

CDC/ATSDR Guidance on the Interpretation and Use of Blood Laboratory Analyses for Volatile Organic Compounds

The Centers for Disease Control and Prevention (CDC) and the Agency for Toxic Substances and Disease Registry (ATSDR) recently received reports of analyses of volatile organic compounds (VOC) in blood samples from a few Gulf Coast residents, volunteers, or workers. CDC and ATSDR guidelines issued during the Deepwater Horizon Oil Spill did not recommend the use of laboratory testing for specific chemicals to either determine exposure or guide delivery of clinical care; nonetheless, we recognize that clinicians may have offered these tests to their patients to provide reassurance or to respond to patient requests.

The Gulf oil spill had a major impact on the environment and communities, and concerns about human health are understandable. For several months CDC and state health departments tracked potential short-term health effects related to the oil spill in the affected communities. No trends in illnesses were identified by the multiple surveillance systems used. CDC surveillance did detect some complaints of non-specific symptoms such as throat irritation, eye irritation, nausea, headache and cough. Based on other oil spill disasters, symptoms related to mental or behavioral health such as anxiety, stress and depression also would reasonably be expected. For treatment and management of these symptoms, standard clinical protocols guided by the presentation of the patient are appropriate, and no laboratory testing for specific chemicals is indicated.

Volatile Organic Compounds (VOC)

VOC refers to a group of carbon-containing compounds that readily become vapor at room temperature http://toxtown.nlm.nih.gov/text_version/chemicals.php?id=31. VOCs are ubiquitous in the environment, and most people have multiple sources of exposure. People living close to refineries, chemical plants and highways will have some background exposure to VOCs. VOCs are present in and also released from burning fuel, such as gasoline, wood, coal or natural gas. Crude oil is a mixture of hydrocarbons, many of which are volatile. Other more typical sources of VOC exposure include solvents, paint thinners, degreasers, gasoline fuel additives, some scented candles, and cigarette smoke.

The VOCs that were of most concern for inhalational or direct contact exposure from the Gulf oil spill were benzene, toluene, ethylbenzene, and xylene. These VOC compounds are readily absorbed by inhalation and rapidly leave the blood to distribute to other parts of the body including adipose tissue. While each has different metabolic pathways, typically their half-lives are bi-phasic with a very short (minutes to hour) first phase followed by a slightly longer (hours to days) second phase. Health effects vary by compound, but at air concentrations associated with large industrial accidents or inhalational self-abuse, they may cause CNS depression ranging from dizziness and confusion to loss of consciousness. Removal from exposure typically resolves these health effects. Long-term effects from chronic exposures, typically over years, can lead to hematological and nervous system effects. Benzene is a known human carcinogen and exposure increases the risk of leukemia.

During the Gulf oil spill, analyses of environmental air samples for VOCs along the Gulf shore found air concentrations that would not likely result in long term health effects to residents of Gulf coast communities. Ongoing investigations by Federal agencies such as the National Institutes of Health (NIH) will help further understand any exposures to people who helped with clean-up activities.



Considerations for Laboratory Testing

In commercial clinical laboratory analyses, chemicals that may be included in a VOC panel include benzene, toluene, ethylbenzene, xylene, and hexane. These chemicals have a short half life in the blood and test results only reflect very recent exposures (within hours or days) prior to testing. The laboratory tests for blood VOCs are technically difficult to perform. For example, test tubes must be prepared and stored in a specific manner. For detecting environmental exposures, the laboratory must be equipped to perform analyses with detection limits in the parts per trillion range for these contaminants. All people have occasional exposure to VOCs from episodic exposures to common sources such as gasoline refueling, breathing vehicular exhaust, cigarette smoke, and working with paints, glues, or solvents. Activities immediately prior to collection, specimen collection locations, and roadway travel to these sites are often a source of exposure prior to blood collection. Testing without consideration of such sources or casual testing can be misleading.

As part of CDC's National Health and Nutrition Assessment Survey (NHANES), CDC's Environmental Health Laboratory measured more than 200 chemicals, including VOCs, in blood or urine of a representative sample of the U.S. population. NHANES is a continuous survey with data being released in two-year cycles. Laboratory measurements undergo extensive quality control and quality assessment review including operational tolerance limits. Stringent procedures are followed to ensure the ability for comparison with previous 2-year cycles. Data from the 2003-04 survey is published in the *Fourth National Report on Human Exposure to Environmental Chemicals* <http://www.cdc.gov/exposurereport/pdf/FourthReport.pdf>. The bio-monitoring data and information in the Report do not establish health effects, nor do they create guidelines. Consideration should be given to comparability of laboratory techniques and the populations sampled if NHANES data is used as a reference range.

CDC/ATSDR Guidance for Laboratory Blood VOC Interpretation

If you have tested your patient for blood VOCs:

Advise/counsel patients

- The presence of a volatile chemical in their blood does not generally indicate any adverse health effect, even at levels multiple times higher than reference ranges.
- We are all commonly exposed to low-levels of VOCs from multiple sources, and laboratory testing cannot distinguish among possible sources of exposure.
- Limit or avoid exposures to sources of VOCs (e.g., crude oil, fuel, solvents, cigarette smoke). VOCs tend to rapidly leave your body; thus no treatment is necessary to remove VOCs from your blood.
- No follow-up testing for VOCs in blood is generally needed.

Review the exposure history taken at the time of testing. The exposure history should have included recent occupational and home sources of VOCs (including second hand cigarette smoke) that will influence patients' blood results.

Evaluate if other factors may influence the interpretation of the laboratory results.

- Time from exposure to sampling (the blood half life of most VOCs is typically a few hours).
- Time from sampling to analytical results (a laboratory turn-around time of days to weeks may not reflect the patient's blood level of the chemical when the results are received).
- Laboratories used for testing occupational exposures may not be suitable to detect low-level environmental exposures.
- Proper preparation and storage of samples including the inadvertent introduction of contaminants from blood collection tubes, such as the use of butyl rubber stoppers on collection tubes.

Evaluate the appropriateness of the reference comparison values.

- Reference ranges may be based on samples analyzed at that laboratory or based on published reference ranges.
- Laboratory reference ranges reflect the population tested and can differ by age, gender, race/ethnicity, location, state of health and other variables. Reference ranges from published analyses, including NHANES, may have used other laboratory procedures with different detection limits and different populations, and thus may not be directly comparable.

Treat and manage patient's symptoms and conditions according to standard clinical protocols guided by the patient's presentation.

- No treatment to 'remove' the VOC chemicals is recommended.
- No follow-up testing for laboratory blood VOC is generally recommended.
- Workers covered by OSHA who are in a medical surveillance plan should follow OSHA guidelines for bio-monitoring of specific chemicals.
- Provide advice and counseling on VOC detection in blood as described above.

For More Information

Oil Spill Clinical Guidance: http://www.bt.cdc.gov/gulfoilspill2010/oilspill_clinical.asp

For information on health and VOCs:

Benzene: <http://www.atsdr.cdc.gov/toxguides/toxguide-3.pdf>

Ethylbenzene: <http://www.atsdr.cdc.gov/toxguides/toxguide-110.pdf>

Hexane: <http://www.atsdr.cdc.gov/toxfaqs/TF.asp?id=392&tid=68>

Toluene: <http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=160&tid=29>

Xylene: <http://www.atsdr.cdc.gov/toxguides/toxguide-71.pdf>

Toxicological Profiles are peer reviewed summaries for more than 300 compounds, published by ATSDR: <http://www.atsdr.cdc.gov/toxprofiles/index.asp>.

NIH Gulf health study: <http://www.niehs.nih.gov/about/od/programs/gulfspill/gulfstudy/index.cfm>

Fourth National Report on Human Exposure to Environmental Chemicals

<http://www.cdc.gov/exposurereport/pdf/FourthReport.pdf>

Case studies in Environmental Medicine:

Benzene: <http://www.atsdr.cdc.gov/csem/benzene/>

Toluene: <http://www.atsdr.cdc.gov/csem/toluene/>

Taking an Exposure History (CME Available): <http://www.atsdr.cdc.gov/csem/exphistory/>

Poison Control Centers: To reach your nearest Poison Control Center, call 1-800-222-1222.

Pediatric Environmental Health Specialty Units: <http://aoec.org/PEHSU/index.html>

For questions not addressed by these resources, please visit <http://www.bt.cdc.gov/gulfoilspill2010/> or call CDC's toll-free information line, 800-CDC-INFO (800-232-4636).

TTY: (888) 232-6348, is available 24 hours a day, every day.