

Risk Assessment in Occupational Safety, Health, and the Environment

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Doctors of chiropractic, like other health care providers and citizens, are concerned with the potential adverse health effects of our increasingly toxic environment. There exists a great public fervor over air, water, and soil pollutants, ozone depletion, greenhouse gasses, and the potential for global warming, as well as pesticide residues in our food or chemicals in the indoor air of our offices and homes.

Have you ever wondered how the "experts" determine "safe" levels of chemical concentration? This brief essay is an overview of the risk assessment model used by the Occupational Safety and Health Administration (OSHA), Environmental Protection Agency (EPA), Food and Drug Administration (FDA), and the National Research Council (NRC) to determine safe levels for toxic substance exposure to humans. In addition, I wish to discuss some of the peculiar aspects of risk taking, public and personal perceptions, and sound risk communication strategies.

It has only been a mere quarter of a century since OSHA and the EPA were created to protect our health and well being both on and off the job. Prior to their existence, known standards for unsafe exposures to toxic substances did exist. However, this information was used in the scientific, health, and industrial communities selectively. Few laws existed to protect citizens until the early 1960s when awareness and interest for the environment and human health from toxic pollution burgeoned with the arrival of Rachel Carson's book, *Silent Spring*. Since that time great efforts have been made to develop a system for examining and ranking the concerns for toxic substances and their impact on human health and the environment. Risk assessment provides a method to evaluate that potential impact.

"Only in the last 15 years has the potential extent of the linkage between such conditions and toxic substance been revealed. The often-cited estimate that a large fraction of all cancers may be attributed to human exposure to toxic agents (including smoking, diet, lifestyle, and occupation) originated fairly recently, and it was not until the 1970s that regulatory agencies focused their attention on cancer and other chronic health risks" (NRC, 1993, p. 10).

Complete risk assessment mandates characterization of the potential adverse health effects to humans and the environment. Elements to consider in this process include research and description of adverse health effects from epidemiological, clinical, toxicological and environmental studies on animals, plants, microbes, and humans. Then extrapolation of data is necessary to estimate and predict the potential adverse affects on human health, and the extent and magnitude of the health problem. The U.S. government risk assessment process has four basic steps: hazard identification; dose-response assessment; exposure assessment, and risk characterization. Following this process regulatory steps may or may not be taken.

Hazard identification is the determination of increased incidence of disease, birth defects, cancers, or

other adverse health effects, compared to the normal rate of occurrences in the general population. After evaluating the data, a determination is made of the nature and strength of causation. That is, some degree of certainty must exist between the health problem and exposure to a specific substance. An example is asbestos exposure.

Long-term studies conclusively established a cause and effect relationship between asbestos exposure and the development of asbestosis and lung cancers. While asbestos is a naturally occurring substance in the environment, it's certain that concentrated exposures, such as seen in the ship yards of the 1940s, caused an increased incidence of asbestos-related disease in those exposed. Legislative action was taken to remediate those circumstances. Laws were passed to limit man-made asbestos exposure to humans, and additional laws were passed to assist those adversely affected by asbestos disease.

In contrast, the health problems espoused and suffered by Gulf War veterans due to alleged toxic substance exposures during combat have not been determined to have the same nature and strength relationship of cause and effect. Hence, the policy of the government is that no health problem exists that warrants legislative action.

Dose-response assessment is the process of establishing and characterizing the relationship of a given dose exposure of a toxic substance to the adverse health effect. In doing so, the effects of increasing exposure are observed or measured through scientific means. Since little definitive data is available showing results on human exposures, animal studies are used to establish dose-response curves. A typical dose-response curve depicts increasing effect with increasing exposure:

Variables also taken into account, aside from the extrapolation of animal data to humans are: patterns of exposure; routes of exposure; routes of absorption; age, sex, diet; overall fitness condition; co-morbid disease, etc. Virtually anything that affects the metabolism of xenobiotics (foreign materials) in the body must be considered.

Difficulties with this model arise when dealing with carcinogens. For example, benzene, a common component of gasoline, is a known carcinogen. Exposure of any quantity has the potential to activate or perpetuate cancer in the human body. In this case, no dose is best. Because of technologic and economic barriers, the standard for safe concentrations has been set at 10 ppm by OSHA.

Exposure assessment estimates or measures the general intensity, frequency, and duration of human exposures to toxic substances. Educated guesstimates or hypothetical models are made to identify the impact on human health and the environment. Specific elements of exposure assessment include: the description of the magnitude, duration, frequency, schedule, and route of exposure, the size, nature, and class of human populations, and uncertainties of estimates. This process enables authorities to evaluate the feasibility of risk management alternatives.

Examples of differing exposure assessments might be demonstrated in comparing the exposures of nuclear radiation fallout to Alar. A nuclear radiation fallout exposure is considered high risk, it's infrequent, very intense, and with devastating results of enormous adverse effect to human health and the environment. Whereas Alar, used by the apple industry as a pesticide, is low risk, occurs with high frequency of exposure, low intensity, affects a greater population, and has had no measurable adverse effects to human health and the environment. Public policy is stronger regarding nuclear fallout than Alar.

Risk characterization is the process of guesstimating or modeling the incidence of adverse health

effects under the conditions described in the exposure assessment. This phase of risk assessment combines the information from preceding phases of dose-response and exposure assessment to ultimately generate alternative risk management solutions.

Using our examples from above, the nuclear fallout risk is characterized as high risk with great intensity and low frequency, whereas Alar is low risk with low intensity and high frequency.

Through this process the U.S. government has established acceptable levels of risk for human health and the environment relating to toxic substance exposure. The FDA, EPA, and OSHA considers less than one-in-a-million lifetime risk of cancer from a toxic substance acceptable.

Public and personal opinions vary dramatically. The battle wages between the forces for a clean environment and the cost of cleanliness. Most unfortunately, the technology capable of producing extremely toxic substances doesn't have the same skills and success at containing them or removing them from the environment once released into air, water, soil, or our food. Perceptions of risk are quite personal and certain risks are taken daily by all of us, while other risks create public outcry and protest.

Taking chances is how we live our lives. In the U.S. a citizen dies every six minutes. Each year, the average person has a one in 2,900 chance of dying from an accident away from work. You're safer at work; odds are 1 in 11,000. Drinking two glasses of milk every day, having a pet bird, or eating three strips of bacon poses a greater threat of death from cancer than a lifetime of secondhand smoke exposure (Laudan, 1994). One of the highest risk activities we do frequently is drive a car; your annual risk of death is 1 in 5,800.

Putting risks in perspective helps to understand them. Frequently comparisons are used when describing potential consequences of toxic substance exposure. When attending a health and safety lecture in Denver given by a immunotoxicologist, a member of the audience asked about the risk of cancer from eating an apple contaminated with Alar residue. The lecturer responded by saying there was no more carcinogenicity than eating three strips of bacon, and went on with his lecture.

As doctors of chiropractic and responsible members of the health care community, effort should be made to understand basic risk assessment with communication to your patients. Don't exacerbate their fears unless it's warranted. Good risk communication involves getting informed with the facts; evaluate current data; look at the quality of risk assessment behind the alleged statements, good or bad. With hotly contested public health issues, attempt to recognize outrage, values, and beliefs within a community and help those members manage their resulting feelings. When dealing with the public you must understand their concerns, earn their trust, be honest, keep them informed, and educate them however and whenever possible.

Bibliography

- Booth W. (1989). Alar: The numbers game. *Science*, 243, 1430.
- Foster S. (1995). *Environmental Risk Assessment and Management*. University of Denver: CO.
- Glickman TS, Gough M. (Eds.). (1990). *Reading in Risk. Resources for the Future*: WDC.
- Hance BJ, Chess C, Sandman PM. (1991). *Improving Dialogue with Commentaries: A Risk Communication Manual for Government*. EPA: NJ.
- Laudan L. (1994). *The Book of Risks*. John Wiley & Sons: NY.
- National Research Council. (1993). *Risk Assessment in the Federal Government: Managing the*

Process. National Academy Press: WDC.

- Sibley R. (1997). Risk management. [on-line]. Internet, <http://www.chops.com/~nvprima/basic/htm>

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