Medical Toxicology and Public Health—Update on Research and Activities at the Centers for Disease Control and Prevention and the Agency for Toxic Substances and Disease Registry

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The following is an update on research and activities in which clinical toxicologists are actively involved at CDC/ATSDR. The Journal of Medical Toxicology will highlight periodically some of these activities to illustrate the growing relationship between medical toxicology and public health.

DIVISION OF LABORATORY SCIENCES

The Division of Laboratory Sciences at CDC's National Center for Environmental Health seeks to improve people's health across the United States and internationally by preventing disease from exposure to toxic chemicals in the environment, responding to terrorism and public health emergencies involving chemicals, and improving laboratory methods to diagnose and prevent disease. Using advanced laboratory science and innovative techniques, CDC's environmental health laboratory has led the assessment of people's exposure to environmental chemicals by measuring chemicals directly in people's blood or urine. Known as biomonitoring, this process provides the most health-relevant assessment of exposure because it indicates the amount of chemicals that people receive from all environmental sources, such as air, soil, water, dust, or food, combined.

The role of the environmental health laboratory in public health response events

The environmental health laboratory at CDC supports public health response activities by assessing human exposure to toxic chemicals. Local, state, and international governments or health officials request CDC's participation in these assessments, and the information that CDC provides can assist in answering specific questions about a population's pattern of exposure to toxic chemicals. Biomonitoring assesses human exposure to chemicals by determining the internal dose of a chemical by measuring the concentration of the chemical or its metabolite in biological specimens [1]. Biomonitoring data can be used to support human

exposure and risk assessment activities by identifying people who are actually exposed, measuring their internal level of exposure, and defining potential health consequences from the exposure to chemicals with known health risks. For example, in 2001 CDC collaborated with local officials and scientists from academic institutions to evaluate the chemical exposures of first responders and vulnerable populations residing or working near the tragic collapse of the World Trade Center (WTC) towers on September 11, 2001.

The attack on the WTC towers resulted in the unprecedented collapse of more than 10 million tons of building material and in fires that lasted for 3 months. First responders and people in the nearby community were exposed to airborne particulates and chemicals that largely consisted of building material and byproducts of the combustion of jet fuel and office and building equipment. The levels of atmospheric contaminants, such as particulate matter, decreased over time since the collapse of the towers and over distance from the WTC complex ("Ground Zero") [2–4]. In the first 4 weeks following the collapse of the towers, the major air pollutants included particulate matter; trace metals, such as lead, vanadium, magnesium, titanium, and aluminum; and products of combustion, such as polycyclic aromatic hydrocarbons (PAHs) and other semivolatile chemicals [2,4,5]. The fires contributed to human exposure to PAHs during the 3 months following the collapse of the WTC towers; exhausts from diesel trucks and generators were additional sources of exposure to these chemicals in the months that followed the cessation of the fires [4,5]. Air specimens collected from September 26, 2001 to October 21, 2001 at the WTC site demonstrated PAH levels

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consistent with those measured in Los Angeles during a smog episode in 1993, although the levels of the higher-molecular-weight PAHs at the WTC site were higher than their average levels from the smog [5].

Biomonitoring data in firefighters responding to the fires and in pregnant women who were near the WTC complex during or soon after the collapse of the towers demonstrated the human exposure to chemical byproducts in combustion processes from the collapse of the towers. Firefighters responding to the WTC fires were assessed for their exposure to several chemicals, including volatile organic compounds (VOCs), selected metals, polychlorinated biphenyls (PCBs), polychlorinated dibenzo-*p*-dioxins/polychlorinated dibenzofurans (PCDDs/Fs), PAHs, and cyanide [6]. Among the first responders, Special Operations Command firefighters (SOC) were found to have higher levels or frequencies of detection of mono-hydroxylated PAH metabolites (pyrene, phenanthrene); VOCs (*meta*-, *para*-xylenes, methyl tertiary butyl ether [MTBE], tetrachloroethylene, ethylbenzene, para-dichlorobenzene); 1,2,3,4,6,7,8-heptachlorodibenzofuran; and certain metals (lead, antimony, cadmium, uranium) than firefighters arriving at a later time or who were not at the scene. The levels of these chemicals in the SOC firefighters were low and comparable to the levels measured in the general population. Pregnant women located near the site of the collapse of the WTC towers were also found to be exposed to PAHs based on the measurement of PAH DNA adducts (benzo[a]pyrene) [7,8]. Women residing within one mile, but not at two miles, of the WTC complex during the first 4 weeks of the event had higher levels of PAH DNA adducts than those who were employed within the same distance [8].

These findings suggest that people were exposed to PAHs and other chemicals from the collapse of the WTC towers and that their exposure to these chemicals depended on their activity and location during this period. These biomonitoring data are consistent with the above findings in environmental specimens and can be attributed to the various sources of chemicals resulting from the collapse of the WTC towers. Biomonitoring is an essential function that CDC's environmental health laboratory can

provide during public health response events involving chemical exposures.

REFERENCES

1. National Research Council. Committee on Human Biomonitoring for Environmental Toxicants. Board on Environmental Studies and Toxicology. National Academies of Sciences. Human Biomonitoring for Environmental Chemicals. Washington, DC: National Academy Press; **2006**.
2. Landrigan PJ, Liroy PJ, Thurston G, et al. NIEHS World Trade Center Working Group. Health and environmental consequences of the World Trade Center disaster. *Environ Health Perspect* **2004** May;112(6):731–739.
3. Olson DA, Norris GA, Landis MS, Vette AF. Chemical characterization of ambient particulate matter near the World Trade Center: elemental carbon, organic carbon, and mass reconstruction. *Environ Sci Technol* **2004** Sep 1;38(17):4465–4473.
4. Pleil JD, Vette AF, Johnson BA, Rappaport SM. Air levels of carcinogenic polycyclic aromatic hydrocarbons after the World Trade Center disaster. *Proc Natl Acad Sci U S A*. **2004** Aug 10;101(32):11685–11688.
5. Swartz E, Stockburger L, Vallero DA. Polycyclic aromatic hydrocarbons and other semivolatile organic compounds collected in New York City in response to the events of 9/11. *Environ Sci Technol* **2003** Aug 15;37(16):3537–3546.
6. Edelman P, Osterloh J, Pirkle J, et al. Biomonitoring of chemical exposure among New York City firefighters responding to the World Trade Center fire and collapse. *Environ Health Perspect* **2003**;111(16):1906–1911.
7. Wolff MS, Teitelbaum SL, Liroy PJ, et al. Exposures among pregnant women near the World Trade Center site on 11 September 2001. *Environ Health Perspect* **2005**;113(6):739–748.
8. Perera FP, Tang D, Rauh V, et al. Relationships among polycyclic aromatic hydrocarbon-DNA adducts, proximity to the World Trade Center, and effects on fetal growth. *Environ Health Perspect* **2005**;113(8):1062–106