PFAS Exposure Assessment Orange County, New York

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National Center
for Environmental Health
Agency for Toxic Substances
and Disease Registry

ATSDR's Role in Addressing PFAS

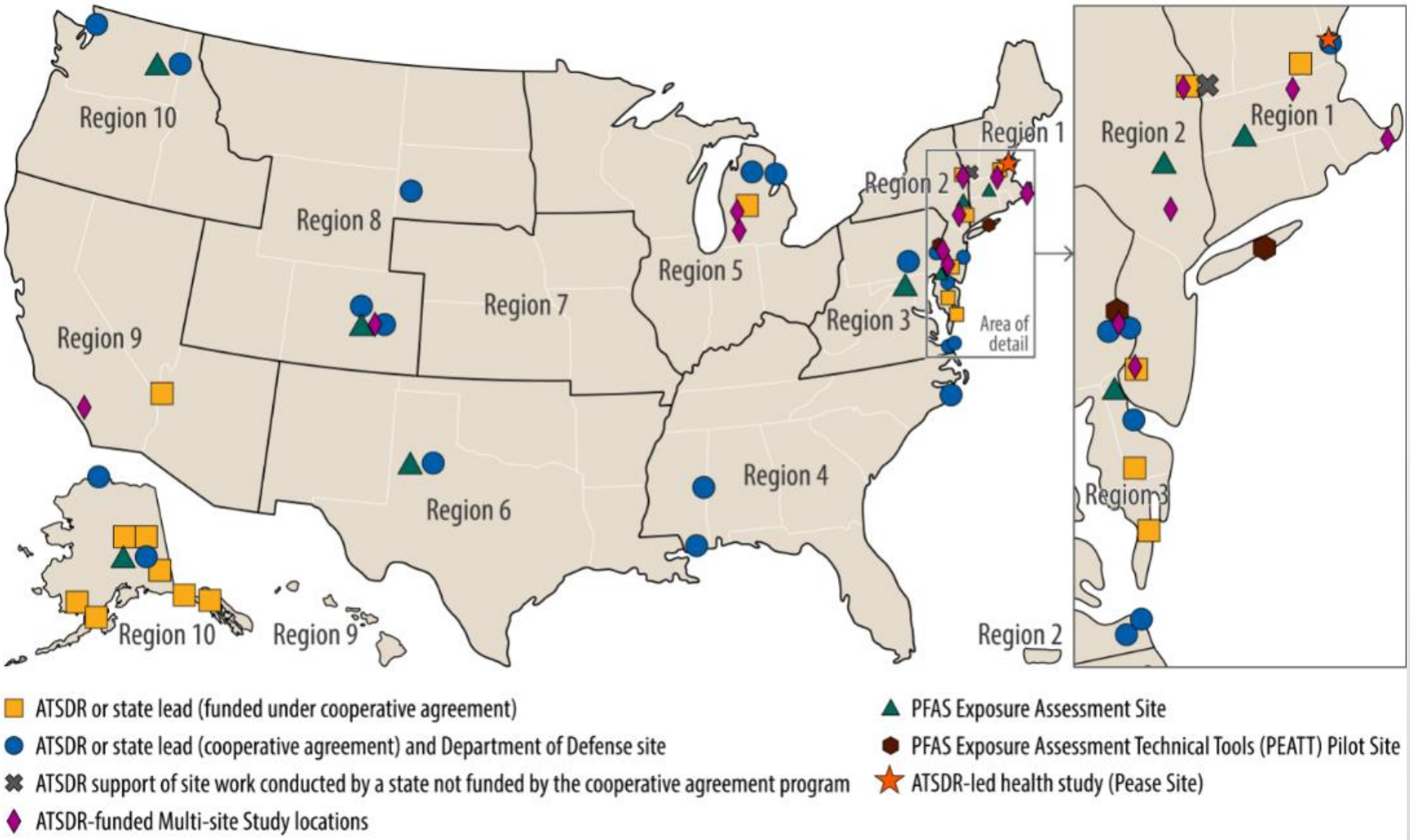
- Investigate exposure to PFAS

- Address community health concerns

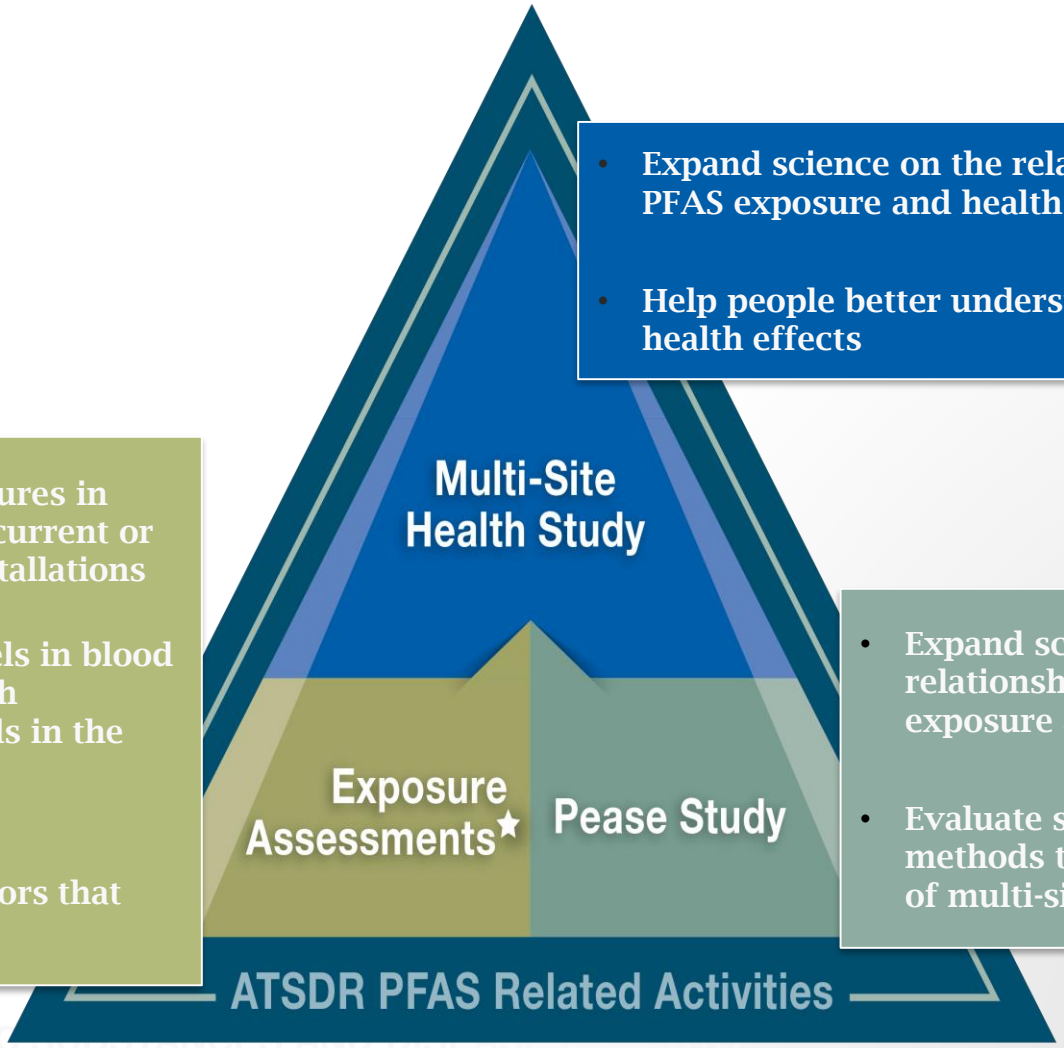
- Take action on the basis of scientific information

- Provide information to communities and health care providers so they may take action

ATSDR Support in Communities



ATSDR PFAS Research Activities



- Expand science on the relationship between PFAS exposure and health outcomes
- Help people better understand their risk for health effects

- Assess PFAS exposures in communities near current or former military installations
- Compare PFAS levels in blood and urine from each community to levels in the general population
- Identify and assess environmental factors that affect exposure

- Expand science on the relationship between PFAS exposure and health outcomes
- Evaluate study procedures and methods to improve the design of multi-site health study

ATSDR's PFAS Exposure Assessments

CDC/ATSDR funded two pilot assessments done by the Pennsylvania Department of Health in Bucks and Montgomery Counties and by the New York State Department of Health in Westhampton

Assessing PFAS exposure in ten U.S. communities to determine:

- Distribution of PFAS serum concentrations
- PFAS concentrations in indoor dust and drinking water from a subset of participants' homes

PFAS Exposure Assessments

WHAT WE **CAN** LEARN

- **How much PFAS are in the blood and urine** of participants

- **The range of PFAS levels** we might expect to see in untested people in each community

- **How PFAS levels** in communities exposed to PFAS through drinking **compare to the general U.S. population**

- **What environmental factors might affect PFAS levels** in people's bodies

WHAT WE **CANNOT** LEARN

- **Whether or not** the PFAS levels in someone's blood or urine **will make them sick** now or later in life

- **Whether or not** a health condition was **caused by PFAS exposure**

- Exactly **how or where someone was exposed to PFAS**

- Exactly **when or how long the PFAS exposure lasted**

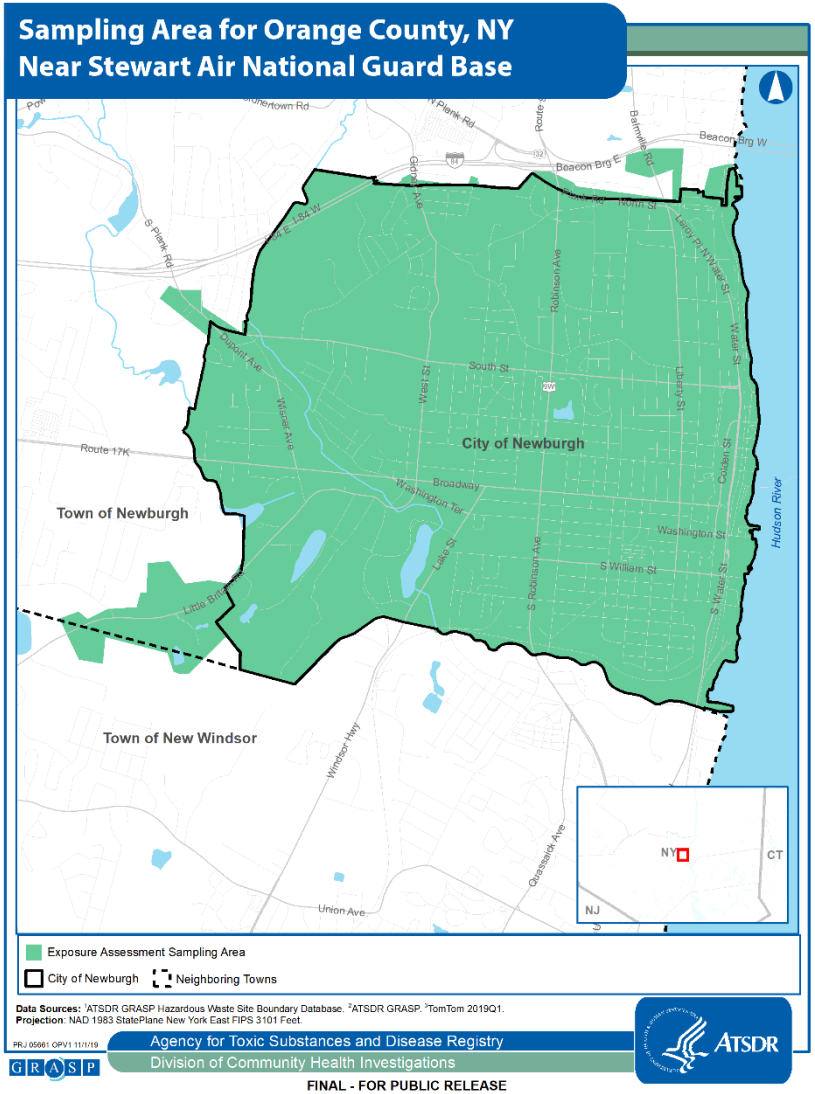
PFAS in Orange County, NY

Use and spills of aqueous film forming foam (AFFF) containing PFAS occurred at the Stewart Air National Guard base

- PFAS first measured in City of Newburgh's drinking water source (Washington Lake) in 2013
- In 2016, the City switched water sources
- The City connected to the New York City Catskill Aqueduct

In 2016, the New York State Department of Health initiated a PFAS blood testing program

Exposure Assessment Sampling Area for Orange County, NY



We identified an area served by the City's water system.

- PFAS levels were above state or federal guidelines in the past.
- A random selection of households served in this area were invited to participate.

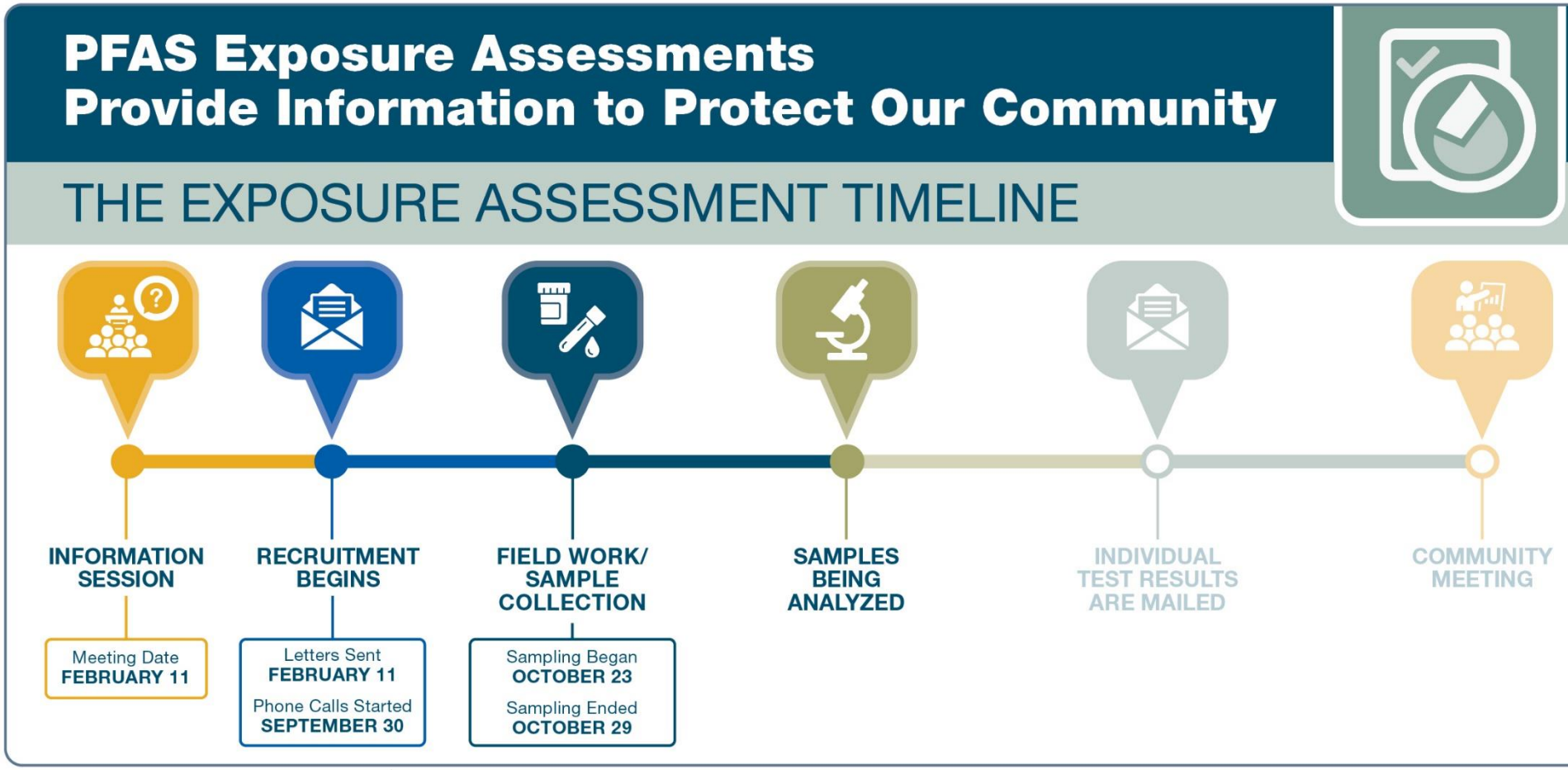
RECRUITMENT

Eligibility Criteria

Household members were eligible to participate if they:

- Lived in the recruitment area at least one year before May 2, 2016
- Were 3 years of age or older
- Did not have a bleeding disorder and were not anemic

Exposure Assessment in Orange County, NY



Next steps

ATSDR will:

- Send individual test results and share summary results.
- Reach out to health care providers to provide PFAS information.
- Write report with Orange County results and one final report combining findings from all sites.
- Host information session to talk with community members.

National Academies of Science Engineering and Medicine will:

- NASEM will conduct review of current evidence regarding human health effects of PFAS and will develop principles clinicians can use to advise patients.

Questions?

For more information on CDC/ATSDR PFAS exposure assessments, visit: **atsdr.cdc.gov/PFAS**

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Per- and Polyfluoroalkyl Substances (PFAS): What Clinicians Need to Know

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*Disclosure: The medical information provided in these courses is for educational use only

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Learning Objectives

Participants will be able to:

WHAT:

- Define per- and polyfluoroalkyl substances (PFAS)
- List exposure pathways

SO WHAT:

- Describe potential health effects of PFAS
- Identify special issues regarding children and PFAS

NOW WHAT:

- Patient assessment and medical management
- Identify how to best address patient concerns
- Discuss ongoing PFAS biomonitoring activities
- Identify resources available to health care providers

Presentation Flow

- Overview of PFAS
- Risk of Exposure and Adverse Health Effects
- Animal Research Findings
- Human Health Effects
- Addressing Patient Care
- ATSDR'S PFAS Work

Hypothetical Clinical Encounter

Scenario

- Mother and 12-year-old son in good health
- Family has lived in PFAS study area for the past 12 years
- The mother heard that the water in their community was contaminated with PFAS
- The family participated in ATSDR's exposure assessment and brings you their individual biomonitoring results

Sample Letter for Biomonitoring Blood Results

PFAS	Your Level in µg/L	U.S. Population (all ages) Geometric Mean in µg/L[a]	U.S. Population (all ages) 95th percentile in µg/L[a]
PFDA		0.154	0.700
PFHxS		1.18	4.90
PFNA		0.577	1.90
PFOA[b]		1.56	4.17
n-PFOA		1.46	4.10
Sb-PFOA		*	<LOD
PFOS[b]		4.72	18.3
n-PFOS		3.2	12.8
Sm-PFOS		1.42	5.7
MeFOSAA		*	0.600
PFUnA		*	0.400

Note: U.S. Population results above from NHANES 2015-2016.

ND – Not detected (limit of detection = 0.1 µg/L)

* Geometric mean was not calculated because not enough people had results that were detectable.

**95th percentile was below the limit of detection, 0.1 µg/L.

OVERVIEW OF PER – AND - POLYFLUOROALKYL SUBSTANCES (PFAS)

PFAS Overview

- Formerly called PFCs, PFAS are a family of thousands of chemicals that contain a chain of carbon atoms bonded to fluorine atoms
- PFAS are resistant to water, oil and fire, making them useful in a wide range of consumer/industrial products
- PFOA and PFOS (two main species) have been detected in the drinking water of millions of people across the country

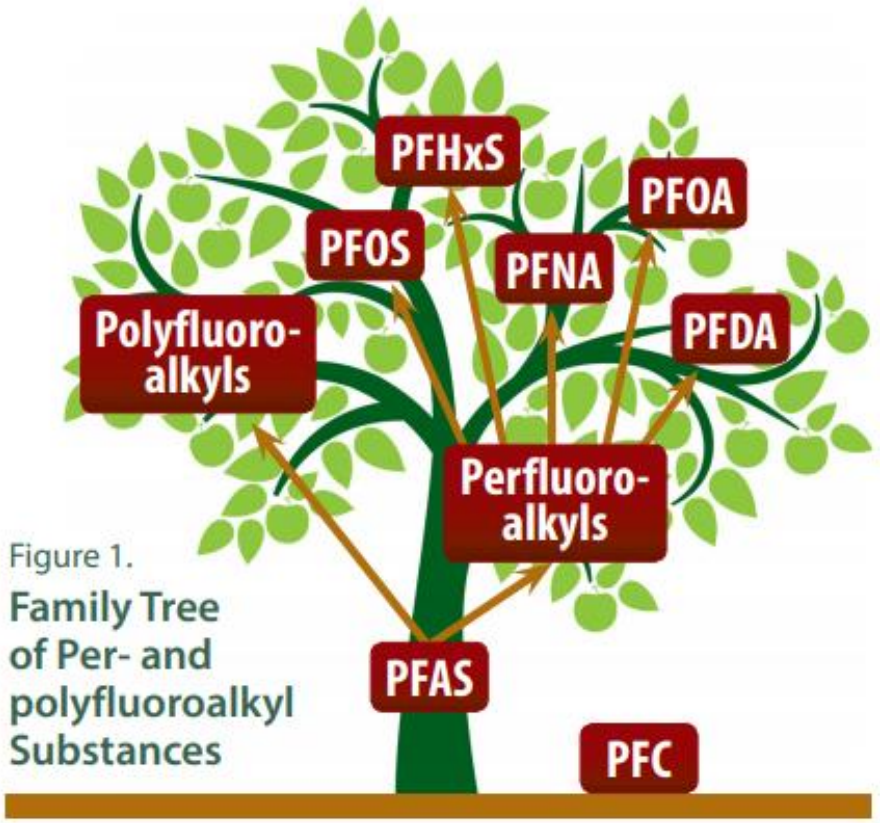
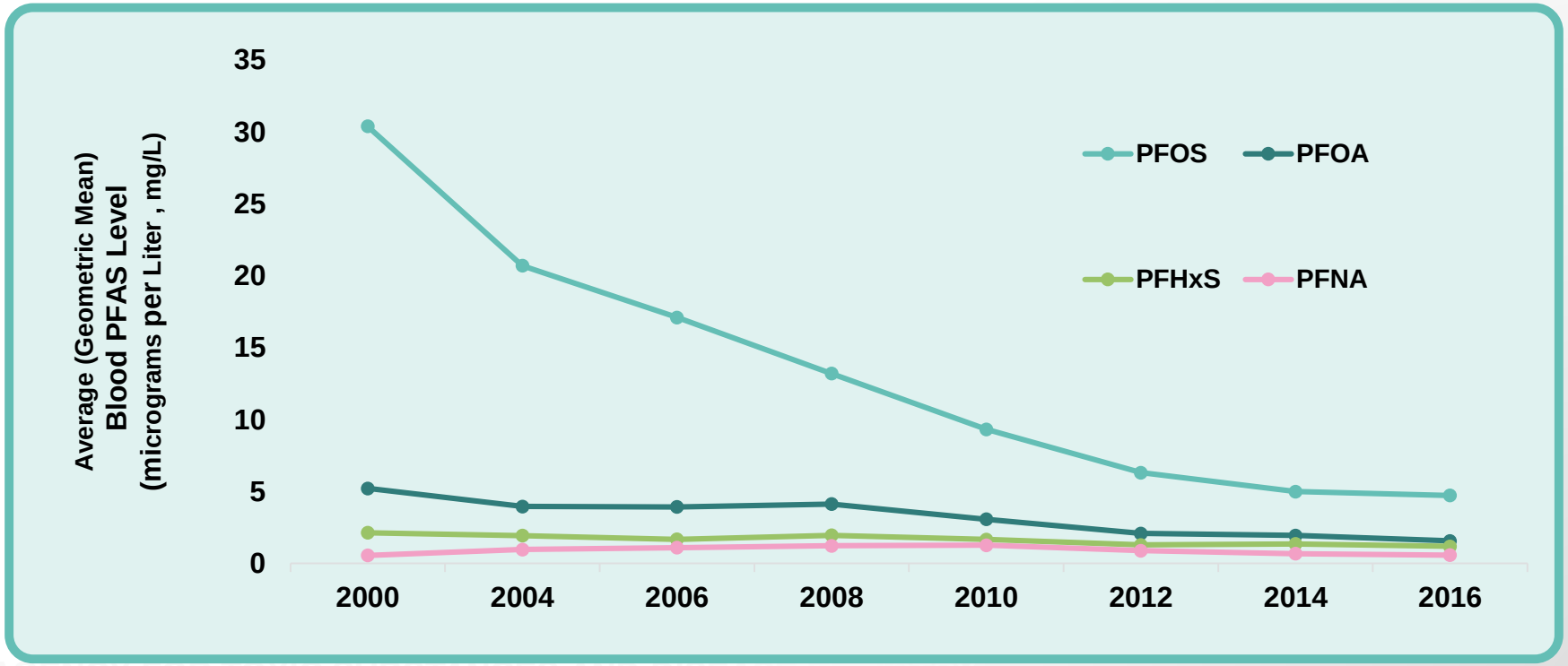


Figure 1.
Family Tree of Per- and polyfluoroalkyl Substances

PFAS in the US Population

CDC's National Health and Nutrition Examination Survey (NHANES) has been measuring PFAS in the blood of the general US population since 1999

Blood Levels of the Most Common PFAS in US Population, 2000-2016



Data Source: CDC. Fourth National Report on Human Exposure to Environmental Chemicals, Updated Tables, January 2019, Volume One.

PFAS in the Environment- Uses

PFAS Uses:

- Non-stick cookware
- Carpet and clothing treatments
- Paper and cardboard packaging
- Food containers/wrapping
- Waterproof clothing/coating
- Aqueous film-forming firefighting foam (AFFF)

PFAS in the Environment - Sources

Sources:

- Waste from manufacturing facilities
- AFFF fire fighting foam run-off
- PFAS-containing sludge used as soil amendment
- Occupational settings

PFAS in the Environment – Exposure Pathways

- **Ingestion:**
  - Drinking water
  - Food grown/raised in PFAS-contaminated areas
  - Food containers/wrappers
  - Cookware off-gassing
  - Stain protectors
  - Breastmilk
- **Inhalation:**
  - Air and dust
- **Other:**
  - Cord blood

Biological Persistence in Humans

Substance	Half-life
Perfluorooctanoic acid (PFOA)	2.1 to 10.1 years
Perfluorooctane sulfonate (PFOS)	3.3 to 27 years
Perfluorohexane sulfonic acid (PFHxS)	4.7 to 35 years
Perfluorobutane sulfonate (PFBS)	0.1 years

PFAS Elimination in Humans

- PFAS bind to tissue proteins, accumulate in the blood, and at much lower levels, in the liver, kidneys, and brain
- Most PFAS are not metabolized by the body
- PFAS are primarily excreted through urine
- In women, PFAS are also excreted through breastmilk and during pregnancy and menstruation
- Shorter-chain PFAS tend to be eliminated faster than long-chain PFAS
- Elimination rates appear to be different in males and females

Clinical Importance of PFAS Exposure

- PFAS have been detected in the blood of most people tested in the US, exposure is widespread
- Some PFAS bioaccumulate in people and have long half-lives
- Research suggest that PFAS exposure in humans may affect many organ systems
- PFAS have been detected in many drinking water systems across the country at levels that exceeded the EPA health advisory putting populations at risk

EPA Health Advisory

- EPA established a Health Advisory for PFOA and PFOS to provide communities with information on the health risks of these chemicals
- The EPA Health Advisory in drinking water is currently 70 parts per trillion (ppt), individually or combined
- Some states have released their own advisories, which are often much lower
- EPA's Health Advisory is non-regulatory, but provides a threshold for consideration

RISK OF ADVERSE HEALTH EFFECTS FROM PFAS

Risk of Adverse Health Effects from PFAS

- The risk of adverse health effects from exposure to PFAS depends on:
  - Potential toxicity of the specific species
  - Bioaccumulation
  - Exposure dose
  - Frequency, route and duration of exposure
  - Phase of life at time of exposure
  - Genetic and epigenetic variations in individuals

Why Children are a Susceptible Population

- PFAS can reach children through:
  - The placental barrier
  - Breastmilk
- Children are more vulnerable because they:
  - Have an immature blood-brain barrier
  - Have immature vital organs
  - Ingest more toxicants (pound per pound, weight)
  - Spend more time on the floor
  - Are more likely to put objects in their mouths

PFAS and Breastmilk Risk

- PFOS and PFOA are commonly found in breastmilk and cord blood.
- Background levels have been steadily declining over the last decade
- Depending on the specific PFAS, breastmilk concentrations reflect roughly 3% to 10% of maternal serum concentrations
- The benefits of breastfeeding currently outweigh any potential risk posed by PFAS exposure through breastfeeding

PFAS ANIMAL RESEARCH FINDINGS

Research Findings: Animal Studies

- Animal studies have demonstrated increased risk of adverse health effects, but the effects occurred at exposure levels higher than most people experience. The main health effects observed were:
  - Enlargement and changes in the function of the liver
  - Changes in hormone levels
  - Suppression of adaptive immunity
  - Adverse developmental and reproductive outcomes

Strengths & Limitations in Animal Research Findings

Informative for humans

- Potential organs systems affected
- Precise exposure evaluated
- Evaluate controlled exposure without other exposures

Differences from humans

- Half-lives
- Metabolic differences
- Lack genetic diversity
- Doses typically higher compared to human experience

PFAS ASSOCIATED HUMAN HEALTH EFFECTS

C8 Study

The C8 Health Study (2005-2013), an epidemiological study of 69,030 persons ≥18 years found a probable link* between exposure to PFOA and:

- Increased cholesterol levels
- Ulcerative colitis
- Thyroid effects
- Increased risk of high blood pressure or pre-eclampsia in pregnant women
- Increased risk of kidney cancer
- Increased risk of testicular cancer

*Probable link here means that given the available scientific evidence, it is more likely than not that among class members a connection exists between PFOA exposure and a particular human disease.

Elevated Cholesterol

Epidemiological studies have identified significant positive correlations between serum PFOA and PFOS concentrations and total cholesterol specifically in:

- Residents of communities with high levels of PFOA in drinking water
- Workers exposed to PFAS in occupational context

Immune Dysfunction in Children

The National Toxicology Program (NTP) conducted a systematic review of the human, animal, and in vitro data examining immunotoxic effects of PFOA and PFOS

- NTP concluded that both PFOA and PFOS are "presumed to be immune hazards to humans"
  - Decreased antibody response to vaccines
  - Evidence of impairment of infectious disease resistance is weak

Testicular and Kidney Cancer

- International Agency for Research on Cancer (IARC) classified PFOA under Group 2B, possibly carcinogenic to humans
- Evidence suggests carcinogenic potential for both PFOS and PFOA in humans
- Workers exposed to PFAS and residents living near a PFOA production facility have both experienced increases in testicular and kidney cancer

Other Health Effects

Effects	Details
Elevated serum uric acid	
Liver	Elevated AST, ALT, GGT, ALP
Kidney	Reduced kidney function, dysregulated metabolic pathways
Endocrine	Increased body fat and risk of cardio-metabolic disorders, obesity
Thyroid effects	Increased TSH, T3, T4
Ulcerative colitis	
Asthma	
Neurodevelopmental	ADHD, autism, hyperactivity
Neurobehavioral	Learning problems
Reproductive health	Lower fertility and fecundity
Preeclampsia	
Reduced birth weight	

Strengths & Limitations of Human Epidemiological Studies

Strengths

- Represent real world exposures and scenarios
- Supports many of the toxic endpoints observed in animal studies

Limitations

- Exposure to multiple PFAS that are correlated presents challenges to interpretation
- Prospective studies are more expensive/take longer to conduct but are stronger than cross sectional studies
- Complexity of differences between individuals regarding other non PFAS exposures & vulnerability factors is important to address and challenging to do

Understanding the evidence base

- No single animal or human epidemiological study can establish causality.
- Overall, the evidence base for PFAS effects on health is in its infancy. Many of the newer PFAS have very limited study.
- Currently, the ATSDR PFAS clinician guidance reports “No causal relationship has been established” for those health effects from epidemiological studies.
- As the research evolves and grows, observed consistency among studies, dose-response relationships, & identification of susceptibility co-factors will enhance our understanding of the health implications of exposures in the population.

ADDRESSING HEALTH-RELATED PFAS CONCERNS WITH YOUR PATIENTS

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**95th percentile was below the limit of detection, 0.1 µg/L.

Hypothetical Clinical Encounter

- It is appropriate to discuss the patient's concerns and perform a:
  - A thorough health and exposure history
  - A physical exam
  - Appropriate laboratory evaluation
    - If indicated by the reported signs and symptoms or the potential differential diagnosis

Questions to Consider for Clinical Encounter

- Are you able to interpret the results?
- Does this family need further testing?
  - If so, for what?
- How else can you help this patient (e.g., reducing exposure and stress)?

Talking to Patients

- A visit to the physician's office can leave patients feeling supported and reaffirmed or it can leave them feeling frustrated, judged and concerned
- Tips for engaging with patients concerned about PFAS exposure:
  - Engage proactively
  - Show empathy for the patient's concerns (i.e., listen and validate)
  - Be clear and honest about what you do and don't know
- For delivery of preventive care use AAP's *Bright Futures*, 4th edition for children and the *Guide for Preventive Clinical Services* for adults

Treatment Recommendations

- For asymptomatic individuals exposed to PFAS, there is insufficient evidence to support deviations from established standards of 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 (NHLBI) guidelines for pediatric cholesterol screening, regardless of PFAS exposure
- There is no change to the current immunization schedule for children exposed to PFAS

Recommendations for Pregnant and Breastfeeding Women

- Monitor blood pressure during pregnancy, but no need for additional measurements
- Given the scientific evidence at this time, the benefits of breastfeeding outweigh those of not breastfeeding
- Women who choose to breastfeed should continue to do so even if exposed to PFAS

Preventative Measures to Reduce Exposure

If the PFAS concentration detected in a patient's drinking water is above the EPA Health Advisory and/or a state's guidelines, or if a patient is concerned, they can:

- Install a filtration system or use a pitcher-type filter
- Use an alternative water source for drinking, food preparation, cooking, brushing teeth, or any other activity that might result in ingestion of water

Additionally patients should

- Check for local fish advisories
- Read consumer product labels and avoid using those with PFAS

Blood Testing

- While most people in the US have measurable amounts of PFAS in their blood, there is no established PFAS blood level at which a health risk is expected or can be predicted
- Serum PFAS measurements are most helpful when they are part of a carefully designed research study
- A patient's PFAS blood concentration can be compared to:
  - Those measured in the general US population as part of NHANES
  - Those from other biomonitoring studies in PFAS-affected communities
- If you decide to test your patient, serum PFAS level tests are commercially available

KEY TAKEAWAYS

Key Takeaways

- Most people in the US have some PFAS in their bodies
- When patients express concern about PFAS exposure, be prepared to talk about exposure history, health effects and blood testing
- Reducing exposure to PFAS is the most important first step for families with concerns
- There are currently no deviations from established standards of care for patients with elevated PFAS serum concentrations
- When talking to patients, empathize, validate their concerns and be honest about what you know and what you can do to help
- Promote standard, age-appropriate preventive care measures for general health and wellness (i.e., Bright Futures and Clinical Preventive Services guide)

RESOURCES

Evaluation: https://is.gd/pfasindrinkingwater

Resources

- PEHSU
  - https://www.pehsu.net/PFAS_Resources.html
- Updates on CDC/ATSDR PFAS Initiatives
  - https://www.atsdr.cdc.gov/pfas/related_activities.html
- ATSDR Guidance for Health Professionals
  - https://www.atsdr.cdc.gov/pfas/info-for-health-professionals.html
- PFAS Overview
  - https://www.atsdr.cdc.gov/pfas/index.html
- National Report on Human Exposure to Environmental Chemicals, 2018
  - https://www.cdc.gov/exposurereport/pdf/FourthReport_UpdatedTables_Volume1_Mar2018.pdf
- Resources on Medical Testing
  https://georgetown.app.box.com/s/da8t2cekmeidsgkcq41i2sufd2tgmu1n
- EPA Data on unregulated contamination
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Slide 10

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Slide 14

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