

Per- and Polyfluoroalkyl Substances (PFAS): A Short Review and Guidance for Clinicians

PFAS Basics

Per- and polyfluoroalkyl substances (PFAS) are a family of >5,000 synthetic substances characterized by a fully or partially fluorinated carbon chain.

Commonly studied PFAS include:

- Perfluorooctanoic acid (PFOA)
- Perfluorooctane sulfonic acid (PFOS)
- Perfluorohexane sulfonic acid (PFHxS)
- Perfluorononanoic acid (PFNA)

PFAS have been widely used in many consumer products since the 1950s, including

- Non-stick cookware
- Food packaging
- Stain and water proofing treatments for clothing, carpet, and furniture
- Some firefighting foams (e.g., aqueous film forming foam (AFFF))

Production and use of two PFAS (i.e., PFOA and PFOS) in the United States has declined but new PFAS have been developed. Some PFAS are:

- Extremely environmentally persistent and resistant to environmental degradation
- Able to accumulate in the blood
- Primarily eliminated slowly through urine (biological half-life can range from 2-35 years)

How are people exposed to PFAS?

Ingestion of PFAS is the primary exposure pathway for adults in the general population:

- Drinking contaminated water, or beverages made with contaminated water (e.g., baby formula, coffee)
- Eating foods grown or raised in PFAS contaminated areas (e.g., fish, produce, milk)
- Eating food packaged in materials containing PFAS (e.g., popcorn bags, fast food containers, pizza boxes)

Infants and children may be at additional increased risk of PFAS exposure due to:

- Time spent crawling and playing on the floor combined with hand-to-mouth behavior
- Maternal transmission in utero
- Transfer during breastfeeding [NOTE: Nursing mothers should continue to breastfeed. Despite potential PFAS exposure from breastmilk, breastfeeding is good for the health of both infants and mothers.]

Workers in industries that manufacture, manipulate, or use PFAS and community members living in PFAS contaminated areas are at higher risk for PFAS exposure than the general population.

What are exposure limits for PFAS in drinking water?

EPA has established a non-regulatory Health Advisory level for PFOA and PFOS in drinking water at 70 parts per trillion (ppt) (0.07µg/L), individually or combined. Some states have established their own PFAS drinking water guidelines. In some cases, these guidelines are lower than the EPA Health Advisory.

How can PFAS potentially affect human health?

A large number of studies have examined possible relationships between levels of PFAS in blood and harmful health effects in people. However, these diverse studies involved different study populations, exposure types, and PFAS. Therefore, the outcomes may not be directly comparable. PFAS exposure is associated with an increased risk of some adverse effects for human health, including:

- Increased cholesterol levels
- Changes in liver enzymes (elevated AST, ALT, GGT, ALP)
- Decreased immune response to vaccines in children
- Increased risk of high blood pressure and/or pre-eclampsia in pregnant women
- Small decreases in infant birth weights (<20 grams decrease per 1 ng/mL increase in blood PFOA or PFOS)
- Increased risk of kidney or testicular cancer

At this time, scientists are still learning about the health effects of exposures to mixtures of different PFAS.



How may clinicians approach patient care for PFAS exposed individuals?

For patients with concerns about PFAS exposure, important components of the patient visit include:

- Identifying and reducing current sources of environmental exposure
- Promoting standard, age-appropriate preventive care measures for general health and wellness (i.e., *Bright Futures* and *Clinical Preventive Services Guidelines*).

Exposure Reduction:

If the PFAS detected in a patient's drinking water are above the EPA's health advisory or the guidelines of his or her state of residence or if patients are concerned, they may consider:

- Installing water filtration system or using a pitcher-type filter shown to reduce PFAS levels*
- Using alternative water source for drinking, food preparation, cooking, brushing teeth, or any other activity that might result in ingestion of water
- Following local fish advisories to limit or avoid consuming fish from PFAS contaminated water.
- Read consumer product labels and avoid using those with PFAS

*Installing a home water filtration system or using a pitcher-type filter, if monitored, maintained, and used properly, can reduce PFAS levels. However, these filters may not reduce PFAS below guidance levels. How much PFAS are removed by filtration is determined by 1) the PFAS contaminant levels, 2) the type of filter, and 3) how well the filter is maintained.

Preventative Care:

- The C8 Medical Panel (a panel established to carry out PFOA exposure and health studies in the Mid-Ohio Valley) in 2013 suggested blood tests for cholesterol, uric acid, thyroid hormones and liver function for members of the C8 class action settlement. This is not currently recommended. Although these tests were recommended for all C8 settlement members, attending physicians should base any diagnostic decisions on their own clinical judgement.
- For asymptomatic individuals exposed to PFAS, there is insufficient evidence to support deviations from established standards of medical care.
- For patients with signs or symptoms of disease, treat using the same established standards of care regardless of PFAS exposure.

- Follow the National Heart, Lung, and Blood Institute guidelines for pediatric cholesterol screening, regardless of PFAS exposure.
- There is no change to the current immunization schedule for children exposed to PFAS.
- Feeling stress is a normal reaction to environmental contamination in a community. If a patient is worried about PFAS exposure, review the ATSDR "Coping with Stress" fact sheet with them, screen for mental health illness, and treat accordingly.

PFAS Blood Testing:

- Most people in the United States have measurable amounts of PFAS in their blood.
- There is no established PFAS blood level at which a health risk is expected or that predicts health problems.
- Serum PFAS measurements are most helpful when part of a carefully designed research study.
- If you and your patient decide to test serum PFAS levels, tests are commercially available.
- A patient's blood PFAS concentration can be compared to those measured in the general US population as part of the National Health and Nutrition Examination Survey, or those identified through population studies in other PFAS-impacted communities.

Resources and References

1. ATSDR

PFAS Overview: <http://www.atsdr.cdc.gov/pfas/index.html>

Toxic Substance Portal (Tox FAQs): <http://www.atsdr.cdc.gov/toxfaqs/faq.asp?id=1116&tid=237>

Taking an Exposure History: <https://www.atsdr.cdc.gov/csem/csem.asp?csem=33&po=0>

Coping with the stress that environmental contamination can cause:

<https://www.atsdr.cdc.gov/docs/factsheet/ATSDR-Stress-Fact-Sheet.pdf>

Tips on using the “Coping with stress” fact sheet: https://www.atsdr.cdc.gov/docs/factsheet/Stress_Tips_Fact_Sheet-508.pdf

Clinician Information and Guidance:

<https://www.atsdr.cdc.gov/pfas/docs/clinical-guidance-12-20-2019.pdf>

2. CDC

PFAS Biomonitoring: https://www.cdc.gov/biomonitoring/PFAS_FactSheet.html

Breastfeeding: <https://www.cdc.gov/breastfeeding/about-breastfeeding/why-it-matters.html>

3. C8 Panel

C8 Science Panel: http://www.c8sciencepanel.org/prob_link.html

C8 Medical Panel: http://www.c8medicalmonitoringprogram.com/docs/med_panel_education_doc.pdf

C8 Medical Panel: http://www.c-8medicalmonitoringprogram.com/docs/med_panel_education_doc.pdf

4. EPA

PFAS: <https://www.epa.gov/pfas>

PFAS: <https://www.epa.gov/chemical-research/research-perfluorooctanoic-acid-pfoa-and-other-perfluorinated-chemicals-pfcs>

PFAS in water: <https://www.epa.gov/ground-water-and-drinking-water/drinking-water-health-advisories-pfoa-and-pfos>

5. NIEHS

PFAS: <https://www.niehs.nih.gov/health/topics/agents/pfc/index.cfm>

6. NHLBI Lipid Screening in Children & Adolescents

Cholesterol: <https://www.nhlbi.nih.gov/health-pro/guidelines/current/cardiovascular-health-pediatric-guidelines/full-report-chapter-9>

7. PEHSU – <http://www.pehsu.net/>

The Pediatric Environmental Health Specialty Units (PEHSU) are a national network of experts available to provide consultation and education to clinicians and communities wishing to learn more about PFAS and other hazardous substances. These units are staffed by clinicians with environmental health expertise in pediatrics, reproductive health, occupational and environmental medicine, medical toxicology, and other related areas of medicine.

8. Uncertainty Resources

Uncertainty and Stress in the Clinical Setting. Helping Patient and Clinician Manage Uncertainty During Clinical Care:

<https://publichealth.wustl.edu/helping-patients-and-clinicians-manage-uncertainty-during-clinical-care/>

Navigating the Unknown: Shared Decision-Making in the Face of Uncertainty. J Gen Intern Med. 2015 May; 30 (5): 675-678:

<http://tinyurl.com/zrd587f>

Uncertainty Toolbox: Principle in the Approach to Uncertainty in the Clinic Encounter. J Gen Intern Med. 2015 May; 30 (5): 675-678.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4395589/>