Fact or Fiction?

Jack W. Dini
1537 Desoto Way
Livermore, CA 94550
E-mail: jdini@comcast.net

Arsenic

Arsenic is the 20th most prevalent element in the earth's crust, the 14th in sea water, and the 12th in the human body.[1]

What do you think of when you hear someone mention the play/movie "Arsenic and Old Lace?" For most folks this evokes the thought of arsenic and poison. Well, in spite of the title of the entertainment, arsenic was the least effective agent two seemingly harmless sisters used to dispatch lonely gentleman callers. Arsenicals are relatively weak poisons and the sisters being aware of this used two poisons, strychnine and cyanide, which dwarf arsenicals in their effectiveness.[2]

Even though arsenic wasn't the agent of death, "arsenic and old lace" has a much nicer artistic ring to it then 'strychnine and old lace' or "cyanide and old lace." Regardless, arsenic is a much feared chemical, resulting is what Ralph Zingaro calls arsenophobia.[3] He points out that it still plays a powerful role in our thinking and uses the example of former president Zachary Taylor. In the early 1990s Taylor's remains were exhumed because of the wide national exposure and publicity claiming that he had been a victim of arsenic poisoning. However, laboratory analysis found no evidence of arsenic poisoning.

More recently Napoleon has received much publicity relating to arsenic poisoning. Analysis of a lock of his hair showed from 10 to 30 ppm arsenic, considerably higher than the value of less than 1 ppm typically present in most people. This led to a book on the subject which concluded that a man who had accompanied Napoleon into exile deliberately poisoned him with arsenic.[4] However, British chemist David Jones suggests that Napoleon was done in by his wallpaper. As Carol Stone reports on Jones, "He knew of many 19th century cases of arsenic poisoning that were not deliberate murders, but the accidental effects of mold growing in damp wallpaper containing a pigment called Scheele's Green. The pigment, often used in cloth and wallpaper, contained arsenic in the form of $CuHAsO_3$. That compound was harmless in itself, but as the wallpaper got damp, the mold converted the arsenic to the poisonous gas trimethyl arsine, $As(CH_3)_3$."[5] Analysis of a piece of green and gold wallpaper from Napoleon's house revealed a high level or arsenic leading Jones to conclude that "the emperor actually died of stomach cancer consistent with the autopsy reports, but that his chronic illness had been caused by low-level arsenic poisoning from the wall paper." In a similar vein, the death of Mrs. Clare Boothe Luce, the U.S. Ambassador to Italy has been suggested by some folks to be caused by arsenic poisoning from falling flakes of green paint containing lead arsenate from the ceiling of the bedroom in the 17th-century embassy that she used as a private office.[6] All of this isn't as far-fetched as it might sound at first blush. Recently, an article in Nature provides clear evidence that trellis pattern wallpaper produced from 1864 onwards contained copper arsenic salt that could have caused health problems in damp houses.[7] Beware of antique establishments with green wallpaper!

Arsenic in Water

With all this publicity about the poisonous properties of arsenic coupled with the severe health problems currently encountered in places like Bangladesh[8] and Vietnam,[9] which have extremely high levels of arsenic in water, it's not surprising that arsenic in drinking water is a hot topic. EPA has revised the existing 50 ppb standard for arsenic in drinking water. On January 22, 2001, the agency adopted a new standard, and public water systems must comply with a 10 ppb standard beginning January 23, 2006.[10] The U.S. Geological Survey found that most cities had arsenic levels around 2 ppb. About one in four U.S. counties had arsenic concentrations exceeding 10 ppb, but these were mostly desert or mountainous counties with low populations.[11]

Higher arsenic contents in lowly populated areas means the number of lives saved would be quite small. The EPA predicts that three deaths per year from bladder cancer would be prevented with the 10 ppb standard. Iain Murray reports that the U.S. would be spending between $50 million to $300 million per life saved with this approach.[11] For comparison purposes, the U.S. Department of Transportation uses a value of about $2.5 million per life saved when looking at traffic safety. Labor unions, when free to bargain about safety rules, use a value of $5-6 million per live saved.[12]

Angela Logomasini adds the following: "Many of those who will be affected are either low-income or live on tightly fixed incomes. For many of these families, higher costs for water may mean fewer resources for health care or other essential needs. Towns in rural areas may decide to help cover part of the cost of compliance by sacrificing essential social needs, such as the purchase of fire trucks, or addressing other, more serious drinking water concerns."[13]

The city of Albuquerque and the state of New Mexico are suing to block the new rule, noting it will cost the city about $150 million. Rep. Heather Wilson, R-N.M., says the tougher arsenic standard would actually threaten public health by forcing some rural water systems to close. "We'll go back to having untreated water with wells," she said during a House floor debate.[14] A similar suit by the city of Alliance, NE, and the State of Nebraska was rejected by a federal appeals court in June 2003.[15]

So how good is the science behind all this? There's no question that arsenic is a bad actor at high concentrations. Gerhard

Stohrer notes that arsenic has caused about 1,000 cases of cancer worldwide, in addition to about 10,000 cases of non-cancerous skin disease. However, he emphasizes that all these cancers occurred in a small number of outbreaks where arsenic levels greatly exceeded 250 ppb.[16] The National Research Council (NRC) reported that arsenic levels of hundreds of parts per billion in water can cause cancer.[17]

However, the evidence that exposure at the 50 ppb range causes cancer is very weak. Patrick Chishom notes: "the NRC made the iffy assumption that the effects of small doses are proportional to the effects of larger doses. Based on that, it guesstimated the risk for all cancers would be about 1 in 100. However, if that were the case, New Mexico (where naturally occurring arsenic can boost levels into the 20–50 ppb range) would have a lot more cancer cases than it does."[17]

How Much is Too Much?

The EPA uses the 'linear model' for arsenic. This model assumes that any concentration is harmful. Angela Logomasini points out that the EPA's own Science Advisory Board and the National Research Council "have noted that it is more likely that the arsenic risk is 'sublinear.' That means there is relatively little risk increase as the dose increases until exposure reaches a certain critical point, at which risk increases more substantially."[18]

The other possibility is the hormesis model, which says that small doses and large doses produce opposite results, with small doses being beneficial. This could make sense, because arsenic is an essential element for our bodies and we contain plenty of it. For example, the arsenic content of a normal, healthy human being is 4.4 mg, which is 9 x 10^{18} molecules of arsenic as As_4.[19]

Gerhard Stohrer is even more emphatic about the EPA estimates. "Where are EPA's statistically calculated cancer deaths at low levels? According to EPA's numbers, there should be at least a million cases of arsenic cancer at the regulated level in the United States, and hundreds of millions worldwide—but none has ever been reported. And it is not that these cancers are difficult to detect; quite the contrary. Even in Third World nations, arsenic cancer has been promptly identified wherever it occurred. Has EPA bothered to investigate this astounding mismatch between prediction and reality? If it did, it has not told the public."[16]

Benefits from Arsenic

In spite of the fact that arsenic is poisonous and can cause cancer it can be beneficial in some cases.

- Arsenic compounds have been used therapeutically for over 2,000 years. Modern Chinese medicine includes about 50 drugs that contain arsenic as realgar.[20]
- Arsenic was so widely prescribed in the 18th century to treat skin diseases, neuralgia, intermittent fever and malaria, syphilis, lumbago epilepsy and so on, that it earned the name "Therapeutic Mule." [20]
- A designer compound containing arsenic and sulfide, which is non-toxic in laboratory mice, offers promise for fighting HIV/AIDS.[21]
- There are reports that arsenic at low dose has some anti-cancer activity.[22]
- Joe Schwarcz suggests that arsenic was responsible for helping stop the plague, which had devastated Europe up to the 17th century. It wasn't until cheap arsenic trioxide came along that folks were able to noticeably reduce the huge rat population. As Schwarcz adds, "It is interesting that one of the first industrial pollutants may have played a role in improving public health."[23]
- Lastly, although not a benefit, a strange quirk is that arsenic is the only chemical that causes cancer in humans but not in animals.[24]

Summary

The scientific uncertainties regarding arsenic are so large that different assumptions could lead to vastly different conclusions about the economic efficiency of proposed regulations, reports Kenneth Foster.[25] And Angela Logomasini adds: "In reality, the science is very unclear. Politicians, environmentalists, and some members of the press have grossly misrepresented the issue."[18] The vast majority of Americans will never need to worry that our drinking water contains anything like the current or rescinded levels of arsenic. Morrone and Lohner sum it up best: "The regulation of arsenic in drinking water provides a good example of how sound science has been overshadowed by politics as the basis for regulatory decisions."[26]

References

1. Peter S. Thorne, *Chemical Engineering Science*, **50**, 741 (1995).
2. Joseph Kesselring, *Arsenic and Old Lace*, (New York, Random House, 1941), 26.
3. Ralph A. Zingaro, "Arsenic—A Classic Example Of Chemophobia," *Environment International*, **19**, 167 (1993).
4. B. Wieder and S. Forshufvud, *Assassination at St. Helena's Revisited*, (New York, John Wiley & Sons, 1995).
5. Carol Stone, "The Case of Napoleon Bonaparte," ChemMatters, **16**, 4 (December 1998).
6. Jose M. Azcue and Jerome O. Nriagu, "Arsenic: Historical Perspectives," in *Arsenic in the Environment Part I: Cycling and Characterization*, Jerome O. Nriagu, Editor, (N e w York, John Wiley & Sons, 1994), 11.
7. Andy Meharg, "The arsenic green," *Nature*, 423, 688, (June 12, 2003).
8. Rebecca L. Rawls, "Tackling Arsenic in Bangladesh," *Chemical & Engineering News*, **80**, 42 (October 21, 2002).
9. Kris Christen, "The Arsenic Threat," *Environmental Science & Technology*, **35**, 286A (July 1, 2001).
10. "Arsenic in Drinking Water," www.epa.gov/safewater/arsenic.html, accessed December 16, 2003.
11. Iain Murray, "Needless Worry About Arsenic in Our Water," *The Record*, Bergen County, NJ, March 29, 2001
12. W. Kip Viscusi, *Fatal Tradeoffs*, (New York, Oxford University Press, 1992)
13. Angela Logomasini, "Arsenic and Old Politics," *Competitive Enterprise Institute*, (May 16, 2001), http://www.cei.org/gencon/004,02034.cfm, accessed February 25, 2003.
14. Elizabeth Shogren, "Towns battle EPA's orders to reduce arsenic in water," *San Francisco Chronicle*, April 5, 2002, page H5.
15. Associated Press, "EPA's tightened restriction on arsenic in drinking water survives legal challenge," *Milwaukee Journal Sentinel*, 7A, (June 21, 2003).
16. Gerhard Stohrer, "Why the arsenic standard should not be changed," *Environment & Climate News*, **4**, 3 (October 2001).
17. Patrick D. Chisholm, "Straining Out the Facts From Drippy Attacks on Drinking Water," *Citizen Outlook*, **16**, 1 (Fall 2001).
18. Angela Logomasini, "Review of Arsenic Standard May Save Lives," *Consumers' Research*, **85**, 16 (June 2001)
19. Thomas H. Jukes, "Chasing a Receding Zero," in *Rational Readings on Environmental Concerns*, Jay H. Lehr, Editor, (Van Nostrand Reinhold, 1992), 33.
20. Jorg Feldmann, "An appetite for arsenic," *Chemistry in Britain*, **37**, 31 (January 2001).
21. "Sulphur and Arsenic Block HIV from Entering Cells," *Australian Science*, **24**, 45 (Jan/Feb 2003),
22. Susan Freinkel, "New Remedies From Old Poisons," *Discover*, **23**, 48 (July 2002).
23. Joe Schwarcz, *That's the Way the Cookie Crumbles*, (Toronto, ECW Press, 2002), 143.
24. Herman F. Kraybill & Leonard T. Flynn, *From Mice to Men*, (New York, American Council on Science and Health, 1991), 36.
25. Kenneth R. Foster, "Celebrating Technocratic Wisdom," *Science*, **299**, 348 (January 17, 2003).
26. Michele Morrone & Timothy W. Lohner, *Sound Science, Junk Policy*, (Westport, Connecticut, Auburn House, 2002), 125.