A review of the effects of hazardous waste on reproductive health

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Approximately 1 in 4 Americans lives within 4 miles of a hazardous waste site according to the Environmental Protection Agency. In light of this large proportion and the public’s high level of concern that hazardous waste causes health problems, it is important for primary care physicians and other health care providers to know that residential proximity to some kinds of hazardous waste sites is associated with adverse reproductive effects. Findings from both state-based surveillance programs and studies of individual hazardous waste sites have shown increased risk of congenital malformations and reductions in birth weight among infants born to parents living near hazardous waste sites. This article summarizes salient literature on human health effects of hazardous waste and suggests actions for primary care providers to consider. (Am J Obstet Gynecol 1999;180:S12-S16.)

Key words: Congenital malformations, environmental health, hazardous waste

In 1990 the Institute of Medicine recommended that all primary care physicians be able to identify environmentally-related illnesses and, when indicated, refer patients for follow-up. The Institute of Medicine also observed, however, that although the medical community generally does well in recognizing the potential adverse health effects of environmental factors, primary care physicians do not always understand those factors well. One environmental hazard that is poorly understood by the medical community is hazardous waste, even though the US Environmental Protection Agency estimates that nearly 70 million Americans, including 10 million children, live within 4 miles of sites where hazardous waste has been buried or otherwise discarded.

The reproductive effects of hazardous substances released from hazardous waste sites are now documented in the scientific literature. Several studies have examined the effects of parental residence near hazardous waste sites on the occurrence of congenital malformations, low birth weight, and other adverse reproductive outcomes. These studies have relied primarily on birth defects surveillance systems maintained by some state health departments. Examples of such surveillance systems are state-based reporting by hospitals and physicians of congenital malformations and low birth weight. In addition some waste site-specific studies of residents’ reproductive health have also been conducted. This article summarizes the salient scientific literature that associates parental residential proximity with adverse reproductive health outcomes and suggests actions for health care providers to consider.

Findings from surveillance systems

New York State. A study conducted in collaboration with the New York State Department of Health examined the association between congenital malformations in children and maternal proximity to hazardous waste sites in the state. The study populations consisted of 9313 neonates with congenital malformations, as recorded in the New York State Congenital Malformations Registry, and 17,802 healthy comparison children. In 20 New York counties 590 uncontrolled (unregulated) hazardous waste sites were selected for analysis. An exposure risk index was calculated for each respondent. This index included the state’s environmental hazard ranking score for each site and the presence of a waste site within a 1-mile radius of the birth residence.

Findings indicated that maternal proximity to uncontrolled hazardous waste sites was associated with an increased risk of approximately 12% for bearing children with any kind of congenital malformation. The risks were 32% higher for malformations of the integument system, 29% higher for nervous system malformations, 16% higher for the musculoskeletal system, and 15% higher for oral cleft malformations. Higher overall malformation rates were associated with both higher exposure risk (63% increased risk) and documentation of off-site chemical leaks (17% increased risk).

San Francisco Bay area. The California Department of Health Services examined congenital malformations and birth weight in the 5-county San Francisco Bay area. The investigators reviewed case records of congenital malformations and birth weights for all live births and fetal deaths that occurred from 1983 through 1985. Each mother’s census tract of residence at the time of delivery was used to categorize exposure potential. An elevated risk for giving birth to infants with malformations of the heart and circulatory system was found to be associated with census tracts with hazardous waste sites that had the
potential for releasing hazardous substances into the environment; no similar risk was found to be associated with census tracts without waste sites. No increased risk was found for other malformations or for low birth weight.

**California State.** Croen et al used data from 2 population-based case-control studies conducted in California to investigate the risk of giving birth to an infant with congenital malformations associated with proximity to hazardous waste sites. Cases of malformations were obtained from the California Birth Defects Monitoring Program. Control infants were live-born infants without congenital malformations. Residential histories and extensive data on potential confounders were obtained from detailed interviews of mothers of case patients and control subjects. Proximity measures were (1) presence or absence of a hazardous waste site in a given census tract and (2) distance (1 mile) from a waste site. Croen et al found 1.5- to 5-fold risks for neural tube defects and conotruncal heart defects in association with both proximity measures, but no increased risks for oral defects were observed in association with either proximity measure.

**Europe.** European investigators used data from 7 regional registers of congenital anomalies in 5 countries in Europe to examine associations with residential proximity to hazardous waste landfills. They studied 1089 live births, stillbirths, and terminations of pregnancy with nonchromosomal congenital anomalies and 2366 control births without anomalies. Mothers were included in the analysis if they lived within 7 km of 21 landfill sites in Belgium, Denmark, France, Italy, and the United Kingdom. Findings showed that residence within 3 km of a hazardous waste landfill was associated with a significantly raised risk of congenital anomaly after adjustment for maternal age and socioeconomic status. A significantly raised odds ratio for residence within 3 km of a hazardous waste landfill was found for neural tube defects, malformations of the cardiac septa, and anomalies of great arteries and veins. Decreased risk was associated with increased residential distance from landfills. These findings from Europe are in general agreement with those from the United States.

**Comment.** These are all examples of ecologic studies. Such studies explore the statistical connection between disease and estimated exposures in population groups rather than in individuals. Data from vital records, hospital discharges, or disease registries are combined with grouped data or estimates of exposure to specific environmental factors. Ecologic studies can be difficult to interpret, because the investigator is seldom able to directly examine the various potential explanations for findings. One significant problem is the lack of individual exposure data. Ecologic studies are appealing to investigators as a first step in assessing adverse health patterns, often in large populations, because they are simpler to conduct than are other epidemiologic study designs.

**Findings from studies of individual waste sites**

**Love Canal.** Love Canal, an area of Niagara Falls, NY, was the first large residential area known to be affected by buried hazardous waste. The community had been built over an abandoned chemical waste dump. Two studies of Love Canal residents' reproductive outcomes and infants' development have been published. One study compared growth of Love Canal children with that of a comparison group. Children born and spending ≥75% of their lives in the Love Canal area (n = 172) had a mean (± SE) stature for age percentile of 46.6 ± 2.2, compared with 53.3 ± 1.4 for children born in the comparison area (P = .004). This difference could not be accounted for by differences in parents' stature, socioeconomic status, nutrition, birth weight, or chronic illness.

In another study the incidence of low birth weight among white infants born live from 1940 through 1978 was studied in various sections of the Love Canal area. Infants who weighed ≤2500 g at birth were considered to be of low birth weight. Investigators gave particular attention to the swale areas of Love Canal because these served as drainage areas and therefore may have been areas of concentrated hazardous substances in the soil. A significant excess of low birth weight births in the historic swale area was found from 1940 through 1953, the period during which various chemicals were being dumped in the waste site.

**Woburn.** The health of children living in Woburn, Mass, has been the subject of investigation for several years. In 1979, 2 municipal wells were found to be contaminated with volatile organic compounds. In 1982 investigators conducted a telephone survey of Woburn households about adverse reproductive outcomes. The survey gathered information on adverse pregnancy outcomes occurring among former and current family members between 1960 and 1982. Investigators estimated the percentage of contaminated water delivered annually to each household in the sample of households surveyed. The surveyed households provided information on 4396 pregnancies during the specified period. No evidence was found to associate exposure to contaminated water with spontaneous abortion and low birth weight. With respect to congenital malformations, no association was found between exposure to contaminated water and musculoskeletal and cardiovascular defects, but a positive association was found for eye and ear defects when grouped together and for central nervous system, chromosomal, and oral cleft anomalies when grouped together.

**Wayne Township.** A study was conducted on the effects on local residents' health of a thorium hazardous waste disposal site in Wayne Township, Passaic County, NJ.
281 exposed persons and 287 comparison persons additionally underwent biomedical testing. Findings showed a statistically significant increase in the prevalence of difficulty in conceiving children among residents of Silver Valley; the prevalence increased with increasing duration of residence in Silver Valley. This finding of lesser fertility is remarkable in light of the fact that the lead exposure had primarily occurred >20 years earlier.

Comment

The weight of evidence points to an association between residential proximity to hazardous waste sites and adverse reproductive outcomes, although some studies have not found any association. The primary findings are, in aggregate, as follows:

- Studies that used data from reproductive outcomes surveillance systems in New York, California, and 5 European countries reported increased risk of congenital malformations among infants whose parents lived near hazardous waste sites. Defects of the heart, neural tube, and oral cleft palate were the malformations most frequently reported in these studies.
- Congenital malformations of the heart were reported in infants born to parents exposed to trichloroethylene and other volatile organic compounds in drinking water contaminated by a hazardous waste site in Tucson.
- Reduced birth weight was reported for infants whose parents lived near hazardous waste sites in New York, New Jersey, North Carolina, and Quebec.
- Of particular note, reduction in birth weight among infants whose parents resided in Love Canal and Gloucester County occurred during periods of known peak releases of contaminants from these hazardous waste landfills.
- Decreased fertility was reported in 2 separate studies of female smelter workers and persons exposed as young children to large amounts of lead in soil and ambient air from a primary smelter that later became a hazardous waste site.
- Epidemiologic studies of adverse reproductive outcomes have all relied on parental residential proximity to hazardous waste sites as a surrogate for measured levels of exposure to specific hazardous substances. This of course limits these studies' strength, because measured levels of hazardous substances or their metabolites are always preferred.

Conclusion.

Approximately 1 in 4 Americans lives within 4 miles of a hazardous waste site according to the Environmental Protection Agency. In light of this large proportion and the public's high level of concern that hazardous waste causes health problems, it is important for primary care physicians and other health care providers to know that residential proximity to hazardous waste sites is associated with adverse reproductive effects. What might this mean for primary care providers?

First and foremost should be the prevention of exposure to hazardous substances released from waste sites or similar sources. Primary care providers should consider asking their patients about environmental conditions that might subject them to exposure to hazardous substances. Does the patient live near a hazardous waste site or a similar source of exposure to substances known to be hazardous? If so, questions about the patient's exposure history should be considered. An exposure history questionnaire that the Agency for Toxic Substances and Disease Registry and the National Institute for Occupational Safety and Health jointly developed for this purpose is available.

If a patient is potentially exposed to hazardous substances in ambient air or in drinking water supplies, the local health department should be contacted for further information. If the patient uses private well water, it may be advisable to recommend the use of bottled water until the potability of the well water can be established. Of note are situations in which fish consumption advisories have been issued by state and local health departments. These advisories recommend restricted consumption of fish that are known to bear toxic substances (e.g., methylmercury) in their tissues. Primary care providers should consider asking patients about fish consumption and may wish to refer them to local health departments for fish consumption advice.

The Association of Occupational and Environmental Clinics is a network of approximately 60 clinics in the United States and Canada, most associated with medical schools, that can provide assistance to primary care physicians on matters of environmental hazards in general. Within the federal sector, both the Agency for Toxic Substances and Disease Registry and the Environmental Protection Agency can provide assistance on matters of hazardous substances.

Environmental remediation of hazardous waste sites is the best long-term solution to the prevention of adverse reproductive effects from exposure to hazardous substances released from such sites. Environmental remediation is the process whereby the contaminated soil, groundwater, or surface water is treated or removed from the area of the waste site. Removal of the chemical hazard interdicts any human exposure and thereby prevents adverse health effects among persons living near the site.

REFERENCES


