do not provide the ideal groundwater sample.

Fourteen hand pump wells at a variety of Iowa cemeteries were sampled for arsenic. The U.S. Geological Survey staff in Iowa City did not expect detectable levels of arsenic in shallow groundwater samples. Two of the samples contained arsenic at 30 parts per billion, above the new proposed drinking water standard for arsenic.

Installing groundwater monitoring wells near cemeteries can provide a better indication of the impact of arsenic. In one study at Hamilton College in Clinton, New York, up gradient and down gradient wells were installed outside of the College cemetery. The cemetery contains at least 68 graves from before 1910. Samples from the wells indicate elevated levels of arsenic down gradient from the cemetery. Zinc, copper, and lead also increased down gradient.

Hand pump wells in old cemeteries are a good source of shallow groundwater samples for arsenic and other metals analysis.

What significance does the presence of arsenic have for archeologists, cemetery workers and others that may come into contact with contaminated soil or human remains at old burial sites or cemeteries? Because the main routes of exposure are ingestion, inhalation and skin contact, there can be important health and safety implications for personnel working at sites where arsenic is present in sufficient concentrations.

Acute arsenic poisoning by ingestion can occur as the result of hand contact with dusts or objects containing arsenic compounds, and subsequent hand-to-mouth contact. Another common mechanism includes the dust settling on objects which later have contact with the mouth, including the tops of soda cans, cigarettes in a shirt pocket, or eating utensils. The smallest recorded fatal dose is 130 mg, although recovery has occurred after much larger doses.

Most ingested arsenic is quickly absorbed through the stomach and intestines and enters the blood stream. A common effect of arsenic ingestion is irritation of the digestive tract, leading to pain, nausea, vomiting, and diarrhea. Other effects characteristic of oral exposure include abnormal heart function and impaired nerve function, causing a “pins and needles” sensation in the feet and hands.

The inhalation route of exposure may be operative at dry, dusty sites, or during the handling of objects coated with dust. Inhalation exposure to arsenic can produce the same types of systemic health effects as oral exposure, although symptoms and effects are usually milder. The current Occupational Safety and Health Administration Action Level for arsenic inhalation exposure is 0.005 mg/cubic meter.

Direct dermal contact with arsenic compounds may result in mild to severe irritation of the skin (dermatitis), as well as irritation to the mucous membranes of the eyes, nose, and throat. Dermatitis of the face and eyelids is sometimes accompanied by conjunctivitis, with redness, swelling, and pain.

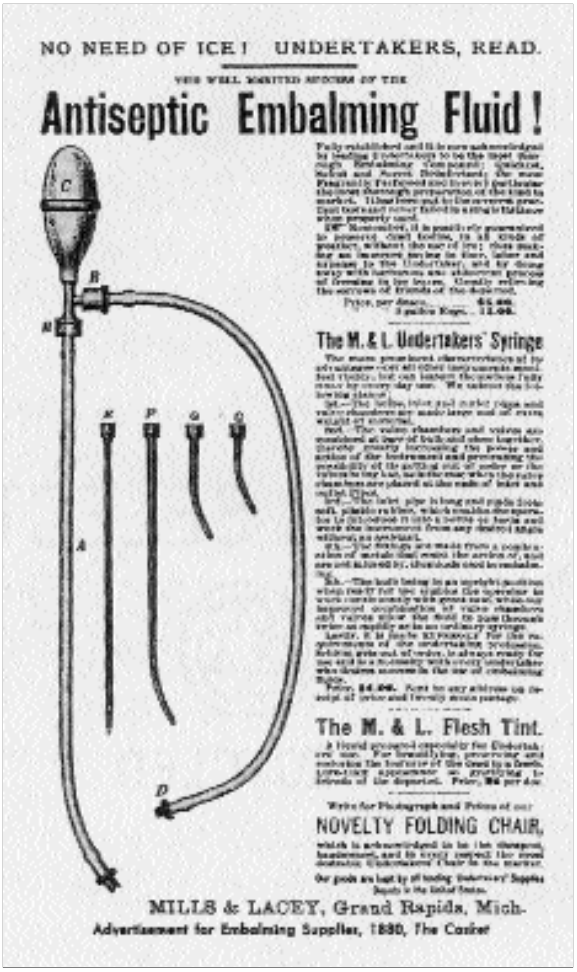
Due to the level of toxicity associated with arsenic, it is important to take precautionary measures when working in and around burial sites that may contain arsenic embalmed remains. Protective measures include using protective work clothing and equipment, housekeeping, and hygiene practices. Individual project requirements may differ; Occupational Safety and Health Administration standards, in particular 29 CFR 1910.1028, can give further guidance on proper procedures.

Protective work clothing would include coveralls or similar full-body work clothing, gloves and shoes or shoe coverlets. Face shields or vented goggles should be worn when necessary to prevent eye irritation. Protective clothing and equipment should be replaced at least weekly, and preferably on a daily basis. Disposable clothing is preferred because laundering clothing and gloves can result in additional exposure problems. Disposal of arsenic contaminated materials must comply with federal, state, and local hazardous waste regulations.

Engineering controls, such as exhaust ventilation, will not be available to control dust exposure in many applications. In that case, respiratory protection should be used to control dust exposures within acceptable limits. The minimum level of respiratory protection would be a half-mask air purifying respirator equipped with high efficiency filters. Efforts must be taken to keep the inside of the respirator free of dust, and filters should be changed frequently, usually at least daily.

Surfaces should be kept as free from dust as practical. Use of compressed air, sweeping or brushing should be avoided, since these methods will increase ambient air dust levels. Vacuuming is an effective method; however, special high efficiency equipment should be used.

Smoking, eating, or drinking should not be allowed in any work areas where arsenic may be present. Hands and face should be washed prior to eating, drinking, or smoking. Protective clothing must be removed and handled carefully to avoid



Advertisement for Embalming Supplies, 1880, The Casket

Chemical embalming fluid suppliers aided the rapid spread of arsenic embalming.

the generation of dust. A separate area for storage of street clothes should be available and a shower should be taken at the end of each work period.

These general guidelines are a starting point for protective measures needed to work at old cemeteries, or with materials from old cemeteries, that may contain arsenic embalmed remains. It is recommended that a certified industrial hygienist be consulted before beginning a project for specific measures.

Without an extensive review of public agency or private funeral establishment records, accurate determinations of the number and location of arsenic-embalmed bodies present in the nation's graveyards is impossible. Even if records were made available, they may not contain sufficient information to verify use of arsenic and the effort to obtain such information would be enormous.

The best opportunities to ascertain the presence and impact of arsenic in old cemeteries can come through cooperative efforts of forensic and other archeology experts with environmental scientists. Opportunities to collect and analyze soil and groundwater samples from excavations should be utilized. Not only will this provide information on the dangers to the environment, it will also provide critical information needed for proper protection of those engaged in archeological endeavors that could expose them to arsenic.

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