Third Report of the Independent PFAS Scientific Advisory Panel for Jersey – Testing, biomonitoring and management of PFAS in the human body.

May 2025 (revised October 2025)

PSAP
PFAS Scientific Advisory Panel

Executive summary

This report is the third in a series produced by the Independent PFAS Scientific Advisory Panel for Jersey. It focuses on the testing, biomonitoring, and management of PFAS (per- and polyfluoroalkyl substances) in the human body.

Per- and polyfluoroalkyl substances (PFAS) are synthetic compounds that have been used extensively in industrial processes (e.g. fluoropolymer manufacturing) and consumer products (e.g. non-stick cookware and water-repellent textiles) since the 1950s. From the late 1960s onwards, PFAS have also been used in aqueous film forming foams (AFFF), which are used to extinguish certain types of fires. The exceptional durability of PFAS, while advantageous in industrial settings and consumer products, also renders them highly persistent in the environment. This high persistence combined with the ability of certain PFAS with long perfluoroalkyl chains to bioaccumulate in humans means that they are capable of building up in human tissues. Certain long-chain PFAS have also been linked to multiple adverse human health outcomes.

In Jersey, extensive use of AFFF at the airport's firefighting training facility led to PFAS contamination of nearby groundwater and subsequently private drinking water wells used by residents. While the extension of mains water in 2006 reduced some direct exposures, PFAS can remain in human bodies for years, prompting the Government of Jersey in 2022 to initiate blood testing for potentially affected residents. They subsequently recruited a PFAS Scientific Advisory Panel to offer independent advice.

The panel reviews the published scientific evidence, hears from affected Islanders and meets with subject matter experts from around the world.

The long-chain PFAS present in AFFF accumulate in the body mainly via ingestion (e.g., contaminated water or foods), and are distributed to blood serum and other tissues. Because these chemicals resist metabolic breakdown and the human body eliminates them only slowly, they have notably long biological half-lives in humans. After external exposures cease or diminish, the levels of long-chain PFAS in serum gradually fall through urinary excretion, faecal elimination, and menstrual blood loss. However, because PFAS are continually reabsorbed in the gut and kidney and preferentially bind to proteins, clearance remains slow.

Epidemiological research typically indicates that the higher a person's PFAS levels, the greater the likelihood of certain adverse health outcomes, such as elevated cholesterol and specific cancers. While the shape of these relationships can vary with exposure and between studies; some data suggest a plateau at higher concentrations; the overarching trend holds that rising PFAS correlates with heightened health risk. Encouragingly, some studies show that reductions in PFAS levels may partially reverse the impact on these associated markers (e.g., lowering cholesterol). However, quantifying direct benefits of reducing serum levels in terms of long-term disease risk remains uncertain and an evolving area of study.

PFAS Testing and screening for health effects

Assessing PFAS exposure in communities or individuals typically involves measuring concentrations in blood serum. Public health bodies may implement serum measurement when there is credible evidence that a subset of individuals has higher-than-average PFAS exposure. Such testing can:

- **Identify Individuals at Elevated Risk:** Serum PFAS testing pinpoints those whose levels surpass typical background values, allowing for more targeted health surveillance or interventions.
- **Characterise the Extent of Contamination:** Aggregating test results can help authorities map which neighbourhoods or water supplies are most affected.
- **Guide Communication and Mitigation Strategies:** Positive tests may prompt installation of filtration systems, recommendations for alternative water sources, or advice on lowering other potential exposure routes.

In Jersey's case, the 2022 screening initiative offered blood tests to people suspected of having consumed contaminated borehole water for extended periods, and who had certain illnesses or symptoms, uncovering some with markedly elevated PFAS.

While PFAS serum tests are highly effective at confirming exposure, their direct clinical value can be nuanced:

- **Individual Risk vs. Population Patterns:** Even at elevated PFAS levels, not all individuals develop associated health problems; these chemicals typically raise risks in a population-wide sense.
- **Intervention Guidance:** Testing results may help medical professionals or public health workers decide if measures to reduce body burden are appropriate—especially for those at the upper range of exposures.

Retesting individuals can clarify whether interventions or changes in exposure effectively reduce PFAS. For instance:

- **Monitoring Efficacy of Treatments:** Populations using PFAS lowering treatments might undergo periodic blood tests to assess how quickly PFAS levels are declining.
- **Evaluating Source Remediation:** If a contaminated water source is switched to a clean supply, subsequent rounds of testing can confirm whether local PFAS loads are dropping.

In the absence of an intervention to evaluate, a formal research project or a medicolegal requirement, few public authorities consider retesting appropriate.

Because PFAS exposure has been associated with elevated cholesterol and certain cancers, some have proposed or implemented screening for these health issues in heavily affected communities:

- **Cholesterol Checks:** Given the consistent finding of higher LDL cholesterol in PFAS-exposed groups, lipid profiling can help detect dangerously high cholesterol, prompting conventional interventions like dietary changes or lipid-lowering medications.
- **Cancer Vigilance:** Screening for kidney and testicular cancers can be more challenging, as routine population screening is not typically recommended for these diseases. However, individuals aware of their elevated PFAS exposure may be encouraged to remain alert for suspicious symptoms and promptly consult healthcare providers.

Overall, screening for the downstream effects of PFAS is more about standard medical prudence (e.g., checking cholesterol if risk factors accumulate) than adopting specialised, PFAS-specific protocols. Nonetheless, knowledge of high PFAS levels may encourage earlier or more frequent checks for the conditions that are plausibly linked.

Interventions to Reduce PFAS Levels

Given the slow natural decline of PFAS, active interventions are of keen interest to individuals with especially high exposures. A variety of measures have been proposed or tested:

Dietary Fibre and Probiotic Supplements

- **Mechanism:** Some data suggest that higher fibre intake or certain probiotic regimens reduce gastrointestinal reabsorption of PFAS.
- **Effectiveness:** Observed declines are modest, typically in the single-digit percentage range, insufficient to substantially lower very high PFAS levels but potentially beneficial as an adjunct measure.
- **Safety & Side Effects:** Usually minimal; some individuals experience bloating or other mild GI discomfort.
- **Cost-Effectiveness:** Inexpensive and non-invasive, though limited in magnitude of PFAS reduction.

Bile Acid Sequestrants

- **Mechanism:** By binding PFAS in the gut (along with bile acids), bile acid sequestrants facilitate faecal excretion instead of reabsorption.
- **Effectiveness:** Research appears to show these medications outperforming other interventions at significantly lowering PFAS levels in serum. PFOS, PFOA, and PFHxS all respond well, with multi-week or multi-month treatment regimens often showing substantial declines.
- **Safety & Side Effects:** Mild gastrointestinal issues, primarily constipation or bloating, are the most frequently reported side effects. Most patients can manage these effects long term with dietary adjustments and proper guidance.
- **Cost-Effectiveness: High.** Considering their robust PFAS-lowering potential, moderate side effects, and relatively low medication cost, bile acid sequestrants represent the single best intervention.

Phlebotomy (Blood Donation)

- **Mechanism:** Removing whole blood at regular intervals (e.g., every 8–12 weeks) removes PFAS bound to serum proteins.
- **Effectiveness:** Studies in firefighters and other exposed populations confirm significant PFAS reductions, but overall efficacy tends to lag behind that achievable with bile acid sequestrants.
- **Safety & Side Effects:** Potential risk of mild anaemia, especially if donation frequency is high; possible vasovagal reactions.
- **Cost-Effectiveness:** Moderate. Requires trained staff and repeated sessions, which can be logistically challenging, especially for larger cohorts.

Plasmapheresis and Plasma Exchange

- **Mechanism:** Plasma, rich in PFAS, is separated out and discarded or replaced with a substitute fluid, leaving blood cells behind.
- **Effectiveness:** Quick serum reductions are possible, although ongoing therapy falls short of the consistent effect of bile acid sequestrants.
- **Safety & Side Effects:** Invasive; risk of fluid imbalances or allergic reactions, plus repeated venous access.

- **Cost-Effectiveness:** Low for large-scale adoption. Special equipment, personnel, and higher complication risks.

Probenecid

- **Mechanism:** Known for boosting renal excretion of some acids, it has been suggested that it may raise clearance of PFAS.
- **Effectiveness:** Very little evidence of any efficacy. Studies in humans suggest that it does not increase renal excretion of PFAS
- **Safety & Side Effects:** GI upset, possible kidney stones, and allergic reactions if not carefully managed.
- **Cost-Effectiveness:** Uncertain. Probenecid is cheap, but its efficacy in PFAS removal remains unclear.

Haemodialysis

- **Mechanism:** Routine dialysis for end-stage renal disease may also remove PFAS from the blood, along with the other waste products, toxins and excess fluids targeted by haemodialysis.
- **Effectiveness:** Potentially sizable for those already on dialysis, but not a realistic intervention for healthy persons.
- **Safety & Side Effects:** Dialysis entails risks like infection, clotting, or fluid imbalances. It is an invasive procedure.
- **Cost-Effectiveness:** Unjustifiable solely to treat PFAS exposure in otherwise healthy individuals.

Comparative Cost-Effectiveness

1. **Bile Acid Sequestrants: Most effective and most cost-effective** in reducing PFAS among all available interventions, with relatively mild side effects and an affordable medication cost.
2. **Phlebotomy:** Demonstrably lowers PFAS but requires repeated sessions and is generally overshadowed by the more consistent, user-friendly benefits of bile acid sequestrants.
3. **Plasmapheresis:** Reasonably swift PFAS reduction yet resource-intensive, invasive, and less sustainable than daily medications.
4. **Dietary Fiber/Probiotics:** Low-risk and low-cost but only modestly beneficial. Useful as a supportive measure.
5. **Probenecid:** Data remain insufficient to confirm PFAS reductions.
6. **Haemodialysis:** Only pertinent to end-stage kidney disease patients, not a targeted PFAS intervention.

Recommendations:

- **That PFAS testing should be conducted at laboratories that have been accredited for assessing PFAS levels in human samples, with a full chain of custody and evidence of prevention of contamination from the point of sampling to the completion of the analytical testing. This is a prerequisite for test results to be considered valid.**
- **That PFAS testing be offered to those who met the 2022 PFAS testing criteria but did not choose to participate in the programme and also to those who did not have a relevant condition or symptoms, but met the other criteria for the 2022 programme. This includes any wider area of contamination that is identified through commissioned environmental assessments.**

- **That PFAS testing be offered to those who worked as firefighters during the period when firefighting foams containing PFAS of concern were in use, and to those who were involved in the transport, loading or cleanup of the concentrates, solutions or foams or in servicing or maintaining machinery or facilities contaminated with the foams as part of their job.**
- **That background levels of PFAS in the wider community, by parish, be estimated either by the analysis of altruistic blood donation samples, or excess serum collected to perform other tests, or by other means. This should be undertaken on an anonymous basis but with the age, sex and Parish of residence recorded.**
- **That clinicians, when seeing people with proven elevated serum PFAS, should consider testing for serum cholesterol.**
- **That when people who know or believe they have elevated serum PFAS exhibit symptoms which are consistent with kidney cancer or testicular cancer, clinicians should have a higher level of suspicion of cancer than in unexposed populations.**
- **That promoting regular testicular self-examination should be considered in PFAS-exposed populations**
- **That colesevelam be made available, on a case-by-case basis, to women of childbearing potential (who are not currently pregnant nor planning to be pregnant during any course of treatment) who have been found to have a total across 8 measured PFAS compounds (PFHxS PFOS PFOA PFHpS PFNA PFPeS PFDA MeFOSAA) of at least 10 nanograms per millilitre of blood serum. Those eligible should receive information explaining the potential impact of PFAS exposure on future offspring and the potential risks and benefits of intervention, so they can make an informed choice about whether they wish to take colesevelam. This intervention should be offered early in life, ideally, completing the course several months before planning a pregnancy, and appropriate advice about contraceptive methods and dietary supplementation given.**
- **That colesevelam be considered by clinicians as a lipid lowering therapy in people who have elevated cholesterol and who have been found to have a total across 8 measured PFAS compounds (PFHxS PFOS PFOA PFHpS PFNA PFPeS PFDA MeFOSAA) of at least 20 nanograms per millilitre of blood serum.**
- **That clinicians consider, for people who have been found to have a total across 8 measured PFAS compounds (PFHxS PFOS PFOA PFHpS PFNA PFPeS PFDA MeFOSAA) of at least 20 nanograms per millilitre of blood serum, where there is an exceptional benefit from the prescribing of colesevelam for that person on a case-by-case basis.**
- **That, only for those people who otherwise meet the criteria for an intervention (other than the elevated cholesterol criterion) but for whom colesevelam is not an appropriate intervention (due to adverse reaction or clinical contraindication), should therapeutic phlebotomy be considered as a second line offer.**
- **That people taking colesevelam or having phlebotomy to reduce PFAS, should have periodic repeat PFAS blood tests to check on the effect of the intervention.**
- **That when an individual's serum PFAS levels reach the median background levels, further colesevelam prescribing or therapeutic phlebotomy should not be undertaken**

Non-technical summary

There are some chemicals called PFAS. They were used in many things, like special foam to put out certain types of fires, pans that don't stick, and clothes that don't get wet. PFAS are very durable and do not go away easily, so they stay in the world and can get into our bodies.

Why People Are Worried

Some places in Jersey used a lot of foam with PFAS in when they practiced fighting fires. This foam got into the water in the ground and into private wells. People who drank water from those wells might have more PFAS in their bodies. PFAS can stay in our bodies for a long time. The government checked some people's blood in 2022 to see if they had too much PFAS.

How PFAS Stay in Our Bodies

PFAS get into our bodies mostly if we eat food or drink water which contains them. Once they are inside our bodies, it can take many years for them to come out again. This is because our bodies do not break them and they don’t get flushed out when we go to the toilet.

Why That Matters

Scientists say that if you have more PFAS in your body, you might have more problems, like high cholesterol or certain sicknesses. But it doesn't mean you will definitely get sick—just that the risk is higher.

Testing for PFAS

To see if people have PFAS, doctors or nurses can take a little bit of blood and test it. If the level is high, they can decide how to help. Some ways to help include giving certain medicines. If people change how much PFAS goes into their bodies, or take medicines to take PFAS out of their body, tests can be done again to see if the amount of PFAS has gone down.

Sometimes, doctors might also check cholesterol or look for signs of kidney and testicular cancer, because PFAS can be linked to those problems.

Ways to Lower PFAS in People

- **Eat More Fibre or Take Probiotics**: This might help a little, but it won't fix very high levels of PFAS.
- **Take Bile Acid Tablets**: These help your body get rid of PFAS when you poo. Scientists say this works the best for most people.
- **Give Blood (Phlebotomy)**: Taking some blood out can also lower PFAS. But it may not work as well as the bile acid medicine, and you have to do it often.
- **Plasmapheresis**: This is a process that takes out your blood, removes liquid called plasma (which has PFAS), and gives you back your blood cells. It works, but it is expensive and harder to do.
- **Probenecid**: Another medicine, but we don’t know if it really helps.

- **Dialysis**: People with bad kidney problems use machines to clean their blood, which can remove PFAS. But this is only for very sick people who need dialysis.

Ideas and Tips

- **Only Have Accredited Labs Test Blood and make sure that it gets there safely**: So we know the results are correct.
- **Give People Who Missed Testing Another Chance**: If they lived in the areas with PFAS but did not get tested before.
- **Firefighters and Other People Who Used PFAS Foams**: They should also get tested.
- **Check some of the General Public in a Simple Way**: We can see roughly how much PFAS is in people's blood who didn't live in the area with PFAS (without knowing who is who). This will tell us what normal levels are.
- **If You Have PFAS Exposure**: Doctors might want to check your cholesterol or be extra watchful for signs of certain cancers.
- **Bile Acid Tablets**: Women who might have babies and have high PFAS levels can take this medicine. People with high cholesterol and high PFAS might also benefit.
- **Phlebotomy**: If you cannot take the bile acid tablets, giving blood from time to time can help.
- **Stop When Levels Get Lower**: Once your PFAS are at more normal levels, you might not need these treatments.

Final Thoughts

PFAS stick around in our bodies and are tough to remove. But we can test for them in our blood, and we can try certain ways to help remove them. Using the right medicine, keeping track of our health, and stopping PFAS from coming back into our water and food are all important steps. That way, people in Jersey can stay healthier and worry less about these chemicals.

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1 Background

Per- and polyfluoroalkyl substances (PFAS) comprise a group of over 14,000 synthetic chemicals (this total number is evolving all the time and differs in various reports) used in a wide range of consumer product and industrial applications around the world including, from the 1960s, in fire-fighting foams, the manufacture of non-stick cookware, water repellents, and food packaging(Glüge et al., 2020). Their chemical stability and resistance to degradation(Cousins et al., 2020), which has led to long-term environmental contamination and the toxicological profiles of certain PFAS (*Toxicological Profile for Perfluoroalkyls*, 2021) have driven concerns regarding possible human health effects(Buck et al., 2011).

The main source of concern in Jersey relates to the historical use of PFAS-containing aqueous film-forming foams (AFFF) used in firefighting. PFAS-containing AFFFs have been effective in extinguishing liquid fuel fires but have been identified as a significant source of environmental contamination(Prevedouros et al., 2006). These foams were in use at Jersey Airport and its on-site training facility in the parish of Saint Peter. Groundwater near the airport and, as a consequence, some water supplies became contaminated with PFAS. In 2006, mains water was extended to the area, and therefore the initial exposure from the airport is believed to have been markedly reduced for those households that switched to using mains water, although there will be some ongoing exposure from secondary sources and recirculation of PFAS. While AFFF use and consequent exposure started some years ago; before potential environmental and human health risks from PFAS had become known; the persistence of PFAS in the environment and in the human body mean that there are still concerns today.

In response to the concerns that had been raised, a company called Arcadis were commissioned in 2018 to survey private water supplies for the presence of certain PFAS, and an Officer Technical Group (drawing its membership from several directorates across Infrastructure and Environment, Public Health, Jersey Water and others) was established by the Government in 2019*PFAS in Jersey* (2023).

In 2022, a programme of blood testing was arranged for people who had regularly used borehole water supplies in the affected area as a source of drinking water and had symptoms consistent with conditions that have been associated with PFAS exposure.

In 2023, the Government of Jersey made provision, through the public health team, to commission an independent group of scientists to assess the current situation in Jersey, with regard to PFAS, and make recommendation for actions to be taken. The Independent PFAS Scientific Advisory Panel has three standing members and a standing observer from the public health team. They have regular, publicly livestreamed, meetings where they hear from subject matter experts from around the world, as well as from affected people in Jersey (experts by experience). The key issues brought to light by these contributors as well as those from the scientific literature are explored. The standing Panel members are:

- PFAS Scientific Advisory Panel Chair, Dr Steve Hajioff

  Steve Hajioff is an experienced leader with over 30 years as a practicing doctor and more than two decades in leadership roles in the health sector and public health practice: including being Director of Public Health in the London Borough of Hillingdon - an area with two international airports and other environmental challenges. He has worked for a variety of organisations including the WHO, World Bank, EU, international governments, UK government departments, the Greater London Authority (where he co-led the health impact assessment of the nine mayoral strategies), several NHS bodies, and has advised BMJ, Elsevier, British Standards Institute, Reuters, and many others. He is experienced at chairing scientific panels, having chaired two high-profile guideline development groups for NICE, and also at chairing groups with a high level of political and media engagement; he chaired the Representative Body of the British Medical Association for several years and several scientific fora, regional, national, and international. Steve has also served in Chief Medical Officer roles for a variety of biotechnology businesses and has been involved in many clinical trials.

- PFAS and health expert, Dr Tony Fletcher

  Tony Fletcher PhD is an environmental epidemiologist with over 40 years' work in occupational and environmental epidemiology and risk assessment, with experience of studies of exposure, biomonitoring, and health impacts such as cancer, respiratory disease, and metabolic disorders. He has been researching the health effects of PFAS – perfluorinated substances – since 2005, as a member of the C8 Science Panel which led a major investigation on potential health effects of PFOA polluted drinking water in West Virginia and Ohio. More recently he has been working in epidemiology programmes in PFAS-contaminated communities in Ronneby, Sweden and Veneto, Italy. He is currently Associate Professor at the London School of Hygiene and Tropical Medicine, where he has been since 1992, and has held jobs in the past at Public Health England, UKHSA, the International Agency for Research on Cancer (IARC) in Lyon, France, Birmingham University, the MRC Environmental Epidemiology Unit, Southampton and Aston University. He was Adjunct Research Professor in Environmental Health in the School of Public Health, Boston University, Massachusetts, and President of International Society for Environmental Epidemiology.

- PFAS and environment expert, Professor Ian Cousins

  Professor Ian Cousins is Professor of Environmental Organic Chemistry at the Department of Environmental Science at Stockholm University. Professor Cousins leads a research group focusing on understanding the sources, transport, fate, and exposure of organic contaminants and is particularly well known for his research on PFAS. Professor Cousins has extensive PFAS research experience, dating back over 20 years to 1999. Some notable career highlights include being a keynote speaker at international PFAS workshops on multiple occasions and receiving several best paper awards for his research. In recent years, Ian has coordinated a large European multidisciplinary project, PERFORCE3, which focused on PFAS. He was also chair of the recent international conference, FLUOROS 2023, where the world's leading experts on PFAS gathered. Ian's research currently focuses on better understanding uses of PFAS and investigating suitable alternatives, using analytical approaches to measure PFAS in consumer products and environmental samples, and investigating the transport and fate of PFAS in the environment.

- Standing observer and Deputy Director of Public Health, Grace Norman
  Grace Norman is the Deputy Director of Public Health for Jersey. She began working in Jersey in 2021, and took on the role of Deputy Director in 2022. In the latter role, she has responsibility for health protection, which is the branch of public health which deals with infectious disease and environmental hazards, including PFAS. Grace led the work to arrange PFAS blood testing in 2022 and commissioning the Scientific Advisory Panel. Grace is a standing observer so that she can contribute to the discussion, bringing the island perspective and knowledge from the work already undertaken.

The panel will be producing five reports over the course of its work programme to provide best available evidence and evidence-based recommendations to the Government of Jersey, other key stakeholders like health services and Jersey Water and to wider society across Jersey and, potentially, beyond.

The five reports are:

1. An interim report on the appropriateness and feasibility of the use of therapeutic phlebotomy to lower PFAS body burden in affected individuals in Jersey.
2. A report on the current state of knowledge about the health effects of PFAS on people and an evaluation of which groups of people may be at increased risk.
3. A review of the range of interventions which may reduce PFAS body burden in those with elevated PFAS levels and the expected impacts, along with recommendations on the nature and extent of serum PFAS testing in both the affected community and the wider population of Jersey.
4. A systematic review of the technologies and methods that may be used to manage PFAS in the environment, along with key strategies for environmental monitoring.
5. An update report taking into account new and emerging evidence from the previous report areas, as well as progress made and any emergent results in the environment or population of Jersey.

All the reports will take due account of the balancing of risks and benefits and also of opportunity cost, including any potential consequences of impacts on services, and will pay particular attention to ensuring that people at greater risk are given additional consideration. The overall approach the panel will take is:

- Being led by evidence
- Working through consensus
- Involving input from experts by experience and subject matter experts
- Public involvement throughout the process
- Default to meetings being in public
- Ability to work in private where there is a need for confidentiality
- Regular engagement with key stakeholders in addition to Panel meetings
- No surprises

Each report will follow a similar process, with an initial draft scope being agreed within the panel and consulted on with stakeholders (including Islanders) before a final scope is developed. There will then be a series of systematic reviews of the available, relevant scientific literature and the consideration of evidence from subject matter experts and experts by experience. These draft reviews and meeting summaries will be shared in advance of the publicly accessible Panel meetings,

where they will be discussed, and draft inferences and recommendations arrived at. A draft report will be prepared, integrating the various workstreams and will be shared with Government of Jersey through public health (the commissioners of the process) and with the public for consultation and comment. The consultation findings will be reviewed by the panel and, where appropriate, the report revised. The final report will be shared with the Government to consider the findings and launched through one or more public meetings. The panel meets normally once a month online and the public can observe and email in comments, the agenda and minutes of the meetings are publicly available on the Jersey Government website: PFAS in Jersey (gov.je)

In order to optimise the use of time, there may be some time overlap between consecutive reports, with reports processes starting before the previous report has been finalised.

2 Introduction and approach

The assessment and quantification of any effects resulting from environmental contamination is a complex process. Even if there is sufficient high-quality evidence to quantify a risk, translating a population level risk to the health of an individual or group of individuals is difficult. In a similar way, the appraisal and evaluation of scientific studies is a complex matter, and several criteria are crucial to that assessment. It is not uncommon that a scientific study appears, on face value, to say something very clear, but does not really to have strong evidence that it is the case. Even if there is strong evidence in a particular study, different places and people have distinct characteristics that can make such findings less relevant.

Because of that level of complexity, the panel has decided to explain some of those concepts, techniques, and caveats in this section to make the discussion of specific findings later in the report easier to understand.

2.1 Understanding efficacy evidence

Clinical studies are important in advancing medical knowledge, improving people's health, and developing new treatments and therapies. These studies are designed to investigate various aspects of human health, ranging from understanding disease mechanisms to assessing the effectiveness, acceptability, cost-effectiveness and safety of medical interventions.

2.1.1 Types of clinical study

There are several different methodologies for conducting clinical studies; each having different strengths, weaknesses, and ethical considerations. Some of these are outlined below(*What types of studies are there?*, 2016).

1. **Observational Studies**: Observational studies are designed to observe and analyse individuals in their natural settings without any intervention by the researchers. They aim to identify associations between certain variables, such as risk factors and health outcomes. Observational studies can be categorized into three main types:
    a) **Cohort Studies**: Cohort studies follow a group of people over a specific period, tracking their exposure to risk factors and monitoring their health outcomes. These studies help identify potential causes or risk factors for diseases.
    b) **Case-Control Studies**: In case-control studies, researchers compare individuals with a particular outcome (cases) to those without it (controls). By analysing past exposures or characteristics, researchers can determine potential associations between risk factors and diseases.
    c) **Cross-sectional Studies**: Cross-sectional studies collect data at a specific point in time to assess the prevalence or frequency of a condition or exposure in a population. They provide a snapshot of the population and help generate hypotheses for further investigation.
    d) **Case series**: Case series studies are a type of observational research design that provides valuable insights into rare or novel medical conditions, treatments, or interventions. In these studies, researchers collect and analyse data from a group of patients who share similar characteristics or have been exposed to a particular treatment. Unlike randomised controlled trials, case series studies lack a control group, making them less rigorous in establishing causality but highly informative in generating hypotheses for further investigation. Medical professionals often employ

case series studies to explore the presentation of new diseases, adverse reactions to medications, or the outcomes of innovative treatments when randomised trials may not be feasible or ethical.(Mathes & Pieper, 2017).

2. **Experimental Studies**: Experimental studies involve intentional manipulation of variables to assess the effects of interventions or treatments. These studies are often used to evaluate the efficacy and safety of medical interventions. Experimental studies can be further divided into two main categories:
    a) **Randomised Controlled Trials** (RCTs): RCTs are considered the gold standard in clinical research. Participants are randomly assigned to different groups: an intervention group receiving the treatment under investigation and a control group receiving either a placebo or standard care. Ideally this is done on a “double blind” basis; where neither the participants nor the treating clinicians know whether an individual is in the intervention group or the control group. RCTs allow researchers to establish causal relationships between interventions and outcomes.
    b) **Non-Randomised Controlled Trials**: In some cases, randomisation may not be feasible or ethical. Non-randomized controlled trials assign participants to different groups based on other criteria, such as their location, age or clinical characteristics. While these studies have limitations, they can still provide valuable insights when randomised designs are not possible.
3. **Intervention Studies**: Intervention studies focus on assessing the effects of specific interventions or treatments on participants' health outcomes, clinical markers and/or biomarkers of exposure. These studies aim to investigate the potential benefits, risks, and optimal dosage or administration of interventions. They can be conducted as both experimental and non-experimental studies, including clinical trials and other controlled investigations. Such studies may or may not have comparison groups with different interventions, or a control group with no intervention. Healthcare service evaluations may also be interventional studies.
4. **Descriptive Studies**: Descriptive studies aim to describe the characteristics, patterns, and distribution of diseases or health-related events in populations. They often involve collecting data from medical records, surveys, or registries. Descriptive studies provide valuable information about the burden of diseases, risk factors, and potential public health interventions. They may also highlight areas for further study.
5. **Healthcare service evaluation**: Healthcare service evaluation studies play an important role in assessing and improving the quality and effectiveness of healthcare services. These studies are designed to analyse the various aspects of healthcare delivery, ranging from the accessibility and affordability of services to the satisfaction of patients and overall health outcomes. Researchers use a combination of quantitative and qualitative methods to gather data, often involving surveys, interviews, and clinical assessments. By scrutinising these findings, healthcare professionals and policymakers can identify strengths, weaknesses, and areas for enhancement in healthcare(Moore et al., 2015).
6. **Literature-based studies**: Literature-based studies are studies where scientific research that has been published in academic journals is analysed together so overall conclusions can be drawn. They are powerful methods of evidence synthesis in medical research that aim to summarise and evaluate the findings of multiple individual studies on a specific topic(Bello et al., 2015).

a) **Systematic reviews**: Systematic reviews involve a comprehensive and systematic search of the literature to identify all relevant studies meeting predefined inclusion criteria. Once selected, these studies are critically appraised for their quality, and their results are synthesised to provide a comprehensive overview of the evidence available.
b) **Meta-analyses**: Meta-analyses take the process one step further by statistically combining the results of the included studies, providing a more precise estimate of the treatment effect or association between variables.

By pooling data from multiple sources, systematic reviews and meta-analyses increases the statistical power and generalisability of the findings, enabling researchers and healthcare professionals to draw more robust conclusions and make evidence-based decisions.

2.1.2 Components of clinical studies

The analysis above explores the different approaches to clinical study design, but there are common components or concepts that may be necessary regardless of the type of study. These include(Evans, 2010):

- **A study protocol**: This is a written document that describes the purpose of the study, the study design, the methods that will be used, and the safety and ethical considerations.
- **Inclusion and exclusion criteria**: These are the criteria that participants must meet in order to be eligible to participate in the study. This can relate to a given illness or exposure to a given hazard, to the person's wider characteristics like age or gender, or to other characteristics that may impinge on potential risk or benefit.
- **Informed consent**: This is a process that explains the study and any risks, benefits and rights to potential participants. Participants must sign an informed consent form before they can participate in the study.
- **Data collection**: This is the process of collecting information about the participants, such as their medical history, their responses to the treatment, and any side effects they may experience.
- **Data analysis**: This is the process of analysing the data that was collected to determine the safety and effectiveness of the treatment.

2.1.3 The study protocol

A study protocol is the blueprint for a study and ensures that all aspects of the study are conducted in a consistent and ethical manner. A study protocol should include the following information:

- The purpose of the study
- The study design
- The methods that will be used
- The safety and ethical considerations
- The inclusion and exclusion criteria
- The informed consent process

- The data collection methods
- The data analysis plan

2.1.4 The importance of sample size in clinical studies

Sample size determination is crucial for ensuring adequate statistical power in a clinical study. Statistical power refers to the probability of detecting a true effect when it exists. By including an adequate number of participants, researchers increase the power of their study, enabling them to detect smaller, yet clinically meaningful, differences between treatment groups. A small sample size may result in insufficient power, leading to a higher likelihood of false-negative results and missed opportunities for identifying effective interventions. Therefore, a larger sample size enhances the ability to detect significant treatment effects accurately(Evans, 2010).

The generalisability of study findings, or external validity, is contingent on an appropriate sample size. In clinical research, it is essential to ensure that the sample is representative of the target population to generalize the results to a larger group of individuals. A small sample size may not adequately capture the heterogeneity (differences) present in the population, leading to limited external validity. By increasing the sample size, researchers can enhance the representativeness of the sample, increasing the generalisability of the study findings and their applicability to a broader population. For this reason, a study with a smaller sample size is usually less influential scientifically that a similar study with a larger sample size.

Sample size also influences the precision of statistical tests and the width of confidence intervals. Statistical significance is determined by the p-value, which measures the probability of obtaining the observed results by chance alone. A larger sample size increases the precision of estimates leading to narrower confidence intervals. Consequently, it becomes easier to determine whether the observed results are statistically significant or due to random variation. A small sample size can result in wider confidence intervals and decreased precision, which may lead to inconclusive findings or overestimation of treatment effects.

Several factors influence the determination of an appropriate sample size. These factors include the research question, study design, desired effect size, expected variability, statistical power, and available resources. Researchers must carefully consider these factors to strike a balance between practicality and statistical robustness. Consulting statisticians and utilising power calculations can aid in sample size estimation and ensure that the study has sufficient power to detect clinically meaningful effects.

Generally speaking, cohort studies or studies that contain a control group need to be larger than things like case series or healthcare evaluation studies(Mathes & Pieper, 2017), so it is not always practicable to conduct an RCT. This can be a particular issue with smaller effect sizes, rarer conditions or smaller populations.

2.2 Ethical issues

In any clinical study, there are key ethical considerations(Muthuswamy, 2010). These Include:

1. **Informed Consent**: As alluded to above, one of the fundamental ethical principles in clinical studies is obtaining informed consent from study participants. Informed consent ensures that individuals fully understand the nature, purpose, risks, and benefits of the study before deciding to participate. Researchers have a responsibility to provide clear and comprehensive information to participants, allowing them to make autonomous decisions.

Informed consent must be voluntary, without any coercion, and participants should have the freedom to withdraw from the study at any time without penalty.

2. **Beneficence and Non-Maleficence**: The principles of beneficence and non-maleficence emphasise the obligation of researchers to maximise benefits and minimise harm to study participants. Researchers must carefully design studies to maximise potential benefits while minimising risks and adverse effects. Ethical considerations include selecting appropriate control groups, ensuring the validity and reliability of data collection, and monitoring participant safety throughout the study. If potential risks outweigh the expected benefits or if harm occurs during the study, researchers have an ethical obligation to halt the study and prioritise participant well-being.
3. **Privacy and Confidentiality**: Respecting privacy and maintaining confidentiality are crucial ethical considerations in clinical studies. Participants' personal information, medical records, and study data must be kept confidential to protect their privacy and maintain trust. Researchers must adhere to strict data protection protocols, use anonymised data whenever possible, and ensure that only authorised individuals have access to participants' personal information. Safeguarding privacy is not only a legal requirement but also an ethical imperative that promotes respect for individuals and upholds their dignity.
4. **Equitable Participant Selection**: Equity in participant selection is essential to avoid biases and ensure fair representation in clinical studies. Researchers should strive to include diverse populations, including individuals of different ages, genders, races, and socioeconomic backgrounds, to ensure the generalisability of study findings. Exclusion criteria must be scientifically justified and not based on discriminatory factors. Ethical considerations also involve addressing any potential power imbalances between researchers and participants and promoting inclusivity in the research process.
5. **Risk-Benefit Assessment**: Clinical studies must undergo rigorous risk-benefit assessment before initiation. Researchers must carefully evaluate the potential risks and benefits associated with the study and weigh them against alternative approaches. The risks should be minimised to the greatest extent possible, and the potential benefits should outweigh the potential harm. Ethical considerations include regular monitoring of participant safety during the study and prompt reporting of any adverse events to relevant authorities.

Ethical considerations in clinical studies are essential to protect the rights, safety, and well-being of study participants. For this reason, most studies will need to undergo ethical scrutiny from an external body, either an institutional ethics committee or a national or regional one.

2.3 Assessment approach for interventions

In looking at the different potential interventions, we have recognised that there are several dimensions that may need to be considered in assessing the optimal approach. These are discussed in this section.

2.3.1 Clinical effectiveness

Clinical effectiveness refers to the extent to which specific healthcare interventions, when used under real-world conditions, achieve desired health outcomes. It encompasses the assessment of both the benefits and risks of treatments, procedures, and health services, thus guiding clinical decision-making and policy formulation. Evaluations often rely on evidence from randomized controlled trials, observational studies, and meta-analyses to determine the effectiveness of interventions. The goal is to ensure that the healthcare provided to patients is not only safe and efficient but also leads to improved health outcomes. For instance, the National Institute for Health and Care Excellence (NICE) in the UK employs rigorous methodologies to evaluate clinical effectiveness, influencing practice guidelines and policy decisions. (Shekelle et al., 1999)

2.3.2 Cost effectiveness

Cost-effectiveness in healthcare evaluation examines the balance between the costs incurred by healthcare interventions and the health outcomes they produce, typically measured in terms of quality-adjusted life years (QALYs) or disability-adjusted life years (DALYs). This approach helps determine the most efficient allocation of healthcare resources by comparing the relative costs and outcomes of different interventions. Cost-effectiveness analysis (CEA) is crucial for policymakers and healthcare providers as it aids in prioritizing interventions that provide the greatest benefit relative to their cost. For example, the World Health Organization (WHO) recommends using CEA to inform resource allocation decisions(World Health et al., 2003), ensuring that health investments maximize population health benefits. Additionally, organizations like the National Institute for Health and Care Excellence (NICE) in the UK employ cost-effectiveness thresholds to decide which treatments and technologies should be funded by the National Health Service (NHS)(National Institute for Health and Care Excellence, 2013).

2.3.3 Risks and side effects

Risks and side effects are critical components in treatment evaluation, as they directly affect patient wellbeing and the overall effectiveness of medical interventions. Assessing these factors involves identifying potential adverse events, determining their likelihood and severity, and implementing strategies to mitigate them. This way, any benefits can be balanced against the risks of a potential treatment. Regulatory bodies like the Medicines and Healthcare products Regulatory Agency (MHRA) mandate extensive clinical trials to evaluate risks and side effects before approving new medications or therapies(Gough, 2005). Additionally, post-marketing surveillance is conducted to monitor adverse effects in the broader population after a treatment becomes widely available. Understanding and managing risks and side effects are essential for optimising treatment outcomes, improving patient trust, and ensuring the integrity of healthcare systems(World Health Organization, 2002).

2.3.4 Tolerability

Tolerability refers to the degree to which patients can endure the adverse effects of a medical treatment without significant discomfort or disruption to their quality of life. It is a critical factor alongside efficacy and safety when assessing the overall value of a therapeutic intervention. Tolerability impacts patient adherence to treatment regimens; if a treatment is poorly tolerated, patients may discontinue use or be less compliant, which can diminish the effectiveness of the

therapy. Evaluating tolerability involves collecting data on side effects and adverse reactions during clinical trials and post-marketing surveillance, often utilising patient-reported outcome measures to capture the patient's perspective. Understanding and improving tolerability can help optimise treatment plans, enhance patient satisfaction, and achieve better health outcomes(Stanulović et al., 2022).

2.3.5 Acceptability

Public acceptability in healthcare evaluation refers to the degree to which health interventions, policies, and services are perceived as appropriate and satisfactory by the general population. This concept encompasses factors such as cultural compatibility, ethical considerations, perceived effectiveness, and trust in healthcare providers and systems. Public acceptability is crucial for the successful implementation and sustainability of health initiatives, as interventions that align with public values and preferences are more likely to be adopted and adhered to by the community. For instance, the National Institute for Health and Care Excellence (NICE) in the UK considers public acceptability when developing health guidelines and policies, ensuring that they reflect the values and needs of the population(National Institute for Health and Care Excellence, 2021). Research shows that involving the public in the decision-making process through consultations and participatory approaches can enhance acceptability and improve health outcomes. Public acceptability thus plays a vital role in bridging the gap between healthcare provision and community needs, fostering a collaborative and responsive health system(Boivin et al., 2010).

2.3.6 Equality of access

Equality of access is a critical principle ensuring that all individuals, regardless of their socio-economic status, geographic location, ethnicity, gender, or other demographic factors, have equal opportunities to receive healthcare services. This involves assessing and addressing barriers that may prevent certain populations from accessing necessary care, such as financial constraints or lack of transportation. Research indicates that equitable healthcare systems not only improve health outcomes but also enhance social cohesion and economic productivity by ensuring that all individuals can lead healthy, productive lives(Marmot et al., 2008).

2.3.7 Capital and training requirements

Affordability of capital costs and service delivery is pivotal for ensuring sustainable and equitable health systems. Capital costs encompass expenditures for infrastructure, medical equipment, and technology necessary for healthcare delivery. Evaluating these costs involves analysing initial investments and long-term maintenance expenses to determine their financial feasibility and impact on service delivery(Zsolt & Peter, 2005). Service delivery costs include operational expenses, such as staffing, supplies, and administrative functions. Efficient allocation and management of these costs are crucial to maintaining affordability without compromising the quality of care.

2.3.8 Speed of deployment

The potential speed of deployment of a new healthcare intervention is determined by a combination of regulatory, logistical, clinical, economic, and social factors. Regulatory bodies like the Medicines and Healthcare products Regulatory Agency (MHRA) must review and approve interventions, and the duration of this process can significantly impact deployment speed(Van Norman, 2016). The robustness of clinical trial data demonstrating the intervention's safety and efficacy is crucial for swift regulatory approval and professional acceptance(DiMasi et al., 2016). The readiness of healthcare providers, including necessary training and familiarity with the new intervention, affects the implementation rate in clinical settings(Rogers et al., 2014). Economic factors such as cost,

reimbursement policies, and funding can either facilitate or hinder access to the intervention(McGuire & Pauly, 1991). Additionally, public and professional acceptance, shaped by perceived benefits and risks, play a critical role in adoption rates(Dearing & Cox, 2018). Therefore, the interplay of these factors collectively determines how quickly a new healthcare intervention can be made widely available.

2.4 Criteria for assessing the appropriateness of screening for illness or exposure in a population

Population screening programmes aim to detect diseases or environmental exposures at a stage where timely intervention can lead to better health outcomes, reduced morbidity, and potentially saved lives(Wilson et al., 1968). Nevertheless, launching a screening programme is resource-intensive and requires a robust framework to ensure that it does more good than harm(Andermann et al., 2008). This section discusses seven key criteria for evaluating the appropriateness of a population screening programme, focusing on screening for both diseases and environmental exposures.

1. Importance of the Condition or Exposure

A fundamental consideration for introducing a screening programme is whether the disease or exposure represents a significant public health concern. Conditions with high prevalence or those contributing substantially to morbidity and mortality are prime candidates for screening(Gray & Ison, 2009). In the case of disease-specific programmes, such as breast or cervical cancer screening, the condition's frequency and its severity justify extensive population-level efforts(Wilson et al., 1968). For environmental exposures; like radon, lead, or air pollution; the rationale may be compelling if the exposure is prevalent and carries a significant risk to population health

2. Understanding of Natural History and Epidemiology

A thorough understanding of the natural history and epidemiology of the disease or exposure is essential(Andermann et al., 2008). For diseases, knowledge of progression from early stages to advanced stages; and the potential asymptomatic or latent phase; is critical. During this subclinical window, early detection through screening can offer significant benefits(Wilson et al., 1968). A classic example is cervical cancer, which is often preceded by detectable precancerous lesions that can be discovered through cervical smears or HPV tests.

When assessing an environmental exposure, it is crucial to comprehend its dose-response relationship, how it accumulates in the environment or human body, and the timeframe in which adverse effects may manifest(Gray & Ison, 2009). For instance, elevated blood lead levels in children correlate with neurodevelopmental issues, and understanding this pathophysiology supports the rationale for proactive screening in at-risk communities.

3. Existence of a Valid and Reliable Screening Test

Any screening test must demonstrate both validity and reliability(Wilson et al., 1968). Validity refers to the extent to which the test is applicable to the real world context of the people being tested. Reliability refers to the test's sensitivity: the ability to accurately detect true positives; and specificity: the ability to avoid false positives(Andermann et al., 2008). A highly sensitive test minimizes missed cases, while high specificity ensures that individuals without the condition are not burdened by false-positive results. In environmental exposure screening, the test must be capable of detecting harmful substances in biological samples accurately and consistently(Gray & Ison, 2009).

Additionally, acceptability of the test to the population is a key factor. Screening tests that are invasive, expensive, or otherwise burdensome may face low participation rates, undermining programme effectiveness.

4. Availability of an Effective Intervention or Mitigation Strategy

Screening programmes must be supported by effective interventions or mitigation strategies for those who test positive(Wilson et al., 1968). Without a way to treat an early-detected disease or reduce a hazardous exposure, the screening process may only generate anxiety and unnecessary follow-up procedures(Andermann et al., 2008). For disease-based screening, proven treatments; whether surgical, pharmacological, or lifestyle-oriented; should demonstrably improve outcomes when administered early(Gray & Ison, 2009). For example, early-stage breast cancer detection through mammography often leads to more conservative treatment options and better long-term survival rates.

In the realm of environmental exposures, interventions might involve removing or reducing the source of exposure, as in reducing or stopping lead exposure for children found to have elevated blood lead levels, or reducing the body burden of the pollutant. Screening becomes truly valuable only if it leads to actionable steps that lower risk and improve health outcomes.

5. Demonstrated Benefit of Screening

A crucial criterion for introducing a screening programme at scale is evidence of real-world benefit(Wilson et al., 1968). Typically, this proof comes from randomised controlled trials or large observational studies that show improved outcomes; such as reduced mortality or morbidity; in screened groups compared to unscreened groups(Gray & Ison, 2009). In disease-focused screening, researchers might observe a drop in disease-specific mortality or earlier detection of less aggressive disease stages. For environmental exposures, demonstrated benefits might include reductions in exposure levels, subsequent decreases in disease incidence, or improvements in health indicators like respiratory function in areas with high air pollution(Andermann et al., 2008).

6. Cost-Effectiveness and Resource Availability

The introduction of a population screening programme can be expensive, necessitating careful consideration of cost-effectiveness(Gray & Ison, 2009). Economic evaluations estimate whether the potential benefits; such as lives saved or morbidity reduced; outweigh the financial and logistical expenses(Andermann et al., 2008). Costs include not only the screening tests themselves but also follow-up diagnostic procedures, treatments, or interventions, as well as the possible downstream burden of false positives or negatives(Wilson et al., 1968). In resource-limited settings, screening programmes must be carefully weighed against competing healthcare priorities.

7. Ethical and Social Considerations

Population screening initiatives must take ethical and social factors into account to ensure equitable access and proper patient care(Andermann et al., 2008). Ideally, these programmes should be readily available and accessible to all who would benefit, including socioeconomically disadvantaged or geographically isolated populations(Gray & Ison, 2009). Informed consent, confidentiality, and the right to privacy must be respected, especially when sensitive health information or exposure data is collected.

Ensuring appropriate support and counselling for individuals who test positive is likewise essential. They should not be left with alarming news about a serious disease or hazardous

exposure without clear guidance on possible next steps for mitigation or treatment(Wilson et al., 1968). By maintaining ethical transparency and social fairness, screening programmes foster trust and encourage higher rates of participation.

Conclusion

In summary, determining the appropriateness of a population screening programme involves systematically evaluating several critical criteria. Policymakers and public health teams must consider the significance of the health threat, the natural history and epidemiology of the condition or exposure, the quality and acceptability of the screening test, and the availability of effective interventions. Proven benefits through empirical studies, a favourable cost-effectiveness balance, and robust ethical and social frameworks further validate the rationale behind adopting a screening initiative. By adhering to these guidelines, screening programmes can be strategically designed to maximize benefits, mitigate harms, and wisely use limited healthcare resources.

2.5 Key findings from Report 2 on the health effects of PFAS

Cardiovascular Health

The panel found a consistent association between exposure to certain PFAS and elevated cholesterol levels, particularly low-density lipoprotein (LDL), known as "bad cholesterol." Elevated LDL levels are typically associated with increased risk of cardiovascular diseases, such as ischaemic heart disease and strokes. However, despite the increased cholesterol levels, evidence of a corresponding increase in cardiovascular diseases among PFAS-exposed populations (particularly PFOA) was less clear. The panel hypothesized that factors such as increased high-density lipoprotein (HDL) levels (good cholesterol) and indications of lower inflammation in the body might mitigate some effect of LDL on cardiovascular risk. Nevertheless, the panel took a precautionary approach; they recommended that individuals with elevated cholesterol due to PFAS exposure should follow standard management practices, including diet, exercise, and possibly lipid-lowering medications.

Cancer Risks

There is evidence suggesting a probable increase in the incidence of kidney and testicular cancers among populations exposed to certain PFAS. The panel also noted some evidence indicating an increased risk of bladder cancer, though this was less clear. In contrast, common cancers such as breast, colon, and prostate cancers did not show a significant increase in incidence across the most relevant research studies, providing some reassurance. Nevertheless, a link not having been clearly found does not mean that a link is not there. The panel noted that there were also concerns expressed by Islanders about rarer cancers and concluded that, although there is not yet evidence to give a clear answer on rare cancers, there is also insufficient evidence to rule out any potential risk from PFAS exposure.

Immune System and Autoimmune Diseases

Exposure to certain PFAS has been associated with a reduced antibody response to childhood vaccinations, which could theoretically lower the effectiveness of immunisations. While the panel was of the view that it is very likely that there is an effect on antibodies after childhood vaccination, the studies to date do not show an increase in vaccine-preventable or other infectious diseases. There was not consistent evidence linking PFAS exposure to a higher incidence of autoimmune diseases, such as rheumatoid arthritis, ulcerative colitis, or lupus. The panel suggested that enhanced public health efforts to maintain high vaccination coverage should help protect vulnerable populations, including those potentially affected by PFAS.

Endocrine and Metabolic Disorders

The evidence linking PFAS exposure to endocrine disorders, including thyroid dysfunction and metabolic issues like obesity and type 2 diabetes, was found to be inconsistent. While some studies indicated potential associations, these were not uniformly supported across different populations and settings. The panel acknowledged the complexity of these potential health effects and were of the view that further research to clarify these associations and inform public health recommendations is needed.

Mental Health and Wellbeing

The psychological impact of environmental contamination, including stress, anxiety, and depression, was identified in the scientific literature. The panel recognized that these concerns may be impacting in Islanders' lives and recommended providing mental health support to those affected by PFAS exposure. This includes access to talking therapies and other mental health services as needed.

Reproductive Health

While the only concern raised by the community was fertility, subject matter experts brought up a broader range of issues. These included potential complications like intrauterine growth retardation, reduced birth weight, high blood pressure during pregnancy, and breastfeeding challenges. Studies on birth weight are inconsistent. Some research suggested a possible reduction in birth weight associated with maternal PFAS exposure, but others not. The panel noted that the studies showing a connection often relied on measurements taken later in pregnancy, potentially introducing bias. With regard to pregnancy-associated hypertension and polycystic ovarian syndrome (PCOS). While some studies, like the C8 study, reported an association between PFAS exposure and hypertension in pregnancy and there was a report of increased PCOS cases in a high-exposure area like Ronneby, the panel did not find sufficient evidence across other studies to establish a clear link. This was also no clear evidence of reduced fertility. Overall, the panel was not persuaded that PFAS exposure been demonstrated to have impacts on most reproductive health outcomes, except for some evidence pointing to challenges with breastfeeding. They strongly recommended that mothers, even those exposed to PFAS, should breastfeed, emphasising that the considerable benefits are likely outweigh any potential risks from PFAS transfer during breastfeeding.

Other Health Concerns

Additional health concerns explored included some gastrointestinal issues for which there was not good evidence, and changes in liver enzyme levels. The panel noted that while changes in liver enzymes were observed, they generally fell within normal ranges and were unlikely to be clinically significant or associated with poor health outcomes. The panel also looked at neurodevelopmental issues (such as speech and language delay), but the evidence in that area was also not yet clear. With regard to potential impacts on the musculoskeletal system, like osteoporosis and an increased risk of fractures the evidence was also not yet sufficiently clear. The panel was of the view that further research was needed in these areas in order to ascertain whether any risks can be corroborated across studies and what the magnitude of those risks might be.

2.6 Body burden and disease risk

By the term “body burden” of PFAS is meant the cumulative amount of these substances accumulated in an individual over time. Part of this is in the blood, mainly the serum or plasma rather than the cells, part of this is spread around other organs in the body. The proportion of the total body burden residing in other parts of the body is at least as much as in the blood, but we use the serum concentration as the measure of body burden. The rate of excretion (through bladder, gut and menstrual blood loss) is proportional to the serum concentration or body burden. Therefore, with steady intake (from diet and water) the body burden increases, until the rate of excretion equals intake and the serum concentration reaches a steady state.

Epidemiological studies seek to relate the risk of disease to PFAS exposure. The exposure can be in terms of comparing an exposed population with a non-exposed one, or comparing measured or estimated degree of body burden i.e. serum concentration, with the risk of disease. Disease can be directly characterised, such as having a diagnosed cancer or thyroid disease, or a clinical marker which if affected, may indicate a risk of development into clinical disease. Examples of these clinical markers include blood pressure, antibody reactions to vaccination, cholesterol levels or thyroid hormone levels measured in blood.

For understanding and preventing disease in populations exposed to potential toxins, both the nature of the relationship - the dose-response relationship - and the reversibility of these associations are important and we discuss them here.

2.6.1 Dose-Response Relationship

The dose-response relationship (or strictly speaking the exposure-response, as the exposure may be concentration or the accumulated dose) describes how the magnitude of exposure to a chemical relates to the severity or frequency of associated adverse health effects(Eaton & Klaassen, 2008). The shape can be a simple straight line where the effect proportionally increases with dose, though whether it is straight or a curve depends on how the data are analysed – in published papers the exposure or the outcome, or both may or may not be log-transformed. So the disease risk may be reported as rising with PFAS concentration or with the log of the concentration.

Such straight-line relationships are very helpful for assessing risk as one can extrapolate the risk from one study based on a particular exposure range, to estimate the risk at higher or lower exposure levels. Sometimes the dose response relationship may indicate a threshold response, when the low exposures are not associated with any risk relative to zero exposure, although in practice it can be hard to be sure that there is a threshold. At the other end of the exposure range, the effect may flatten off: further exposure does not incrementally increase the risk further. Rarer still are non-monotonic dose response curves, where the risk may go down and then up again as the exposure changes, or even suggest a beneficial effect at low doses but harmful at high doses(Vandenberg et al., 2012). In practice, we do not see clear evidence of non-monotonic (not straight line) dose-response for PFAS. Many studies show results by dividing the population into a number of groups by increasing exposure, and then investigate if there is trend of risk increasing with exposure across these groups. All these studies should also carefully adjust in these analyses, by other risk factors to avoid having a misleading or confounded dose-response pattern.

Studies have demonstrated an exposure-dependent relationship between PFAS exposure and immunotoxic effects. Higher serum concentrations of PFAS have been associated with reduced antibody responses to vaccines in children(Bline et al., 2024). Grandjean et al. found that a doubling

of PFAS concentration corresponded to a significant decrease in antibody levels, indicating a dose-response relationship in this case between antibody levels and the logarithm of serum PFAS(Grandjean et al., 2012).

Several studies have demonstrated a positive dose-response relationship between serum PFAS levels and plasma cholesterol. Higher concentrations of the PFAS compounds perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) are associated with increased total and LDL cholesterol levels. For instance, (Nelson et al., 2010)found that elevated serum PFAS concentrations correlated with higher cholesterol in a U.S. population sample. Several studies spanning large ranges of concentration show a pattern of steep increase in relation to PFAS at lower serum concentration ranges and a shallower or levelling of the dose response relationship at higher levels(Canova et al., 2020).

Several studies have demonstrated a positive dose-response relationship between serum levels of perfluorooctanoic acid (PFOA), and the risk of cancer. For example, Barry et al. found among individuals living near a chemical plant leading to PFOA exposure there was a dose response between groups of increasing estimated serum concentrations and increased incidence of kidney and testicular cancers(Barry et al., 2013). In this case the exposure measure was a cumulative dose reflecting both serum concentrations and length of exposure.

Overall, there are many studies indicating an increasing risk in relation to higher body burdens of PFAS, although the relationship may be curved, not a simple linear straight line.

2.6.2 Evidence for Risk Reduction Through Body Burden Decrease

Past PFAS exposure has been associated with adverse health effects such as cancers. Cross sectional studies show adverse effects on clinical markers, such as raised cholesterol.

Once exposure stops, we can observe the serum levels going down, although it takes some time for the body burden to go down, given the long half-life of these PFAS. One would like to know if the associated disease risks also fall. While reducing the body burden of PFAS may reasonably be considered to reduce disease risk, there is not yet much direct evidence on the reduction of risk following the reduction of PFAS exposure. Given the PFOA and PFOS serum levels have generally fallen over the last 20 years, we may expect some studies to come which will track PFAS-related health effects over time. One study which sought to address this in the Veneto region, could not demonstrate a decrease in exposure related risk after the PFAS exposure was identified and controlled, but the post clean-up follow up was still too short(Biggeri et al., 2024).

Considering infants, as the maternal body burden goes down this would directly benefit the unborn child and infants by preventing their exposure. However, for people with past exposure, whether these disease risks disappear if exposure falls to zero is not certain.

We do know from studies of other exposures that have reduced that the associated risks do fall. The increased cancer risk resulting from exposure to certain toxins can sometimes be reduced by eliminating or minimizing the exposure, but complete reversibility is not always possible. For example, smoking cessation significantly decreases the risk of lung cancer over time; former smokers experience a gradual risk reduction, approaching that of never-smokers after about 15 years(Peto et al., 2000). Similarly, reducing exposure to ultraviolet (UV) radiation can lower the risk of skin cancer, as DNA repair mechanisms may correct some of the damage caused by prior exposure(Armstrong & Kricker, 2001). However, for carcinogens like asbestos, the risk of mesothelioma remains elevated

even after exposure stops due to irreversible changes in mesothelial cells and persistence of the fibres in the tissue (Stayner et al., 2013) . Therefore, while reducing exposure to certain toxins can decrease future cancer risk, the extent of reversibility depends on the type of toxin, the duration of exposure, and the timing of intervention. It is plausible this also applies to PFAS.

For immune effects, reversibility of immunotoxicity depends on factors such as the type of toxin, exposure duration, and individual health status. For instance, immunosuppression caused by heavy metals like lead and mercury can be partially reversible upon cessation of exposure and with appropriate medical intervention(Lawrence & McCabe, 2002). Similarly, exposure to certain pesticides has been linked to immune system impairments that may improve over time after the exposure ends(Corsini et al., 2013). However, the extent of recovery can vary, and in some cases, prolonged or high-level exposure may lead to lasting immune dysfunction. Overall, reducing exposure to immunotoxic substances can facilitate the partial or full restoration of immune function. It is plausible that this also applies to PFAS.

The only direct evidence of the impact of reducing PFAS exposure are some studies of the association of cholesterol in populations where exposure had fallen and serum levels were going down. In the C8 study of a US population exposed to PFOA a group of 700 people had repeated measurements of both PFAS and cholesterol four years apart(Fitz-Simon, Fletcher, & Luster, 2013). Both PFOA and PFOS declined over the survey period, and they found that there was a tendency for people with greater declines in serum PFOA or PFOS to a drop in total cholesterol and LDL, relative to those whose PFAS decreased less. If serum PFOA fell by half, the predicted fall in LDL cholesterol was 3.6% (95% confidence interval = 1.5–5.7%). The association with a decline in PFOS was even stronger, with a 5% decrease in LDL (2.5–7.4%) per halving in PFOS. A larger study in Italy also included repeat measurements of both lipids and PFAS, averaging 4 years apart, with the same direction of association but smaller decreases in cholesterol(Batzella et al., 2024). Declines in PFAS concentrations were associated with decreases in all lipids. For a natural log-decrease in PFOA, HDL-C decreased by 1.99 % (95 % CI: 1.28, 2.70), TC by 1.49 % (95 % CI: 0.88, 2.10), and LDL-C by 1.40 % (95 % CI: 0.45, 2.37). A natural log decrease is a reduction by a little more than a half. Overall, there was not a decrease in cholesterol in the two populations, but the individual correlations of changes in PFAS to changes in lipids is reassuring that the association of cholesterol with PFAS is reversible.

Thus, in conclusion it is plausible, given research on other exposures, that reducing body burdens will result in reduction of any PFAS associated risks, but there is no direct evidence of this for PFAS and therefore it cannot be quantified. There is however direct evidence that reducing serum PFAS results in a reduction of the impact on serum cholesterol. It is therefore reasonable to conclude there are health benefits of a fall in the PFAS body burden. However, the benefit depends on whether future risks to the exposed person are more related to current body burden/serum concentration or the cumulative exposure. In a population with past exposure that has been stopped or reduced, there would have been higher serum levels in the past and the total cumulative exposure would not be reduced by much however rapidly one reduces the body from now. Conversely for future possible exposures to children during pregnancy and breastfeeding from maternal body burden, reducing serum levels would directly reduce that exposure to child.

3 Evidence from experts by experience

An Islander presented evidence to the panel. In order to maintain patient confidentiality, the full comments are not displayed in these public minutes, but have been made available to the panel. A concise summary is presented.

The expert by experience spoke to the panel about their health history and health conditions they attribute to PFAS exposure. They described how it impacts their life, and their current health status. It was confirmed that they had participated in the testing programme, and their PFAS levels had been found to be elevated. The panel answered several questions the Islander had about their own clinical journey, expressing empathy for their health difficulties.

4 Evidence from subject matter experts

Introduction

The panel received evidence from several subject matter experts who have been involved in key studies that can help to inform on the management of PFAS load in the body, strategies for measuring serum PFAS levels in the population and screening for potential PFAS-related ill-health. This added depth and context to the evidence obtained through the literature reviews and allowed for questions to be asked that arose from those studies. This section includes the experts who spoke to the panel about phlebotomy in report 1 as well as those who spoke to the panel on other treatments and strategies for report 3. The subject matter experts were:

- **Professor Jonathan Martin, Stockholm University**: Professor at Stockholm University, working on PFAS since 2000, focuses on environmental analytical chemistry, and is a content matter expert in terms of environmental sources, the fate, and effects of PFAS. And he was a co-author in one of the intervention studies in the literature review.
- **Dr Roger A Klein, PFAS expert, Chemist and Medic**: Physical Chemist and Medic, working on PFAS for many years. Worked for over 50 years with the fire service and since 2000 in transitioning from fluorine containing firefighting foams to fluorine free firefighting foams and the environmental consequences and has been involved in a number of large legal cases. And he was a co-author in another of the intervention studies in the literature review.
- **Dr Axel Andersson**, **clinician and PhD candidate**. Dr Andersson is a medical doctor and has been a PhD candidate in Prof Jakobsson's group for 3 years. He is currently focusing on conducting elimination trials in Ronneby in Sweden, studying the effects of cholestyramine and similar compounds on PFAS levels in the blood. He is also conducting additional studies on immunotoxic effects in adults such as whether the COVID-19 vaccine is affected by PFAS levels.
- **Dr Ann Christine Lyngberg – University Hospital of Holbæk.** Dr Lyngberg has a medical background in public health and a research background in epidemiology. She is currently Chief Medical Officer for Occupational and Environmental medicine in Zealand, Denmark.
- **Professor Kristina Jakobsson, University of Gothenburg**: Physician Specialist in Occupational and Environmental Medicine and has been involved from 10 years ago in the Ronneby population exposed to firefighting foam as a clinician, as a health adviser to the Municipality from the healthcare system, and PFAS researcher exploring the health effects of PFAS in that community.

4.1 Professor Jonathan Martin- Phlebotomy Treatment for Elimination of Perfluoroalkyl Acids in a Highly Exposed Family: A Retrospective Case-Series

Background:

This was a case study of a highly exposed family in Canada that was discovered Stephen Genuis (an environmental health clinician, who is interested in environmental exposures), and was a colleague of Professor Martin. Dr Genuis routinely asked his patients about their work history or their life history and would send plasma samples out for testing for environmental contaminants. He discovered a family of six with high exposure to PFOA, PFOS and PFHxS, and began an intervention study, the results below have been collated using the data from the study(S. Genuis et al., 2014).

Context

This was a family of six people, the father who is 52, the mother who is 48, a son who is 23, a son who is 21, a daughter who is 18, a son who is 17 and a son who is 15.

The mother and father had their first son in 1985, a second son in 1987, and then they moved into a new house in 1989 and had three more children in that house. Because the house had a lot of carpeting, they thought it was a good idea to treat those carpets with 3M Scotchgard formulations, which was a stain repellent. You could hire companies to come in and treat the carpet in your home. They did that five years in a row when the house was quite new. They paused for about five years and then did more applications, the last ones in 2007 and in 2008. This is when the biological sampling was first done, and it was discovered they had quite high levels. The youngest children had the highest levels of exposure; possibly because they would have crawled around on the carpets when they were very young, and it had been treated with Scotchgard, and they also probably ingested more dust or had more hand to mouth activity and therefore got more of it in their body.

The family stopped treating their carpets with Scotchgard, replacing carpets with hardwood, and renovating to increase ventilation in their home, to make the air cleaner. They started phlebotomy in 2009.

Limitations to this study

Some limitations were identified that affect the extent to which any findings can be generalised. There were no experimental controls in this study because it was not an experiment. There was a comparator group from another study who were older people with historical occupation exposure, but there was concern that they were not an ideal comparator. The results may look quite different with a different comparator group.

Secondly, the participants are all from one family, so it is difficult to generalise or compare to broader populations or other groups of people.

Finally, it is a small study.

Summary of results/conclusions:

Notwithstanding the limitations outlined above, the intervention did appear to show benefit to the participants:

- Intermittent phlebotomy at rate similar to blood donation services appears safe and effective to facilitate removal of PFHxS, PFOS, and possibly PFOA.
- None of the participants described any ill effects of the phlebotomy.
- To balance some of the risks of phlebotomy a mineral supplement was taken.
- The Canadian Blood services prescribed that no more than 500 mills of blood be withdrawn every 56 days, and the family were under that, so this is a schedule that is quite a reasonable schedule if you are a regular blood donor.
- There was a 4-year intervention period.
- Clinical judgement in conjunction with informed patient consent should be used when considering interventions to facilitate removal of PFAAs.
- Weaker effect for PFOA may be real, or because baseline levels were closer to background levels.

It should also be noted that they did not completely eliminate the exposure. In 2008 a vacuum cleaner dust sample taken from the house showed high levels of PFAS PHOA and PFHxS. In 2012, the

vacuum dust sample was taken again and showed the PFAS were still there, but they were nine to tenfold lower. Even at that level, however, ongoing exposure may have affected elimination. PFHxS, PFOS and PFAS all had relatively long biological half-lives.

The body burden of PFAS was stated to be mostly in the blood, so if you did remove blood, you would actually remove a significant fraction of the body burden.

4.2 Dr. Roger Klein – PFAS Contamination and the Effect of Plasma and Blood Donations in Australian Firefighters

Dr. Roger Klein presented findings from a randomised clinical trial in Victoria, Australia, investigating the effectiveness of plasma and blood donations in reducing perfluoroalkyl and polyfluoroalkyl substance (PFAS) concentrations among firefighters. The study was prompted by concerns regarding elevated PFAS levels—particularly PFOS and PFHxS—identified in over 600 firefighters, two-thirds of whom exceeded the 29 ng/mL threshold set by the German Human Biomonitoring Commission (HBM-II) as an intervention trigger. In some cases, PFOS levels reached1400 ng/mL. This discovery, coupled with knowledge of significant ground and drinking water contamination near airport training grounds, underscored the urgency of examining strategies to lower PFAS in exposed populations.

Background and Rationale

In Australia, substantial PFAS contamination of groundwater has been linked to firefighting foam use over extended periods. At one military airfield, repeated training exercises over 25 years discharged approximately 1.43 million litres of foam concentrate into the environment, resulting in contamination extending 10–20 km downstream. Multiple studies revealed that firefighters not only had far higher PFOS levels than the general population but also elevated PFHxS, a frequent contaminant in commercial PFOS formulations. Serum ratios for PFHxS, PFOS, and PFOA were found to be roughly 1:1 relative to plasma, indicating that PFAS compounds predominantly bind to plasma proteins rather than red blood cells (where the ratio of plasma/serum to whole blood is approximately 2:1).

Given that PFHxS is structurally similar to PFOS but has a longer biological half-life, concentrations of PFHxS in groundwater—and, consequently, in exposed populations—tend to persist for extended periods. To address health implications, the German Human Biomonitoring Commission established two action thresholds. HBM-I (2016) for PFOS was set at 5 ng/mL plasma, with PFOA at 2 ng/mL; by 2019, HBM-II increased these thresholds to 20 ng/mL for PFOS and 10 ng/mL for PFOA. For women of childbearing age, more stringent cutoffs were recommended. Many Australian firefighters were found to exceed these levels, prompting consideration of phlebotomy—specifically, plasma donation and whole blood donation—as a potential route for PFAS reduction.

Study Design and Methods

Dr. Klein's randomized controlled trial allocated participants to three groups: plasma donation, whole blood donation (phlebotomy), and a control group receiving no intervention. Donations were performed within the guidelines for blood product collection, allowing plasma donations at more frequent intervals than whole blood donations. Approximately 100 participants were enrolled in each arm. Levels of PFOS, PFHxS, and other PFAS were measured at baseline, after 12 months, and again several weeks post-intervention to assess any rebound effect.

Key Findings

Both the plasma and the whole blood donation groups demonstrated reduced PFOS concentrations,

with plasma donation yielding a more pronounced decrease. This greater efficacy was attributed to the higher frequency of plasma donation and the fact that PFAS compounds predominantly bind to plasma proteins (particularly serum albumin). Although PFHxS levels also declined, the decrease was less pronounced than for PFOS, likely reflecting PFHxS's longer half-life. A modest increase ("bounce back") in PFAS was observed in both groups once donations ceased, but data were limited.

Advantages and Disadvantages of Plasma Donation

Dr. Klein emphasized that plasma donation removes PFAS-rich plasma more frequently, avoids reducing iron stores, and is therefore more effective than blood donation in lowering PFAS. However, it is more intrusive, requires repeated sessions, and may involve significant travel to specialised centres, making long-term adherence challenging. Nonetheless, plasma donation directly targets serum albumin—the principal carrier of PFAS—rendering it a potentially viable intervention for individuals with elevated PFAS levels.

Concluding Remarks

Dr. Klein concluded by noting that many PFAS compounds remain under-researched, and contamination events in Australia and elsewhere continue to pose a substantial public health concern. Ongoing work is essential to determine the long-term efficacy of interventions such as plasma donation, the clinical significance of small increases post-cessation, and the potential relevance for broader populations affected by PFAS contamination.

4.3 Dr Axel Andersson – Pharmacological PFAS interventions

Dr. Axel Andersson began by noting that humans exhibit markedly longer half-lives for PFAS than rodents and monkeys. Consequently, targeted interventions may be warranted in certain high-exposure regions.

He first discussed bile acid sequestrants, such as cholestyramine, which disrupt the enterohepatic circulation of bile acids. Because PFAS is present in high concentrations in bile but relatively low concentrations in faeces, cholestyramine may enhance PFAS excretion by binding to bile acids, leading to PFAS bound to bile acids to be eliminated through faeces. The body is then prompted to produce more bile acids, thereby further increasing faecal PFAS elimination. Several small studies support this hypothesis. Common adverse effects of cholestyramine include constipation, nausea, and stomach pain; these side effects appear less frequent with other cholesterol-lowering drugs, but without the PFAS lowering effect.

A 2024 clinical trial in Korsør, Denmark, where cows had grazed on grass contaminated with firefighting foam, enrolled 45 participants in a 12-week cholestyramine intervention. Serum levels of PFOS were significantly higher than in other populations, but after treatment they decreased notably, with a 63% elimination rate on cholestyramine compared to 3% during the observation period. The applicability of these results to other locations, such as Jersey (where PFOS levels are lower), remains uncertain. Dr. Andersson further highlighted data suggesting cholestyramine is more effective than blood or plasma donation for reducing PFAS.

He next discussed probenecid, an older gout medication affecting renal re-uptake of uric acid and, hypothetically, PFAS. In a trial conducted in Ronneby, a community affected by firefighting foam pollution, short-term (one-week) probenecid therapy did not show a significant impact on PFAS excretion.

Dr. Andersson concluded that current evidence indicates cholestyramine effectively reduces PFAS levels, whereas probenecid does not. Nevertheless, uncertainties persist regarding effectiveness in populations with lower PFAS levels and alternative dosing regimens. He also noted that a long-term, medium-dose tablet form of a cholestyramine-like compound has recently undergone study in Ronneby, with results expected in early 2025.

In closing, Dr. Andersson emphasized that it remains unclear whether reducing PFAS serum levels leads to improved health outcomes. This unknown benefit-risk profile warrants further investigation.

4.4 Dr. Ann Christine Lyngberg – PFAS: Danish Experiences

In 2021, Korsør in Denmark experienced significant PFAS contamination linked to aqueous film-forming foam (AFFF) use at a firefighting educational facility. Groundwater from the facility flowed into nearby meadows, where cows grazed and drank contaminated water. Members of the local Cow Grazing Association, who consumed meat from these cattle, exhibited markedly elevated PFOS and PFHxS levels compared to the general Danish population. Despite having similar diets, their blood PFAS concentrations varied substantially, indicating unknown additional factors. Around 60% of the association's members participated in subsequent research.

Dr. Lyngberg described an emerging body of literature on a potential treatment for PFAS exposure, including a trial that investigated the bile acid sequestrant, cholestyramine, which can trap bile acids and potentially PFAS in the gut. Data from the U.S. National Health and Nutrition Examination Survey (NHANES) showed that users of such sequestrants had 80% lower PFAS concentrations, suggesting a possible therapeutic opportunity.

Her team conducted a bile acid sequestrant crossover trial involving individuals above the 97.5th percentile for PFOS in Denmark (21 ng/mL at that time). The 45 participants were randomly assigned whether to start with the 12-weeks of active treatment or the 12-weeks observation period. Some had gastrointestinal side effects, and several withdrew early. The study, published by Møller et al. ("Substantial decrease of PFAS with anion exchange resin treatment—A clinical cross-over trial," *ScienceDirect*), reported a 63% PFOS reduction over 12 weeks. Most participants received cholestyramine granules, which many found unpalatable. PFNA and PFDA rose during the observational period, possibly due to ongoing external exposure. Overall, this was the first trial examining PFAS elimination via ion exchange resins. Dr Lyngberg stress that - for all interventions -it remains unclear whether lowered PFAS levels reduce adverse health outcomes.

Dr. Lyngberg highlighted ethical considerations in offering such interventions. Past public health measures sometimes yielded no tangible health benefits or produced unintended harms. Without robust evidence that reducing PFAS levels prevents disease, population-wide interventions remain unwarranted. Nevertheless, Denmark does allow "off-label" treatment for highly exposed women of reproductive age, who are planning a pregnancy in near future, in order to mitigate fetal PFAS exposure and potential immune effects in children. This requires thorough individual assessment and informed consent.

Currently, Denmark does not provide re-testing for PFAS because these levels do not predict individual health outcomes or alter clinical management. According to Dr. Lyngberg, screening programs must adhere to World Health Organization (WHO) guidelines, requiring evidence that early detection improves outcomes. PFAS screening fails to meet these criteria. Historical trends show that PFOS concentrations in the Danish population have declined markedly since the 1990s, illustrating that regulation can successfully lower public exposure.

Regarding risk communication, Dr. Lyngberg underscored the distinction between relative and absolute risk. For example, an observed 20–30% relative increase in kidney cancer among heavily exposed workers translates to only a modest rise in lifetime risk (from ~1.1% to about 1.4%), equating to a small number of extra cases in a population. In contrast, other environmental factors like air pollution and passive smoking yield similar relative risk increases for lung cancer but from a higher baseline (around 4.5%), thus posing a greater absolute risk for the individual. According to Dr. Lyngberg, risk communication to individuals should always be given as absolute risk.

Key Takeaways

1. Bile acid sequestrants can accelerate PFAS elimination.
2. For all interventions, it is unproven whether lowering PFAS in serum reduces the risk of health effects.
3. Evidence-based policies and interventions should precede any large-scale public health measures.
4. PFAS screening does not fulfil WHO guidelines for screening, as it does not guide specific clinical interventions.
5. Translating elevated relative risks into absolute risk is critical for accurate public understanding. Risk communication to individuals should be given as absolute risk.
6. In Denmark, PFAS interventions are limited to women of reproductive age with high exposure, who are planning a pregnancy in near future. The intervention is “off-label” and require detailed assessment and consent.
7. Routine re-testing for PFAS is not offered because it provides no actionable clinical information.

4.5 Prof. Kristina Jakobsson – PFAS Exposure, Screening, Testing, and Biological Monitoring

In December 2013, one of two water treatment facilities in a small Swedish municipality was found to be heavily contaminated with PFOS, affecting nearly one-third of its 30,000 residents. The source was firefighting foam used at a nearby military airfield. The duration of contamination was unknown, prompting extensive research into PFAS exposure.

In 2014, an initial study revealed elevated PFAS levels among local children, leading to broader blood sampling from 2014 to 2016. Older individuals exhibited higher concentrations, suggesting prolonged exposure. These findings informed risk assessments and guided studies on the elimination of PFAS once high-level exposure ended, and studies on health effects.

Analyses showed PFOS, PFHxS, and PFOA levels in Ronneby to be significantly higher than those in general Swedish populations. PFOS and PFHxS levels dominated and were considerably higher than in two other hotspots—Veneto (Italy) and the C8 region (United States) which were dominated by PFOA. Residents received individual serum results for PFOS, PFOA and PFHxS and were informed whether that was considered a high, medium or low level. This was accompanied by risk communication from clinical, occupational, and environmental medicine specialists at townhall meetings. No additional health screening was provided, and participants were simply informed about their serum levels and whether they were at the high, middle, or lower level of exposure. The clinic

of Occupational and Environmental Medicine had an open phone and mail line for individual questions. Those with health concerns were advised to consult their general practitioners.

By 2024, extensive research in general populations with background level exposures, and in hotspot populations has identified associations between PFOS exposure and elevated blood lipid levels, particularly cholesterol—an important cardiovascular risk factor. Further studies have indicated an increased risk of testicular and kidney cancers, as well as a diminished antibody response following childhood vaccinations. Some research elsewhere links PFAS to lower birth weight, though Ronneby and C8 data did not reflect this despite higher exposure levels.

Ongoing investigations continue to emphasize cardiovascular outcomes due to the relationship between PFAS and cholesterol. Systematic monitoring and further research will help clarify the long-term health implications of PFAS exposure

This summary reflects the current state of knowledge. Particular attention is paid to cardiovascular health risks, given the association between PFAS exposure and elevated cholesterol. Ongoing surveillance of exposed populations, coupled with systematic reviews of emerging evidence, is essential to refine understanding of any health impacts.

In the broader context, medical screening is relevant to biomonitoring in the general healthy population. Certain serious health conditions can be screened if it is clearly demonstrated that early detection improves treatment outcomes (e.g., breast cancer in women). Screening is also undertaken to identify modifiable risk factors, including elevated blood pressure or cholesterol. Essential criteria for medical screening programmes require that they improve health outcomes. While some screening efforts target specific risk groups, opportunistic screening (e.g., blood pressure checks) may occur as part of routine healthcare.

A successful screening programme should detect most cases of the targeted condition while minimizing false positives, be reasonably safe, cost-effective, and broadly accessible, and offer an effective intervention that improves outcomes. In the United Kingdom, for example, individuals over the age of 40 are encouraged to undergo checks for blood lipids. Testicular self-examination is recommended for early detection of testicular cancer, whereas there is currently no standard screening test for kidney cancer. Robust vaccination coverage protects populations against various infectious diseases, and maternity and child healthcare services address concerns such as low birth weight.

Regarding PFAS testing, measuring PFAS concentrations in individuals is more informative at the population level than for individual clinical decisions. An individual's PFAS level does not reliably predict future disease risk or indicate whether PFAS caused any current condition. Testing drinking water is generally the most efficient method to determine potential exposure since human PFAS levels can be estimated from water concentrations. Outside areas of known exposure, such data help determine whether more focused testing is warranted. If present drinking water conditions are suspected to differ markedly from historical levels, serum PFAS measurements in select population segments can indicate past exposures. Similarly, if local food products are found to contain elevated PFAS levels, then beyond estimating the likely dietary contribution, targeted testing of high-consumption groups can guide appropriate intake recommendations.

Ultimately, clear risk communication and supportive measures for exposed populations remain essential. From a strictly medical standpoint, knowing one's specific PFAS blood concentration

provides limited clinical value, although the desire for such information is understandable for those who have experienced exposure.

4.6 Discussion between subject matter experts and the panel

Below is a thematic summary of the discussions between the subject matter experts and the panel.

4.6.1 Background to consider for the situation in Jersey

Jersey's PFAS hotspot has been considered comparable to Ronneby's scenario, especially concerning contamination from AFFF (aqueous film-forming foam). Experts stated that estimated exposure levels in Jersey, at the time contamination was discovered, were similar to those in Ronneby, rendering evidence from Ronneby highly relevant to Jersey's situation.

Jersey was noted to have recognised its AFFF contamination problems relatively early in the late 1990s. Prompted by the observation of foaming in local water supplies, households were taken off borehole water sooner than similar scenarios elsewhere. This action led to a more rapid reduction in PFAS exposure, meaning present-day blood levels in affected populations have been decreasing for a longer period compared to other regions.

Experts highlighted that PFAS blood levels, even in hotspot areas, have declined significantly in recent decades. Current hotspot levels may be similar to levels found in the general population in the late 1980s or early 1990s. Consequently, health effects reported in hotspot studies likely result from higher, past exposures rather than the comparatively lower levels measured today. This information was taken as cautiously reassuring, although careful monitoring remains essential.

4.6.2 Key clarifications on potential health impacts of PFAS

It was observed that the technical definitions of low birthweight need careful clarification. As explained by members of the panel, "very low birthweight" conventionally refers to babies born under 1.5 kg, and "low birthweight" to those between 1.5 and 2.5kg. Since infants below those thresholds are at a higher risk for complications. By contrast, a minor reduction in birthweight—such as moving from 2.6 kg to 2.5 kg—may have negligible health consequences. It was emphasized that there is considerable variation in birthweights across the general population, so small changes do not necessarily pose immediate risks. While certain studies suggest that PFAS exposure might slightly reduce birthweight, the consensus among the experts was that only significant reductions (i.e., below 2.5 kg) lead to substantial health concerns solely on the basis of birth weight. Minor changes in birthweight of otherwise normal-range infants likely do not pose immediate threats to health, though ongoing research continues to refine these understandings.

PFAS may contribute to slightly elevated cholesterol levels, but pinpointing its exact role is challenging, particularly in populations that also consume a high-fat diet. In Danish cow grazers, for example, it was impossible to differentiate conclusively between elevated cholesterol caused by PFAS-contaminated meat and the effect of dietary habits. Some data suggest that at lower PFAS levels, the dose-response curve for cholesterol is steeper than at higher doses. This plateau effect means that initial exposure can lead to a marked change in cholesterol, after which further increases in PFAS concentration do not necessarily produce a proportionate rise in cholesterol. Experts underscored that such patterns complicate risk assessment, especially in the non-cancer context.

A misconception was reported among some exposed populations that statins might not work for individuals with PFAS-elevated cholesterol. Experts confirmed that there is no evidence to support this concern; those who have been prescribed statins should continue taking them.

With the International Agency for Research on Cancer (IARC) classifying certain PFAS as carcinogens, the panel and experts discussed whether a present-day PFAS level or a past level drives cancer risk. This distinction matters because, if carcinogenesis involves a mutagenic process, early exposures may be more critical. If, however, PFAS acts as a tumour promoter or through immunosuppression, ongoing levels might have greater significance. In either case, data and mechanistic clarity remain limited.

4.6.3 Interventions to reduce PFAS body burden

The panel and experts discussed that, while plasma donation might be more effective in removing PFAS (as PFAS is stored primarily in plasma), the greater logistical challenge and inconvenience could lower participation rates.

With blood or plasma donation, studies observed that PFAS levels rise again after the procedure, due to redistribution. By contrast, continuous daily interventions (such as taking bile acid sequestrants) appear to mitigate this rebound. Nonetheless, experts indicated that the long-term clinical significance remains under investigation, as actual health outcomes from reducing PFAS levels have yet to be fully clarified. The experts also noted that the "unpalatable" nature of certain bile acid sequestrant treatments has led to patient dropout, and further studies are underway using agents with better side effect profiles and lower doses.

Questions arose about whether individuals who wish to reduce their PFAS levels might pursue repeated blood or plasma donation on their own. Ethically, the subject matter experts advised caution, emphasising that donation is meant as a gift to recipients, not merely as a personal exposure-reduction strategy. It was noted, however, that if PFAS-affected blood were widely dispersed in a donor pool, the risk of elevating recipients' PFAS levels is generally minimal.

4.6.4 PFAS level testing, clinical testing and screening

The panel discussed with the experts that there were three potential reasons for testing either PFAS levels or clinical markers:

- Clinical benefit: where doing that test could result in better care or a better health outcome for the individual being tested.
- Research benefit: where doing the test could inform the scientific community of the distribution of PFAS exposure, the way PFAS behave in the body or how other blood tests are affected by PFAS exposure. This would need to be in the context of a formal research study in order to have scientific impact.
- Political, legal or social benefit: where it helps to guide the deployment of resources, is at the direction of a court or helps to allay public concerns.

Experts described the approach taken in Ronneby, Sweden, where participants in PFAS exposure studies were provided with individual test results. These results were presented with bandings (i.e., groupings of test result ranges) to facilitate understanding and reduce anxiety. Individuals could see how their levels compared to others, rather than focusing on an isolated numerical value that might fluctuate slightly over time. A parallel was drawn to practice in Jersey, where results had been compared against the NHANES 95th centile from the United States. By employing reference bands, any slight fluctuation in a single test result is put into context, thereby mitigating unwarranted anxiety and enhancing comprehension of potential exposure levels. Deciding who is tested, and under what circumstances, requires balancing clinical benefits, research gains, and potential political or public reassurance. Authorities in Italy, for example, tested an estimated 50,000 people near a

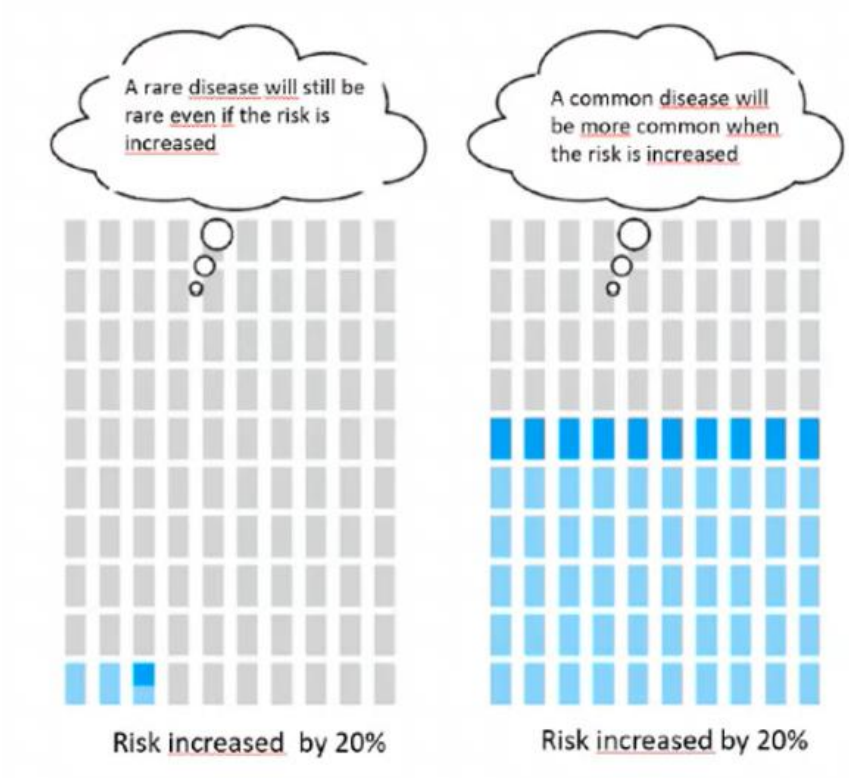
manufacturing facility. This broad approach was costly. By contrast, Danish health authorities applied more targeted testing, particularly in settings where contamination was known to be extensive (e.g., exposed cow meat). Testing offers limited clinical benefit unless actionable interventions exist or significant new data can be gleaned for research. The panel addressed whether individuals have a legal “right to know” their personal PFAS levels. It was clarified that, under English law, there is a right to receive the results of tests that have already been conducted, but there is no absolute right to demand a test be performed. The legal framework in Jersey was not confirmed by the panel, suggesting a need for further investigation into local regulations.

Determining whether a high-risk subgroup (e.g., individuals over 40 who have had elevated PFAS exposure) should receive targeted clinical testing must be weighed carefully. The disease under consideration and the magnitude of PFAS-associated risk increases are the key factors. Some diseases with higher relative risks merit closer scrutiny compared to those where PFAS exposure confers only a minimal increase. Several experts stressed that performing a health examination alone does not necessarily improve population health unless effective interventions are made available. For instance, knowledge of high cholesterol in a PFAS-exposed population should be accompanied by dietary, exercise, and weight-management support, and, where appropriate, medication. Screening can sometimes be detrimental when it identifies conditions or anomalies that would not have progressed to symptomatic disease. Unneeded interventions can lead to anxiety, unnecessary treatments, or both. Hence, clarity about the goals and methods of screening programs is paramount to avoid net harm.

The panel noted that routine health checks for individuals aged over 40 are not systematically provided in Jersey. There was a discussion around whether such checks—particularly those focusing on cholesterol and other key health indicators—could be beneficial, given potential risks associated with elevated PFAS levels. Jersey does not currently offer standardised screening of this nature.

Experts cautioned that an elevated risk of a rare cancer (for example, a 10–20% rise in a low-incidence disease) might not justify widespread screening programs. By contrast, a common disease might warrant more robust screening measures if the risk notably increases.

Figure 1 - Illustration of the effect of increased relative risk on absolute risk in rare and common diseases



Source: Professor Kristina Jakobsson

Any screening decision must balance the likelihood of detecting meaningful disease, the risk of false positives, and the resultant physical or psychological harm. The panel noted how, in some settings, incidental detection of tumours in screenings caused over-diagnosis without improving outcomes. Given the potential for increased cancer risk, some experts argued for an approach aligned with the U.S. Environmental Protection Agency (EPA), which advocates lowering PFAS exposures as much as possible. The challenge remains that reducing PFAS from, for instance, 10 ng/ml to 5 ng/ml cannot be fully quantified in terms of a precise risk reduction. Nonetheless, many consider it prudent to limit exposure wherever feasible, especially in the face of uncertain time factors in disease development.

4.6.5 Risk Communication with Exposed Populations

In several regions—Ronneby, Jersey, and Danish areas with cow-grazing associations—residents have expressed concerns over PFAS exposure. Experts have handled this by providing transparent, yet contextualized, information. Communication often underscores relative risk (e.g., “your levels fall within normal ranges,” or “this is an absolute risk increase of X%”), which helps allay fears or manage expectations. Experts consistently noted that simply speaking with concerned individuals about their test results and possible health risks can significantly reduce anxiety. Sometimes, the greatest benefit lies in providing context and reassurance, rather than an intervention that might not be scientifically justified or ethically viable.

4.7 Additional subject matter expert interactions

The panel engaged with four additional subject matter experts who were not able to join the public meetings, either for accessibility, logistical or legal reasons. This was partly as a sense-check and peer-review for the panel and partly to draw on specific experience and expertise. They included:

Professor Willie Hamilton is Professor of Primary Care Diagnostics at the University of Exeter Willie Hamilton is a third-generation doctor from Belfast. He specialises in primary care diagnostics, with particular expertise in cancer. Willie's research has had a major impact on improving earlier diagnosis of cancer in the UK, which saves lives.

Dr Courtney Carignan is an assistant professor at Michigan State University working on epidemiology and risk assessment of contaminants. She completed a dissertation on flame retardants, and subsequently has worked on PFAS for the past decade now. Courtney is passionate about making sure those highly exposed can access blood testing and medical screening

Dr Alan Ducatman is a physician with experience in occupational medicine He previously worked in industrial toxicology for the Navy. He helped design the C8 health project in the US and has been working on PFAS ever since. He concentrates on and encourages others to think about how physiology relates to epidemiology for PFAS.

Much of what they said was to echo what the panel had already heard from the subject matter experts who addressed public meetings. There were, however, a few additional points raised. These are outlined below.

4.7.1 Additional points raised

- Kidney cancer screening tests are not generally recommended, as current options (e.g., testing for microscopic blood in urine) produce extremely high false positive rates and consequent distress. There is no established medical practice to screen asymptomatic populations for testicular cancer; instead, self-examination for testicular cancer is advised (note, this has already been recommended in report 2).
- PFAS levels should be tested for residents in high-exposure areas; however, some flexibility should be maintained over boundaries. Any decision to test the broader population for PFAS should first be informed by reliable data on water or food-chain contamination, ensuring meaningful interpretation of test results.
- The population may be segmented for potential intervention strategies, focusing particularly on women of childbearing age (to reduce foetal exposures), individuals with elevated cholesterol, and the wider public. Evidence does not confirm whether decreased PFAS burden leads to reversibility of cholesterol; alternative physiological mechanisms remain unverified.
- Community advisory boards, with active membership from local residents, are useful to foster trust, ensure transparent communication, and encourage constructive dialogue about environmental health concerns (the panel process already reflects this in its approach to Islander engagement, but there may be a case for this to continue after the panel has completed its work).

5 Testing for PFAS in people

5.1 Introduction

Concentrations of various PFAS have been measured in plasma, serum, and whole blood, although serum is the most common choice for PFAS testing.(Sunderland et al., 2019) Serum PFAS levels are generally about twofold higher than in whole blood whereas plasma and serum levels are very similar.(Carignan et al., 2023) Measured PFAS concentrations in human serum vary across different populations, from single- or double-digit nanograms per millilitre in the general population to thousands of nanograms per millilitre (ng/mL) in occupationally exposed workers and residents near contaminated sites.(Sunderland et al., 2019) In this section the focus is primarily on PFOS, PFHxS and PFOA as they are the PFAS commonly associated with AFFF contamination. There have been a large number (many hundreds) of studies testing PFAS levels in human serum worldwide and it is not necessary to review all those studies in detail here. There have already been several excellent reviews on PFAS serum levels in the general population and in highly exposed populations. (Kato et al., 2015; Olsen, 2015; Sunderland et al., 2019)Other reviews specifically focused on occupational exposure to PFAS.(Christensen & Calkins, 2023; Rosenfeld et al., 2023)

Testing of chemical contaminants in humans is a mature discipline and a book was written by the National Research Council of the National Academies (NRCNA) on the subject already in 2006.(Council, 2006) Specific guidance on PFAS testing has also been published by the NRCNA more recently in 2022.(National Academies of Sciences, 2022) Regarding PFAS testing, the NRCNA 2022 report (National Academies of Sciences, 2022) recommends that “discussions about PFAS testing should always include information about how PFAS exposure occurs, potential health effects of PFAS, limitations of PFAS testing, and the benefits and harms of the testing”. Clinicians would usually follow the principle that they only order testing when they know how to interpret and act on the results. However, as we will conclude below, in contaminated communities PFAS testing of serum is seldom done for clinical management purposes, but rather to understand the PFAS exposure and effects for research or for legal purposes.

5.2 Testing and retesting in populations with elevated levels of PFAS

As mentioned above, a review published in 2015 already covered testing in populations with elevated levels of PFAS.(Olsen, 2015) The findings of that review will be briefly summarized here. Interestingly, the 2014 review totally neglected exposure related to the use of AFFF at commercial airports and military bases. The reason for this omission was that studies reporting elevated exposures related to AFFF use have all been published in the last decade, i.e. after 2015. Considering that to date there is no review on the elevated PFAS serum levels related to AFFF use, the known studies are summarized below in section 1.2.2.

5.2.1 Testing and retesting in non-AFFF related exposure scenarios

In addition to releases from use of AFFF, several other environmental releases of PFAS have reached surface and/or groundwater sources for drinking water. Depending on location, these other types of environmental releases can be described as: (1) industrial emissions from nearby PFAS manufacturing plants; (2) landfill leachate releases; and (3) run-off from sewage-sludge amended agricultural fields. Testing for PFAS in each affected community demonstrated concentrations above levels reported in the general population. (Olsen, 2015)

Emissions of PFAS from the 3M Cottage Grove manufacturing facility as well as leaching from several local landfills resulted in elevated levels of PFAS in public and private wells in the East Metro

communities of the Minneapolis-St. Paul metropolitan area.(Olsen, 2015) A random sample of East Metro citizens in the affected areas had their serum tested for PFAS. In 2008, the geometric mean serum concentrations for PFOS (35.1 ng/mL), PFHxS (8.2 ng/mL) and PFOA (15.1 ng/mL), were approximately three to four times higher than the 2007–2008 National Health and Nutrition Examination Survey (NHANES) data for the general population In a retesting of this population 2 years later in 2010, the geometric mean serum concentrations for the East Metro area declined (see Figure 2) (Nelson, 2011) A second retesting of the population was conducted in 2014 (these data are not included in Figure 2 because only graphical results were provided in the 2014 report) and the concentrations were shown to decline further compared to 2010(*East Metro PFC3 Biomonitoring Project DECEMBER 2015 REPORT TO THE COMMUNITY*, 2015).

PFAS-contaminated wastewater from the 3M manufacturing plant in Decatur, Alabama was treated at a wastewater treatment facility which resulted in the generation of PFAS-contaminated sewage sludge.(Lindstrom et al., 2011) Subsequent application of the PFAS-contaminated sewage sludge to agricultural land resulted in PFAS contamination of surface waters and private wells. (Lindstrom et al., 2011)The Agency for Toxic Substances and Disease Registry (ATSDR) conducted a human exposure investigation in which a total of 85 households participated (153 people volunteered from these households) in serum testing for PFAS. The geometric means of serum concentrations were 39.8, ng/mL, 6.4 ng/mL and 16.3 ng/mL for PFOS, PFHxS and PFOA, respectively, which was much higher than the general population at that time (Figure 2)(ATSDR, 2013). Retesting of some members of same population (n=45 volunteers) in 2016 showed a decline in serum concentrations (Figure 2). (Worley et al., 2017)

Elevated PFOA serum concentrations were found in the population living in proximity to the DuPont Washington Works fluoropolymer (i.e. Teflon) manufacturing plant (near Parkersburg, West Virginia).(Emmett et al., 2006) Serum testing was originally conducted by Emmett et al. (Emmett et al., 2006)on a limited scale before a large-scale serum testing effort (69,030 individuals tested over a 13-month period) was undertaken as part of a class-action lawsuit.(Frisbee et al., 2009) The overall geometric mean PFOA concentration was 32.9 ng/ml compared to 3.9 ng/L for NHANES at the time (2003-2004). (Frisbee et al., 2009)One of the six water districts sampled (Little Hocking) had a much higher PFOA mean concentration of 227.6 ng/ml (>50 times higher than NHANES) (Figure 2). (Frisbee et al., 2009)This large-scale serum testing was part of a set of well-known epidemiological studies (C8 Panel). Bartell et al.(Bartell et al., 2010) retested the blood of 200 residents of the Little Hocking and Lubeck water districts over an 18-month time frame to monitor potential declines in serum levels after water filtration was implemented. They estimated the average serum PFOA decline was 26 % per year resulting in a median serum PFOA half-life of 2.3 years. A number of other research projects were also set up by the C8 Science Panel and involved retesting on individuals in the contaminated area,(Steenland et al., 2020) but these are not connected to clinical management. Furthermore, the C8 Medical Monitoring Program (http://www.c-8medicalmonitoringprogram.com/index) was created as part of the settlement of the class action lawsuit by DuPont. Settlement Class Members were entitled to medical monitoring paid for by DuPont. The C8 Medical Monitoring Program recommended medical screening every 3 years following the initial medical screening. In the initial screening they underwent a medical examination and provided a serum or urine sample for PFAS testing. Retesting of PFAS levels in serum or urine was offered as part of the 3-yearly follow-up medical screenings. As the C8 Medical Monitoring Program is linked to a class action lawsuit, the motivation for retesting is different compared to other contaminated communities managed by local health authorities.

Levels of perfluoroalkyl ethers (e.g. hexafluoropropylene oxide dimer acid, HFPO-DA or GenX) and "other PFAS" were tested in serum samples (289 adults and 55 children) of Wilmington, North Carolina residents who live downstream of a fluoropolymer manufacturing plant.(Kotlarz, McCord, Collier, et al.) It was believed that the primary drinking water source of Wilmington was contaminated by the plant. Here, only the results of the "other PFAS" are summarized as they are most relevant for Jersey. Concentrations of PFHxS, PFOA, PFOS and PFNA were detected in most (≥97%) participants and their levels were higher than U.S. national levels for the 2015–2016 National Health and Nutrition Examination Survey (Figure 2). (Kotlarz, McCord, Collier, et al.)Median levels of the sum of 5 PFAS (PFOS, PFOA, PFHxS, PFNA and PFHpA) in the adults were 20.8 ng/ml. Retesting was done on 44 participants and the median percentage decrease for the four legacy PFAS (PFOA, PFOS, PFHxS, and PFNA) ranged between 0% and 13%.(Kotlarz, McCord, Wiecha, et al.)

Application of sewage sludge to agricultural land near Arnsberg, Germany led the large-scale contamination of a drinking water reservoir.(Hölzer et al., 2009; Hölzer et al., 2008) Disposal of contaminated sludge from the paper industry was identified as the source of the contamination. A serum testing study was conducted of a sample of residents from Arnsberg (men and mothers/children) with reference populations selected from nearby populations. Blood samples were tested in 2006 (Hölzer et al., 2008) and blood was retested in 2007 (Hölzer et al., 2009) and 2008 (Brede et al., 2010) (Figure 2). In 2006, the geometric mean PFOA plasma concentrations (in parentheses) were: children (23.4 ng/mL); mothers (23.6 ng/mL); and men (30.3 ng/mL). (Hölzer et al., 2008)These geometric mean and concentrations were approximately five times higher than in the reference populations. Two years later after the remediation efforts, the geometric mean PFOA plasma levels declined by 39 % (children and mothers) and 26 % (men) in the Arnsberg population compared to 13–15 % in the reference groups (Figure 2).(Brede et al., 2010).

Elevated serum concentrations of PFAS were reported in the serum from commercial fishermen on the Tangxun Lake in Wuhan China.(Zhou et al., 2014) The fishermen ate the fish they caught on a regular basis. Fluorochemical manufacturing plants in an industrial park upstream from the wastewater treatment plant situated on the upper reaches of the lake were identified as the PFAS contamination source. Median PFOS serum concentrations (for 37 Tangxun Lake fishermen, 7 family members, and 9 reference individuals) were 10,400 ng/mL, 3,540 ng/mL, and 19 ng/mL, respectively (Figure 2). (Zhou et al., 2014)The highest serum PFOS concentration measured was 31,400 ng/mL in a commercial fisherman,(Zhou et al., 2014) which is the world record PFOS serum concentration, and three times higher than the next highest value reported, in a 3M production worker.

In Belgium, a first investigation that tested blood levels (796 participants) of PFAS in people living within a 3 km radius of the 3M Chemicals factory in Zwijndrecht (Antwerp Province) was undertaken and revealed elevated levels of PFAS (especially PFOS) in 9 of 10 people sampled. Median levels of PFOS, PFHxS and PFOA in the 796 participants were 20.8 ng/mL, 1.47 ng/mL and 1.44 ng/mL, respectively (Figure 2)(*PFAS-bloedonderzoeken algemeen*, 2025). The results of the 2021 blood tests will be further investigated and linked with medical data. In the summer of 2022, an additional 5 km population study started where 40,000 blood samples were taken in an area up to 5 km from 3M. In addition, the Youth Study on Human Biomonitoring was also started near 3M, in which more data on lifestyle, eating habits and health were measured and monitored in a selected group of young people. All of the abovementioned studies in Belgium will allow building new knowledge on the health risks of PFAS exposure in this region. In this case the initial testing within 3 km of the factory led to a follow up testing programme which was larger (40,000 instead of 800 participants) and more

widespread geographically (5 km from the factory instead of 3 km). More details of the ongoing work in Belgium can be found on the following website: https://www.vlaanderen.be/en/pfas-in-flanders.

In Veneto, Italy high levels of PFAS contamination have been found and associated with the activity of an industrial plant located in Trissino, in the province of Vicenza. The Miteni Group (formerly called Rimar), a fluorochemical manufacturer which has produced PFAS since 1968, was identified as being responsible for the pollution. (Ingelido et al., 2018)The human population in the region had been exposed to elevated levels of PFAS through the consumption of PFAS contaminated drinking water. In 2016, a biomonitoring study was conducted (Ingelido et al., 2018) on two randomly selected groups of people 20–51 years of age: 257 subjects living in the contaminated area and 250 living in a background area not affected by the contamination incident. The results showed that those living in the contaminated area had significantly higher serum PFAS concentrations than the control group had and that participants residing in municipalities served by contaminated waterworks had the highest serum PFAS concentrations. To address public concerns about exposure to PFAS, a health surveillance program started in January 2017 and continues for the prevention, early diagnosis and treatment of chronic disorders possibly associated with PFAS. Blood (and urine) testing for 12 PFAS was offered to the entire highly exposed population of 105,000 people, which makes this study unique. Data were also collected through a structured interview on socio-demographic characteristics, personal health history and lifestyle habits. A preliminary study of 18,345 participants born between 1978 and 2002, 14–39 years of age at recruitment was published in 2020,(Pitter et al.) but recruitment continued. Median levels of PFOS, PFHxS and PFOA in the 18,345 participants were reported to be 3.9, 3.9 and 44.4 ng/mL, respectively (Figure 2). The population is being recruited for a second round, including retesting of blood and urine for PFAS, which started in September 2020. By February 2022, 55,597 individuals were recruited (60,5% of invited) in the 1st round, and 2,623 in the 2nd round. The median PFAS serum concentrations for PFOS, PFHxS and PFOA were recently reported in this follow up study to be 3.8, 3.7 and 36.8 ng/mL, respectively.(Canova et al.) The program includes a thorough assessment of individual exposure as well as behavioural and clinical risk factors for cardiometabolic disorders, providing tailored counselling for exposure and risk reduction, and the referral of subjects with altered biomarkers for subsequent diagnostic and therapeutic evaluation.

5.2.2 Testing and retesting in AFFF-related exposure scenarios

In addition to Jersey, elevated human serum levels related to AFFF use have been observed at 11 locations in the US,(ATSDR, 2022; Daly et al., 2018) 1 location in Sweden,(Xu et al., 2021) 3 locations in Australia: (Kayla Smurthwaite, 2021)and 1 location in Denmark.(Lyngberg, 2024) Here we briefly review the different serum testing strategies used in these 16 known locations that have elevated PFAS serum levels related to historical AFFF use.

In Jersey, a programme of free-of-charge serum testing was arranged in 2022 for people who had lived in the affected areas between 1991 and 2006, regularly consumed contaminated borehole water from the affected areas, and had symptoms consistent with conditions that have been associated with PFAS exposure(Norman, 2023). A total of 88 results was obtained. The geometric means for serum PFOS, PFHxS and PFOA were 11, 13 and 3 ng/mL (Figure 2).

In Ronneby, Sweden, in 2014, i.e. six months after provision of clean water, all residents in the municipality were invited to free-of-charge serum testing. In total 3507 participants were recruited, which was about 13% of the entire Ronneby population at the time.(Xu et al., 2021) The participation rates from contaminated and minimally contaminated areas were approximately 30%

and 5%, respectively.(Xu et al., 2021) A panel study with 107 participants was followed over 4 years with repeated samplings to determine if PFAS levels were declining and to determine serum half-lives. In Ronneby the mains water was the main historical PFAS exposure source. The geometric means for serum PFOS, PFHxS and PFOA were 135, 114 and 6.8 ng/mL for all Ronneby residents (Figure 2).(Xu et al., 2021) In Ronneby serum was retested to determine if PFAS levels were declining and to determine serum half-lives. (Li et al., 2018b; Xu et al.)

In Australia, between 2016 and 2019, 2392 adults and 195 children were recruited from the PFAS Management Areas in Katherine, Oakey and Williamtown to participate in free-of-charge serum testing. In total, 32% (817/2587) of participants from the exposed communities were current residents of one of the PFAS Management Areas at the time of blood collection. Not all of these participants consumed contaminated borehole water while living in the PFAS Management Areas. The geometric means for serum PFOS, PFHxS and PFOA were 4.9–6.6 ng/mL, 2.9–3.7 ng/mL and 1.3–1.8 ng/mL, respectively (Figure 2). These levels are notably lower than in many of the other studies because the sampling mixed participants who consumed contaminated borehole water with those who did not. About half of participants from the three contaminated communities had significantly elevated blood levels of PFHxS and about a third had elevated blood levels of PFOS. Consumption of contaminated borehole water and local produce were considered the most likely reasons for the elevated PFAS exposures (Kayla Smurthwaite, 2021)

In the United States, The Centers for Disease Control and Prevention (CDC) and the ATSDR conducted free-of-charge serum testing in 10 communities (Westhampton Beach and Quogue Area, New York; Montgomery and Bucks Counties, Pennsylvania; Hampden County, Massachusetts; Berkeley County, West Virginia; New Castle County, Delaware; Spokane County, Washington; Lubbock County, Texas; Fairbanks North Star Borough, Alaska; El Paso County, Colorado and Orange County, New York) that are near current or former military bases and were found to contain PFAS levels in the past exceeding the Environmental Protection Agency's 2016 health advisory of 70 parts per trillion (ppt) for PFOA and PFOS combined. (ATSDR, 2022)These studies assessed PFAS levels in the serum of some residents in each community living near the current or former military bases where public water systems or private wells had PFAS levels above EPA's health advisories. Participants were selected based on specified criteria with the aim of collecting data that were generalizable to each sampling frame (areas within the site communities where known or expected PFAS exposure occurred). Tap water and indoor dust samples from a subset of participating households were also analysed. The primary aim was to understand and control exposure rather than to relate exposure to health effect (i.e. epidemiology). Between September 2019 and October 2020, 1988 eligible people (1791 adults and 197 children) from 1094 households participated in the sampling across the 10 locations (Figure 2). The highest age-adjusting geometric means of serum levels across the 10 studies for PFOS, PFHxS and PFOA were 39.1, 65.6 and 8.9 ng/mL. (ATSDR, 2022)

Also, in the United States, in Pease New Hampshire, a total of 1578 eligible individuals provided serum samples for serum testing in 2015. (Daly et al., 2018)Many members of this community situated near Pease Airforce Base had consumer water from a contaminated well, which had been contaminated due to historical AFFF use at the base. Eligible participants were those who consumed contaminated drinking water while working on, living on, or attending childcare at the former Air Force base, while it was an active base or in the civilian community of Pease after the base closure. The aim of the study was to understand PFAS exposure. The geometric means for serum PFOS, PFHxS and PFOA were 4.12, 8.59 and 3.09 ng/mL. (Daly et al., 2018)

In Denmark in 2020, high levels of PFOS and PFHxS were detected in a wastewater treatment plant in Korsør, Denmark, and the source of contamination was found to be a firefighting training facility where AFFF had been regularly used.(Lyngberg, 2024) In 2021, analysis of the meat from four calves, who had grazed in a field near the firefighting training facility also revealed high levels of PFOS and PFHxS indicative of AFFF contamination. The cattle were the main source of beef intake for members of a local Cow Grazing Association since 1999. Analysis of PFAS in the serum of the Cow Grazing Association (187 individuals) showed particularly high levels of PFOS (mean 43 ng/ml), which is more bioaccumulative in cows than PFHxS and PFOA. (Figure 2) (Lyngberg, 2024) A randomized clinical trial was performed on the exposed population to determine if treatment reduced PFOS serum levels. Despite the treatment effectively decreasing PFOS serum levels in the clinical trial, the Danish authorities decided to not make the treatment generally available. This decision was because they could not conclude that treating individuals to lower PFOS serum levels would provide any health benefits. An exception was made for highly exposed women, who planned a pregnancy. They also decided not to provide retesting to the exposed population as the PFAS levels tested cannot be used to inform on health effects on an individual basis. (Lyngberg, 2024)

In summary, only the Swedish and Australian studies aimed to relate PFAS serum levels to health effects (as summarized in Report 2). While health data are available for Jersey, this study has too low a number of participants to be used for epidemiological studies. The primary aim of the US studies was to better understand exposure so that it could be effectively reduced going forward.(ATSDR, 2022) Only the Swedish study has to date retested a subset of the original participants. The purpose of this retesting was to determine if exposure in the population had declined. (Li et al., 2018b; Xu et al.)

Figure 2 - Summary of concentrations of PFOS, PFHxS and PFOA in human populations with elevated levels of PFAS. These human populations were exposed via contaminated drinking water or food and not via occupational exposure. NHANES data are provided for comparison. Different statistics are provided in the various studies and these are summarized in the footnotes to the table. For example, in most studies the geometric means was provided, but in a few studies the medians are provided. N is the number of participants whose serum was analysed for PFAS

Study area	**Testing year**	**N**	**PFOS**	**PFHxS**	**PFOA**
Non AFFF contamination					
3M, East Metro, Minneapolis St-Paul, US[1] (*East Metro Perfluorochemical Biomonitoring Pilot Project Report to the Community July 2009*, 2009)	2008	196	35.1	8.2	15.1
3M, East Metro, Minneapolis St-Paul, US[1] (Nelson, 2011)	2010	164	24.3	6.4	11.3
3M, Decatur, US[1] (ATSDR, 2013)	2010	153	39.8	6.4	16.3
3M, Decatur, US[1] (Worley et al., 2017)	2016	45	23.4	7.7	11.7
Little Hocking, US[1] (Frisbee et al., 2009)	2005–2006	12,908	23.5	5.70	227.6

Study area	Testing year	N	PFOS	PFHxS	PFOA
Wilmington, North Carolina, US[2] (Kotlarz, McCord, Collier, et al.)	2017–2018	344	8.6	3.2	4.3
Arnsberg, Germany[1] (range of geometric means for children, men and mothers) (Hölzer et al., 2008)	2006	336	4.9–10.5	1.1–2.5	22.1–25.3
Arnsberg, Germany[1] (range of geometric means for children, men and mothers) (Hölzer et al., 2009)	2007	288	4.5–10.2	1.1–2.2	17.4–23.8
Arnsberg, Germany[1] (range of geometric means for children, men and mothers) (Brede et al., 2010)	2008	65	4.1–9.3	0.8–2.3	13.2–21.7
Tangxun Lake in Wuhan China[2] (Zhou et al., 2014)	2012	39	10,400	542	41.0
3M, Zwijndrecht, Belgium[2] (*PFAS-bloedonderzoeken algemeen*, 2025)	2021	796	20.8	1.47	1.44
Veneto, Italy[2] (Pitter et al.)	2017–2019	18,345	3.9	3.9	44.4
AFFF contamination					
Jersey[1] (Norman, 2023)	2022	88	11	13	3
Ronneby, Sweden[1] (Xu et al., 2021)	2014	3,507	114	135	6.8
Katherine, Australia[1] (Kayla Smurthwaite, 2021)	2016–2022	1,181	4.88	3.72	1.29
Oakey, Australia[1] (Kayla Smurthwaite, 2021)	2016–2022	408	6.64	3.29	1.78
Williamtown, Australia[1] (Kayla Smurthwaite, 2021)	2016–2022	1,121	5.14	2.92	1.60
Pease, New Hampshire, US[1] (Daly et al., 2018)	2015	1,578	4.12	8.59	3.09
Korsør, Denmark[1](Lyngberg, 2024)	2020	187	43	3.1	1.0

Study area	Testing year	N	PFOS	PFHxS	PFOA
Exposure assessments (EA) 10 communities monitored by CDC/ATSDR, US (listed below)					
Westhampton Beach and Quogue Area, New York (New York Pilot EA)[1] (ATSDR, 2022)	2018	161	5.64	2.62	1.38
Montgomery and Bucks Counties, Pennsylvania (PA Pilot EA)[1] (ATSDR, 2022)	2018	235	9.43	5.99	2.85
Hampden County, Massachusetts (Westfield EA)[1] (ATSDR, 2022)	2019	459	5.29	4.02	1.77
Berkeley County, West Virginia (Berkeley County EA)[1] (ATSDR, 2022)	2019	275	5.06	2.96	1.33
New Castle County, Delaware (New Castle County EA)[1] (ATSDR, 2022)	2019	214	13.5	11.5	3.74
Spokane County, Washington (Airway Heights EA)[1] (ATSDR, 2022)	2019	333	39.1	65.6	8.91
Lubbock County, Texas (Lubbock County EA)[1] (ATSDR, 2022)	2020	214	3.58	4.93	1.94
Fairbanks North Star Borough, Alaska (Moose Creek EA)[1] (ATSDR, 2022)	2020	88	14.6	9.13	1.75
El Paso County, Colorado (Security-Widefield EA)[1] (ATSDR, 2022)	2020	346	5.15	8.08	1.82
Orange County, New York (Orange County EA)[1] (ATSDR, 2022)	2020	59	4.76	3.56	1.32
NHANES US national testing as a point of comparison					
(CDC, 2024)	2015–2016	1993	4.72	1.18	1.56
(CDC, 2024)	2017–2018	1929	4.25	1.08	1.42

[1]geometric mean, [2]median,

5.3 Testing and retesting in the general population

Exposure to PFAS has been estimated from the concentrations of the target PFAS in serum, plasma, or whole blood in numerous studies conducted around the world since the early 2000s (see multiple references Kato et al.(Kato et al., 2015)). Observed PFAS serum concentrations vary by geographical location, PFAS type, sex, and age. (Sunderland et al., 2019)

NHANES is the most extensive and well-known national serum testing programme and has measured PFAS-levels in blood in the U.S. population since 1999.(Calafat et al., 2007) NHANES PFAS data have been publicly released in 2-year cycles. NHANES is principally designed to assess the health and nutritional status of U.S. adults and children. The survey is unique in that it combines interviews, physical examinations, and analysis of biological samples for contaminants, including PFAS for Americans of 12 years of age and older. The NHANES survey examines a nationally representative sample of about 5,000 persons each year. However, NHANES included a subset of around 2,000 individuals in each cycle for PFAS measurements (see Figure 2 for results for 2015/2016 and 2017/2018, data can be extracted for all years from the website in ref: (CDC, 2024)In studies such as NHANES that aim is to get a representation sample of the general population the following considerations are required; stratifying your target population by relevant demographics like age, sex, socioeconomic status, region, etc., to capture population diversity; having a sample size that provides sufficient statistical power; and using a random sampling method to avoid selection bias.

Even if NHANES is considered a good representation of the PFAS exposure in the U.S. general population, Wisconsin have initiated their own state-wide survey (The Survey of the Health of Wisconsin (SHOW)) which using similar methodology to NHANES.(Pomazal et al., 2024) The aim is to characterize the variability of PFAS exposure in a statewide representative cohort in the US. It can also be used to identify high risk populations and inform state public health standards and interventions, especially among those not living near known contamination sites.

For the majority of the generally exposed populations examined around the world, the four most commonly studied PFAS have been PFOS, PFOA, PFHxS and PFNA). PFOS usually has the highest serum concentrations followed by PFOA, while other PFAS are detected both at lower concentrations and frequencies. (Kato et al., 2015)In hot spot contamination areas and occupational settings, the concentration patterns observed often differ from those reported among the general population (e.g. PFHxS is higher than PFOA in serum in an AFFF-impacted population). Interestingly, the ranges of blood concentrations of PFOS, PFOA, PFHxS, and PFNA in the general population are remarkably similar worldwide among many countries, suggesting a common historical exposure source. Higher concentrations of PFOS, PFOA, and PFHxS are found in males compared to females and this has been mainly attributed to monthly blood loss from menstruation in women.

In many of the studies reviewed in the above sections of the report, the contaminated population was often compared to a nearby reference population which in turn was compared to a well-known testing programme for the general population (often NHANES is used). The aim of this comparison exercise is to confirm that the contaminated population is in an isolated region only.

Temporal trend studies of PFOS, PFOA and PFHxS have been undertaken in several countries through retesting a representative sample of the general population at regular intervals.(Kato et al., 2015; Sunderland et al., 2019) The temporal trend studies are typically “cross-sectional” in design whereby a similar representative cross-section of the population is sampled at each time point (as in NHANES) (Calafat et al., 2007)rather than retesting the same individuals (known as a longitudinal testing

design). In NHANES a cross-section of the US population is sampled every two years since 1999 and the serum analysed for PFAS. Similar temporal trends have been observed between studies and countries despite some differences in sampling design among studies, pools vs individual specimens, plasma vs serum, sample size, time period and potential regional differences in exposure.(Kato et al., 2015) The concentrations of these PFAS in blood followed similar increasing trends from the 1970s to the mid-1990s due to the increasing production volumes in this period (e.g. PFOS peaked at about 30 ng/L in the US general population at the turn of the millennium) and then have declined since the early 2000s following their industrial phase out by 3M in 2000-2002. (Kato et al., 2015)China and some other Asian countries are an exception to these otherwise general time trends because these countries increased production of PFOS and PFOA when 3M phased out their industrial production of long-chain perfluoroalkyl chemistries in 2000-2002, (Wang et al., 2016)and have only recently announced that they too will cease production of some long-chain perfluoroalkyl chemistries. PFAS are still today ubiquitously detected in people around the world in single digit ng/L levels and declining trends in blood may be plateauing off as serum levels approach a steady state with background environmental exposure intakes.(Sunderland et al., 2019). There are further time trend studies from Sweden (Axmon et al., 2014) and from Denmark (Hull et al., 2023) which review time trends and show similar findings.

5.4 Testing and retesting in occupationally exposed populations, especially firefighters

Christensen and Calkins (Christensen & Calkins, 2023) reviewed occupational exposure studies and identified 92 individual studies for PFAS. Most occupational studies reviewed (~60%) evaluated PFAS exposure in fluorochemical production workers or first responders (mostly firefighters). In addition, occupational studies focused on ski wax technicians, fishermen, textile manufacturing, a metal plating workshop, a powder coating shop, a metalworking shop, a plastic production facility, a pesticide packing plant, outdoor clothing (and gear) shops, offices, college lecture halls, school laboratories, computer rooms, primary/secondary classrooms, furniture shops, printing shops, autobody shops, a mechanical shop, an electrotechnical shop, carpet shops, a car selling store, electronic stores, a sports equipment shop, coffee shops, internet cafes, restaurants, libraries, movie theatres, and hotels.(Christensen & Calkins, 2023) The highest serum levels were reported in fluorochemical workers, but, in comparison to reference populations, one or more PFAS were elevated in most workers and in most workplaces that were assessed in the review.(Christensen & Calkins, 2023) Here we provide a summary only of the research done on occupation exposure of PFAS for firefighters as it is most relevant occupational exposure for Jersey.

Serum testing of PFAS in firefighters was reviewed by Rosenfeld et al.(Rosenfeld et al., 2023). The 10 studies that were reviewed by Rosenfeld et al. in the US and Australia showed that firefighters have elevated serum levels of certain PFAS such as PFOS and PFHxS(Christensen & Calkins, 2023). In Australia, Rotander et al. (Rotander et al., 2015)studied 149 firefighters working with AFFF at training facilities in Australia's Airservices Aviation Rescue Fire Fighting Service and reported that firefighter PFOS and PFHxS serum levels were 6–10 times and 10–15 times higher, respectively, than in the general population. A larger study followed on 799 current and former Airservices staff, with 130 staff from the earlier study.(Nilsson et al., 2022) Although PFAS were still elevated, the geometric mean dropped between 2015 and 2018, suggesting that levels continued to decline since the 2005 phase-out of 3M Lightwater AFFF in Australia. Nilsson et al.(Nilsson et al., 2022) further found that PFOS and PFHxS serum levels were positively correlated with length of employment working with AFFF. Firefighters who started work in Australia before 2005 had serum concentrations of PFHxS and

PFOS higher than the general population, while those who started working after 2005 had levels similar to the general population. In the US, eight additional studies reported elevated levels of PFAS in the serum of both fulltime and volunteer firefighters.(Nilsson et al., 2022)

Dermal and inhalation exposure from PFAS-impregnated turnout gear have both been suggested to be exposure pathways for firefighters, but these pathways are considered of lesser importance compared to exposure from the use of AFFF during training and firefighting.(Rosenfeld et al., 2023) The fact that Australian firefighters who commenced worked after 2005, and still wore PFAS impregnated turnout gear, had similar levels to the general population provides supporting evidence that AFFF-derived exposure is much more important than exposure related to turnout gear.(Nilsson et al., 2022) Modern fluorotelomer-based AFFF is based on short-chain C6 PFAS chemistry. No exposure to PFOS or PFHxS is possible from the use of modern fluorotelomer-based AFFF as it does not contain these substances.(Barzen-Hanson et al., 2017)

5.5 Discussion on strategies for testing and retesting serum for PFAS

In the 2006 NRCNA book(Council, 2006) on testing of contaminants in humans, it recommended that it is first necessary to determine the purpose of retesting, which can be several:

- Tracking exposure over time: These studies monitor the levels of PFAS or biomarkers in individuals over extended periods. The aim is primarily to understand how exposure to PFAS changes over time and can be used e.g. to derive serum half-lives.
- Assessing health outcomes: By correlating test data with health outcomes, researchers can identify potential links between exposure to certain chemicals and the development of diseases or health conditions over time.
- Evaluating public health interventions: To assess the effectiveness of public health policies and interventions aimed at reducing exposure to harmful substances. This helps in determining whether these measures are successful and where improvements might be needed.
- Identifying at-risk populations: These studies can highlight specific groups within the population that are more vulnerable to certain exposures, such as children, pregnant women, or occupational groups. This information is crucial for targeted public health strategies.
- Understanding environmental changes: To reveal how changes in environmental levels impact human exposure over time.
- Supporting regulatory decisions: The data from these studies provide evidence that can inform regulatory bodies in setting safety standards and guidelines for exposure to various chemicals.

When it comes to retesting of individuals with elevated PFAS exposures, the following guidance is given in the NRCNA 2022 report,(National Academies of Sciences, 2022) which provides specific guidance on PFAS testing:

- For individual tests, consider confirmatory retesting when the result is much higher or lower than anticipated given exposure history;
- Consider retesting to understand exposure changes due to:

  - public health actions (such as drinking water treatment programs or site cleanup are taken to reduce exposure);
  - patients take actions to reduce exposure (such as installing water filters, moving from a community with known high levels of PFAS in drinking water, or modifying occupational exposures); or
  - the patient moves into a community with known high levels of PFAS or otherwise has a suspected increase in exposure risk.

- If there is interest in follow-up testing of PFAS to determine declines in exposure and determination of serum half-lives, allow at least a year between each retesting.
- Retesting is of no or limited value if initial serum levels are low and exposure does not change.

This guidance given above taken from the NRCNA 2022 report(National Academies of Sciences, 2022) is purely related to retesting for the purpose of understanding exposure. Also, no guidance is given above as to what is considered “low” serum levels. However, it is further recommended in the NRCNA 2022 report(National Academies of Sciences, 2022) that clinicians should use serum or plasma concentrations of the sum of PFAS to inform clinical care of exposed patients, using the following guidelines for interpretation:

- Adverse health effects related to PFAS exposure are not expected at less than 2 ng/mL.
- There is a potential for adverse effects, especially in sensitive populations, between 2 and 20 ng/mL.
- There is an increased risk of adverse effects above 20 ng/mL.

Therefore “low” serum levels can be concluded to be less than 2 ng/L. However, the above advice may lead some individuals to believe that if they have serum levels above 2 ng/L they are at a higher risk of certain health effects related to PFAS exposure. However, it is impossible to predict health outcomes for *individuals* based on their PFAS serum levels. The authors presumably mean that there is a potential increased risk of adverse effects *on the population level* at exposure levels above 20 ng/L. It is nevertheless precautionary guidance because everyone in an industrialized country had levels of at least 20 ng/L 20 years ago and levels of around 2 ng/L are fairly typical for the general population at the time of writing in 2024.

In practice, retesting for clinical management purposes in contaminated communities has not been undertaken often and is not recommended by some health authorities. For example, in Denmark retesting is not recommended in contaminated communities for the following reasons(Lyngberg, 2024):

- PFAS-levels cannot be used to predict health outcomes;
- Testing of blood samples need to be actionable, i.e. guide medical decisions and treatments;
- Counselling for highly exposed individuals does not differ from that of the background population.

At Ronneby in Sweden, the authorities follow the same general approach as in Denmark and do not offer retesting of serum levels to those individuals who took part in the initial broad testing of PFAS in the contaminated community. There is an informational website for the affected population: (Ronneby Kommun, 2013)In Ronneby, there is, however, serum retesting ongoing within various research projects focused on understanding serum half-lives of PFAS,(Li et al., 2018b; Xu et al.) but there is no clinical management connected to this retesting.

In the cases where retesting in contaminated communities has been done, reviewed above, it is clear that retesting was done largely for understanding changes of exposure, e.g. in order to improve understanding of the half-life of PFAS moieties in the community, or for other research purposes, rather than to monitor the patient's wellbeing (i.e. clinical management). It can also be concluded that Jersey is unique in only testing PFAS in the serum of individuals with symptoms consistent with conditions that have been associated with PFAS exposure. All other studies tested individuals asymptomatically in the first testing timepoint and then typically retested a smaller subsample of the original population at a later timepoint to determine if exposure had declined.

Health data are usually collected from the sampled population for epidemiological research, and rarely for clinical management purposes. A few research studies have resampled PFAS levels in order to ascertain if there is a relationship with the course of a particular illness or biomarker related to PFAS exposure,(Fitz-Simon, Fletcher, Luster, et al., 2013; Lin et al., 2019; Steenland et al., 2013) and other studies have retested in order to assess suitability to enter or to remain in programmes of clinical intervention seeking to lower PFAS body burden.(R. Gasiorowski et al., 2022; Møller et al., 2024) In one identified case, regular retesting of serum was performed in conjunction with regular health monitoring, but this was connected to a class action lawsuit and the motivation for retesting is very different compared to other contaminated communities managed by local health authorities. There is limited guidance provided for when retesting should be ceased, although in the NRCNA 2022 report it is suggested that adverse health effects related to PFAS exposure are not expected at serum levels less than 2 ng/mL. (National Academies of Sciences, 2022)If one accepts the conclusion regarding lack of adverse health effects below this level, it would be unnecessary to retest individuals once serum levels were below 2 ng/mL.

6 Clinical testing or screening in exposed individuals

In chapter 2.4we summarised principles for guiding whether it is of benefit to screen for specific diseases or conditions which are likely more frequent due to PFAS exposure.

So here we first focus our discussion on the conditions which we highlighted in report 2 (PSAP, 2024) as being, at least, probably related to PFAS exposures such as have happened in Jersey:

Most likely or probable

- Increased cholesterol level in blood
- Kidney Cancer
- Testicular Cancer
- Reduced vaccination efficiency in children
- Reduced duration of breastfeeding in exposed mothers
- Liver function in the form of an effect on liver enzymes

The three outcomes least suitable for screening are reduced antibody levels following childhood vaccination, shifts in the levels of enzymes reflecting liver function, and reduced duration of breastfeeding. For each it would be desirable to avoid an effect, but the effects of PFAS noted in research studies were small shifts in these measures, and it would be difficult to identify for an individual if they were affected. Further there is no intervention or mitigation that would be appropriate for any of them. The others are discussed in turn

6.1 Increased cholesterol

Although the evidence of an increased risk of cardiovascular disease related to PFAS is inconsistent, raised cholesterol is generally associated with an increased risk of cardiovascular disease. Screening for cholesterol and if it is raised, providing advice on steps to reduce cholesterol levels is a policy in a number of health services(Dehmer et al., 2017). This meets a number of criteria for a valuable screening test(Wilson et al., 1968). There is reliable screening tool, the serum cholesterol test and it is relatively inexpensive, and reducing elevated cholesterol is likely to lead to a clear reduction in subsequent risk of severe cardiac events. This cholesterol reduction can be achieved by diet, exercise and/or lipid lowering medications.

The effects noted in studies of PFAS exposed persons points to a modest increase in total cholesterol, around 5 to 10%), so for most people that would be a shift within the normal range. However, for some that would shift them into higher category where they would be advised to take steps to lower their cholesterol levels. Therefore, the panel advises that residents who have had elevated PFAS exposure should consider asking to have their lipids measured through their GP.

6.2 Kidney cancer

There is evidence of a modest increase in risk of kidney cancer, for example in the Swedish studies in the community affected by AFFF contamination of drinking water they reported close to a 30% excess risk for kidney cancer(H. Li et al., 2022). The lifetime risk of kidney cancer is in the range 1 to 2%, or put another way the incident rate of new kidney cancer is 21 per 100,000 persons per year(*Kidney cancer incidence statistics*, 2025). If we apply the same excess risk that would rise to 27 per 100,000 per year.

So the chance for an individual to develop kidney cancer each year is very low, with or without the any risk associated with PFAS. People at much higher risk of kidney cancer, for example from related to a rare inherited syndrome, may be referred within the NHS for targeted screening with ultrasound or MRI(*Screening for kidney cancer*, 2024). This is not recommended for the normal levels of risk of developing the disease and there is not a reliable simple blood test or urine test for picking it up at an early stage.

The panel does not recommend extra screening, but advises that residents and their GPs should be reminded of early signs which should prompt clinical follow up such as blood in the urine; a lump or mass in the kidney area or a pain in the side between the ribs and the hip.

6.3 Testicular cancer

There is evidence of a modest increase in risk of testicular cancer, for example in the Swedish studies in the community affected by AFFF contamination of drinking water they reported close to a 40% excess risk for kidney cancer(H. Li et al., 2022). The lifetime risk of testicular cancer is around 1in 220, or put another way the incident rate of new testicular cancer is 7 per 100,000 males per year(*Testicular cancer incidence statistics*, 2025). If we apply the same excess risk that would rise to 10 per 100,000 per year.

So the chance for an individual to develop testicular cancer each year is very low, with or without the any risk associated with PFAS. If identified and treated early the prospects for successful treatment are very good, and the best means to achieve early identification is regular self-examination by adult men, and self-referral to their GP if they notice a new or unusual lump.

6.4 Other schemes for clinical screening in PFAS exposed populations

Recently the US National Academy of Sciences convened a panel leading to a report: “Guidance on PFAS Exposure, Testing, and Clinical Follow-Up”(NASEM, 2022). In this report they identified a range of adverse health outcomes they considered could be caused by PFAS, and recommended some health screening depending on the level of measured PFAS.

The committee concluded there was “sufficient” evidence of an association for the following diseases and health outcomes: decreased antibody response (in adults and children); dyslipidaemia (in adults and children); decreased infant and foetal growth and increased risk of kidney cancer (in adults). Further they found “limited or suggestive” evidence of an association for a number of diseases and health outcomes, including increased risk of breast cancer and testicular cancer, ulcerative colitis and thyroid disease.

They recommended that PFAS blood tests were done and if the sum of the main PFAS in blood exceeded 20 ng/ml then the following screenings were recommended:

- screening for Dyslipidemia with a lipid panel
- thyroid function testing with serum thyroid stimulating hormone (TSH),
- assessment for signs and symptoms of kidney cancer (including with urinalysis)
- assessment for signs and symptoms of testicular cancer

- assessment for signs and symptoms of ulcerative colitis

There are some similarities and differences in our conclusions, specifically that the evidence of AFFF exposed persons having increased risks of thyroid disease and ulcerative colitis was very limited and thus was not considered for active screening.

An earlier programme in the USA was set up as part of the legal settlement related to emissions of PFOA from an industrial site, the "C8 Medical Monitoring Program" (http://www.c-8medicalmonitoringprogram.com). This followed on from previous phase of the settlement, where the "C8 Science Panel" had determined 6 conditions deemed likely to be linked to the PFOA exposure.

These 6 conditions are:

- pregnancy-induced hypertension (including preeclampsia),
- kidney cancer,
- testicular cancer,
- thyroid disease,
- ulcerative colitis, and
- high cholesterol (hypercholesterolemia).

Screening was provided for some of these conditions as part of the legal settlement for anybody who had been living in the contaminated area. The programme reimburses costs for people to attend a local doctor who would conduct blood tests to detect high cholesterol, assess thyroid hormones and provide a clinical examination for the cancers and colitis. Pregnancy induced hypertension is already screened for as part of standard antenatal care.

6.5 Other conditions with weaker evidence of associations with PFAS

In our second report we highlighted the conditions with the strongest evidence of a causal link with PFAS, but acknowledged that there are a number of other associations with some, but limited scientific evidence. Further we recommended that a concise knowledge-based resource on PFAS exposure and health should be made available to the public and health professionals in Jersey. Such a document would highlight the signs and symptoms to look out for all the conditions likely or even weakly associated with PFAS exposure.

6.6 Conclusions and recommendation

The panel does not recommend providing screening on the basis of individual PFAS measurements but rather all residents who have had PFAS exposure through drinking water or occupational exposures, should be aware of the potential health effects of PFAS. They and their GPs aware of this information can be more vigilant for signs and symptoms of those conditions. Each of the associations we have highlighted is not associated with a high risk of disease, so it remains unlikely that any specific diseases will arise due to exposure. While this is reassuring, some effects are nevertheless possible and given the general benefits of early detection and treatment, being aware of key signs and symptoms will be of benefit.

The only new specific screening recommendation we make is that people with exposure should be offered lipid panel blood tests to assess cholesterol. Cholesterol levels generally rise with age and the

chance of having levels too high is thus more so at older ages. We recommend that this is offered to people over 40.

7 Literature review on interventions to lower PFAS body burden

7.1 Introduction

In assessing the potential for interventions to reduce the body burden of PFAS various types of study are informative.

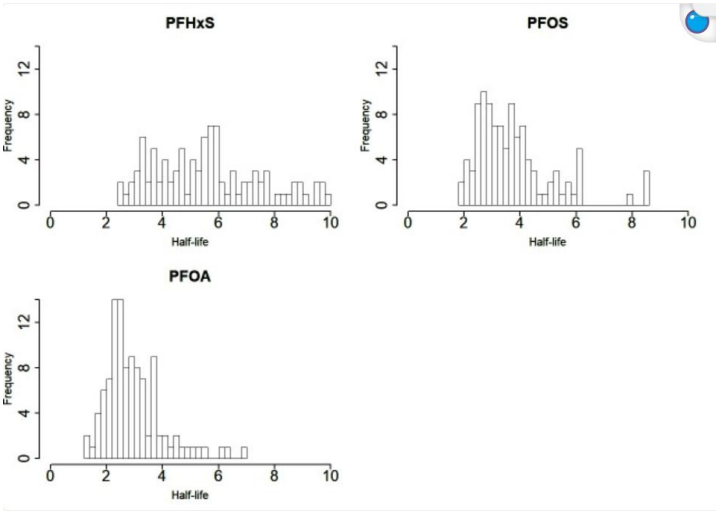
Observational studies consider whether there is an association between a factor which people have chosen on their own accord, but can affect the amount of PFAS in them. For example, a drug, an aspect of diet or a practice such as regular blood donation and the serum levels of PFAS. Such studies have the advantage of learning from what has happened, but these choices might be correlated with other factors which affect intake or excretion, i.e. confounding factors, and thus there is more uncertainty in the causality of these associations than from intervention studies. However, depending on how the data are presented, it may be possible to estimate how much reduction might be achieved by modifying these factors.

Intervention studies involve introducing or modifying the factor and measuring if the intervention has any impact compared to what is expected. The most credible results come from studies where people in the target population have been randomly allocated to those with and without the intervention, so one compares the effect between groups, which because of random allocation, should differ by potential confounding factors. In other studies, with no control group, the impact can be assessed and can still be informative but is only credible for rather dramatic impacts.

As we are exposed to PFAS, the amount increases and builds up in our bodies. Serum concentrations are used to measure our body burden as some of it, up to half the body burden, resides in the circulating blood. Once PFAS is in our system it remains for a long time, with serum concentrations declining after intake is reduced or completely stopped. The half-life (the time it takes for serum concentrations to fall by a half after completely stopping intake) ranges from 3 to 5 years for PFOA, PFOS and PFHxS. All these compounds pass through the kidney and guts, but mostly they are reabsorbed again with a small amount being excreted through urine and faeces. It is this very efficient reabsorption that leads to the slow excretion and long half-lives. This was explained in more detail in our second report(PSAP, 2024).

For each possible intervention we have calculated from published studies an average rate of elimination due to that intervention, which is then added to average elimination rate for each PFAS to estimate the reduction to be expected from adding the intervention. In both the baseline elimination rate and the estimated extra effect of the intervention, behind the averages there is substantial inter-individual variation. Thus, one person's serum PFAS may fall much more slowly or more rapidly than the average expected rate. Data from Ronneby further illustrate the variation in half-life from person to person (Li et al., 2018a)

Figure 3 - Variation in PFAS half lives in Ronneby residents



One way we might reduce the body burden is to reduce the rate of reabsorption in the gut and kidney, thus accelerating our excretion rate. The other possible way is to take out some of the circulating blood or plasma, for example with phlebotomy, as was explained in our first report(PSAP, 2023).

In the next sections we summarise by the different types of potential intervention, what science has been done on these ways of reducing the body burden of PFAS, to speed up excretion to faster rate than the natural rate of elimination.

7.2 Diet

7.2.1 Observational studies

One way of increasing excretion could be by different diets, and some research has studied whether some aspects of diet appear to be associated with lower blood PFAS levels. A particular interest is whether dietary fibre can lead to more rapid excretion from the gut, this had been suggested by some evidence that food items which tended to be high in fibre were associated with reduced PFAS(Halldorsson et al., 2008; Skuladottir et al., 2015). These association studies of food items are not straightforward to interpret because diet is also a source of PFAS, so it may just be part of the reason that some the foods are linked to lower PFAS, is that they happen to be low in PFAS. However, it is plausible that dietary fibre is good for excreting PFAS as it is known to lead to more rapid passage of food through the gut. Several studies have focussed on fibre intake in particular in relation to PFAS concentrations. In these studies, a detailed food questionnaire is completed by each person to characterise their usual diet, and this is converted into ingredients using other studies that have established the average composition in terms of amount of fat, vitamins, fibre etc for each dish or food item.

A report in 2020 related PFAS levels to diet, including fibre, in a population of 941 people with pre-diabetes enrolled in a diabetes prevention programme(Lin et al., 2020). They reported that PFOS was significantly lower in relation to fibre intake, but little effect on PFOA or PFHxS.

In a study of the US NHANES national surveys which included blood tests and dietary questionnaires over the years 2005 to 2016, the association between various dietary elements and PFOA, PFOS and PFNA was investigated for 6482 adults(Dzierlenga et al., 2021). They divided the fibre intake

estimates into quartiles and the association with PFAS levels were reduced per increasing quartile of fibre were presented: 7% for PFOS, 4% for PFOA and 8% for PFNA.

Broadly the same data over the years 2007 to 2018 was looked at in a later paper with similar results, and they presented PFHxS in addition(Zhou et al., 2024). Comparing people with dietary fibre above the median to below the median, the sum of PFAS in serum was 8% lower in the higher fibre group. By specific PFAS the PFOS fell most (9%), PFOA to a lesser extent (6%), but PFHxS was hardly associated with fibre, only falling by 1%. For predicting the effect of fibres on PFAS levels, we shall use these figures.

There is one intervention study where the dietary fibre supplement Chlorella pyrenoidosa was given to a small group of eight people who had had raised PFAS, after they had been given a bile sequestrant(Genuis et al., 2013). The bile sequestrant arm of the study is described below. Chlorella is a freshwater algae that was reputed to have some detoxifying properties on other pollutants, dioxin and chlordecone. While they did not provide information on net decreases in serum levels, they reported on concentrations in stool samples taken before treatments and towards the end of each week's treatment. The Chlorella did not seem to increase excretion, but as it was taken just after a period of a pharmaceutical intervention with bile sequestrant, one cannot be confident in this study providing evidence of an effect or not of this intervention.

Another analysis of the NHANES data focussed on the potential effects of reported use of "probiotic" foods either as yogurt or probiotic supplements, which are thought to aid the maintenance of a healthy balance of bacteria in the gut, and so important for healthy digestion of food(Liao et al., 2023). There were significantly lower PFOS and PFOA serum levels in the 14% who reported probiotic use. In fully adjusted models, including adjustment for other dietary components such fish, eggs and diet, the probiotic use in the adjusted model, was associated with 13% lower serum PFOS and 7% less PFOA with no difference for PFHxS. The apparent effect of probiotic supplements was larger than for yogurt.

In a review paper on the potential for probiotics to help to protect against environmental toxins they summarise a number of experimental animal studies such as in zebrafish where probiotics offered some mitigation of toxic effects of PFAS, especially PFBS(Baralic et al., 2023). Although the general point is made that probiotics may help the more rapid excretion of toxins and give examples such as bisphenol and mercury, no evidence is presented for this having an impact on PFAS.

7.2.2 Estimating the likely benefit from changing the diet.

The variable used to describe the rate at which people excrete something (whether a chemical or a drug) is called the excretion rate constant. This will vary for different substances, so a chemical with a low excretion rate will seem to have a long half-life. The apparent difference in serum concentration between people with different diets can be understood in terms of this excretion rate.

At a constant regular level of intake in the general population, for example an average daily PFOS intake from food, people will on average have a lower concentration in blood if they have a higher excretion rate, in direct proportion. So, if your excretion rate is 20% higher, then over time with a constant excretion rate your serum levels will settle down to concentrations 20% lower. So, taking the fibre example, if we assume that the average PFOS intake across the different groups is the same, but the average serum PFOS levels are 9% lower in the high fibre group, that that means the excretion rate is over average 9% higher due to the effect of higher fibre intake.

On a more technical level, this relationship can be summarised in an equation describing a one compartment pharmacological excretion model by the following equation:

Excretion per day = k.Cs.Vd,

where k is the excretion rate, Cs is the serum concentration and Vd is the volume of distribution, (the effective volume in the body where the PFAS is to be found - blood plus organs including kidney, liver, guts - expressed in terms of equivalent volume of blood plasma eg 12,000 ml). When exposure has stopped, k is an indication of how fast the serum concentration goes down. The rate k is then the rate at which the concentration changes per time (e.g. this could be expressed per year, e.g. 20% per per year, or per day as in the above equation, e.g. 0.1% fall per day). The concentration actually follows an exponential decline ($Cs = C_0.e^{-k.t.}$). At steady state, with excretion equal to constant daily intake, this equation shows how the serum concentration inversely depends on the value of k. With constant intake, people with higher excretion, perhaps due to diet will have a lower steady serum rate.

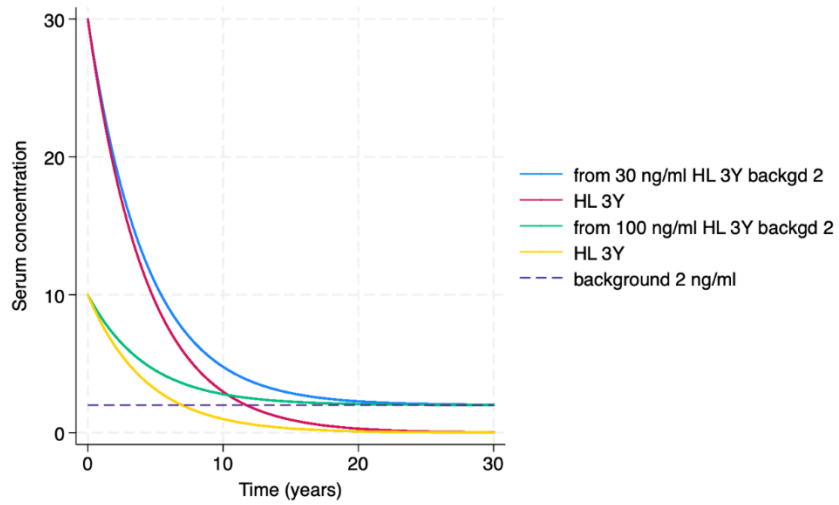
So if two groups one with a different diet are compared and we observe different stable PFAS serum levels C_1 and C_2, we can use that data to estimate the different values of k if we make some assumptions: we assume that both have reached steady state and that they have the same PFAS intake per day. In that case the excretion equals the intake and then: $k_1.C_1.Vd = k_2.C_2.Vd$

So, if the second group has a serum concentration C_2 10% lower then that means the k value is 10% higher. We can use this to predict the impact on the rate of clearance in the population.

Now let us consider how these different excretion rates affect the rate of clearance after stopping exposure. Here we use the half-life values from the later Ronneby paper, 4.5 years for PFHxS, 3 years for PFOS (averaging the linear and branched versions of PFOS which they had presented separately) and 2.5 years for PFOA (Li et al 2022).

The decrease following up from a given point after the end of exposure is shown in the following figure for two examples, with a serum level of 30 ng/ml and 10 ng/ml at the start of the follow up, and a half-life of 3 years, (for PFOS).

Figure 4 - Illustration of decline over time after stopping exposure, for individuals followed up from 10 and 30 ng/ml. PFOS with half life of 3 years. Average decline, no intervention

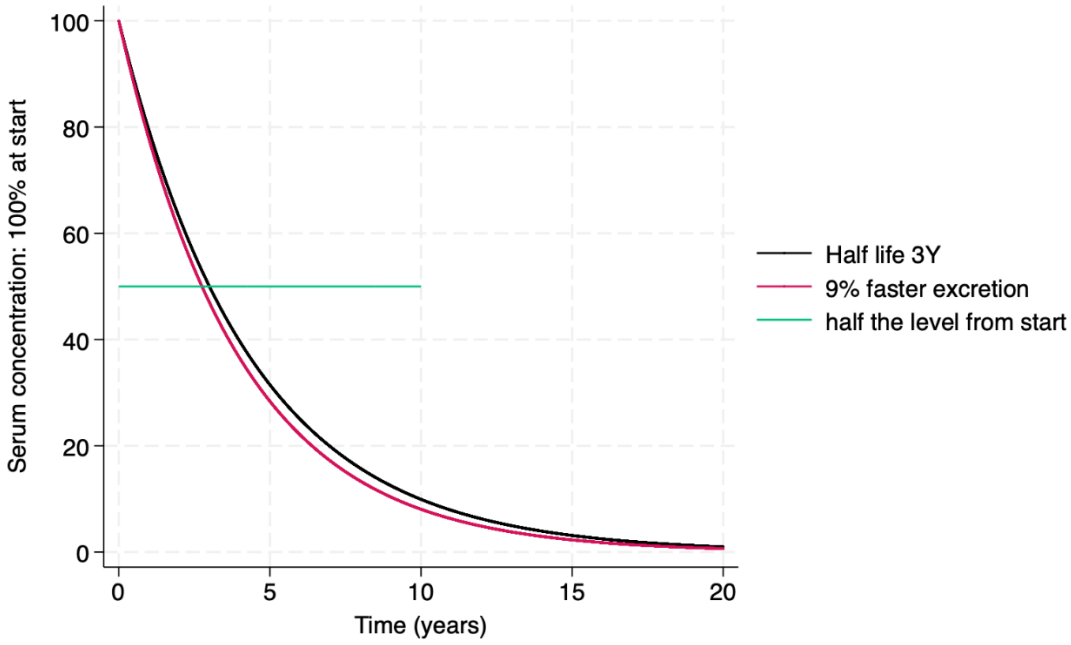


If exposure really completely stops (red line) the serum concentration falls and approaches zero after about 20 years. The level falls by 50% each half life, falling to 15 ng/ml at exactly 3 years. In reality though, there is some ongoing exposure indicated by the background levels of the general population. If we assume that background exposure persists and is equivalent to 2 ng/ml on average, then the serum levels in the modelled individual fall a little more slowly and slowly approach the final background level of 2 (blue line). In this case it takes a little longer to fall to 15 ng/ml, 3.32 years to be precise. This slowing down of excretion as serum levels get closer to the background levels is illustrated in the second case, starting at 10 ng/ml. The ongoing general background exposure significantly slows down the excretion rate as the serum levels gets close to the general background level. The truth is likely to be somewhere in between the curves with or without current average background levels, as we expect (and hope) that average background exposure from these PFAS in the general population will fall over time perhaps being close to zero some 20 years from now.

For this review, we do not know the true background non-water exposure is, and to keep the illustrations of the modelling simple for comparing interventions in the next sections we will compare to the baseline expectation assuming no ongoing exposure in the long term – the black line, and express it as falling from 100% at the start of follow up so show the % declines. For comparing between interventions, this provides a valid and informative picture. Results would be very similar and in the same order of effect if some estimated background were to be included.

Now let us take the example of someone with an excretion rate that is 9% faster (due perhaps to deciding at the start to embrace a high fibre diet). To illustrate the expected effect on excretion patterns, compared to an average lower fibre diet: This is shown in the following example:

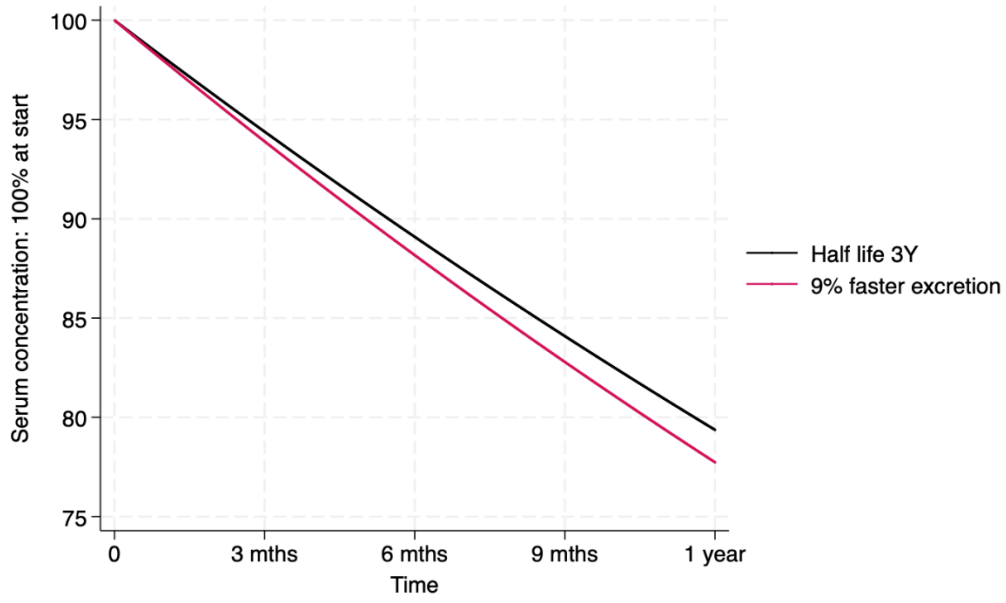
Figure 5 - Illustration of percentage decline over time after stopping exposure, average individual and with extra excretion from diet. PFOS with half-life of 3 years



The black line is, as before, applying the 3 year half life. The red line now reflects the 9% higher excretion which might be expected from the high fibre benefit reducing the time to halve the serum concentration to 2.75 years some 3 months shorter.

Another way of looking at this is to estimate how much this extra excretion takes out after a shorter time.

Figure 6 - . Illustration of percentage decline over a year after stopping exposure, average individual and with extra excretion from diet. PFOS with half life of 3 years



In this example with a half-life of 3 years for PFOS, this would be equivalent to a fall of just over 20%, or in 3 months a fall of 5.6%. And, if they were in the high fibre group and the fibre increase excretion by the 9% indicated in the study summarised above it would fall by 6.1%, a little more.

The table summarises these coefficients for each PFAS in terms of the percent drop after starting this change in diet.

Figure 7 - Summary of average percentage rate of decline over time after stopping exposure for PFHxS, PFOS and PFOA, and additional decline related to high fibre or probiotic consumption

	PFHxS	PFOS	PFOA
Half-life yrs	4.5	3	2.5
Impact of high fibre on excretion rate	nil	9%	6%
Impact of probiotics on excretion rate	nil	12%	7%
% Annual fall average without intervention	14.3	20.6	24.2
% fall in 3 months without intervention	3.8	5.6	6.7
Extra % fall in 3 months estimated for high fibre group	0	0.5	0.4
Extra % fall in 3 months estimated for probiotic group	0	0.7	0.5

Any estimated benefits of either fibre or probiotics must be interpreted with caution. The fibre coefficient derives from estimated fibre composition across the diet. It may be that adding a fibre supplement to the diet would achieve the same effect, but this is quite uncertain. It may be that people with high fibre diet also have other dietary choices that affect PFAS intake or excretion.

The estimated benefits of probiotics are even more difficult to extrapolate. The study relied on people reporting the consumption of “probiotic supplements and/or yoghurt”, it is not possible to separate out specific brands of probiotic supplement which might be more effective, among the

many one can find in the shops. Thus, without knowing which probiotic to use an intervention, we do not consider this as a realistic option.

7.3 Phlebotomy and plasma removal procedures

7.3.1 Interventions without control groups

A phlebotomy intervention study was summarised in report 1(PSAP, 2023) A family had accumulated high levels of PFHxS, PFOS and PFOA from repeated and large-scale use of PFAS-containing carpet treatments in their home(S. J. Genuis et al., 2014). PFHxS was especially high, and PFOA only moderately higher than the general background population. The levels differed between different family members. Once they realised that they had been exposed to PFAS and had high serum levels, they ceased using the treatments and discarded most of their carpets.

They then underwent multiple phlebotomy blood donations to reduce their body burden, with donations averaging 1802 ml/year for family members. The average fall per year was much more than expected from normal clearance rates, and the average reduction in serum attributable to each phlebotomy procedure was estimated to be about a 4% reduction(PSAP, 2023). In this specific study the reduction calculated per phlebotomy was 4.5% for PFHxS, 7.7 for PFOS and 1.5 for PFOA. However, as there was no control group, the impacts are not precise estimates.

7.3.2 Intervention studies with control groups

There is one Australian clinical trial, summarised in report 1(PSAP, 2023). In an Australian study of firefighters (R. Gasiorowski et al., 2022) with occupational exposure to PFAS-containing firefighting foams, participants were randomised into three groups (one offered phlebotomy interventions, one plasma removal procedures (where only blood plasma and not blood cells are taken), and a control group (just observed with no intervention). To assess the impact of the interventions, the impact of the phlebotomy was estimated from the difference between those giving blood and those in the control group who received no intervention. On average, the phlebotomy participants gave 4.3 blood donations over a 12-month period, so the impact per blood draw can be estimated directly. (Please note, the results for PFOA are a little more approximate as they are presented in less detail in the data tables and had to be read from the graph in the paper.) The baseline concentrations, and absolute and relative reductions from phlebotomy are summarised below.

Figure 8 - Reduction in serum PFAS in Australian firefighters attributable to phlebotomy

.	PFHxS	PFOS	PFOA (approx.)
Baseline serum concentration (ng/ml)	3.6	10.9	1.2
Drop attributed to intervention (ng/ml)	0.6	1.1	0.3
% fall attributed to phlebotomy interventions	16.7	10.1	25.0
% fall predicted from one phlebotomy	3.88	2.35	5.81

Source: (R. Gasiorowski et al., 2022)

One of the intervention arms in the Gasiorowski study was the plasma removal procedure. In the plasma removal procedure group in the Gasiorowski study (R. Gasiorowski et al., 2022) participants undertook an average of 6.4 plasma removal procedures; each one “up to 800 ml”. Thus, the reduction per donation is estimated as the reported average fall, divided by 6.4. The results are presented in Figure 9 below.

Figure 9 - Reduction in serum PFAS in Australian firefighters attributable to plasma removal procedure

	PFHxS	PFOS	PFOA *
Baseline serum concentration (ng/ml)	5.2	11.7	1.1
Drop attributed to intervention (ng/ml)	1.5	3.1	0.8
% fall attributed to plasma removal procedure	28.9	26.5	72.7
% fall per plasma removal procedure	4.5	4.1	11.4*

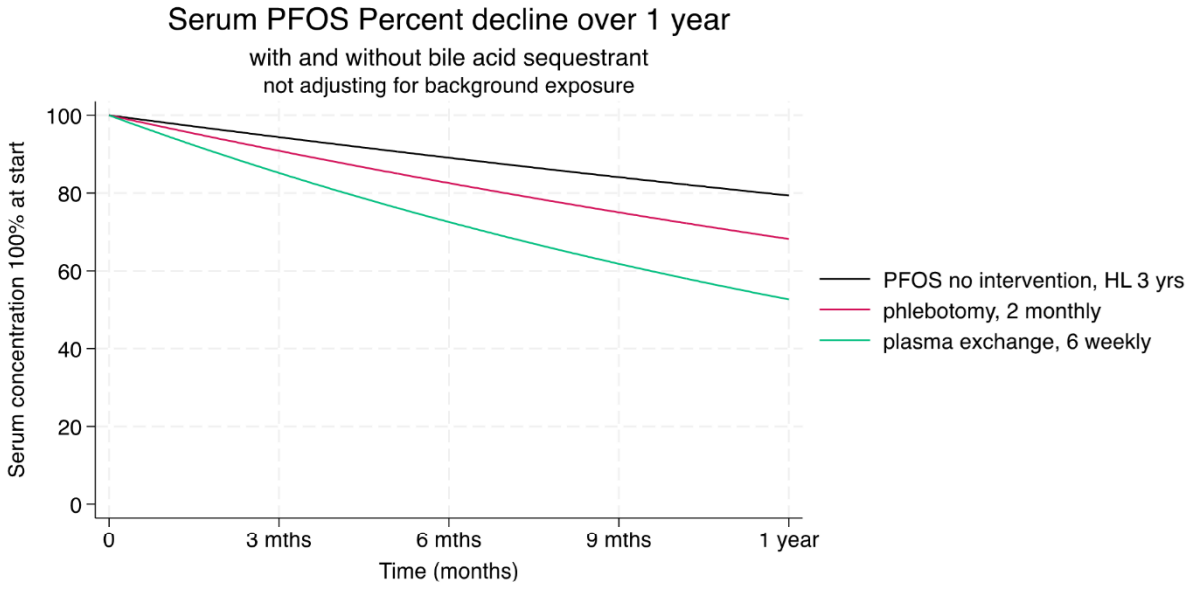
*Source:(R. Gasiorowski et al., 2022) *the PFOA estimates are very uncertain*

7.3.3 Estimating impact as a proportion of the volume of distribution

Another way to estimate the potential impact of blood or plasma removals is to estimate the proportion of total body burden removed. The volume of distribution is the sum of all compartments in the body expressed in terms of the equivalent volume of plasma, and has been estimated in a number of publications, and these provide a range of estimates(Chiu et al., 2022; Fletcher et al., 2023). It is normally expressed in terms of plasma volume per kg of body weight, and estimates range from about 100 to about 400 ml/kg for these PFAS. For an adult of 75kg, the total volumes of distribution may thus lie in the range 7.5 to 30 litres. A typical blood draw in phlebotomy is 450ml, which comprises close to 250ml of plasma, and 250 ml is about 3.3% of 7.5L and close to 1% of 30L. For plasma removal, assuming 600ml for typical quantity of plasma removed, the proportion of the volume of distribution would therefore lie in the range 2% to 8% per procedure.

These ranges overlap with the range of impacts summarised above from the intervention studies and the 4% average impact for phlebotomy concluded in report 1. To reflect the range of estimates, and uncertainty in assigning a single number, we consider that the likely impact of a normal phlebotomy procedure lies in the range 1% to 4% reduction in body burden and thus serum concentration. For plasma exchange we can estimate the benefit as lying between 2% and 8% per procedure. . For the purposes of estimating the average impact we have used the mid points of these ranges, ie 2.5% decrease for phlebotomy and 5% fall per plasma removal procedure.

Figure 10 - Illustration of percentage decline over a year after stopping exposure, average individual and with extra reduction from Phlebotomy or plasma removal. PFOS with half-life of 3 years



7.4 Pharmaceuticals

7.4.1 Observational studies

Some studies have investigated whether reported drug use was correlated with PFAS levels, which might indicate that those drugs influence excretion.

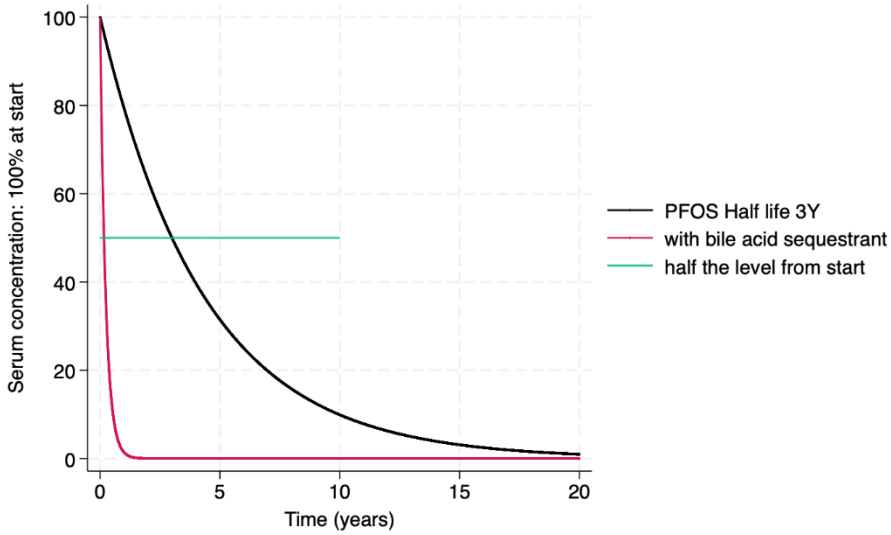
One of particular interest was the drug probenecid which affects the proteins involved in the transport of chemicals, possibly PFAS, in the kidney and thus might affect PFAS serum levels.

One study compared PFAS levels in those reporting probenecid use or not, in the C8 population in the USA(Ducatman et al., 2021). The small number of probenecid users, 23 out of 56000 in the study all had PFAS levels (PFHxS, PFOS, PFOA and PFNA) slightly higher but not significantly different from the non-users. In another study comparing PFAS levels in relation to reported probenecid use in the US NHANES population(Andersen et al., 2021), 5 out of 14000 reported using probenecid and their PFOA and PFOS levels were less than 1% lower, again a non-significant difference. Thus, from these two studies we can conclude that there is no evidence that probenecid would be of any help in affecting PFAS in blood by increasing urinary excretion of PFAS.

The same two studies assessed self-reported use of bile acid sequestrants (such as cholestyramine) and results were clearer. In the C8 population study the 36 people using bile acid sequestrants showed significantly lower serum PFAS(Ducatman et al., 2021), the ratio of serum PFAS in users compared to non-users was in the range 0.39 to 0.45 for PFHxS, PFOA and PFNA, and for PFOS the ratio was 0.07, a dramatic reduction. In the NHANES data there were 10 bile acid sequestrant users with significantly lower PFOA and PFOS, both significant reductions (Andersen et al 2021). From the regression coefficients on the drop in log(PFAS) the equivalent ratios for users to non-users were 0.62 for PFOA and 0.08 for PFOS, very similar to the C8 data results. (We note that in the paper, to extract these results we needed to clarify that the relative fall in serum concentrations related to drug use are erroneously described in the table heading as percentage drops). Thus, from these two studies there is strong evidence that bile acid sequestrants can reduce PFAS, especially PFOS via increasing faecal excretion.

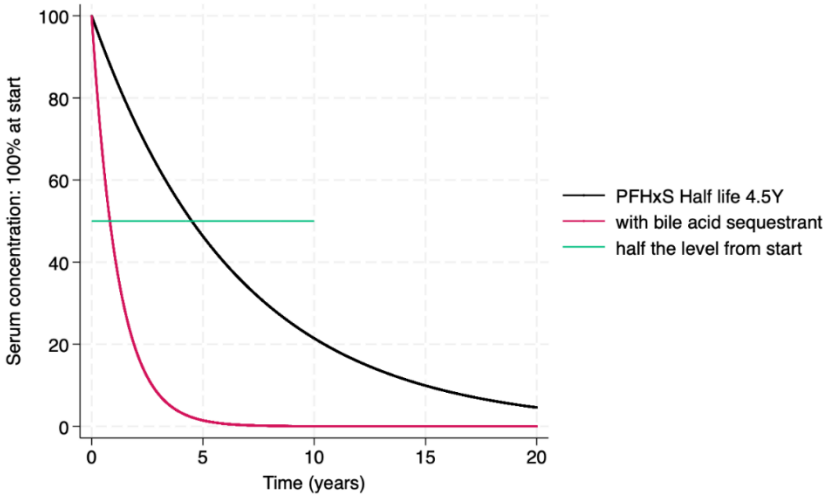
Applying the same approach and modelling in a graph as done above for the drop achieved from starting to take bile acid sequestrants, the PFOS excretion rate from the Ducatman study was estimated to be 14 times faster for those taking the drug and the following figure shows the estimated impact on body burden for PFOS, which is relatively dramatic.

Figure 11 - . Illustration of percentage decline over time after stopping exposure, average individual and with extra excretion from bile acid sequestrants. PFOS with half life of 3 years



For PFHxS with a somewhat slower excretion (and average half-life) and a lower impact of bile acid sequestrants (ratio of users to non-users 0.43) the estimated excretion would be as in this figure, taking some 5 years as compared to 10 more years to clear 80% or more of the PFHxS from the blood.

Figure 12 - Illustration of percentage decline over time after stopping exposure, average individual and with extra excretion from bile acid sequestrants. PFHxS with half-life of 4.5 years



Other drugs were also investigated in these two populations, particularly cholesterol lowering drugs. In the NHANES data, statins (n=707) were associated with 2.9% higher PFOS levels (P=0.001) and 0.3% higher PFOA (P=0.09), and ezetimibe (n=85) had no effect on PFOA nor PFOS (Andersen et al 2021). In the C8 population ezetimibe use (n=1072) was not associated with any large shift in PFAS levels for any of PFHxS, PFOS, PFOA or PFNA, the largest being a 4% reduction for PFOS, with a p-value of 0.06(Ma & Ducatman, 2022). Thus, there is weak evidence for a small reduction of PFOS (4%) but not for other PFAS, for people taking ezetimibe and no evidence of any reduction related to statins.

7.4.2 Interventions without control groups

Genuis and colleagues tried several interventions in small groups of people with high body burdens of PFOS in particular. The first case report (Genuis et al., 2010) described an individual whose blood PFAS was reduced by taking bile acid sequestrants, but he continued to have some ongoing PFAS exposure from a treated carpet and the carpet was only removed at the end of the intervention trial. Thus, the amount of reduction due to the bile acid sequestrants cannot be estimated as the ongoing exposure was topping up his body burden to an extent.

In another paper from the same author (Genuis et al., 2013) 8 individuals with high PFAS levels (mainly PFOS and PFHxS) were identified and offered two supplements to clear the PFAS from their system. They had been mainly exposed to carpet treatments products. One was the bile acid sequestrant drug and the other was the dietary fibre supplement Chlorella pyrenoidosa. Each participant was treated with bile acid sequestrants (4 grams once per day for one week), then after a break of three weeks was followed by the Chlorella (9 grams three times per day for one week). While they did not provide information on net decreases in serum levels, they reported on concentrations in stool samples taken before treatments and towards the end of each week's treatment. It clearly demonstrated that the bile acid sequestrants increased faecal excretion, with high levels measured in faeces, compared to most stool samples at the start being below detection. In the absence of repeated serum measurements this study is not informative for estimating the impact on body burden, but supports the evidence on bile acid sequestrants.

7.4.3 Intervention studies with control groups

There were two studies at the time of initial publication of this report, one published and findings from a trial that was ongoing at that time but has now (October 2025) been published. The paragraphs below have been updated to reflect the published findings.

One clinical trial has been published(Moller et al., 2024), which was a crossover trial. 45 Participants were randomly allocated to two groups, one group was given daily bile acid sequestrants (mostly at the rate of 4g 3 times a day) for 12 weeks, the others just being observed, then after a week's rest the second groups received the bile acid sequestrants for 12 weeks, while the first group was just observed. Therefore, by the end of the trial everybody had received 12 weeks of treatment, and the effect could be observed by comparing to the non-treated group. There was a marked decrease in PFAS as follows:

Figure 13 - Reduction in serum PFAS attributable to bile acid sequestrants in Danish study

	PFHxS	PFOS	PFOA
Baseline serum concentration (ng/ml)	8.8	191	0.92
% fall after 12 weeks of bile acid sequestrants	19	63	22
% fall after 12 weeks of observation	3.5	3.3	2.4
% fall attributable to 12 weeks of bile acid sequestrants	15	60	20

Source: Moller et al 2024

Preliminary findings from a trial in Sweden were shared with the panel by the subject matter expert Dr Andersson. This study was published in September 2025 and the final results are discussed below (Andersson et al., 2025). They do not contradict the preliminary findings previously reported. The drugs Probenecid and Cholestyramine were tried in the first phase of a short-term trial of one week of each treatment and a week of a control treatment. Participants crossed over between the three interventions with a one week washout period between them. This was followed by a longer term

study (12 weeks for the initial intervention followed by a 12-week crossover to the other intervention with no washout) using the drug Colesevelam and a control intervention.

Probenecid has been used as a gout medication, and it works directly on the kidney. Probenecid inhibits the uptake of compounds, and potentially PFAS. Dr Andersson noted that are side effects of nausea, headaches and also interactions with other medications. The results of the short term, one week trial with probenecid indicate that there is no significant effect of probenecid treatment in PFAS excretion, which is consistent with the absence of an effect noted in the observational studies.

Cholestyramine is a medication that has been used to lower cholesterol. In the short study it was associated with a marked increase in the rate of PFAS excretion, however around half of the study participants stated that they would not be prepared to take Cholestyramine for 12 weeks. For this reason, an alternative was sought for the longer study. Cholestyramine and Colesevelam belong to the same class of drug and therefore should behave similarly. It is also easier to take than Cholestyramine. For this reason, the longer term study used Colesevelam, rather than Cholestyramine as originally envisaged.

The longer term study with Colesevelam, a medication usually used to lower cholesterol in the body showed marked reductions in the levels of PFAS in serum over the 12 week intervention period. The reduction in PFHxS and PFOA was statistically indistinguishable from the Danish study (Moller et al., 2024), but the reduction in PFOS was slightly smaller. This could relate to the Colesevelam being twice a day, as opposed to the three times a day dosing of Cholestyramine, or there may be a small differential response to the drugs themselves. Either way, this was only a small difference, and, given the markedly better tolerability of Colesevelam, not sufficient to consider Cholestyramine superior overall.

7.5 Dialysis for patients with chronic kidney disease

Dialysis filters waste products and excess fluids from the blood, in patients whose kidneys can no longer perform this essential function. There is one study conducted in Taiwan which investigated whether dialysis also affected PFAS levels. They compared PFAS levels in the blood of 301 such patents to PFAS in 55 volunteer healthy controls similar with respect to sex, average age and body mass index(Huang et al., 2023). There was a third smaller group of 20 people with chronic kidney disease (CKD) but not on dialysis. Both kidney disease and dialysis were associated with lower levels of PFAS.

For (linear) PFOS serum levels among the controls for PFOS averaged 6.2 ng/ml, which was a little lower 4.2 ng/ml in those with CKD but not on dialysis and 0.29 ng/ml for those on dialysis. The impact of dialysis thus seems to reduce serum levels from 4.2 to 0.29 a ratio of 14 to 1. The equivalent ratios for branched PFOS was 12 to 1, and for PFHxS 3.4 to 1, and PFOA 3.8 to 1.

These ratios are derived from the simple ratio of the average serum concentrations in the different groups and there are uncertainties: because they are not adjusted for other variables, because the clinical disease profile is presumably different between those getting and not getting treatment, because numbers in the comparison groups are small, diets may differ, and they may not be at steady state. However, it gives an approximate estimate of the likely impact if it was used for reducing PFAS.

Dialysis is provided for people with renal disease and is unlikely to be considered for removing PFAS, however one can use these published results to estimate what might be the impact on PFAS levels if otherwise healthy people without renal disease started a programme of dialysis to clear PFAS from the body. The ratios of serum levels in people with and without dialysis are quite similar to the ratio with and without cholestyramine (both at 14 for PFOS and 3.4 vs 2.3 for PFHxS) therefore the graphs of estimated impact from regular dialysis would be quite similar to the graphs for regular bile acid sequestrant take-up, shown following section.

7.6 Summary and synthesis

Dietary interventions such as increasing fibre or taking probiotic supplements, may have a modest effect, increasing natural rates of excretion by between 6 and 12%. However, these come from observational studies, and it seems quite probable that the effect may be overestimated and lower PFAS levels might be due to participants have a lower PFAS intake. The effects were only observed for PFOS and PFOA, not PFHxS. The only intervention study of providing a dietary fibre supplement did not show an effect, but the dietary intervention was following a strong treatment of bile acid sequestrants which may have obscured any benefit.

Phlebotomy and plasma removal both offered technique of reducing the amount of PFAS in the blood (for PFOS, PFHxS, and PFOA). And as about half of these PFAS in our bodies is in the blood stream, thus does reduce the overall body burden. The different studies give slightly different percentage reduction by procedure, but we consider a credible average estimate of effect is 4% per procedure for each of the PFAS. This could be offered once a month for plasma exchange and once every two months weeks for phlebotomy so the annual impact at the higher rate of receiving plasma removal could yield more reduction per year for plasma removal.

Two drug types were considered, probenecid which showed no effect on PFAS clearance and bile acid sequestrants which did. The effect was clearly different for the different PFAS, with drugs having the largest impact on PFOS.

The estimated impact of haemodialysis is numerically very similar to that of bile acid sequestrants so the curves of the latter can be assumed to apply to the haemodialysis effect on PFAS if it were chosen.

The following table summarises the impact in terms of average expected percentage effect on serum levels from the start of these alternative interventions, in addition to the no intervention, for someone who has completely stopped their PFAS intake, based on the average effects from the review above. For comparison, the table shows it over a 3-month period.

The graphs show the effects over a whole year. Obviously, the reduction will be more stepwise for intermittent interventions such a phlebotomy but this shows the average impact smoothed over time.

Figure 14 - Summary of average percentage rate of decline over a 3-month period after stopping exposure for PFHxS, PFOS and PFOA, and additional decline related to various interventions (diet, phlebotomy, plasma removal and bile acid sequestrants)

		Percent reduction with each option		
Option	Source of data	PFHxS	PFOS	PFOA
Do nothing	(Y. Li et al., 2022)	3.8	5.6	6.7
With additional impact of:				
Phlebotomy each two months 1.5 procedures on average	Average impact of 1% to 4% per procedure	7.4	9.1	10.2
Plasma removal each 6 weeks 2 procedures	Average impact of 2% to 8% per procedure	13.2	14.8	15.8
Probenecid drug use	(Ducatman et al., 2021)	0	0	0
Bile acid sequestrant medication use	(Moller et al., 2024)	20.4	66.7	26.8
High fibre diet	(Zhou et al., 2024)	0	6.1	7.1
Probiotic supplements	(Liao et al., 2023)	0	6.2	7.2

Graphical summary of the impact of the various interventions (diet, phlebotomy, plasma removal and bile acid sequestrants) over 12 months for, respectively, PFOS, PFHxS and PFOA)

Figure 15 - Illustration of percentage decline over time after stopping exposure, average individual and with extra excretion from diet, phlebotomy, plasma removal and bile acid sequestrants. PFOS with half-life of 3 years

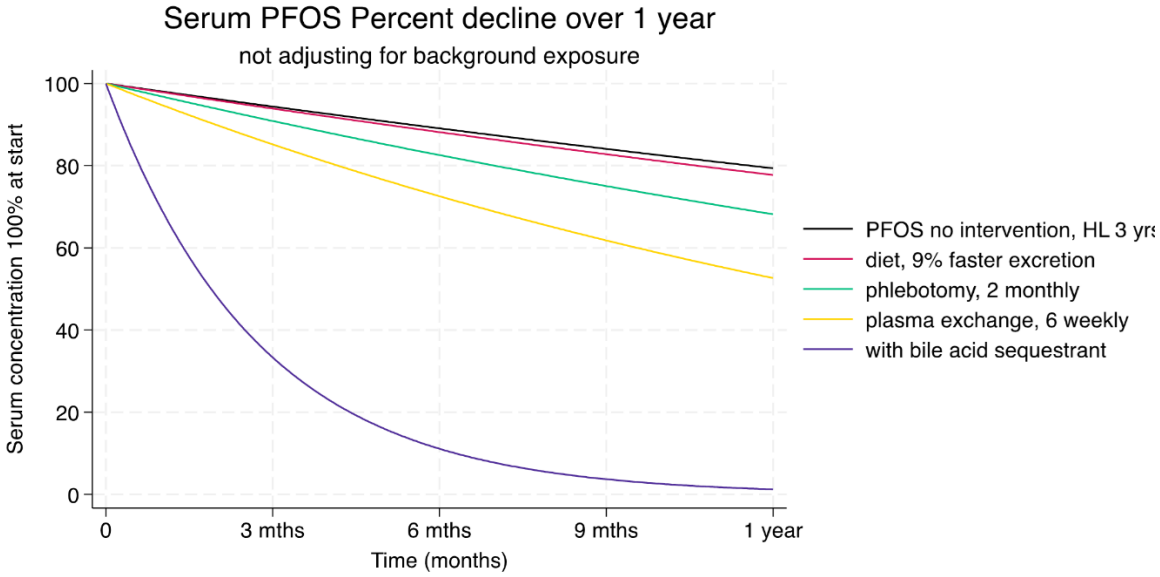


Figure 16 - Illustration of percentage decline over time after stopping exposure, average individual and with extra excretion from diet, phlebotomy, plasma removal and bile acid sequestrants. PFHxS with half life of 4.5 years

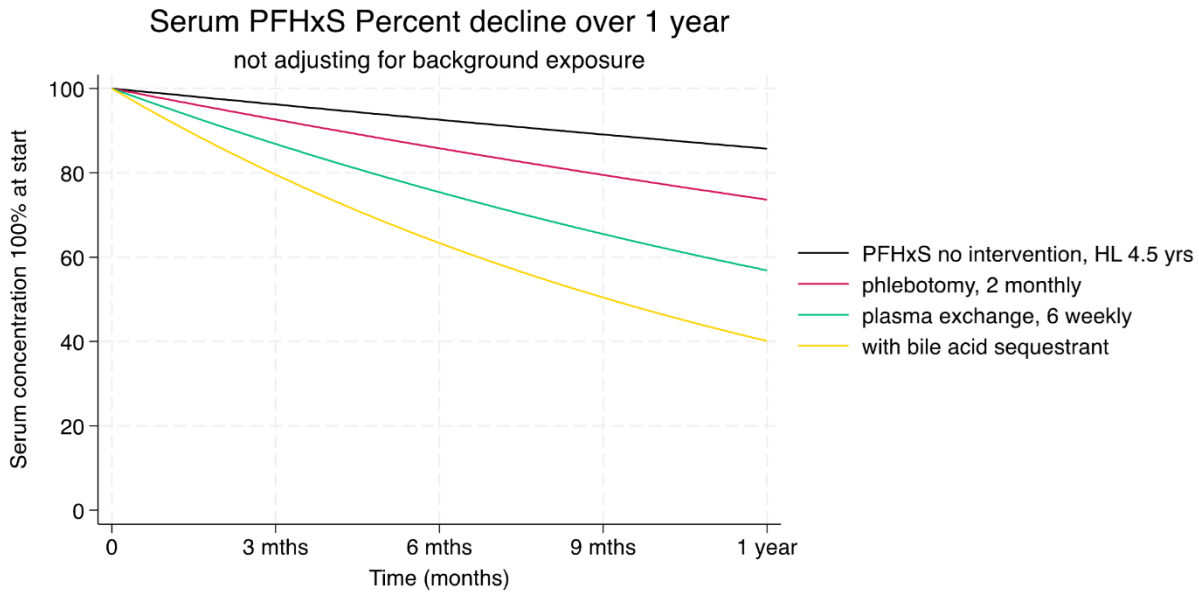
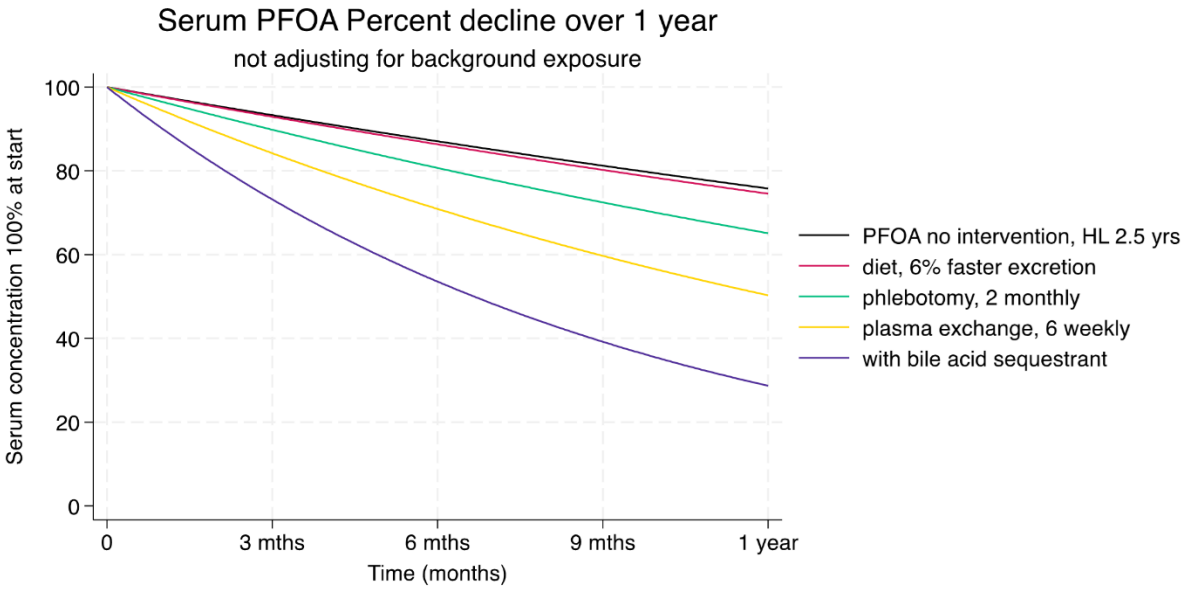


Figure 17 - . Illustration of percentage decline over time after stopping exposure, average individual and with extra excretion from diet, phlebotomy, plasma removal and bile acid sequestrants. PFOA with half-life of 2.5 years.



These figures should be interpreted with caution. The two lines (for dietary interventions and bile acid sequestrants) indicate a relationship without uncertainty bounds as shown for blood and plasma removal. This is because they come from very sparse data, in the case of the bile acid sequestrants, one single study. If more trials are reported, then we might expect a range of results and we might then plot an uncertainty range for those outcomes too. However, in spite of those reservations, comparing the available of effectiveness, it would appear that bile acid sequestrants' use offers more potential impact, especially for PFOS.

8 Blood product removal treatments; effectiveness, safety, tolerability and cost

This chapter looks at several different metrics around the interventions, but does not deal with all logistical barriers, these may also be a factor in the implementation of any service.

8.1 Summary of the evidence for the effectiveness of phlebotomy from the literature review

Phlebotomy has been explored as a method to reduce per- and polyfluoroalkyl substances (PFAS) in the bloodstream(PSAP, 2023). One illustrative case-series (S. Genuis et al., 2014) detailed a Canadian family with unusually high PFHxS, PFOS, and PFOA levels, possibly from repeated carpet treatments. Over four years, family members donated blood intermittently at volumes similar to standard blood donations (up to 500 ml every 56 days). Although the study lacked a control group, reductions in PFHxS and PFOS appeared larger than would be expected by natural elimination alone, with an estimated serum PFAS reduction of about 4% on average per phlebotomy session(PSAP, 2023).

A more robust assessment comes from a randomised controlled trial of Australian firefighters exposed to firefighting foams(R Gasiorowski et al., 2022). One arm of the study offered phlebotomy, while a separate arm received plasma removal (described in the next section), and a third group served as controls. Over 12 months, firefighters undergoing phlebotomy gave around 4.3 donations on average, resulting in measurable decreases in PFHxS (17%), PFOS (10%), and PFOA (25%) compared to controls. Each individual blood draw was estimated to lower serum levels by an average of 2–6%, depending on the specific PFAS moiety.

Phlebotomy's feasibility largely rests on standard blood donor guidelines: typically, an adult can donate whole blood every 8–12 weeks, with adequate health monitoring. Although phlebotomy removes both plasma and red blood cells, a significant fraction of PFAS is found in the plasma component. Periodic phlebotomy can therefore gradually lower PFAS body burden, but individuals should consider logistical factors, iron levels, and the need for medical oversight. Nevertheless, the literature suggests that phlebotomy may be a moderately effective, practical approach, especially in contexts of high PFAS exposure(R Gasiorowski et al., 2022; S. Genuis et al., 2014).

8.2 Risks and benefits of phlebotomy in the general population

8.2.1 Introduction

The most common cause for blood being taken in large quantities is the donation of blood for the benefit of other people in society. This altruistic donation is different in intent from therapeutic phlebotomy but involves very similar processes. Therapeutic phlebotomy is the name for taking blood in order to treat an illness or reduce the risk of a complication. It is most commonly used in conditions such as polycythaemia (where the body has too many blood cells which thicken the blood and risk complications, haemochromatosis (where the body has too much iron on board and it becomes toxic) and genetic conditions like sickle cell disease (where blood cells don't form properly) or porphyria (where certain toxins accumulate because a person doesn't have the mechanisms to break them down like most people do)(Assi & Baz, 2014).

8.2.2 Risks from phlebotomy

Phlebotomy is an extremely safe procedure, and the risks outlined below are either extremely rare, and minor or self-limiting, or both. The main potential risks from phlebotomy are(Newman, 2004):

1) Physical Risks:

    a) Discomfort and pain: During blood donation, individuals may experience temporary discomfort and pain at the site of needle insertion. Although this is typically mild and transient, some donors may find it uncomfortable.

    b) Dizziness and light-headedness: A common risk during or after blood donation is the onset of dizziness or light-headedness. This can be attributed to a drop in blood pressure, which may occur due to the removal of a significant volume of blood.

    c) Haematoma and bruising: Occasionally, donors may develop a haematoma or bruise at the needle insertion site due to accidental damage to blood vessels during the procedure. While these complications are generally minor, they may cause discomfort and require symptomatic treatment.

    d) Arterial or nerve puncture: Damage to other structures in the area of the body from which blood is taken (the front of the elbow area, known as the antecubital fossa) is extremely rare, but it could result in severe bruising or even interruption of the blood flow to the lower arm if an artery is damaged, or nerve damage interfering with movement or feeling in the lower arm.

2) Infection risks:

    a) Needlestick injuries: Healthcare professionals who collect blood donations take precautions to ensure safe needle usage. However, there is always a small risk of needlestick injuries during the process, potentially exposing the donor to bloodborne infections such as HIV, hepatitis B, and hepatitis C. The likelihood of this happening is very low(Prüss-Ustün et al., 2005).

    b) Bacterial contamination: Although stringent hygiene protocols are in place and sterile, single use needles are used for blood donation, bacterial contamination of the needle could theoretically occur, leading to a potential risk of infection. The likelihood of this happening is very low.

3) Iron deficiency: Frequent blood donation can deplete the iron stores in the donor's body, leading to iron deficiency or anaemia. Iron is necessary for the production of new red blood cells, and a significant loss without adequate replenishment can result in fatigue, weakness, and other symptoms associated with anaemia.

4) Psychological risks:

    a) Needle phobia and anxiety: Some potential donors may experience needle phobia or anxiety related to phlebotomy.

8.2.3 Risk factors and mitigation and prevention strategies

There are a range of characteristics which are associated with increased risk of complications from having blood taken. Some complications, such as fainting, and needle site problems are more common based on gender. Body weight, baseline blood pressure and pre-existing anaemia are also factors(Wiersum-Osselton et al., 2014).

To address the risks associated with phlebotomy, the protocol for taking blood needs to ensure the following:

- Blood not being taken from persons who have a body weight below a predetermined threshold.
- Blood not being taken from anyone who have a blood pressure below predetermined threshold values.
- Blood not being taken from people whose haemoglobin is below a certain threshold level (anaemia).
- Proper needle insertion technique. Healthcare professionals are trained to follow proper protocols to minimize the occurrence of discomfort, pain, and complications such as hematomas, bruising, damage to nearby tissues and infection.
- Adequate rest and refreshments. After phlebotomy, people are advised to rest, hydrate, and consume a balanced meal to minimize the risk of dizziness and light-headedness.
- Iron supplementation. To prevent iron deficiency, people may be advised to take iron supplements or increase iron-rich food intake.
- Ensuring that appropriate psychological support is available for those with needle phobia or other anxiety issues.

8.2.4 Potential wider benefits from phlebotomy

There is some evidence that when healthy people give blood, there are certain benefits to their health. This evidence is weak and insufficient to be important in decision-making but has been included here for completeness. A couple of studies have looked at whether phlebotomy can reduce liver damage in non-alcoholic fatty liver disease (a common illness of the liver) but it was not clear that there was real benefit(Kim & Oh, 2016). Another small study (Zacharski et al., 2008) looked at impact on cancer risk, and, while the findings are suggestive of a benefit, there is not enough evidence to draw any conclusions. Several other conditions have been mooted that might be prevented or improved by phlebotomy, but there aren't clinical studies to support that sufficiently. They include: Alzheimer's disease (Dwyer et al., 2009) and heart disease(Houschyar et al., 2012).

8.3 Capital and revenue requirements for establishing and running a phlebotomy service

8.3.1 Necessary Equipment

- **Sterile Disposable Kits:** Needles, tubing, collection bags, and anticoagulant solutions. Single-use kits prevent cross-contamination and ensure sterility.
- **Medical Examination Equipment:** Blood pressure monitors, haemoglobin testing devices, scales, and temperature gauges. These are used to assess donor eligibility and monitor vital signs pre- and post-donation.
- **Emergency Equipment:** Automated External Defibrillators (AEDs), oxygen tanks, and first aid kits. To address any adverse reactions or medical emergencies promptly.

8.3.2 Required Personnel

- **Lead clinician:** Probably a medical consultant with expertise in transfusion medicine or haematology. Role includes oversight of medical procedures, participant eligibility criteria, and compliance with medical standards(JPAC, 2024).
- **Specialist nurses:** To perform vein punctures and monitor donors during the procedure. They need to be certified in phlebotomy.
- **Maintenance and Cleaning Personnel: To e**nsure cleanliness of the facility and proper functioning of equipment. This is critical for infection control and meeting health standards.

8.3.3 Maintenance and Regulatory Compliance

- **Regular Servicing of Equipment**: Defibrillators, monitors and other resuscitation equipment require routine checks and servicing by qualified technicians.
- **Calibration of Equipment**: Medical devices must be calibrated regularly to ensure accuracy(ISO, 2022).
- **Facility Cleaning Protocols**: Adherence to strict cleaning schedules for donor areas, equipment, and common spaces.
- **Infection Control**: Implementation of standard precautions to prevent cross-contamination
- **Licensing and Accreditation**: Obtain necessary licenses from health regulatory organisations.
- **Standard Operating Procedures (SOPs)**: Develop and maintain SOPs for all processes, aligning with MHRA, FDA and European Medicines Agency (EMA) guidelines.
- **Staff Training and Certification**: Ongoing education to keep staff updated on best practices and regulatory changes.
- **Audits and Inspections**: Regular internal audits and readiness for external inspections.

8.3.4 Capital cost

The capital costs of a phlebotomy service are limited and can likely be met without additional investment.

8.3.5 Additional Costs to Consider

- **Maintenance and Service Contracts:** Essential for the safe and effective operation of the machine, there will be regular maintenance and calibration, carried out by facility staff. In addition to that there would be a requirement for a service contract with the manufacturer. These can be of the order of £5,000 per annum.
- **Consumables:** Each blood collection procedure requires a single-use kit, costing between £30 and £50 each.
- **Training and Staffing:** In addition, the salary costs of the staff described above, staff must be trained.

8.3.6 In summary

Bringing all of this together, it is a reasonable assumption that the capital outlay for a service would be nil and the revenue costs, assuming 300 phlebotomy activities (6 interventions each for 50 people) in year 1 and half-time consultant cover and full-time cover from other staff would be between £100,000 and £150,000 per annum.

8.4 Types of plasma removal treatment

Plasma, the liquid component of blood, plays a crucial role in transporting nutrients, hormones, and proteins throughout the body. It constitutes about 55% of total blood volume and contains essential components such as clotting factors, immunoglobulins, and albumin. Medical procedures involving plasma—such as plasma donation, plasmapheresis, and plasma exchange—are vital for both therapeutic and donation purposes. While these terms are sometimes used interchangeably, they refer to distinct processes with specific applications. This essay explores the differences between plasma donation, plasmapheresis, and plasma exchange, highlighting their procedures, purposes, and clinical significance.

8.4.1 Plasma Donation

Plasma donation is a process where a healthy individual voluntarily donates plasma for medical use. The collected plasma is primarily used for manufacturing plasma-derived medicinal products (PDMPs), such as clotting factors for haemophilia patients, immunoglobulins for immune deficiencies, and albumin for critical care situations.

During plasma donation, blood is taken from the donor and passed through a machine that separates plasma from other blood components using centrifugation or filtration. The red blood cells, white blood cells, and platelets are then returned to the donor's bloodstream, while the plasma is collected for use. This process typically takes about 1 to 2 hours and can be performed more frequently than whole blood donation because the body replenishes plasma faster than red blood cells(JPAC, 2024).

8.4.2 Plasmapheresis

Plasmapheresis is a medical procedure that involves the removal, treatment, and return of plasma to the patient's body. It is a form of apheresis specifically targeting plasma components. Plasmapheresis can be therapeutic or donor based. In therapeutic plasmapheresis, harmful substances in the plasma are removed to treat certain medical conditions(Schwartz et al., 2016).

In plasmapheresis, blood is taken from the patient and passed through an apheresis machine. The plasma is separated from the cellular components. Depending on the treatment goal, the plasma may be treated to remove specific substances (like antibodies or toxins) and then returned to the patient along with the blood cells(Kaplan, 2013). The procedure usually takes 1 to 3 hours and may require multiple sessions depending on the condition being treated(Mokrzycki & Kaplan, 1994).

8.4.3 Plasma Exchange (Therapeutic Plasma Exchange)

Plasma exchange, also known as therapeutic plasma exchange (TPE), is a procedure where a patient's plasma is removed and replaced with a substitute, such as donor plasma or albumin solutions. The primary goal is to eliminate pathogenic substances present in the plasma that contribute to disease processes(Winters, 2012).

Similar to plasmapheresis, blood is withdrawn from the patient and separated into plasma and cellular components. However, in plasma exchange, the patient's plasma is discarded entirely, and the blood cells are combined with replacement fluid before being returned to the patient(Cervantes et al., 2023). The replacement fluids can be fresh frozen plasma, albumin, or crystalloid solutions, depending on the clinical scenario.

8.4.4 Comparative Analysis

- **Plasma Donation**: Intended for collecting plasma from healthy donors to produce PDMPs for patients in need. Donor's plasma is collected, and blood cells are returned; used for manufacturing medical products.
- **Plasmapheresis**: Used therapeutically to remove specific components from a patient's plasma and return the treated plasma. Patient's plasma is treated and returned; focuses on filtering out specific pathogenic components.
- **Plasma Exchange**: Involves the removal and replacement of a patient's plasma to eliminate harmful substances. Patient's plasma is entirely replaced with substitute fluids; removes a broader range of substances.

Different studies have looked at different approaches to plasma removal in PFAS exposed people. They have been considered together in this report.

8.5 Summary of the evidence for the effectiveness of plasma removal treatments from the literature review

Plasma removal, sometimes referred to as therapeutic plasma exchange or plasma donation, specifically targets the plasma component of blood—where PFAS predominantly bind to proteins(R Gasiorowski et al., 2022). The same Australian trial that studied firefighter volunteers also evaluated plasma removal in a dedicated arm. Participants underwent an average of 6.4 plasma removal sessions over 12 months, removing up to 800 ml of plasma per session.

Compared to phlebotomy, plasma removal yielded somewhat higher overall reductions in serum PFAS. In the trial, plasma removal led to a 29% decrease in PFHxS, 27% in PFOS, and a larger (though less precise) reduction of about 73% in PFOA levels. When assessed per procedure, each plasma removal session lowered PFHxS by about 4.5% and PFOS by around 4.1%. The bigger drop for PFOA (about 11% per session) was noted but interpreted with caution due to the smaller number of individuals with higher PFOA levels.

This approach can be more effective than phlebotomy because it specifically extracts plasma, which carries most PFAS via albumin binding. The downside is that plasma removal sessions require more specialised equipment, greater clinical support, and frequent appointments. Additionally, removing large volumes of plasma can be physiologically taxing and therefore must be approached with appropriate medical supervision. Despite these hurdles, plasma removal remains a noteworthy option for people with substantially elevated PFAS levels who might benefit from a faster rate of PFAS decline(R Gasiorowski et al., 2022).

8.6 The wider risks and benefits of plasma removal

8.6.1 Safety Measures in Plasma Donation

To ensure donor safety, in altruistic plasma donation, stringent screening processes are in place. Potential donors undergo comprehensive health assessments, including medical history reviews, physical examinations, and laboratory testing. Eligibility criteria often include age restrictions (usually 18 to 65 years), weight requirements (typically over 50 kg or 110 lbs), and overall good health(JPAC, 2024). The use of sterile, single-use collection kits minimizes the risk of infection and cross-contamination. Apheresis machines are designed with closed systems where the blood contacts only sterile, disposable components(JPAC, 2024). Qualified healthcare professionals conduct the donation process, continuously monitoring donors for any adverse reactions. Vital signs such as blood

pressure, pulse, and haemoglobin levels are checked before, during, and after the procedure(JPAC, 2024).

Regulatory bodies like the UK Medicines and Healthcare Products Regulatory Agency (MHRA), U.S. Food and Drug Administration (FDA) and the European Medicines Agency (EMA) enforce strict guidelines for plasma collection centres. Compliance with Good Manufacturing Practices (GMP) and regular inspections are necessary to ensure high safety standards(EQDM, 2023).

8.6.2 Common Side Effects

Most plasma donations proceed without significant issues. However, some donors may experience mild, transient side effects:

- **Bruising or Discomfort at the Needle Site**: Minor bruising, bleeding, or pain can occur at the venepuncture site(Crocco & D'Elia, 2007).
- **Fatigue or Dizziness**: Temporary feelings of tiredness or light-headedness may result from fluid removal but typically resolve quickly(Crocco & D'Elia, 2007).
- **Hypocalcaemia Symptoms**: Tingling sensations in the lips or fingers due to citrate anticoagulant binding calcium, leading to temporary hypocalcaemia(Winters et al., 2011).

8.6.3 Rare but Serious Complications

While serious adverse events are rare, they can occur:

- **Vasovagal Reactions:** A reflex resulting in sudden fainting due to a drop in heart rate and blood pressure. Occurs in approximately 1% of donations(Philip et al., 2014).
- **Citrate Reaction:** An adverse response to citrate anticoagulant used during plasmapheresis, leading to symptoms like muscle cramps, nausea, or arrhythmias in severe cases. Rarely happens, with most reactions being mild(Winters et al., 2011).
- **Allergic Reactions:** Hypersensitivity to materials used during donation, such as the anticoagulant or equipment components. These are extremely rare but can be life-threatening(Crocco et al., 2009).

8.6.4 Long-Term Safety Considerations

Protein Levels: Frequent plasma donation could potentially lower plasma protein levels. This can potentially be hazardous to health (D'Aes et al., 2024)

Iron Levels Unlike whole blood donation, plasma donation has minimal impact on iron stores because red blood cells are returned to the donor(Simon, 2002).

Immunoglobulin Levels Slight decreases in immunoglobulin G (IgG) levels have been observed. This could potentially affect the ability to fight infections, although the reduction is usually small(D'Aes et al., 2024).

8.6.5 Conclusion

Plasma donation is a generally safe and well-tolerated procedure. While minor side effects are relatively common, serious complications are rare and manageable with proper protocols. Rigorous screening, adherence to regulatory standards, and continuous monitoring contribute to donor safety.

8.7 Capital and revenue requirements for establishing and running a plasma donation service

8.7.1 Necessary Equipment

- **Apheresis Machines:** These devices that separate plasma from whole blood through centrifugation or filtration. They must be MHRA-approved and capable of performing plasmapheresis efficiently and safely.
- **Sterile Disposable Kits:** Needles, tubing, collection bags, and anticoagulant solutions. Single-use kits prevent cross-contamination and ensure sterility.
- **Medical Examination Equipment:** Blood pressure monitors, haemoglobin testing devices, scales, and temperature gauges. These are used to assess donor eligibility and monitor vital signs pre- and post-donation.
- **Emergency Equipment:** Automated External Defibrillators (AEDs), oxygen tanks, and first aid kits. To address any adverse reactions or medical emergencies promptly.

8.7.2 Required Personnel

- **Lead clinician:** Probably a medical consultant with expertise in transfusion medicine or haematology. Role includes oversight of medical procedures, donor eligibility criteria, and compliance with medical standards(JPAC, 2024).
- **Specialist nurses:** To perform vein punctures, operate apheresis machines, and monitor donors during the procedure. They need to be certified in phlebotomy and trained in the use of specific apheresis equipment.
- **Maintenance and Cleaning Personnel: To e**nsure cleanliness of the facility and proper functioning of equipment. This is critical for infection control and meeting health standards.

8.7.3 Maintenance and Regulatory Compliance

- **Regular Servicing of Equipment**: Apheresis machines and refrigeration units require routine checks and servicing by qualified technicians.
- **Calibration of Equipment**: Medical devices must be calibrated regularly to ensure accuracy(ISO, 2022).
- **Facility Cleaning Protocols**: Adherence to strict cleaning schedules for donor areas, equipment, and common spaces.
- **Infection Control**: Implementation of standard precautions to prevent cross-contamination
- **Licensing and Accreditation**: Obtain necessary licenses from health regulatory organisations.
- **Standard Operating Procedures (SOPs)**: Develop and maintain SOPs for all processes, aligning with MHRA, FDA and European Medicines Agency (EMA) guidelines.
- **Staff Training and Certification**: Ongoing education to keep staff updated on best practices and regulatory changes.
- **Audits and Inspections**: Regular internal audits and readiness for external inspections.
- **Documentation**: Comprehensive record-keeping for traceability and accountability(EQDM, 2023).

Offering a plasma donation service involves more than just collecting plasma; it requires a robust infrastructure of specialised equipment, skilled personnel, and stringent maintenance protocols.

8.7.4 Cost of an Apheresis Machine for Human Use

8.7.4.1 Capital cost per machine

The cost of an apheresis machine for human use in the United Kingdom can vary significantly based on several factors, including the manufacturer, model, features, whether the machine is new or refurbished, and the supplier. The approximate price range for a new apheresis machine is between £20,000 and £50,000 per unit.

8.7.4.2 Additional Costs to Consider

- **Maintenance and Service Contracts:** Essential for the safe and effective operation of the machine, there will be regular maintenance and calibration, carried out by facility staff. In addition to that there would be a requirement for a service contract with the manufacturer. These can be of the order of £5,000 per annum.
- **Consumables:** Each plasma collection procedure requires a single-use kit, costing between £30 and £50 each. In addition to this, there would need to be anticoagulants and other solutions that are used in the plasmapheresis process.
- **Training and Staffing:** In addition, the salary costs of the staff described above, staff must be trained to operate the machine safely. Some manufacturers offer training programs, which may be included or charged separately.
- **Regulatory Compliance:** Compliance with the Medicines and Healthcare products Regulatory Agency (MHRA) regulations may involve fees and/or modifications to the facility.

8.7.4.3 In summary

Bringing all of this together, it is a reasonable assumption that the capital outlay for a service would be at least £100,000 and the revenue costs, assuming 500 plasma removal activities (10 interventions each for 50 people) in year 1 and half-time consultant cover and full-time cover from other staff would be between £150,000 and £200,000 per annum.

9 Treatments targeting gastrointestinal reabsorption; effectiveness, safety, tolerability and cost

This chapter looks at several different metrics around the interventions, but does not deal with all logistical barriers, these may also be a factor in the implementation of any service.

9.1 Summary of the evidence for the effectiveness of cholestyramine and other bile acid sequestrants from the literature review

Bile acid sequestrants such as cholestyramine have emerged as a potentially powerful method to accelerate PFAS excretion through the gastrointestinal tract. Observational studies (Andersen et al., 2021; Ducatman et al., 2021)found strikingly lower PFAS levels—especially PFOS—among self-reported users of these drugs, with PFOS sometimes reduced to less than 10% of non-user levels. These studies strongly suggested enhanced faecal elimination because PFAS can be excreted via bile but are usually reabsorbed unless bile acids are bound by these resins.

Small-scale interventions without control groups, such as one reported by Genuis, Curtis et al. (2013)(Genuis et al., 2013), demonstrated that cholestyramine significantly increased PFAS levels in stool, though serum measurements were not repeated often enough to quantify total body burden changes. More definitive evidence comes from a recent crossover randomised controlled trial in Denmark(Moller et al., 2024), involving 45 participants with especially high PFOS levels. Individuals were randomly assigned to 12 weeks of daily cholestyramine or observation, then switched. Compared to minimal decline (3%) during observation, participants receiving cholestyramine achieved a 63% reduction in PFOS, 19% in PFHxS, and 22% in PFOA. For PFOS in particular, this was a marked acceleration of excretion.

Bile acid sequestrants may be particularly beneficial in high-exposure situations, potentially outperforming either phlebotomy or plasma removal for PFOS. Whether significant PFAS reductions translate into measurable health benefits remains a central unanswered question(Moller et al., 2024).

9.2 Risks and wider benefits of bile acid sequestrant therapy

Bile acid sequestrants are a class of medications primarily used to lower low-density lipoprotein cholesterol (LDL-C) levels in patients with hypercholesterolemia. They function by binding bile acids in the gastrointestinal tract, preventing their reabsorption, and promoting their excretion. This process leads to increased conversion of cholesterol into bile acids in the liver, thereby reducing serum cholesterol levels. In this instance, however, they would be being used to lower serum PFAS, and any reduction in total or LDL cholesterol would be an additional benefit.

The main agents in this class include cholestyramine, colestipol, and colesevelam. These medications have varying safety and tolerability profiles.

9.2.1 Cholestyramine

Cholestyramine is one of the earliest bile acid sequestrants introduced for clinical use. It is available as a powder for oral suspension, often requiring multiple daily doses (Jacobson et al., 2015)

9.2.1.1 Common Side Effects

- **Gastrointestinal Disturbances**: Constipation is the most frequently reported side effect, occurring in up to 50% of patients(Hou & Goldberg, 2009). Other GI symptoms include bloating, abdominal discomfort, nausea, and flatulence.

- **Interference with Nutrient Absorption**: Cholestyramine can impair the absorption of fat-soluble vitamins (A, D, E, K) and folic acid(Glueck et al., 1972). Long-term use may lead to deficiencies if not monitored.
- **Drug Interactions**: It can bind other orally administered medications, reducing their bioavailability. Drugs such as digoxin, warfarin, and thyroxine may have decreased efficacy(Gallo et al., 1965).

9.2.1.2 Rare Side Effects

- **Hyperchloremic Acidosis**: Particularly in children and patients with renal impairment(Kamar & McQuillan, 2015).
- **Bleeding Tendencies**: Due to vitamin K deficiency from prolonged use(Vroonhof et al., 2003).

9.2.2 Colestipol

Colestipol is available in granule and tablet forms. Similar to cholestyramine, it binds bile acids in the intestine.

9.2.2.1 Common Side Effects

- **Gastrointestinal Symptoms**: Constipation is also common, though some studies suggest a slightly lower incidence compared to cholestyramine (Lent-Schochet D, 2023) Other GI side effects include indigestion, nausea, and haemorrhoids due to straining.
- **Nutrient Absorption Interference**: Like cholestyramine, it can reduce the absorption of vitamins and some medications(Hameed MH, 2024).

9.2.3 Colesevelam

Colesevelam is a newer bile acid sequestrant with a high affinity for bile acids and is available in tablet and oral suspension forms. It has an advantage over the other agents in that it has been shown to improve glycaemic control in type 2 diabetes mellitus(Fonseca et al., 2008).

9.2.3.1 Common Side Effects

- **Gastrointestinal Effects**: Studies have shown that colesevelam has a lower incidence of GI side effects compared to cholestyramine and colestipol(Puleston et al., 2005). Constipation remains the most common, but occurs less frequently.
- **Drug Interactions**: Colesevelam can affect absorption of other medicines

9.2.4 Comparative Analysis of Side Effects and tolerability

Gastrointestinal Side Effects: Cholestyramine and colestipol have higher rates of GI side effects, particularly constipation, compared to colesevelam(Puleston et al., 2005). The severity of constipation and abdominal discomfort is often greater with cholestyramine due to its formulation and higher required doses(Insull, 2006).

Drug and Nutrient Interactions: Cholestyramine and Colestipol can both bind other drugs and reduce absorption of vitamins, necessitating careful timing of medication administration and possible supplementation. Colesevelam exhibits somewhat fewer interactions, potentially allowing for more flexibility in dosing schedules(Drugs.com, 2024).

Patient Compliance: Cholestyramine's powder form can be unpalatable, affecting adherence. Colestipol tablets and colesevelam tablets/suspension offer improved compliance(Brunetti & DeSantis, 2015). Colesevelam requires fewer daily doses, enhancing tolerability(Drugs.com, 2024).

9.3 Capital and revenue requirements for establishing and running a service to prescribe bile acid sequestrants to reduce PFAS body burden

9.3.1 Necessary Equipment

None

9.3.2 Required Personnel

Any doctor can prescribe bile acid sequestrants and so the service could be delivered using existing resources in primary care. Some training may be required.

9.3.3 Maintenance and Regulatory Compliance

No additional requirement over the status quo

9.3.4 Cost of prescribing bile acid sequestrant therapies to reduce PFAS body burden

9.3.4.1 Capital cost

There are no capital costs

9.3.4.2 Additional Costs to Consider

- **Training:** There may be some training costs around the safe and appropriate prescribing of bile acid sequestrants. While it is likely that this could be delivered within existing resources, it would be reasonable to assume an additional cost of £5,000 per annum.
- **Drug costs:** The estimated costs of the different bile acid sequestrants, in generic formulations are outlined below. These are per person per year estimates and do not include any discounts that might be available.

Medication	**Daily Dose**	**Annual Cost (£)**
Cholestyramine (Generic)	12 g (3 sachets)	**£350.40**
Colestipol (Generic)	10 g (2 sachets)	**£438.00**
Colesevelam (Generic)	3.75 g (6 tablets)	**£730.20**

9.3.4.3 In summary

Bringing all of this together, there is zero capital outlay. Assuming that 50 people are treated and they require six months of treatment each, total drug costs vary from £8,760 for cholestyramine to £18,255.50 for colesevelam. On this basis, the maximum total programme cost would be £23,255.50. If twelve months of treatment were needed, the total cost for the programme would be £ 41,510 per annum.

9.4 Other treatments targeting gastrointestinal reabsorption

9.4.1 Summary of the evidence for the efficacy of dietary fibre (including Psyllium husk) from the literature review

A growing body of research has examined whether high-fibre diets or specific fibre supplements can modestly accelerate the excretion of per- and polyfluoroalkyl substances (PFAS), especially PFOS and PFOA. The underlying rationale is that dietary fibre speeds food transit time in the gut, potentially reducing the reabsorption of PFAS excreted via bile and thus enhancing elimination.

Observational data from large population studies offer the clearest indication of this effect. For instance, a study using U.S. NHANES data (2005–2016) looked at 6482 adult participants and found that each higher quartile of fibre intake was associated with 7% lower PFOS, 4% lower PFOA, and 8% lower PFNA. A separate, more recent analysis of NHANES data (2007–2018) yielded similar findings, suggesting that those whose fibre intake exceeded the median had, on average, an 8% lower sum of PFAS in serum, predominantly driven by PFOS (9% lower) and PFOA (6% lower). PFHxS, however, showed almost no reduction in these comparisons(Dzierlenga et al., 2021). Any estimated benefits of either fibre or probiotics must be interpreted with caution. The fibre coefficient derives from estimated fibre composition across the diet. It may be that adding a fibre supplement to the diet would achieve the same effect, but this is quite uncertain. It may be that people with high fibre diet also have other dietary choices that affect PFAS intake or excretion.

A few studies explore particular fibre supplements. One small intervention (Genuis et al., 2013)included a fibre supplement, Chlorella pyrenoidosa, but was administered in a complex, multi-step protocol immediately after a bile acid sequestrant. No net change in serum PFAS levels could be clearly attributed to the fibre supplement alone, limiting conclusions on efficacy.

Overall, the collective evidence from food-frequency questionnaires and population surveys supports a modest link between higher fibre intake and slightly lower PFAS levels. However, causality remains uncertain because dietary patterns may also affect PFAS exposures (for example, through differences in foods that contain PFAS). Randomised trials focusing explicitly on dietary fibre (distinct from other interventions) are lacking. Consequently, while increasing fibre intake through diet or supplements appears sensible for overall health and may contribute to quicker PFAS clearance, its standalone impact is likely modest compared to interventions like cholestyramine or repeated plasma removal.

9.5 Risks and wider benefits of Psyllium husk treatment

Psyllium husk, derived from the seeds of the *Plantago ovata* plant, is a soluble fibre commonly used as a dietary supplement. It is used for its laxative properties and can be used in various gastrointestinal conditions, such as constipation and irritable bowel syndrome (IBS). Additionally, dietary fibre such as that psyllium contains has been associated with beneficial effects on cholesterol levels and glycaemic control(Anderson et al., 2009).

9.5.1 Safety and Tolerability of Psyllium Husk

Psyllium tends to be well-tolerated, particularly if started at low dose and increased gradually and taken with plenty of water(McRorie, 2015).

9.5.1.1 Common Side Effects

- **Gastrointestinal Effects:** Psyllium is generally considered safe for most individuals when taken as directed. The most common side effects are gastrointestinal and include:

- **Bloating and Wind**: Increased fibre intake can lead to bloating, flatulence, and abdominal discomfort, especially during the initial stages of consumption(Fernández-Bañares, 2006).
- **Mild Stomach Cramps**: Some users may experience minor stomach cramps due to increased intestinal activity(Eswaran et al., 2013).

These symptoms typically subside as the body adjusts to the increased fibre intake.

9.5.1.2 Rare Side Effects

- **Allergic Reactions:** Although rare, allergic reactions to psyllium husk can occur. Such reactions range in severity from itching and skin issues through to life-threatening reactions like anaphylactic shock. Individuals with known allergies to psyllium or other members of the *Plantago* genus should avoid its use(James et al., 1991).
- **Oesophageal and Intestinal Obstruction:** Psyllium expands upon contact with water. If not taken with sufficient liquid, it can swell in the throat or oesophagus. Rare cases of intestinal blockage have been reported, particularly in individuals with pre-existing gastrointestinal disorders(Hefny et al., 2018). To mitigate this risk, it's essential to consume psyllium with at least 200ml of water.

9.5.2 Capital and revenue requirements for making Psyllium husk available to reduce PFAS body burden

9.5.2.1 Necessary Equipment

None

9.5.2.2 Required Personnel

None. Psyllium can be purchased over the counter

9.5.2.3 Maintenance and Regulatory Compliance

No additional requirement over the status quo

9.5.3 Cost of accessing Psyllium husk to reduce PFAS body burden

9.5.3.1 Capital cost

There are no capital costs

9.5.3.2 Additional Costs to Consider

- **Training:** There may be some training costs around the safe and appropriate prescribing of Psyllium. While it is likely that this could be delivered within existing resources, it would be reasonable to assume an additional cost of £5,000 per annum.
- **Drug costs:** The estimated costs of the different psyllium preparations are outlined below. These are per person per year estimates and do not include any discounts that might be available.

Product	Daily Dose	Annual Cost (£)
Generic Powder	**7 g**	**£30.66**
Fybogel Sachets	**2 sachets (7 g)**	**£97.09**

Psyllium Capsules **14 capsules (7 g)** **£424.13**

9.5.3.3 In summary

Bringing all of this together, there is zero capital outlay. Assuming that 50 people are treated and they require twelve months of treatment each, total drug costs vary from £1.533 for generic Psyllium to £21,206.50 for capsules. On this basis, the maximum total programme cost, if it were fully funded, would be £26,206.50 per annum.

10 Treatments targeting renal reabsorption; effectiveness, safety, tolerability and cost

This chapter looks at several different metrics around the interventions, but does not deal with all logistical barriers, these may also be a factor in the implementation of any service.

10.1 Summary of the evidence for the effectiveness of probenecid from the literature review

Probenecid is a medication commonly prescribed for gout that inhibits transport mechanisms in the kidney. The rationale for testing probenecid is that it could block PFAS reabsorption and promote urinary excretion. However, two observational studies: one in the C8-exposed population in the United States (Ducatman et al., 2021) and another using U.S. National Health and Nutrition Examination Survey data (Andersen et al., 2021)failed to show lower PFAS levels in the few reported probenecid users.

Subsequent short-term interventional work in Ronneby, Sweden, similarly indicated no significant effects from one week of probenecid treatment on PFOS, PFHxS, or PFOA excretion. Although longer-term data remain unpublished, preliminary indications are that probenecid does not meaningfully alter PFAS kinetics. Based on current evidence, probenecid does not appear to be a viable approach to enhance PFAS removal from the body.

10.2 Risks and wider benefits of probenecid treatment

Probenecid is a uricosuric agent primarily used in the management of hyperuricemia associated with gout and gouty arthritis. It functions by inhibiting the renal tubular reabsorption of uric acid.

10.2.1 Safety and Tolerability of Probenecid

Most patients tolerate probenecid well, but some may experience side effects(Sattui & Gaffo, 2016).

10.2.1.1 Common Side Effects

- **Gastrointestinal Disturbances**: Nausea, vomiting, anorexia, and abdominal pain are the most frequently reported adverse effects.
- **Headache and Dizziness**: Mild to moderate headaches and dizziness may occur.
- **Flushing and Fever**: Occasionally reported in some patients(BOGER & STRICKLAND, 1955).
- **Drug Interactions**: Probenecid interacts with various medications, potentially altering their pharmacokinetics. These include some antibiotics, anti-inflammatory drugs, Methotrexate and HIV drugs(American Pharmacists Association & Inc, 2016).

10.2.1.2 Rare Side Effects

- **Renal Calculi (Kidney Stones)**: Increased uric acid excretion can lead to stone formation in susceptible individuals(BOGER & STRICKLAND, 1955).
- **Aplastic Anaemia and Haemolytic Anaemia**: Rare haematological disorders have been associated with probenecid (NCBI, 2004)
- **Nephrotic Syndrome**: Cases of proteinuria and nephrotic syndrome have been reported (Hertz et al., 1972)

- **Allergic Reactions**: Skin rashes, pruritus, and, rarely, severe hypersensitivity reactions like Stevens-Johnson syndrome and anaphylaxis(Hillecke, 1965).

10.2.2 Capital and revenue requirements for prescribing probenecid to reduce PFAS body burden

10.2.2.1 Necessary Equipment

None

10.2.2.2 Required Personnel

Any doctor can prescribe probenecid and so the service could be delivered using existing resources in primary care. It should be noted, however, that probenecid is no longer licensed in the UK. While off-label drugs can still be prescribed, some doctors may not be comfortable so doing. Some training may also be required.

10.2.2.3 Maintenance and Regulatory Compliance

No additional requirement over the status quo

10.2.3 Cost of prescribing probenecid to reduce PFAS body burden

10.2.3.1 Capital cost

There are no capital costs

10.2.3.2 Additional Costs to Consider

- **Training:** There may be some training costs around the safe and appropriate prescribing of probenecid. While it is likely that this could be delivered within existing resources, it would be reasonable to assume an additional cost of £5,000 per annum.
- **Drug costs:** It is difficult to assess the costs of probenecid because, as an unlicensed medicine, it no longer has a list price in the UK (which is used as a proxy for Jersey pricing). Given that volumes will be relatively low and the costs of importation will increase the effective price, it is reasonable to assume a cost per patient per year of £800.

10.2.3.3 In summary

Bringing all of this together, there is zero capital outlay. Assuming that 50 people are treated and they require twelve months of treatment each, total drug costs would be £40,000. On this basis, the maximum total programme cost, if it were fully funded, would be £45,000 per annum.

11 Other treatment approaches; effectiveness, safety, tolerability and cost

This chapter looks at several different metrics around the interventions, but does not deal with all logistical barriers, these may also be a factor in the implementation of any service.

11.1 Summary of the evidence on the effectiveness of haemodialysis in reducing PFAS from the literature review

Haemodialysis is a life-sustaining therapy for patients with severe kidney dysfunction. Its potential to remove PFAS was highlighted by a Taiwanese study comparing 301 dialysis patients to healthy controls(Huang et al., 2023). Dialysis patients had dramatically lower PFOS levels—on average around 0.29 ng/ml—compared to 4.2 ng/ml in chronic kidney disease patients not on dialysis and 6.2 ng/ml in healthy controls. A similar three- to fourfold reduction was observed for PFHxS and PFOA.

Although the study design cannot entirely confirm that dialysis alone accounted for these differences (patients with chronic kidney disease might have other confounding factors), the magnitude of the discrepancy suggests that haemodialysis efficiently filters PFAS. The mechanism is straightforward: PFAS-protein complexes in the bloodstream pass through dialysis filters, and some fraction is removed from circulation. Yet dialysis is an invasive, high-resource procedure typically reserved for end-stage renal disease. Using it solely to lower PFAS in healthy individuals is highly impractical and poses risks that usually outweigh any benefit. The evidence nonetheless supports the general principle that procedures capable of filtering or binding blood proteins can hasten PFAS elimination(Huang et al., 2023).

11.2 Risks and wider benefits of haemodialysis

Haemodialysis is a life-sustaining treatment for patients with end-stage renal disease (ESRD) or acute kidney injury (AKI), where the kidneys can no longer perform their essential functions of filtering waste products and excess fluids from the blood. During haemodialysis, blood is diverted from the patient's body to a machine called a dialysis machine, where it passes through semi-permeable membranes. These membranes allow waste products and excess electrolytes to diffuse into a dialysis solution while retaining larger molecules like proteins and blood cells(Daugirdas et al., 2012). The purified blood is then returned to the patient's circulation. Typically, haemodialysis sessions occur three times per week, lasting about 3 to 5 hours each(Johansen et al., 2021).

11.2.1 Safety and Tolerability of haemodialysis

Haemodialysis necessitates frequent, lengthy sessions that can disrupt daily activities. It requires some form of surgical intervention to make vascular access easier and also limitations on fluid and certain nutrients may affect enjoyment of food. Fatigue and weakness are common post-dialysis and can hinder social and occupational functioning. Prevalence of depression is high among dialysis patients, affecting quality of life, as well as adherence and outcomes(Palmer et al., 2013). Overall, haemodialysis is poorly tolerated.

11.2.1.1 Common Side Effects

- **Hypotension:** Hypotension is the most frequent intradialytic complication, affecting up to 20-30% of sessions(Henrich, 1986). It can result in dizziness, nausea, vomiting, and loss of consciousness. This may be less common in people with normal kidney function.

- **Muscle Cramps:** Fluid and electrolyte shifts during dialysis may cause cramps. Muscle cramps occur in approximately 5-20% of patients(Hossli, 2005). This may be less common in people with normal kidney function.
- **Pruritus (Itching):** It is not clear what the cause of the itching is; it may involve uremic toxins, dry skin, and inflammation. Pruritus affects up to 50-90% of haemodialysis patients(Mathur et al., 2010). This may be less common in people with normal kidney function.
- **Vascular Access Infections:** Infections can occur in arteriovenous (AV) fistulas, grafts, or central venous catheters. Catheter-related bloodstream infections range from 0.5 to 5.5 episodes per 1,000 catheter-days(Lok & Mokrzycki, 2011).
- **Arrhythmias:** Cardiac arrhythmias occur in up to 25% of patients during dialysis(Mavrakanas & Charytan, 2016). They are caused by electrolyte shifts, particularly potassium and calcium levels. This may be less common in people with normal kidney function.

11.2.1.2 Rare Side Effects

- **Sudden Cardiac Death:** People with **u**nderlying cardiac disease, electrolyte imbalances or hypotension are at risk of sudden cardiac death. This accounts for approximately 25% of all deaths in dialysis patients(Mavrakanas & Charytan, 2016). This may be less common in people with normal kidney function.
- **Dialysis Disequilibrium Syndrome:** This results from the rapid removal of urea leading to cerebral oedema It is characterised by neurological symptoms ranging from headache to seizures and coma(Murdeshwar HN, 2023). This may be less common in people with normal kidney function.
- **Haemolysis:** Mechanical stress from dialysis equipment or contamination with disinfectants can lead to haemolysis; the breakdown of red blood cells(Tharmaraj & Kerr, 2017). This may present with back pain, chest pain or dark urine and can have serious sequelae(Murdeshwar HN, 2023).
- **Anaphylactic Reactions**: These are rare, severe allergic reactions to dialysis membranes or sterilising agents (potentially also some of the medicines given alongside dialysis). This is a medical emergency.

In addition to this, people receiving haemodialysis are at risk of vitamin and mineral depletion and are likely to require regular blood testing and vitamin and mineral supplementation, particularly iron.

11.3 Capital and revenue requirements for establishing and running a haemodialysis service

11.3.1 Necessary Equipment

There are several items needed to deliver dialysis itself (NICE, 2018) and to ensure appropriate water quality for the delivery of dialysis(Coulliette & Arduino, 2013).

- **Haemodialysis Machines:** These are advanced devices that remove waste products and excess fluids from the blood. They are equipped with features like volumetric control, ultrafiltration, and safety alarms They must be MHRA-approved and capable of performing haemodialysis efficiently and safely.
- **Water Treatment Systems:** These are essential for producing ultrapure water required for dialysis. They include reverse osmosis units, deionizers, and ultrafilters to remove contaminants and toxins.

- **Artificial Kidneys (Dialyzers):** These are disposable units containing semi-permeable membranes for blood purification. They are available in different sizes and membrane types to suit patient needs.
- **Other consumable equipment:** Sterile single-use tubing, fistula needles, personal protective equipment and waste disposal supplies.
- **Dialysate Concentrates:** Acid and bicarbonate solutions mixed with purified water to create dialysate. These allow customised electrolyte composition to match patient requirements.
- **Anticoagulants:** Typically, heparin, administered to prevent blood clotting during dialysis.
- **Saline Solutions:** Used for priming the extracorporeal circuit and managing hypotension.
- **Patient Monitoring Equipment:** Devices to monitor vital signs like blood pressure, heart rate, and oxygen saturation. Scales are also required for pre- and post-dialysis weight measurement to assess fluid removal.
- **Emergency Equipment:** Includes defibrillators, oxygen supplies, and resuscitation kits for immediate response to emergencies.
- **Water Testing Supplies:** Kits and devices to regularly test water quality for contaminants and bacteria.
- **Imaging equipment:** To facilitate vascular access

In addition to this equipment, vascular access would be required, either through a long-term indwelling cannula or through the surgical creation of an arteriovenous fistula. Catheters require care and maintenance and both catheters and fistulæ are prone to failure.

11.3.2 Required Personnel

- **Lead clinician:** Probably a consultant nephrologist with expertise in haemodialysis. Role includes oversight of medical procedures, assessing patient therapeutic and diagnostic needs, and compliance with medical standards.
- **Specialist nurses:** To perform vein punctures, operate dialysis machines, and monitor patients during the procedure. They need to be certified in the delivery of dialysis and trained in the use of specific dialysis equipment.
- **Dialysis Technicians:** To prepare machines and monitor equipment
- **Surgical staff:** To obtain vascular access
- **Maintenance and Cleaning Personnel: To e**nsure cleanliness of the facility and proper functioning of equipment. This is critical for infection control and meeting health standards.

11.3.3 Maintenance and Regulatory Compliance

- **Regular Servicing of Equipment**: Haemodialysis machines and water purification units require routine checks and servicing by qualified technicians.
- **Calibration of Equipment**: Medical devices must be calibrated regularly to ensure accuracy(ISO, 2022).
- **Facility Cleaning Protocols**: Adherence to strict cleaning schedules for donor areas, equipment, and common spaces.
- **Infection Control**: Implementation of standard precautions to prevent cross-contamination
- **Licensing and Accreditation**: Obtain necessary licenses from health regulatory organisations.

- **Standard Operating Procedures (SOPs)**: Develop and maintain SOPs for all processes, aligning with MHRA, FDA and European Medicines Agency (EMA) guidelines.
- **Staff Training and Certification**: Ongoing education to keep staff updated on best practices and regulatory changes.
- **Audits and Inspections**: Regular internal audits and readiness for external inspections.
- **Documentation**: Comprehensive record-keeping for patient care and adverse event tracking(Lundin et al., 2008).

Offering a haemodialysis service involves more than just cleansing blood; it requires a robust infrastructure of specialised equipment, skilled personnel, and stringent maintenance protocols.

11.3.4 Cost of a Haemodialysis Service for Human Use

11.3.4.1 Capital cost

The cost of a new haemodialysis machine in the UK ranges from approximately **£15,000 to £30,000** per unit, depending on the manufacturer, model, and features(Roberts et al., 2022). Advanced models with additional capabilities such as online hemodiafiltration or biofeedback systems may be at the higher end of the price range. It should be noted that, in order to maintain continuity of service, at least two machines would be required. Because the potential use here is for the removal of PFAS, rather than to replace renal function, it is difficult to predict how many treatments might be needed. It is unlikely that it would be anywhere near the number needed to offer renal replacement therapy in Jersey.

In addition, a Water Treatment System is **e**ssential to provide ultrapure water for dialysis. Costs range from **£10,000 to £20,000**, depending on capacity and technology(ISO, 2024). Installing such a system may require modifications to existing facilities to accommodate the machine, including water supply, drainage, and dedicated electrical circuits. Estimated cost: **£5,000 to £10,000**.

11.3.4.2 Additional Costs to Consider

- **Maintenance and Service Contracts:** Essential for the safe and effective operation of the machine and the water treatment system, there will be regular maintenance and calibration, carried out by facility staff. In addition to that there would be a requirement for a service contract with the manufacturers. These can be of the order of **£10,000-£20,000** per annum (assuming two dialysis machines and one water treatment system).
- **Consumables:** Artificial kidneys cost approximately **£10 to £20**. Assuming ten treatments required, that equates to **£100 to £200** per patient per year, or **£5,000 - £10,000** overall. Tubing sets cost **£5 to £10**, so calculating on a similar basis, the total cost would be **£2,500 - £5,000** overall. Dialysate solutions cost approximately **£3** per treatment, or **£1,500** overall. Vascular access costs, if using a tunnelled cannula, would be approximately **£800** per cannula; cannulæ last up to six months, so the cost is **£1,600** per patient per year. Cannula care, blood testing and vitamin/electrolyte replacement cane be reasonably estimated to cost around **£5,000** per patient per year. Taking all those together, consumable costs would potentially be up to **£23,100** per annum.
- **Training and Staffing:** In addition, the salary costs of the staff described above, staff must be trained to operate the machine safely. Some manufacturers offer training programs, which may be included or charged separately. Assuming the consultant nephrologist is half time,

the surgical staff are 0.1 WTE and all other staff are full time, staff costs (excluding on costs) are likely to be between **£200,000 and £250,000** per annum.

- **Regulatory Compliance:** Compliance with the Medicines and Healthcare products Regulatory Agency (MHRA) regulations may involve fees and/or modifications to the facility.

11.3.4.3 In summary

Bring all this together, a haemodialysis service would have set up costs, assuming two machines, and the necessary water treatment infrastructure and installation, of the order of **£100, 000**. Running the service for one year, assuming 50 patients receiving 10 sessions each, would cost around **£1,380,000 per annum**.

12 Cost-effectiveness analysis of different interventions to reduce PFAS body burden

In order to be able to make a meaningful comparison between the different potential interventions, we need to be able to compare like with like, in terms of how effective the various interventions are at reducing PFAS in the body. It should be noted that several assumptions have been made in these analyses. Where there were a range of half-lives shown in the literature review, the midpoint of that range has been used in all the modelling here. In addition, the modelling of efficacy is solely for the purposes of comparison and does not represent real-world projections of serum levels (ongoing exposure has been excluded from the analysis, for example).

12.1 Understanding and exploring relative efficacy of different interventions

Based on the analysis in the literature review, the panel has calculated the duration of each treatment needed for the individual moieties of PFAS in the body to reduce by half. These overall half-lives are summarised in Figure 18 below.

Figure 18 - Overall effective half-lives (months) of different PFAS moieties by intervention

	PFHxS	PFOS	PFOA
No Intervention	54.0	36.0	30.0
Phlebotomy	27.2	21.7	19.4
Plasma Removal	14.7	13.0	12.1
Probenecid (no effect)	54.0	36.0	30.0
Bile Acid Sequestrants	9.1	1.9	6.7
High-Fibre Diet	54.0	33.0	28.3
Haemodialysis	15.9	2.6	7.9

Looking at the data, it is clear that there is a very wide range of durations, from 2 months to halve PFOS levels with bile acid sequestrants, up to 54 months for PFHxS to halve in the absence of any intervention. Because Probenecid is not effective, it is not included in the analyses below.

We have already discussed that the median levels of the different PFAS in the serum of the people from the plume area, tested under the Public Health testing programme in 2022. They were **13ng/mL for PFHxS, 11ng/mL for PFOS and 3ng/mL for PFOA That gives a total PFAS of 27 ng/mL**. If we assume that those are the starting levels for each intervention, we can look at the levels of each of the PFAS moieties after twelve months of each of the interventions, there is much variation. **These are not real-world projections as they ignore any ongoing exposure, they are there solely for comparison of different intervention approaches:**

Figure 19 - levels of PFAS in ng/mL of serum after twelve months of each intervention scenario based on testing programme baseline levels

	Duration	PFHxS[1]	PFOS[1]	PFOA[1]	Total[1]
No Intervention	12 months	11.1	8.7	2.3	**22.1**
Phlebotomy	12 months	9.6	7.5	2.0	**19.0**
Plasma Removal	12 months	7.4	5.8	1.5	**14.7**
Bile Acid Sequestrants	12 months	5.2	0.1	0.9	**6.2**
High-Fibre Diet	12 months	11.1	8.5	2.2	**21.9**
Haemodialysis	12 months	7.7	0.4	1.0	**9.2**

1 Assuming zero ongoing exposure

As Figure 19 demonstrates, there are marked differences in the overall benefit of the different intervention strategies over a twelve-month treatment period. While plasma removal, and, to a marginally lesser extent, phlebotomy show incremental improvement over no intervention in this time frame, Bile acid sequestrants and, to a lesser extent, haemodialysis show dramatic reductions in serum PFAS.

Given that, in every scenario above, PFHxS has the longest half-life, and it is generally the moiety with the highest serum level in Jersey residents, we will use those half-lives as the unit of comparison for cost-effectiveness purposes. It should be noted that we are not suggesting that one half-life of PFHxS should be the duration of treatment, it is just the common unit that we are using to triangulate the costs

Before moving into the actual cost effectiveness analysis, we just wanted to contextualise the meaning, in terms of PFAS levels, of a one PFHxS half-life duration of treatment, in terms of its impact on levels of PFAS at the end of that period. **This is a thought experiment, assuming no ongoing exposure through the environment and should not be seen as real-world projections but merely a comparative exercise looking at the relative efficacy of the different intervention approaches.**

If we repeat the analysis on the basis of the time each of the interventions take for the PFHxS levels to be halved, we can see the levels of other PFAS moieties at that point. We can also look at the effect on total PFAS. These are summarised in Figure 20, below.

Figure 20 - Levels, in ng/mL of serum, of different PFAS moieties after one effective PFHxS half-life of each intervention

	Duration of intervention (to reduce PFHxS by one half life)	PFHxS[1]	PFOS[1]	PFOA[1]	Total[1]
No Intervention	54 months	6.5	3.9	0.9	**11.3**
Phlebotomy	27.2 months	6.5	4.6	1.1	**12.2**
Plasma Removal	14.7 months	6.5	5.0	1.3	**12.8**
Bile Acid Sequestrants	9.1 months	6.5	0.4	1.2	**8.1**
High-Fibre Diet	54 months	6.5	3.5	0.8	**10.8**
Haemodialysis	15.9 months	6.5	0.2	0.7	**7.4**

Note that the starting total level of 3 PFAS in serum is assumed to be 13 + 11 + 3 = 27 ng/mL. For example, with no intervention a person's serum levels drop from 27 to 11.3 ng/L (total of 3 PFAS) in 54 months whereas with bile acid sequestrants a person's serum levels drop from 27 to 8.0 ng/mL (total of 3 PFAS) in 9.8 months

1 Assuming zero ongoing exposure

As you will see, even with a greater than fourfold variation in the duration of intervention, the total of the three PFAS moieties is fairly similar, other than for bile acid sequestrants and haemodialysis.

12.2 Projected costs of different interventions

Looking at the costs of the different intervention approaches is an important step in assessing the proportionality and affordability of a given intervention for Jersey. These costs are divided into two types: capital costs and revenue costs. Capital costs include the purchase and installation of any specialised equipment that might be needed to deliver that service. In this analysis, we have assumed that there does not need to be significant building or rebuilding of facilities where the service could be housed. Revenue costs, on the other hand, are the costs of running the service once it has been established. These include staffing costs, the costs of drugs and consumables, maintenance, calibration and standardisation costs and suchlike. Capital costs are incurred at the purchase and installation of any equipment and can also recur when equipment reaches the end of its lifecycle. In the following analyses, we have assumed that no capital equipment would need to be replaced during an intervention programme. Revenue costs are incurred throughout the time the programme is in progress. Some revenue costs, such as drugs and consumables will vary depending on the throughput of the service, while others, such as staffing and maintenance, will be fixed costs regardless of how much use the service is getting. For the purpose of this analysis (and the later cost-effectiveness analyses), we have made the assumption that fibre supplements, like Psyllium husk, would have the same effect as a high fibre diet and that the government were picking up the cost, rather than Islanders self-funding. As has been noted above, there evidence for fibre supplements is

weak such that it would be hard to recommend them as an effective treatment, they have been included here for cost-effectiveness comparison purposes only.

The table below summarises the capital costs for each intervention and the revenue cost per annum of delivering the service to fifty persons

Figure 21 - Capital and revenue costs to deliver a service for fifty persons

	Capital costs	Revenue costs per annum
No Intervention[2]		
Phlebotomy	Nil	£125,000
Plasma Removal	£100,000	£175,000
Bile Acid Sequestrants	Nil	£ 41,510 [1]
Fibre Supplements	Nil	£26,206
Haemodialysis	£100,000	£1,380,000

1 using the most expensive bile acid sequestrant, colesevelam and a full twelve months of the drug

2 There are no direct costs of doing nothing

Just looking at delivery costs, without considering efficacy, the table shows a greater than thirty-fold differential in the cost of delivering a service to fifty persons, with haemodialysis costing close to £1.5 million and bile acid sequestrants (the most expensive such agent, colesevelam) costing under £50,000.

While fibre supplements appear to be reasonably low cost, it is important to note that the assumption that they are as clinically effective as a high fibre diet is a large leap and unlikely to be actually the case in real life. Furthermore, the fact that they do not reduce PFHxS at all beyond no intervention, mean that they are not a suitable intervention where PFHxS is the most elevated of the PFAS moieties. For these reasons, they have been omitted from the final analyses.

12.3 Cost effectiveness analysis

This section brings together the evidence on efficacy with the modelled costs to assess the relative value for money of each treatment approach. This analysis will not look at all the interventions previously considered, but will focus on those where there is evidence of some efficacy over and above no intervention and where costs of regulator approved, licensed drugs, equipment and services are used. Three intervention approaches have been excluded, therefore; not to intervene at all, Probenecid (because it has not outperformed no intervention in studies) and probiotic supplements, because no licensed product is currently available.

The table below models the total cost to treat fifty people until such time as they halve their PFHxS levels. The panel is not suggesting that that would be the endpoint of any intervention, it has simply been chosen in order to compare the costs of the different treatments on a like for like basis, predicated on outcomes. The costing incorporates capital costs (where relevant) and the revenue costs from the duration of treatment that would be necessary.

As there is no direct evidence of fibre supplements having effect on PFHxS, they are not part of this analysis.

Figure 22 - Cost to treat until PFHxS level is halved

	Capital costs	Revenue costs per annum	Months to halve PFHxS	Cost to halve PFHxS
Phlebotomy	Nil	£125,000	27.2	£283,333
Plasma Removal	£100,000	£175,000	14.7	£314,375
Bile Acid Sequestrants[1]	Nil	£ 41,510	9.1	£31,478
Haemodialysis	£100,000	£1,380,000	15.9	£1,928,500

1 using colesevelam, the most expensive bile acid sequestrant

As can be seen in the table, even the most expensive bile acid sequestrant therapy is between nine and sixty times more cost-effective than any other potential intervention option. On the face of it, other bile acid sequestrant agents may be even more cost-effective, but they are far more likely to have adherence problems due to adverse effects being more common, and that is likely to significantly reduce and potential cost-effectiveness advantage in the real world. It should be noted, however, that the direct evidence in the literature is for a sequence of bile acid sequestrants (due to tolerability and supply issues), not solely colesevelam, and, while it is highly likely that PFAS reduction is a class effect, any programme using colesevelam would require thorough evaluation.

Figure 23 - Relative cost effectiveness of different PFAS lowering interventions in lowering PFHxS

	Cost to halve PFHxS	Relative cost-effectiveness
Bile Acid Sequestrants	£31,478	100.0%
Phlebotomy	£283,333	11.1%
Plasma Removal	£314,375	10.0%
Haemodialysis	£1,928,500	1.6%

It should be noted that the figures above represent the likely real-world costs of treating until PFHxS is halved

Those analyses can be repeated, looking at total of the three major PFAS in Jersey, PFHxS, PFOS and PFOA. A key assumption is that the three PFAS moieties are in the same proportions, relative to each other, as they are in the median values from the 2022 PFAS testing programme in the plume area of St Oeun. This is presented in the table below:

Figure 24 - Cost to treat until total PFAS (of 3 moieties) is halved

	Capital costs	Revenue costs per annum	Months to halve PFAS total	Cost to halve PFAS total
Phlebotomy	Nil	£125,000	23.8	£247,917
Plasma Removal	£100,000	£175,000	13.7	£299,792
Bile Acid Sequestrants[1]	Nil	£ 41,510	4.3	£14,874
Haemodialysis	£100,000	£1,380,000	6.4	£836,000

This represents the real-world costs of treating until the total of the three PFAS moieties is halved.

A similar analysis can be done to calculate the relative cost-effectiveness of each of the treatment interventions at lowering the total of the three PFAS moieties by half shows similar results:

Figure 25 - Relative cost effectiveness of different interventions at lowering total PFAS

	Cost to halve total PFAS	Relative cost-effectiveness
Bile Acid Sequestrants	£14,874	100.0%
Phlebotomy	£247,917	6.0%
Plasma Removal	£299,792	5.0%
Haemodialysis	£836,000	1.8%

This represents the relative cost-effectiveness in practice.

12.3.1 Additional analyses

The panel conducted several additional analyses, including modelling to take natural decay in PFAS levels into account, and other ways to measure cost effectiveness. These all had very similar findings but were considerably harder to understand. For those reasons the panel has not included them in the main text of the report, but they are available in the minutes at Appendix 1.

12.4 In summary

Bile acid sequestrants outperform other interventions in terms of efficacy significantly; they are fifty percent more effective than the next most effective intervention in the real world and have more than triple the efficacy of any viable intervention.

Bile acid sequestrants are more effective and marginally cheaper than any other form of intervention and therefore are markedly more cost-effective than any other option, more than an order of magnitude better than the next best, in terms of cost effectiveness. This same pattern applies whether looking at any of the three PFAS moieties or at the total of these PFAS and also whether background decay is corrected for or not.

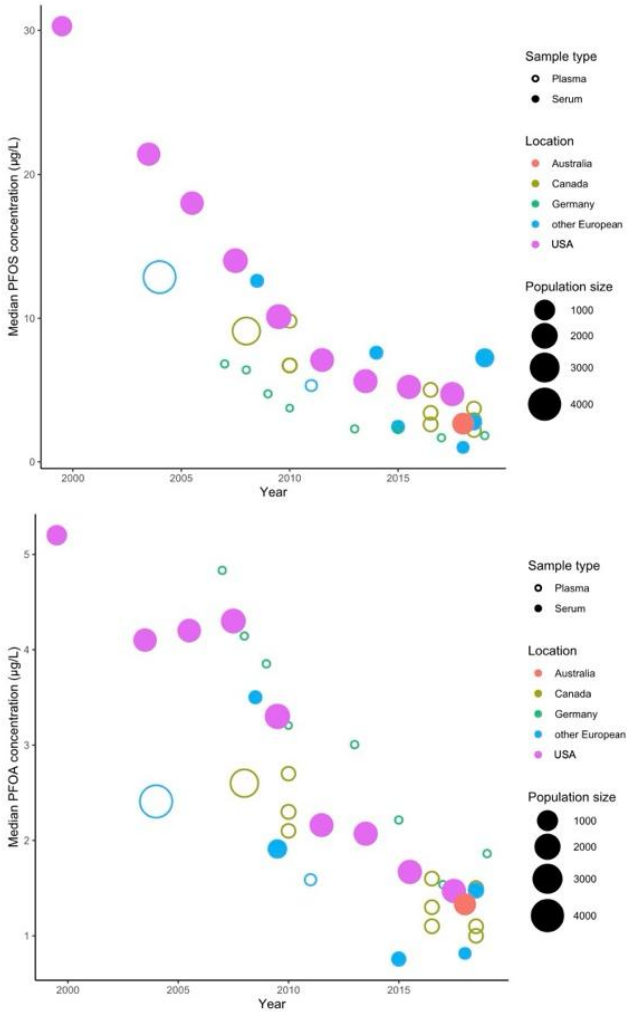
13 Projected background and plume serum levels and further analysis on the implications for intervention effectiveness

For the purpose of comparing the relative effectiveness between different interventions the amount of background PFAS in the population was ignored, however, to estimate the real impact background levels need to be taken into account. For people with past exposure, for example in the plume area, their serum levels are very likely to be steadily falling but will not fall to zero but rather to a background serum level reflecting the general ongoing level of PFAS.

We do not know the true average "background" exposure outside the plume area as we have not sampled a random representative population yet, but we can make a reasonable estimate of the average serum level to be expected.

Studies in other countries across Europe, as well as Canada, Australia and the US have measured PFAS in general population samples and these show a trend in serum levels falling over time. A number if these studies have been summarised in the recent IARC monograph (page 107) for PFOS and PFOA(IARC, 2025):

Figure 26- Median PFOA and PFOS concentrations reported from the adult general population in several countries



Source: data aggregated form HBM4EU, CDC, and Government of Canada 2023

From these figures the recent average levels in various European and other countries are around 2 ng/ml for PFOS and 1.5 ng/ml for PFOA. For PFHxS the recent average shown in the HBM4EU data is around 0.5 ng/ml. This is considered to be mainly due to dietary sources. To this we can add a component from piped drinking water. Annual reports on Jersey water quality have provided concentrations of monitored PFAS, in water supplied by the two water treatment plants. We can estimate recent intake as the average between the two plants over the last 3 reported years 2022 to 2024, and the average concentrations calculated in this way are 6 ng/L for PFOS and PFOA and 4 ng/L for PFHxS. On average a given amount of PFAS in drinking water will lead to an increment in serum concentration at steady state, depending on the average water consumption and half-life for each compound. From these water averages the estimated contribution to serum concentrations would be each close to 1 ng/ml (0.8 to 0.95). Putting the general background from food and the local water related background together, one might expect levels for PFOS, PFOA and PFHxS of 3, 2.5 and 1.5 ng/ml respectively, **a sum of 7 ng/ml**. Obviously there will be variability between individuals, but this is a reasonable average for the population.

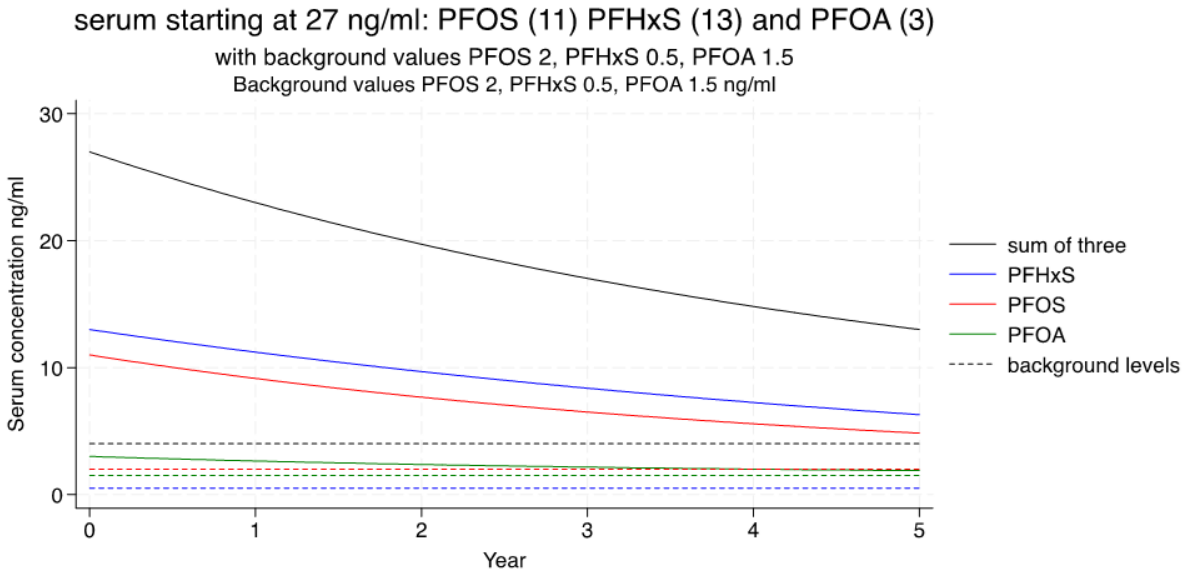
For the islanders living near the airport who were sampled in 2022, the median serum levels measured were 11, 3 and 13 summing to 27 ng/ml (for PFOS, PFOA and PFHxS, respectively). For these individuals and assuming that the background levels were 3, 2.5 and 1.5 ng/ml, the fall in these three can be predicted on the basis of average elimination rates for each substance. The model uses a standard equation for excretion from a single compartment:

$C_t=C_b + (C_o-C_b)e^{-kt}$

Where C_t is the concentration at time t, C_b is the background serum concentrations due to general background exposure, C_o is the starting concentration and k is the elimination rate constant. (Bartell, 2017)can be obtained from the half-life ($k=\log_e(2)/\text{half-life}$).

The decrease over time, to be expected on average is shown in the following graph. , illustrating how for someone with the starting concentration of 27 ng/ml for the 3 PFAS, levels would fall towards the background levels over the next five years.

Figure 27- Serum PFOS, PFHxS and PFOA with modelled background levels

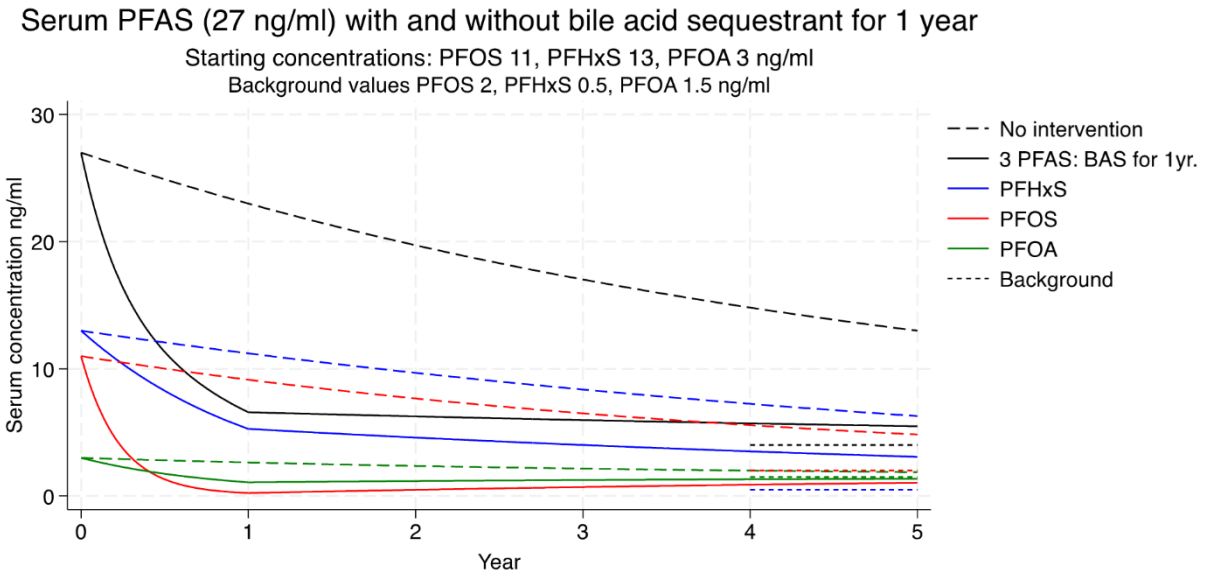


2022 median values: PFOS 11ng/mL, PFHxS 13ng/mL, PFOA 3ng/mL

It is noticeable that the PFOA concentration has hardly fallen. This is because the gap between the serum levels 2.5 years earlier and the background level was only 0.5 (3 minus the background estimate of 2.5). PFOA-half life is 2.5 years, and this time has passed between the end of 2023 and now, the gap that has fallen by half. So, the modelled PFOA falls from 3 to 2.75 ng/ml over this period. Over this same 2.5-year period, PFHxS falls from 13 to 9.3 and PFOS falls from 11 to 7.5, the sum of the three would therefore be expected to have fallen from 27 to 19.6 ng/ml.

Considering the bile acid sequestrants (BAS) intervention, the following graph shows the likely impact of 12 months of taking BAS starting in mid-2025 (with differing impacts on the different PFAS).

Figure 28- PFAS levels over time with 12 months of bile acid sequestrants from mid-2025 compared with no intervention



Assuming background levels: PFOS 3ng/mL, PFHxS 1.5ng/mL, PFOA 2.5ng/mL

For some this would reduce serum levels even below the background levels, as the more rapid excretion would reduce both the accumulated PFAS from prior AFFF exposure and the ongoing contribution from background exposures in the general diet. Levels would then converge towards the background levels in each PFAS, either from above or below, slowly approaching them over time. As has been noticed, this convergence slows down as the serum levels approach the background levels. We do not have data on how much background levels have fallen over time, presumably falling, and for this estimation we have assumed that the background serum PFAS has stayed constant at the current levels over the years in the graph. The top line is the sum of the three PFAS.

The sum was 27 ng/ml at the end of 2022, having fallen to 19.6 by mid-2025 through normal average decay, falling further to 4.9 after a year of treatment, and then recovering towards the estimated total background of 7 ng/ml, being estimated as 6.5 ng/ml in 2030. Without intervention it would have been 12.6 in 2028.

In round numbers a typical total serum now of 20 ng/ml for PFOS, PFHxS and PFOA would fall to 12 ng/ml through natural excretion by 2030 but would fall to 6 ng/ml if you also had a year of the most effective intervention, the bile acid sequestrants.

14 Discussion

14.1 Blood testing for PFAS

The panel are of the view that standard approaches to human testing should be applied when looking at PFAS testing. That tests should be undertaken in a laboratory that has been formally accredited for testing PFAS in humans, that there is a "chain of custody" (i.e. clarity around the movement and security of the sample) from the moment the blood sample is taken to the moment it is analysed in the laboratory, and that there is evidence that any risks of contamination at any point of the process have been minimised. This is similar to the processes that health services put into place to ensure that other tests, like blood counts, tests of liver and kidney function and tests of drug levels etc. The panel made a recommendation to this effect.

The panel initially discussed testing PFAS levels in serum and identified four potential groups to be discussed separately. The first group discussed were those people who would have been eligible for the Government run testing programme in 2022 but they either did not have symptoms and were excluded on that basis, or chose not to participate in the programme. The second group were people who were not eligible for the 2022 programme, but may have been exposed to PFAS in their work. The third discussion was on whether people who had participated in the 2022 testing programme should be recommended for retesting, and the final group considered was the wider population of Jersey. These are considered below.

14.1.1 Testing people likely to have been exposed in the plume area who did not participate in 2022 testing programme.

14.1.1.1 Purpose and Rationale

In communities with known PFAS contamination, testing is often provided to determine the extent of exposure. In international settings, residents in the affected area are offered testing irrespective of symptoms. In some, but not all of these cases, there is a legal "right to know". Testing helps authorities understand the scope of contamination and supports interventions to mitigate or reduce exposure.

14.1.1.2 Interpreting Test Results

Individual health outcomes cannot be predicted on the basis of serum PFAS levels. Instead, these ranges offer population-level risk indications rather than definitive individual prognoses.

14.1.1.3 Evidence heard by the panel

The consensus in many contaminated communities is that individuals should be offered an initial test if they live in (or have lived in) a confirmed contamination zone, to assess whether there is a clear elevation above the typical background.

14.1.1.4 Areas for recommendation

The panel resolved to write a recommendation about residents in the plume area (using 2022 eligibility criteria, excluding the criteria relating to health symptoms or conditions) who did not participate in the 2022 testing programme should be offered PFAS testing.

14.1.2 Occupational Exposure

Certain occupations are known to have a higher potential for PFAS exposure, especially firefighters who used PFAS-containing firefighting foams (AFFF). Individuals working with PFAS in industrial or manufacturing processes may also be at elevated risk, but in Jersey, the main concern has centred on firefighters and, potentially, those involved in cleaning up contaminated sites.

14.1.2.1 Firefighting Foam Exposure

Firefighting foams containing PFAS of concern (e.g. 3M Lightwater) were widely used historically. Although many places phased out the types of AFFF containing the PFAS of concern, in the early 2000s, there could have been residual stockpiles for training or actual firefighting beyond their official market phase-out date of the end of 2002. Firefighters who used these foams historically often experienced high serum PFAS levels, likely from both inhalation during foam application and possible dermal contact, though inhalation is generally considered the more significant route. This is borne out by evidence which indicates that more recently recruited firefighters; after the phase-out date; tend to have PFAS levels similar to the general population. This supports the contention that dermal absorption from PFAS-impregnated clothing is not a major source of PFAS exposure.

14.1.2.2 Considerations for testing

For individuals who directly handled or used PFAS-based firefighting foams, testing may be warranted to determine if they experienced elevated exposures. Those repeatedly involved in cleanup of these foams could also consider testing if their exposure is considered significant. Beyond firefighting, other occupational exposures (e.g., ski wax technicians, electronics manufacturing) can be relevant in different parts of the world. In Jersey, however, these industries are not believed to be significant.

14.1.2.3 Areas for recommendation

The panel resolved to write a recommendation about those who have worked in firefighting and who used the PFAS containing foams prior to cessation of use. This will also include those who have been responsible for repeated cleanup of those foams. This recommendation should offer testing to those persons.

14.1.3 Retesting participants in the 2022 testing programme

Retesting serum PFAS levels in individuals or groups with elevated exposure can serve several purposes:

- **Tracking Exposure Over Time:** Measuring PFAS at multiple time points helps clarify how exposure evolves. It can be critical for understanding PFAS half-lives in the body and can inform both scientific knowledge and intervention strategies.
- **Assessing the Impact of Interventions:** If environmental interventions or personal measures (such as installing water filters or undergoing treatments to lower PFAS) have been taken to reduce exposure or body burden, retesting can confirm whether serum levels are declining as expected.
- **As part of a legal settlement:** Occasionally, retesting is offered as part of a legal settlement.

14.1.3.1 Examples of Retesting in Practice

- **Ronneby, Sweden**: Retesting has occurred for research purposes, aiming to refine understanding of PFAS half-lives and environmental exposure. It is not done as a systematic clinical follow-up.

- **Denmark**: The general recommendation is not to retest people in contaminated communities because serum levels do not predict individual health outcomes, and no specific interventions (other than exposure cessation) are routinely offered in Denmark for elevated levels.

- **Other Studies Internationally**
    - Some studies have monitored changes in PFAS levels for epidemiological analyses (e.g., to understand associations with cholesterol or other biomarkers).
    - In certain legal settlement contexts (e.g., in the US), periodic testing was included as part of the agreement.

14.1.3.2 Practical Considerations

An individual can potentially have significant variation from time to time in measured serum PFAS on the basis of whether or not they are dehydrated, whether or not they have recently had surgery or donated blood, or variation in laboratory processes or calibration; so it can be difficult to interpret retesting results on an individual level. More frequent testing might also add to uncertainty or anxiety. Retesting can be of limited or no value when initial serum levels approach background levels.

The panel noted that the primary intervention, moving households from borehole water to mains water, had been in 2006, the testing programme was in 2022 and there had been no formal intervention in the intervening three years. It was also noted that, in three years, only for PFOA, of the three PFAS of particular concern in Jersey, would a single half-life have passed.

14.1.3.3 Considerations for Jersey

There has been debate about the value of retesting when no new interventions have occurred. In settings where contamination is confirmed, retesting might serve a research purpose or demonstrate the effectiveness of prior interventions, but it is not typically carried out solely for individual clinical management unless there is a clear rationale.

The panel agreed to not make a recommendation about re-testing of the population at the current time, but will review the question of re-testing at a later date once further information has been gathered about exposures within and outside of the plume area as part of Report 4.

14.1.4 Wider Population Testing

There are two potential elements to wider public testing: systematic population testing and anonymous, systematic assessment of samples to establish baseline levels in the community.

14.1.4.1 Systematic population testing

Internationally, outside of known contamination zones, systematic population testing is uncommon. Routine population-wide testing can be expensive, difficult to interpret at the individual level, and may generate anxiety. Furthermore, the evidence on health effects of PFAS is derived from hotspots with high levels of contamination and little is known about any health impacts from lower levels of exposure.

14.1.4.1.1 Potential rationale for testing outside hotspots

- **Establishing Baseline Levels**: Sometimes, authorities measure population-average PFAS concentrations to compare to “hotspot” areas (e.g., contaminated communities).
- **Research and Public Health Strategy**: Collecting these data might inform future environmental policies or interventions and help track changes over time.

14.1.4.2 Anonymous, Systematic Assessment

- Rather than offering individual tests to everyone, public health authorities sometimes conduct anonymous or population-level sampling to understand the general exposure distribution.
- Comparing these data with samples from the contaminated plume area can quantify the gap in exposure, assess the need for further interventions, and guide policy.

14.1.4.3 Areas for recommendation

The panel resolved not to recommend testing more widely on an individual basis.

The panel agreed that broader community average levels outside of the plume area should be determined in Jersey and will write a recommendation about systematic, anonymous assessments to be made for average serum levels by parish in order to inform the endpoint of any clinical interventions, to better understand the effectiveness of environmental interventions, and in order to assess the nature of any contamination outside of the plume area.

14.2 Clinical testing/screening

14.2.1 Rationale and requirements for screening

Medical screening is typically offered when detecting a condition or risk factor early can improve clinical outcomes. This principle underpins established screening programs (e.g., breast cancer, high blood pressure, cholesterol).

For a screening program to be justified, there should be:

- Evidence of a meaningful health issue with a sufficiently high prevalence or risk.
- A reliable screening test that can detect early disease or a significant risk marker.
- Effective interventions or treatments that improve outcomes once a risk or early disease is identified.
- A favourable balance between benefits (detecting and treating potentially serious conditions) and harms (false positives, overdiagnosis, anxiety).

Even though PFAS exposure correlates with an increased risk of certain conditions, systematic screening is recommended only if it is clear that identifying early disease or elevated risk markers leads to better health outcomes. Some communities or legal frameworks advocate broad testing under a “right to know,” especially where large-scale contamination has occurred. However, the medical value of testing individuals for PFAS-specific health effects depends on the availability of interventions that could meaningfully reduce risk or improve outcomes. Where no clear intervention exists, screening can raise concern without offering a remedy, potentially causing more harm than benefit.

Overdiagnosis and false positives are significant concerns in screening programmes in general; detecting and treating mild abnormalities or benign findings may lead to unnecessary intervention and anxiety. Many screening strategies that identify very rare conditions require large-scale testing and may not yield a net benefit if only a small number of true cases can be identified. Not all conditions that show an association with PFAS are amenable to screening. For example, shifts in antibody response to vaccination or a modest effect on liver enzymes do not have established, actionable medical interventions for individuals.

14.2.2 Serum Cholesterol

Elevated cholesterol is associated with an increased risk of cardiovascular disease, which is a leading cause of morbidity and mortality. Research in PFAS-exposed communities suggests a modest (approximately 5–10%) increase in total cholesterol levels. For most people, such a small rise remains within the normal range, and may not trigger medical intervention. However, in some individuals, that shift could move them into a higher-risk category where they would benefit from treatment or lifestyle modifications. Unlike many other PFAS-linked outcomes, high cholesterol is both measurable through a simple, non-invasive test and modifiable through lifestyle changes or medication (e.g., statins).

Routine cholesterol screening is already part of standard healthcare in many places (e.g., NHS Health Checks in the UK for adults over 40). It is not part of routine care in Jersey. In settings without universal programs for cholesterol checks, it may be advisable for individuals with a history of elevated PFAS exposure to request cholesterol screening since even a modest rise in cholesterol may be clinically significant in some cases. Healthcare providers can also opportunistically check cholesterol as part of routine assessments, especially if they know the patient has been exposed to PFAS.

If results show elevated cholesterol, appropriate advice or treatment (dietary changes, weight management, exercise, or lipid-lowering medication) may follow.

On balance, the panel were of the view that it would be reasonable to consider testing cholesterol in people known to have elevated PFAS levels The panel recommended encouraging doctors to assess cholesterol in people who have a history of PFAS exposure. However, the evidence is not strong enough to offer this screening to everyone through a dedicated screening programme.

14.2.3 Kidney and Testicular Cancers

Certain epidemiological studies indicate a modest excess risk for both kidney and testicular cancers in communities exposed to elevated PFAS (e.g., firefighting foam contamination of drinking water). Despite the increase in relative risk, the absolute risk for any one individual remains low because these cancers are not very common at the population level. This is illustrated in the table below.

Figure 29 - Lifetime risk of kidney and testicular cancers in the general population and potential extra cases with high PFAS exposure

Kidney & testicular cancer risk in the plume area

	Kidney cancer - males	Kidney cancer - females	Testicular cancer - males
Expected to develop the condition in general population, per 100 people	2.6	1.5	0.45
Extra cases due to exposure, per 100 people	0.6	0.3	0.09
People unaffected, per 100 people	96.8	98.2	99.4

The figure above projects lifetime total risk and lifetime attributable risk for kidney and testicular cancers. It shows that 0.6 percent of males and 0.3 percent of females with the sort of exposure to

PFAS that is in the plume area might get kidney cancer attributable to that exposure over the course of a lifetime. It also shows that less than 0.1 percent of males would get testicular cancer over the course of a lifetime that may be related to PFAS exposure. At any given time, only a very small fraction of the numbers shown above would be likely to have the diseases and only some of those would be potentially detectable. This means that a very large number of people would need to be tested to have any chance at all of finding one single case.

14.2.4 Kidney Cancer Screening

Routine screening for kidney cancer is not standard practice for the general population or for PFAS-exposed groups because:

- There is no simple and reliable screening tool, such as a blood or urine test, that reliably detects early kidney cancer. Urinalysis for microscopic blood tends to produce many false positives (99% of positive tests are in people who don't have kidney cancer).
- Imaging (e.g., ultrasound, MRI) on all exposed individuals would mean testing very large numbers to find very few cases, leading to high costs and much anxiety without evidence of improved survival.

The panel has already recommended a higher index of suspicion for kidney cancer in people with relevant symptoms and a history of PFAS exposure in Report 2. Further analysis of the evidence did not justify going any further and that recommendation was agreed to be replicated in this report.

14.2.5 Testicular Cancer Screening

Testicular cancer remains an uncommon disease overall. Formal screening programs (such as routine ultrasound) are not recommended for use internationally for the general population or for PFAS-exposed communities, because of the low incidence and lack of proven population-level benefit. The commonly accepted approach in general use is self-examination and prompt medical consultation for any unusual lumps or changes, as early detection may significantly improve outcomes.

The panel has already made a recommendation in report 2 about testicular self-examination in people with a history of PFAS exposure. Further analysis of the evidence did not justify going any

14.3 Interventions to lower PFAS in the human body

The panel discussed several potential interventions to lower PFAS in the human body, who they might be applied to and the circumstances in which they may be applied. There was also a detailed discussion of what might be seen to constitute elevated PFAS for the purposes of any intervention.

14.3.1 Effectiveness, Cost-Effectiveness, and Tolerability of Different Interventions

The panel discussed several different potential interventions that might potentially reduce the burden of PFAS in the human body. These interventions were considered in the light of the clinical effectiveness, cost effectiveness safety and tolerability evidence that the panel had already reviewed. These different intervention approaches are discussed in turn below.

14.3.1.1 Bile Acid Sequestrants

From the evidence reviewed, bile acid sequestrants appear to reduce PFAS in the body considerably faster than any other intervention and much faster than no intervention. This is the case for PFOS, PFOA and PFHxS as well as the total of the three moieties.

Bile acid sequestrants potentially cause fewer serious side effects than the other, more invasive, interventions. While some of the older agents, like cholestyramine, can be unpalatable, the newer

agents, like colesevelam, are better tolerated and have even fewer side effects than other drugs in the class.

Because of the greater clinical effectiveness and also a lower cost due to there not being a need for specialised equipment or additional clinical staff, bile acid sequestrants are eight to ten times as cost effective at reducing PFAS than any other of the interventions studied.

During their deliberations, the panel were made aware of an ongoing study comparing different bile acid sequestrants and their effect on PFAS. At that time, the study had not yet been submitted for publication and could not be cited. That study has now been accepted for publication and is available here: (Andersson et al., 2025).

Overall, the panel were of the view, that bile acid sequestrants, specifically colesevelam because of its better tolerability and fewer side effects, would be suitable as the first line intervention to lower PFAS body burden.

14.3.1.2 Phlebotomy (Blood Donation) and Plasma Removal

These interventions are markedly less effective than bile acid sequestrants, from the evidence reviewed and lower PFAS in the body more slowly. While the amount of PFAS removed from the body per procedure is similar between the two procedures (slightly higher with plasma donation), the fact that plasma removal can be offered more frequently means it may result in a greater reduction of PFAS body burden per unit time. Both treatments are subject to a rebound effect, where PFAS redistributes from other parts of the body, driving serum levels up again in the period after the intervention (albeit to reach a slightly lower peak each time). Bile acid sequestrants, notably, do not appear to show a rebound effect.

Both interventions can have serious side effects, particularly plasma removal, and are more likely to be problematic from a tolerability point of view than the newer bile acid sequestrants. For most people, phlebotomy is generally better tolerated than plasma removal, which is more invasive.

Because of the lesser effectiveness and the greater cost of delivery, both interventions are markedly less cost-effective than bile acid sequestrants, with phlebotomy generally outperforming plasma removal, largely because of the lack of need for specialised equipment and maintenance.

The panel were of the view that neither procedure was suitable for recommendation as a first line intervention, but came to the view that therapeutic phlebotomy could be, potentially, offered as a second line for people who for whom bile acid sequestrants are unsuitable.

14.3.1.3 Probenecid

Probenecid is not effective at lowering PFAS levels, from the evidence reviewed, and therefore cannot be recommended.

14.3.1.4 Haemodialysis

In terms of clinical efficacy, haemodialysis is closer to the effectiveness of bile acid sequestrants than other treatments, but it is still markedly less effective. Haemodialysis is a highly invasive procedure with significant risk of serious complication and a major effect on the person's quality of life. Because of the very high costs of implementation, it is the least cost effective of the interventions analysed and the panel felt that it was not appropriate to recommend it.

14.3.1.5 Dietary Interventions (Fibre, Probiotics)

The panel only had evidence from observational studies for high fibre diet and probiotic supplements and was not in a position to take into account potential confounding factors, like reduced meat or fish consumption, or to extrapolate the findings from a high fibre diet to the use of dietary supplements. On this basis, it would not be appropriate to make a primary recommendation. There is, however, good evidence that a high fibre diet is beneficial for general health, and there is some, weaker evidence for probiotics. On this basis, it may be something that affected persons might want to consider.

14.3.1.6 In summary

- **Bile acid sequestrants** are suitable as a first-line strategy for lowering PFAS body burden. They offer the best balance of effectiveness, cost-effectiveness, and tolerability.
- **Therapeutic phlebotomy** is a possible second-line option for those unsuitable for bile acid sequestrants, though it is more invasive and less cost-effective.
- **Dietary measures** (high-fibre, probiotics) lack robust evidence for major PFAS reduction but may be considered supportive for general health.

14.3.2 Potential Population Groups for Intervention

The panel identified four main groups to be discussed for eligibility. Each of these were discussed separately and conclusions drawn. They are discussed in the following sections. Where the phrase “elevated PFAS” is used, it refers to the results from testing organised with a full chain of custody and delivered in an appropriately credentialed laboratory as discussed above. Any specific levels for “elevated PFAS” are discussed below in the section on start and stop levels for intervention.

14.3.2.1 People of Childbearing Potential with Elevated PFAS

Intervention aims to lower maternal PFAS levels and prevent exposure to future offspring through placental transfer or breast feeding. Those offspring should, from the time of conception, not have a high level of PFAS exposure as a result. They should therefore have a reduced lifetime risk of developing PFAS-related ill-health.

The panel resolved to make a recommendation to offer intervention to people in this category.

14.3.2.2 People with High Cholesterol and Elevated PFAS

The panel noted that one of the treatments under consideration, bile acid sequestrants, were originally developed as drugs to reduce cholesterol. On this basis, there is a potential for an additional benefit in this population group from the use of those drugs.

On this basis, the panel were comfortable to recommend that, if a person is known to have elevated PFAS and elevated cholesterol, clinicians may consider the use of bile acid sequestrants as part of their cholesterol management.

14.3.2.3 Islanders with Elevated PFAS and Symptoms Possibly Linked to PFAS

While some individuals may have health issues theoretically related to PFAS, there is no reliable method to confirm that PFAS caused these symptoms. The panel concluded that intervention should not hinge on the presence of symptoms, given the current uncertainties.

14.3.2.4 Islanders with Significantly Elevated Serum PFAS (with or without symptoms)

There are significant uncertainties over whether lowering body burden of PFAS has an effect on health outcomes for that individual, this is discussed in detail in the chapter on dose-response. Given

that, the panel did not feel it appropriate to make a general recommendation. The panel, however, acknowledged that concern about PFAS in the body may have significant adverse impacts on a person's psychological wellbeing, and also that the lack of evidence that lowering body burden reduces health risks does not meant that it does not so do. On this basis, the panel came to the view that clinicians providing day to day care for a person shown to have PFAS levels in excess of a certain threshold, could consider offering bile acid sequestrants (or not) on a case-by-case basis.

14.3.3 What constitutes high levels for potential interventions and clinical testing

The panel explored different levels in the light of international guidance, practicability, and likely potential to benefit. For those of childbearing potential, where the rationale is to prevent prenatal exposure and exposure through breast milk for future offspring, the panel initially resolved to set an inclusion criterion for consideration of PFAS-lowering interventions of 10 ng/mL as the total from a sum of eight PFAS moieties. This is somewhat elevated above global background levels and represents a precautionary approach. The Panel were of the view that, if background levels in Jersey were to be found to be significantly higher than global background levels, this threshold may have to be revised upward. Subsequent projections of background levels in Jersey, based on the concentrations in mains water, found the likely background levels to be somewhat higher than global background, at around 7ng/mL. There was further discussion and consideration of this, whether the threshold should be increased to 20ng/mL, or remain at 10ng/mL or whether an intermediate value should be used. The panel came to the view that, given that there are additional actions people could take to reduce their exposure, it would not be appropriate to change the threshold for eligibility for intervention to prevent prenatal exposure. The panel resolved that the eligibility threshold should remain at 10ng/mL/.

For other groups of people for whom intervention might be a consideration, the panel was of the view that the threshold for "high PFAS levels" should be 20 ng/mL as the sum of eight PFAS moieties.

14.3.4 Stop Levels

Once individuals reach near-background PFAS concentrations, the benefit of further intervention diminishes. On this basis, any intervention should stop as serum levels approach background serum levels. An exact background level is not yet established for Jersey, so a proxy from another population may be used initially. The panel has already recommended that background levels in Jersey be ascertained through anonymous testing and will repeat that recommendation. Stop levels may be updated in the light of those data or on projections of background serum levels on the bases of PFAS levels in mains water supplies.

15 Recommendations

1. **That PFAS testing should be conducted at laboratories that have been accredited for assessing PFAS levels in human samples, with a full chain of custody and evidence of prevention of contamination from the point of sampling to the completion of the analytical testing. This is a prerequisite for test results to be considered valid.**

2. **That PFAS testing be offered to those who met the 2022 PFAS testing criteria but did not choose to participate in the programme and also to those who did not have a relevant condition or symptoms, but met the other criteria for the 2022 programme. This includes any wider area of contamination that is identified through commissioned environmental assessments.**

3. **That PFAS testing be offered to those who worked as firefighters during the period when firefighting foams containing PFAS of concern were in use, and to those who were involved in the transport, loading or cleanup of the concentrates, solutions or foams or in servicing or maintaining machinery or facilities contaminated with the foams as part of their job.**

4. **That background levels of PFAS in the wider community, by parish, be estimated either by the analysis of altruistic blood donation samples, or excess serum collected to perform other tests, or by other means. This should be undertaken on an anonymous basis but with the age, sex and Parish of residence recorded.**

5. **That clinicians, when seeing people with proven elevated serum PFAS, should consider testing for serum cholesterol.**

6. **That when people who know or believe they have elevated serum PFAS exhibit symptoms which are consistent with kidney cancer or testicular cancer, clinicians should have a higher level of suspicion of cancer than in unexposed populations.**

7. **That promoting regular testicular self-examination should be considered in PFAS-exposed populations**

8. **That colesevelam be made available, on a case-by-case basis, to women of childbearing potential (who are not currently pregnant nor planning to be pregnant during any course of treatment) who have been found to have a total across 8 measured PFAS compounds (PFHxS PFOS PFOA PFHpS PFNA PFPeS PFDA MeFOSAA) of at least 10 nanograms per millilitre of blood serum. Those eligible should receive information explaining the potential impact of PFAS exposure on future offspring and the potential risks and benefits of intervention, so they can make an informed choice about whether they wish to take colesevelam. This intervention should be offered early in life, ideally, completing the course several months before planning a pregnancy, and appropriate advice about contraceptive methods and dietary supplementation given.**

9. **That colesevelam be considered by clinicians as a lipid lowering therapy in people who have elevated cholesterol and who have been found to have a total across 8 measured PFAS compounds (PFHxS PFOS PFOA PFHpS PFNA PFPeS PFDA MeFOSAA) of at least 20 nanograms per millilitre of blood serum.**

10. **That clinicians consider, for people who have been found to have a total across 8 measured PFAS compounds (PFHxS PFOS PFOA PFHpS PFNA PFPeS PFDA MeFOSAA) of at least 20**

nanograms per millilitre of blood serum, where there is an exceptional benefit from the prescribing of colesevelam for that person on a case-by-case basis.

11. **That, only for those people who otherwise meet the criteria for an intervention (other than the elevated cholesterol criterion) but for whom colesevelam is not an appropriate intervention (due to adverse reaction or clinical contraindication), should therapeutic phlebotomy be considered as a second line offer.**
12. **That people taking colesevelam or having phlebotomy to reduce PFAS, should have periodic repeat PFAS blood tests to check on the effect of the intervention.**
13. **That when an individual's serum PFAS levels reach the median background levels, further colesevelam prescribing or therapeutic phlebotomy should not be undertaken.**

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Glossary

AFFF	aqueous film-forming foams; used in firefighting, particularly where liquid fuel may be involved. Can contain PFAS.
ALT (Alanine Aminotransferase)	An enzyme found in the liver and blood, often measured to assess liver health
anaemia	a condition where there is a lower-than-normal number of healthy blood cells. This can reduce oxygen availability and lead to shortness of breath and fatigue.
anionic	Refers to PFAS molecules that carry a negative charge in aqueous solutions. Anionic PFAS compounds are commonly found in industrial applications and consumer products, often as surfactants due to their ability to lower surface tension
apheresis	A process separating specific components from blood (like plasma or cells), then returning the remainder to the donor or patient.
aplastic Anaemia	A serious condition where the body stops producing enough new blood cells, leading to fatigue, infections, and bleeding risks.
ATSDR (Agency for Toxic Substances and Disease Registry)	A federal public health agency within the United States Department of Health and Human Services. The ATSDR is responsible for assessing the health effects of exposure to hazardous substances and providing guidance on preventing or reducing harmful exposures. It conducts public health assessments, health consultations, and studies to evaluate the impact of environmental contaminants on human health, offering recommendations and support to communities, health professionals, and policymakers
attributable risk	The difference in the rate of a condition between an exposed population and an unexposed population, attributable to a specific risk factor
autoimmune diseases	Conditions where the immune system mistakenly attacks the body's own cells
beneficence	Acting in the best interest of others, especially in healthcare, by promoting well-being, preventing harm, and ensuring positive outcomes for patients or communities.
bile acid sequestrants	Medications that bind bile acids in the gut, promoting excretion of certain substances (including lipids or pollutants, like PFAS) to lower blood levels.
bioaccumulative, bioaccumulation	The accumulation of substances, such as pesticides or chemicals, in an organism over time
biological plausibility	The logical relationship between a cause and an effect based on existing biological or medical knowledge
BMJ	British Medical Journal.
body burden	describes the amount of chemicals in the human body.
bwt	Bodyweight.
C8	the name given to the surfactant PFOA in some commercial contexts, the name deriving from it having an 8-carbon length structure. Fluorosurfactants known as C8. It is also the name given to a research study and remediation programme of a contamination incident in the Unite States of America
cationic	Refers to PFAS molecules that carry a positive charge. These cationic PFAS compounds are less common than anionic ones but can be used in specific industrial applications, such as coatings and textile treatments, where they help bind the PFAS to surfaces
causality (Causal relationship)	The relationship between cause and effect, where one event (the cause) directly influences another event (the effect)

causation	The action of causing something; a relationship where one event causes another
CDC	Centers for Disease Control, a national public health body in the US.
cerebrovascular disease	Disorders affecting the blood vessels in the brain, which can lead to strokes
chance association	A relationship between two variables that occurs randomly rather than through a causal link
Cholestyramine	A bile acid sequestrant that binds bile acids in the intestines, used to lower cholesterol or remove certain contaminants.
Colesevelam	A newer bile acid sequestrant that helps lower cholesterol levels and can remove specific toxins or pollutants in the digestive tract.
Colestipol	Another bile acid sequestrant medication, reducing cholesterol or unwanted substances in the gut by binding bile acids.
community advisory boards	Groups of local stakeholders who offer guidance, feedback, and support to ensure research or interventions align with community interests.
confounding (confounding bias)	A distortion in the perceived relationship between an exposure and an outcome caused by a third variable that is associated with both the exposure and the outcome
cost effectiveness	A measure of whether an intervention's benefits justify its financial cost, helping compare different strategies for achieving the best outcomes with limited resources.
c-reactive protein (CRP)	A substance produced by the liver in response to inflammation, used as a marker in blood tests
data triangulation	The use of multiple data sources or methods to validate research findings and ensure accuracy
decile groups	Statistical divisions that split a population into ten equal parts, often used in data analysis to compare different groups
degradation	The breakdown or decay of substances
dose-response	Describes how varying levels of exposure to a substance relate to changes in magnitude or frequency of an observed effect.
dyslipidaemia	An abnormal level of lipids (fats), like cholesterol or triglycerides, in the blood, potentially increasing cardiovascular disease risk.
Ecological fallacy	The error of making inferences about individuals based on aggregate data for a group
EFSA (European Food Safety Authority)	An agency of the European Union that provides independent scientific advice on food-related risks
EMA	The European Medicines Agency, which evaluates and supervises medicines within the European Union to ensure their quality and safety.
endometriosis	A condition where tissue similar to the lining inside the uterus grows outside of it, causing pain and potential fertility issues
endometrium	The mucous membrane lining the uterus, which thickens during the menstrual cycle
enterohepatic circulation	The circulation of substances from the liver to the bile, absorbed by the intestine, and returned to the liver
EPA	Environmental Protection Agency, the federal agency in the US responsible for protecting the environment.
EQ5D-5L	European 5 dimension, 5 level, quality of life assessment. A commonly used tool to assess health related quality of life.
EU	European Union

experts by experience	Individuals who provide expertise based on personal experiences rather than formal qualifications
exposure media	The different environments (e.g., air, water, soil) through which individuals can be exposed to substances
FDA	Food and Drug Administration, the regulator of medicines in the US.
FDA	The Food and Drug Administration, a U.S. agency regulating food, drugs, medical devices, and related public health measures.
gastrooesophageal reflux	A condition where stomach acid frequently flows back into the tube connecting the mouth and stomach, causing heartburn
Gen X	Refers to a specific type of PFAS developed as a replacement for older, longer-chain PFAS chemicals. The term "Gen X" in this context is used both to describe the chemical process and the resulting products, which are marketed as having a shorter environmental persistence and potentially lower toxicity compared to traditional PFAS like PFOA and PFOS. However, concerns remain about the environmental and health impacts of these substances.
GMP	Good Manufacturing Practice, guidelines ensuring products are consistently produced and controlled to quality standards.
gut microbiome	The community of microorganisms living in the digestive tracts of humans and other animals
haematoma	localised collection of blood outside blood vessels.
haemodialysis	A procedure using a machine to filter wastes, salts, and excess fluid from the blood when kidneys cannot perform adequately
haemolytic Anaemia	Occurs when red blood cells are destroyed faster than they can be made, leading to fatigue, jaundice, and other health issues.
half-life	the time it takes for the concentration of a substance in the body or in the environment to reduce to half its initial value
HBM	Human Biomonitoring Committee of the German Environmental Agency.
herd immunity	The resistance to the spread of a contagious disease within a population, achieved when a high proportion of individuals are immune
high-density lipoprotein (HDL)	Known as "good" cholesterol, it helps remove other forms of cholesterol from the bloodstream
hypotension	Low blood pressure, where the force of the blood pumping through the arteries is below normal, possibly causing dizziness or fainting.
IARC (International Agency for Research on Cancer)	An agency of the World Health Organization that conducts and coordinates research on the causes of cancer
immunosuppression	The reduction of the activation or efficacy of the immune system, which can occur naturally or be induced by medication or disease
immunotoxic	Refers to a substance that harms the immune system, potentially reducing the body's ability to fight infections or maintain normal immune function.
information bias	Bias arising from measurement errors or misclassification in the data collection process
intrauterine growth retardation	A condition where a foetus is smaller than expected for the number of weeks of pregnancy, due to various factors
ischaemic heart disease	A condition characterized by reduced blood supply to the heart, often due to clogged arteries
Kg	Kilograms.
leiomyoma	A benign smooth muscle tumour, often found in the uterus (uterine fibroids)

log	Short for “logarithm,” a mathematical function indicating how many times a base number must be multiplied by itself to reach a specific value.
log-transformed	A mathematical operation converting data by applying the logarithm function, often used to handle skewed distributions or stabilize variance in statistical analysis.
low density lipoprotein (LDL)	A type of cholesterol known as "bad" cholesterol because high levels can lead to plaque buildup in arteries
mean	a statistical average where all values are added up and divided by the number of readings.
median	a statistical measure where the middle value of a list of findings is used.
MeFOSAA	N-Methylperfluorooctanesulfonamidoacetic acid.
mesothelioma	A rare and aggressive cancer of the lining of the lungs or abdomen, often linked to asbestos exposure.
MHRA	The Medicines and Healthcare products Regulatory Agency, responsible for overseeing the safety and efficacy of medical products in the UK.
millilitre (ml)	one thousandth of a litre.
ml/y	millilitre per year.
monotonic dose response	A relationship in which increases in exposure consistently lead to either increasing or decreasing effects, without reversing direction. A straight-line relationship.
moral injury	Psychological distress resulting from actions that violate one's moral or ethical code
nanogram (ng)	one billionth of a gram.
natural log-decrease	A reduction measured using the natural logarithm (base e), often applied in studies to describe exponential declines or half-life processes.
nephrotic Syndrome	A kidney disorder causing the body to lose excess protein in the urine, leading to swelling, low protein levels, and other complications.
neurodevelopment	The process of brain development, often focusing on growth and maturation from birth through adolescence
ng/ml	nanogram per millilitre.
NHANES	The National Health and Nutrition Examination Survey in the United States, which collects data on health and nutrition from a representative population sample.
NHS	National Health Service.
NICE	The National Institute of Health and Care Excellence, the national clinical guidelines organisation in England.
non-maleficence	The duty to “do no harm,” requiring healthcare providers and researchers to avoid causing injury or suffering
non-monotonic dose response	A relationship in which increases in exposure do not consistently lead to either increasing or decreasing effects, without reversing direction. The dose response is a curve or may have multiple phases.
OECD	The Organisation for Economic Cooperation and Development, an international organisation comprising the countries with advanced economies.
osteoporosis	A condition characterized by weakened bones, increasing the risk of fractures
PCOS (Polycystic Ovary Syndrome)	A hormonal disorder causing enlarged ovaries with small cysts on the outer edges
PFAS	per- and polyfluoroalkyl substances.
PFCAs	perfluoroalkyl carboxylic acids or perfluoroalkyl carboxylate.
PFDA	perfluorodecanoic acid.
PFHpS	perfluoroheptane sulfonic acid.

PFHxS	perfluorohexane sulfonic acid.
PFNA	perfluorononanoic acid.
PFOA	perfluorooctanoic acid.
PFOS	perfluorooctane sulfonic acid.
PFPeS	perfluoropentane sulfonic acid.
PFSAs	perfluoroalkane sulfonic acids or perfluoroalkane sulfonates.
PFUnDA	perfluoroundecanoic acid.
plasma	the liquid portion of the blood.
plasmapheresis	A procedure that filters out plasma (where certain substances reside) from a patient's blood, returning blood cells to the body.
plume	the geographical area over which a contaminant spreads. In the context of this report, it is interpreted broadly, to mean the area where contamination is likely, and not just to relate to the known dispersion of the contaminant
primiparous	Referring to a woman who has given birth for the first time
Probenecid	A medication increasing urinary excretion of certain compounds, historically used to manage gout and sometimes investigated for pollutant removal.
Psyllium husk	A natural soluble fibre often used to improve digestion and lower cholesterol, possibly aiding in excreting certain substances.
PTFE (Polytetrafluoroethylene)	A synthetic fluoropolymer, commonly known by the brand name Teflon™, used in non-stick cookware and other products
REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals)	A European Union regulation governing the use of chemicals to protect human health and the environment
reliability	The consistency and stability of a measurement or test over time
renal calculi	Also known as kidney stones, these are hard deposits of minerals and salts forming in the kidneys, potentially causing pain.
reverse causality	A situation where the direction of cause and effect is opposite to what is presumed
rheumatoid disease	Refers to autoimmune conditions like rheumatoid arthritis, where chronic inflammation affects joints and other parts of the body
risk factors	Characteristics or variables associated with an increased risk of a disease or condition
saturated	Refers to organic compounds where all the carbon atoms are fully bonded with hydrogen and fluorine atoms, with no double or triple bonds present. Their saturated nature contributes to their stability and low reactivity under normal conditions.
saturation Point	The level above which a further increase in the level of PFAS does not lead to any additional increase in risk of a particular health condition. This may apply in some instances but is not yet proven.
Scotchgard	a waterproofing and stain proofing treatment developed by 3M.
selection bias	A type of bias caused by the non-random selection of participants, leading to unrepresentative samples
serum	the liquid that is left when blood has clotted, often used for doing medical tests.
somatisation	The manifestation of psychological distress through physical symptoms
specificity	The extent to which a particular exposure leads to a specific outcome, used to help establish causal relationships

systemic lupus erythematosus (SLE)	A chronic autoimmune disease affecting multiple organ systems, including the skin, joints, and kidneys
Teflon	A brand name for PTFE, known for its non-stick properties
temporality	The timing of exposure relative to the occurrence of an outcome, important in establishing causality
therapeutic phlebotomy	withdrawal of blood to prevent or cure disease.
threshold response	A dose-response pattern where no effect is observed until a certain exposure level (the threshold) is reached, after which effects appear.
total risk	The overall risk of an outcome occurring in a population or study group, encompassing all possible contributing factors
toxicokinetics	The study of how a substance enters, moves through, and exits the body
toxicologist	A scientist who studies the effects of chemicals on living organisms
UK	United Kingdom.
validity	The extent to which a measurement or test accurately represents the concept it is intended to measure
venesection	taking blood
Volume of Distribution (Vd)	the theoretical volume into which an amount chemical or drug would be dispersed to result in the observed concentration in serum or plasma. Usually expressed in volume per body weight ml/kg.
WHO	World Health Organization, the United Nations agency devoted to health and health protection.
zwitterionic	Molecules with both positive and negative charges but are overall electrically neutral

Appendix 1 – Minutes of Panel meetings

Minutes of public meeting of the PFAS Scientific Advisory Panel on Teams 10am on 11 July 2024

Panel Members present:	Dr Steve Hajioff – Independent Chair
	Dr Tony Fletcher – PFAS and Health member
	Professor Ian Cousins – PFAS and Environment member
In attendance:	Julia Head – Senior Public Health Officer
Apologies:	Grace Norman – Deputy Director of Public Health

Welcome:

The Chair welcomed everyone to the panel meeting, and reminded people the meeting was being recorded.

Dr Hajioff reminded Islanders that queries should be send to the pfaspanel@gov.je mailbox so that the whole panel can feed into the response, rather than sending queries to individual panel members please.

Finally, he gave a reminder for offering evidence of experience around PFAS testing or treatments to lower PFAS body burden for Report 3. Please email pfaspanel@gov.je and instructions will be sent.

Introductions

The Chair and Panel members introduced themselves.

Dr Steve Hajioff, Independent Panel Chair: A background as a GP for 25 years and a retired Director of Public Health from an area of London with two major international airports and a variety of other environmental hazards and challenges. Not a PFAS expert but has done lots of work with National Institute of Care Excellence and other groups about translating science into policy. Dr Hajioff has also worked a lot in the pharmaceutical industry.

Dr Tony Fletcher, PFAS and Health Panel Member: Environmental Epidemiologist at the London School of Hygiene and Tropical Medicine, working on PFAS since 2006 and member of the panel with experience of epidemiological studies on the health effects of PFAS in contaminated communities in West Virginia in the United States, in the Veneto region, in Italy, and in Ronneby, and is the health expert on the panel.

Professor Ian Cousins, PFAS and Environment Panel Member: A Professor in Environmental Chemistry at Stockholm University, an expert on PFAS, appointed as the environmental expert on this Panel and whose expertise on PFAS is on the sources, transport, fate, and exposure of PFAS.

Support staff for programme management and administration were also in attendance.

Declarations of Interest

No additional declarations.

Minutes of last meeting

There were no minutes to review in this meeting. They will be ready for the next meeting in August.

On 26 June the panel discussed reflections and recommendations for Report 2 on the health effects of PFAS. To update, that report is now almost complete and there will be a public meeting on 12 September where the draft will be formally launched for Islander input. The final version will be published once the panel has provided responses to the feedback.

Additional findings since the last meeting

Dr Fletcher noted there may be another source of PFAS exposure to consider from the manufacture, disposal and recycling of batteries in mobile phones and batteries for electric vehicles. Prof Cousins noted that they are different PFAS to those being investigated in Jersey, and are not a human toxicological concern due to them being very mobile and not bioaccumulative in humans. The concerns are during the manufacture and disposal of batteries, and not during normal use.

Agenda item 5 – Assessment approach

The Chair introduced the approach to Report 3 and noted that the panel have consulted with Islanders on the structure of this report already. The structure has been revised as a result.

<u>Interventions</u>

The panel will consider the following factors for the potential interventions to lower PFAS body burden:

- Effectiveness
- Tolerability
- Cost effectiveness
- Capital and training
- Speed of deployment
- Affordability and proportionality

<u>Testing</u>

The Chair noted that there are 4 components to this section of the report.

1. Retesting those who have already been tested under the Public Health testing
2. Other people in the plume area who didn't meet the criteria for testing under the Public Health programme or were not tested for other reasons
3. People elsewhere in Jersey
4. People with occupational exposure e.g. those who worked with AFFF at the airport

A literature review will be conducted by a panel member to consider what has happened in other AFFF affected populations. The Chair reminded observers that the panel have already

made a recommendation in report 1 that there be a representative sample of people tested in order to assess background levels in Jersey.

The panel discussed what the principal goal of testing should be; to gather a representative sample of the population, or, to provide individuals with levels of PFAS in their own body. The panel noted that if individuals were given levels, then they should be accompanied by a warning to note that these measurements are imprecise. The panel will review the options and make a decision about how to proceed.

The panel predicted that in the most contaminated area, most people will want to know their blood levels. For the rest of the Island, it might be more appropriate to get a representative sample of people to understand what the blood levels are like in those areas.

Biomonitoring

The panel will review the evidence and decide whether to recommend that wider screening or testing on the basis of the potential health impacts of PFAS, as described in Report 2. The panel will build on a Report 2 discussion that PFAS exposure is associated with elevated serum cholesterol. The panel will discuss whether high cholesterol should be screened for regularly in affected populations. It will also consider kidney cancer screening in affected populations and potentially advising on self exam for testicular cancer again.

Dr Fletcher noted that there are several pieces of evidence to review for biomonitoring, with several review papers which will be useful. Additionally, the Agency for Toxic Substances and Disease Registry (ATSDR) has recommendations which can be critically considered and HBM4EU (Human Biomonitoring for the EU) have a paper with recommendations about a priority list. He noted that there was a screening programme in Italian which was justified due to the fact that there were added benefits for widespread screening, for example being able to identify additional diseases which wouldn't otherwise be picked up.

Prof Cousins questioned whether it would be possible to look at environmental markers such as tap water and dust and match exposures to assess the potential for ongoing exposure? Dr Hajioff replied noting that that work would be more relevant in Report 4 than this report. There will be a good discussion to have around different routes of exposure in Jersey, and noted that the panel will be meeting with the Infrastructure and Environment team to start planning out potential approach for Report 4 shortly. They will discuss if there is an ability to do a paired analysis in Report 4.

The panel discussed the potential for looking at historical blood and other tissue samples for assessing PFAS levels in order to give an indication over time of human exposure. There may be issues with generalising this information across a population, and potential difficulties with using stored tissues with precursors and PFAS sticking to test media. The panel decided to not review the literature on testing historical samples at this present time, but would first like to discuss with Health and Community Services (HCS) and Public Health to identify if there are historical samples available to test.

Interventions to lower body burden of PFAS

The Chair reminded the panel that there will be two parts to the analysis for each treatment; one to investigate how effective the treatment is, and the second looking at potential side effects and other aspects, e.g. cost effectiveness, speed of deployment etc. The work will be allocated between Panel members through a consensus between the panel members.

Blood and blood product removal treatments

- Phlebotomy (looked at in Report 1)
- Plasma interventions – including plasma exchange, plasma donation, plasmapheresis

The panel plan to review the literature around these treatments. They noted that they have already reviewed phlebotomy in Report 1, and also included plasma treatments in this report. The panel understand that there has been no further work in this area in the general scientific literature since Report 1 was published. Dr Fletcher noted that he will conduct another search to confirm this understanding. There is a study planned with Fire Fighters in the USA looking at interventions, but the study is at the recruitment phase and has not yet commenced.

The work in Report 1 will be built on and updated for Report 3.

Prevent reabsorption in the gut

- Cholestyramine granules
- Cholestyramine capsules
- Psyllium husk

Dr Fletcher noted that he had a colleague in Denmark who is planning an intervention study which compares the impact of cholestyramine, psyllium husk, and a placebo. The study is designed to investigate whether psyllium husk is a more acceptable way to reduce PFAS levels than cholestyramine. The study will not produce results for 2 or 3 years, but the panel believes it is useful to understand the rationale for the study.

Prevent reabsorption in the kidney

There are medications designed to prevent reabsorption of PFAS in the tubules in the kidney. The most well-known drug is probenecid although there are others on the market. The panel will review the literature regarding reducing kidney uptake and therefore reducing body burden of PFAS.

Dr Fletcher noted that there is a study in the C8 programme looking at these two drugs and levels of PFAS. There was a significant reduction in PFOA levels in those taking cholestyramine, but not for probenecid. This was not an intervention study. The evidence shows that probenecid works in animals, but there is limited evidence of effectiveness in humans. This work will be reviewed formally during Report 3.

Other potential treatments

Haemodialysis will be reviewed by the panel. Prof Cousins indicated he was aware of a paper from a group in China.

There may be other technologies and approaches. The panel will look into the literature to confirm.

The Chair noted that during Report 1, Dr Fletcher calculated the reduction in body burden of PFAS over and above background reduction from each episode of phlebotomy or plasma donation. Dr Hajioff asked if conducting a calculation of reduction in body burden was possible for the treatments to be discussed in Report 3, so that comparisons can be made between different interventions.

Dr Fletcher answered saying it was certainly possible, but accuracy depends on length of trials. It was suggested that providing a figure in ng/ml would be very useful for discussions and comparisons between treatments.

Prof Cousins noted that there are a huge number of studies on biomonitoring in the scientific literature, and that the panel cannot review every study in detail. It therefore might need a more pragmatic approach. He suggests reviewing the reviews such as a new occupational exposure review paper recently published.

The Chair agreed and commented that it is not proportionate for the panel to review every paper from every context around biomonitoring. The panel should concentrate on the specific conditions which were identified as being of significant and considerable risk in Report 2. The normal biomonitoring approaches for those conditions should be reviewed in the literature and summarised in Report 3.

Dr Fletcher agreed and commented that there are two levels of screening. The first is keeping an eye out for symptoms which may prompt a visit to the doctor, and another is active screening and surveillance whereby the patient attends for specific tests. The panel should make comments on both of those possibilities.

Dr Hajioff noted that he had a previous colleague who is an expert on 'positive predictive value' as a way to inform decision making. He suggested that the panel consult with that person as a Subject Matter Expert, as a similar approach could be useful in prioritising biomonitoring.

Experts by Experience

The Chair noted that the panel has put out a call for affected Islanders to talk to the panel about their treatment experiences to lower body burden. The panel have not formally reviewed the submissions yet, but will in the next few days. The panel plan to hear from EBE at the next meeting on 7 August or another time if this is not suitable for anyone.

Subject Matter Experts

The Chair noted that Subject Matter Experts will be invited shortly to a meeting in September and identified areas in which they would like to speak to experts.

The Chair noted that they had previously consulted experts in the area of blood removal and testing as part of Report 1 preparation.

Dr Fletcher noted that the panel should reach out the C8 medical panel to identify how the panel has worked to identify treatments and biomonitoring.

In the area of cholestyramine, there are 3 trials which are known about. Dr Fletcher noted that one has completed and suggests that the panel should speak to the authors about their experiences.

The panel are unaware of any SME to consult on Probenecid.

Dr Hajioff mentioned an expert on cancer and predictive value of tests earlier and noted that there are technical reasons why he can't appear online, but the panel might be able to arrange a consultation in person or in writing.

The panel will review the information available on Haemodialysis and investigate whether the panel can consult with the authors of a Chinese study on this topic. If the study is found to have been an incidental observation, the panel consider this consultation less urgent.

The authors of a study on a very heavily exposed family in Canada were also mentioned and could potentially be approached again for input.

The panel agreed to collate contact details and invitations will be sent shortly.

Any other business

No other business was raised by the panel.

Date of next meeting

7 August 2024. It will be held 10am-1pm online.

The Chair thanked everyone for their contributions, those watching the meeting and Julia for her support throughout the whole process. A reminder to the public that this meeting has been recorded and the video will be available online on request by emailing the PFAS mailbox. This will take a couple of days to make sure the observers are anonymised.

There being no further business, the meeting was closed.

To note that the panel can be emailed via PFASpanel@gov.je.

Details of meeting dates and times can be found at PFAS in Jersey (gov.je)

Actions from the meeting

Action	Action given by	Action taken by	Date for delivery
Conduct active search on phlebotomy developments since Report 1 publication	Dr Fletcher	Dr Fletcher	August 7 panel meeting
Collate contact details for SME	Chair	Panel members	ASAP
Invite SME to speak at September meeting	Chair	Julia	ASAP

Minutes of public meeting of the PFAS Scientific Advisory Panel on Teams 10am on 7 August 2024

Panel Members present:	Dr Steve Hajioff – Independent Chair
	Dr Tony Fletcher – PFAS and Health member
	Professor Ian Cousins – PFAS and Environment member
In attendance:	Adrian Milner – Public Health support staff
Apologies:	Julia Head – Senior Public Health Officer
	Grace Norman – Deputy Director of Public Health

Welcome:

The Chair welcomed everyone to the panel meeting, and reminded people the meeting was being recorded.

Dr Hajioff reminded Islanders that queries should be send to the pfaspanel@gov.je mailbox so that the whole panel can feed into the response, rather than sending queries to individual panel members please.

Introductions

The Chair and Panel members introduced themselves.

Dr Steve Hajioff, Independent Panel Chair: A background as a GP for 25 years and a retired Director of Public Health from an area of London with two major international airports and a variety of other environmental hazards and challenges. Not a PFAS expert but has done lots of work with National Institute of Care Excellence and other groups about translating science into policy. Dr Hajioff has also worked a lot in the pharmaceutical industry.

Dr Tony Fletcher, PFAS and Health Panel Member: Environmental Epidemiologist at the London School of Hygiene and Tropical Medicine, working on PFAS since 2006 and member of the panel with experience of epidemiological studies on the health effects of PFAS in contaminated communities in West Virginia in the United States, in the Veneto region, in Italy, and in Ronneby, and is the health expert on the panel.

Professor Ian Cousins, PFAS and Environment Panel Member: A Professor in Environmental Chemistry at Stockholm University, an expert on PFAS, appointed as the environmental expert on this Panel and whose expertise on PFAS is on the sources, transport, fate, and exposure of PFAS.

Support staff for programme management and administration were also in attendance.

Declarations of Interest

Prof Cousins declared that he has been appointed as an expert in a class action lawsuit which is AFFF related outside of Europe. It will be beneficial to this work as it will increase

knowledge of AFFF. Dr Hajioff confirmed that the panel had discussed this role and had agreed there are no conflicts of interest.

Minutes of last meeting

Minutes from the meeting of 26th June were reviewed. The Chair asked for the top paragraph on page 12 to be reviewed by the panel. An amendment was made by Dr Fletcher and has been reflected in the final minutes. Prof Cousins commented that he had previously provided written comments on the minutes which Dr Hajioff confirmed have been taken into account.

June 26 was the last meeting on Report 2. A draft report is very near completion and will be available for Islanders to comment upon soon. Dr Hajioff thanked the panel and support staff for their help. There will be a meeting on September 12 to present the draft report and invite comments and suggestions. The final report will then go to Ministers for action.

Minutes for 11 July meeting are not yet available. They will be considered at the next meeting in September.

Additional findings since the last meeting

Meeting with Ministers

Dr Hajioff mentioned that there was a public meeting with Ministers in the preceding week which he was not at. The feedback from Grace via Dr Hajioff in her absence was that it was a productive meeting and there was a meaningful dialogue between ministers and Islanders. Several actions have been taken by Government relating to PFAS. This does not affect the panel's work.

Agenda item 5 – Expert by Experience testimony

The areas the panel requested Islander input are:

- Testing for PFAS
- Interventions to reduce the amount of PFAS in the body
- Testing for diseases/conditions which could be complications of PFAS

An Islander presented evidence to the panel. In the interests of anonymity, the full comments are not displayed in these public minutes, but have been made available to the panel. A concise summary is presented in these public minutes.

The expert by experience Islander spoke to the panel about their health history and health conditions they attribute to PFAS exposure. They described how it impacts their life, and their current health status.

The panel empathised with the Islander's situation and asked several follow up questions. Dr Hajioff asked if the Islander had their PFAS level tested as part of the public health testing programme in 2022. They said that they did, and it was confirmed to be elevated. The Islander asked whether having received several units of blood during their life has impacted on the level of PFAS in their blood. Dr Fletcher commented that it is unlikely that this will impact on the body burden of PFAS as only increasing excretion over time will make a difference. When receiving packed blood cells, the amount of plasma remains the same.

Dr Hajioff reminded those listening that if there is no evidence that a particular health condition is related to PFAS, it does not mean that it is not related, but may just mean that the research has not been done or sufficient evidence has not been found yet.

Dr Hajioff thanked the Islander for their time, commenting that it will influence how the panel work in the future.

Recap on the benefits of phlebotomy – Dr Fletcher

Dr Hajioff reminded the audience that the panel has already published on phlebotomy in Report 1, published in 2023, and the science has not changed since then. Dr Fletcher displayed a presentation summarising what he discovered in the literature review in Report 1 on phlebotomy.

The PFAS compounds of concern in Jersey have a long half life, determined using an AFFF population in Sweden. Blood measurements were repeated every month over a period of a year which allowed the researchers to determine the half life, defined as the period of time taken to reduce the blood serum level of PFAS by half. It is longest for PFHxS at 5 years, 3 years for PFOS and 2 years for PFOA. There is a great deal of individual variation for all of these chemicals and the range of years is much larger. The reasons for the variability are not well understood. Some will be genetic, but there are also environmental factors, for example diet.

For report 3, the various methods that could be used to increase the rate of excretion will be investigated. These include drugs (probenecid, bile acid sequestrants), diet (high fibre diet and probiotic supplements), and reducing amount in blood (taking blood or plasma). These will be investigated through a study of the scientific literature and input from subject matter experts through Panel meetings.

Phlebotomy has been reviewed previously in Report 1. There are three studies available:

1. A case study of a family in Canada with very high PFHxS and PFOS
2. Moderately raised PFAS in Australian firefighters, highest for PFOS
3. A large Italian population exposed to PFOA mainly

Dr Fletcher summarised each of these studies in turn.

1. Case study in Canada

This study was conducted with one family who were high users of home carpet treatment, which resulted in high body burdens of PFAS. Phlebotomy was used as a pilot to reduce levels in the family. Dr Fletcher displayed graphs detailing the change in levels of PFAS in serum, demonstrating that the phlebotomy interventions reduced the levels faster than not intervening. The average reduction was 29% over a year with regular phlebotomies, in comparison to a 12% reduction through natural excretion without any specific interventions. The PFAS reduction due to phlebotomy is 17%, and is calculated as the difference between the intervention and comparison percentage (i.e. 29% - 12% = 17%). Per phlebotomy, the difference is 4.4% per unit of blood for PFHxS, 7.72% for PFOS and 1.47% for PFOA.

	PFHxS	PFOS	PFOA
Baseline serum			
% fall per year in Genuis et al 2014	29.4	47.7	28.5
Expected % fall per year in comparison population (Li et al, 2018)	12.2	18.1	22.9
% fall from Genuis minus expected	17.2	29.6	5.6
% fall predicted for one phlebotomy	4.48	7.72	1.47

2. Firefighters in Australia.

This was a randomised controlled trial to assess the impact of phlebotomy and plasma donation in comparison to not providing an intervention. The firefighters were randomised into three groups, one giving whole blood, one gave plasma donation and the third was the control group and received no interventions. The results show that for those in the control group, their PFAS body burden increased slightly; the firefighters in the study had ongoing exposure due to continuing to use PFAS containing foams and equipment. The blood donation group showed a small drop in PFAS blood levels and the greatest reduction was from plasma donation, which was significantly lower than the control group. Both interventions resulted in had significantly lower levels than the control group.

Phlebotomy

	PFHxS	PFOS	PFOA (approx.)
Baseline serum concentration (ng/ml)	3.6	10.9	1.2
Drop attributed to intervention (ng/ml)	0.6	1.1	0.3
% fall attributed to several phlebot.	16.67	10.09	25.00
% fall predicted from one phlebotomy	3.88	2.35	5.81

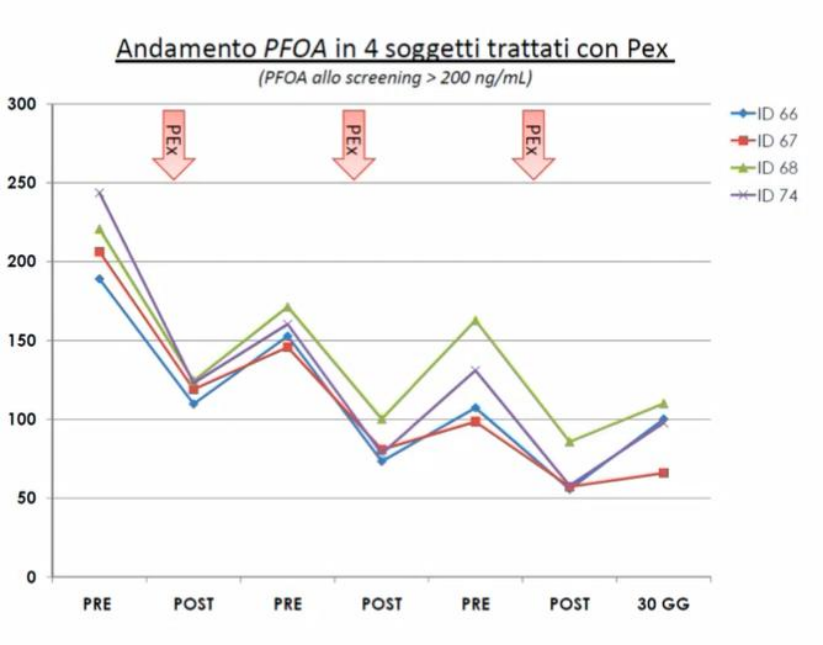
Plasma exchange

	PFHxS	PFOS	PFOA (approx.)
Baseline serum concentration ng/ml	5.2	11.7	1.1
Drop attributed to intervention (ng/ml)	1.5	3.1	0.8
% fall attributed to several plasma ex.	28.9	26.5	72.7
% fall predicted from one phlebotomy	1.47	1.35	3.7

The benefit of the interventions in this study are similar to the Canadian study described previously. The effectiveness varies between PFAS compounds.

3. Large Italian population exposed to emissions from a factory in the Veneto region

Residents in the Veneto area with over 100ng/ml PFAS in blood were offered a programme of plasmapheresis. There were two groups. The first group with between 100 and 200ng/ml PFAS in blood were offered plasma removal intervention where plasma was donated. Those with levels above 200ng/ml PFAS in blood were offered plasma exchange, where plasma was removed and replaced with clean plasma. A report on the preliminary results was not published formally, but a report was available online which summarised the results.



This graph shows the effect of phlebotomy from 4 individuals where each person is a different coloured line. It shows that there is a reduction in PFOA levels after plasma has been removed, and that the levels increase again, suggesting that once PFOA is removed from the blood it is released from the organs and reaches equilibrium in the blood following each intervention. Overall, the PFOA level reduced by 56% over the three donations.

For plasmapheresis, there is also a clear reduction up to 5 interventions, achieving a reduction in PFAS by over 50%.

To summarise, Dr Fletcher constructed an overall table as displayed below:

	PFHxS		PFOS		PFOA	
Study location:	**Serum med. conc. ng/ml at baseline**	**% reduction from 1 phlebotomy**	**Serum med. conc. ng/ml at baseline**	**% reduction from 1 phlebotomy**	**Serum med. conc. ng/ml at baseline**	**% reduction from 1 phlebotomy**
Canada (phlebotomy)	109.3		39.5		5.7	
		4.48		**7.72**		**1.47**
Australia (phlebotomy)	3.6		10.9		1.2	
		3.88		**2.35**		**5.81**
Australia (plasma)	5.2		11.7		1.1	
		1.47		**1.35**		**3.7**
Italy (phlebotomy)					114	
						3.7
range		**1.5 – 4.5**		**1.4 – 7.7**		**1.5 – 5.8**

Dr Fletcher noted there is always variability between individuals, interventions and compounds. Some types of PFAS are more efficiently excreted than others, but overall, the amount of difference between all variables is small. Therefore, it is reasonable to take the average and conclude that there is around 4% reduction in the level of PFAS in serum caused by the interventions reducing plasma concentrations including phlebotomy, plasma donation and plasma exchange.

To conclude, Dr Fletcher commented that if phlebotomy is conducted at maximum capacity of 6 times a year, the average reduction in PFAS blood levels would be 22%. This compares to a reduction based on the normal half life of an annual fall of 12%, 18% or 23% for the individual compounds. On average, the rate of excretion is doubled if phlebotomy is conducted 6 times a year. Dr Fletcher reiterated that these are average figures, and that the disadvantages and advantages of the intervention needs to be evaluated. He commented that the percentage reductions shown are the percentage of the concentration above background. The percentage reductions attributable to the interventions reduce to zero over time as the serum levels approach background levels.

Dr Hajioff thanked Dr Fletcher for his presentation. He commented that it is important to consider the per procedure reduction both to understand how much PFAS could be reduced by, but also how much discomfort and disruption is required by the patient to get the reductions. Dr Hajioff commented that the panel would need to produce a comparison between the different techniques using a common denominator such as reduction in body burden per month or per three months, but that the panel would discuss this at a later date. Dr Fletcher commented that this calculation should be conducted for different scenarios, such as an average PFAS serum level, half the average serum level of PFAS and twice the

average serum level. This analysis would therefore allow an individual to calculate the expected impact for themselves based on their known serum levels of PFAS. Dr Hajioff agreed.

Wider risks and benefits of phlebotomy – Dr Hajioff

Dr Hajioff introduced the need for the panel to consider the wider characteristics of each intervention over and above the impact of reduction of PFAS during the preparation of Report 3. This includes the safety, tolerability, risks, wider benefits, and the safe parameters within which the intervention can be offered. This has already been completed for phlebotomy during Report 1. The science of phlebotomy has not changed in this time, and so this work can be reused in Report 3.

Dr Hajioff indicated that the section from Report 1 had been circulated ahead of the meeting and talked through the paper. He commented that the majority of phlebotomy is conducted for altruistic donation purposes, however it can also be used for therapeutic purposes. Prof Cousins reminded the panel that there have been studies on therapeutic phlebotomy for PFAS which were reviewed in Report 1. These studies conclude that these individuals have lower levels of PFAS, indicating that this technique is effective for lowering body burden of PFAS.

Most of the research on risk has been conducted on altruistic donation situations. This is a situation where the risk of harm to the individual must be carefully considered as there is no benefit to the donor. For this reason, the analysis of risks of phlebotomy is very conservative. Minimum body weights and frequency of this technique are based on this scenario. Often, therapeutic phlebotomy has different guidelines due to a different risk benefit ratio in these conditions. The risk/benefit analysis of this technique in PFAS exposure is likely to be closer to altruistic blood donation than therapeutic phlebotomy.

Dr Hajioff explained the physical risks of phlebotomy:

- Pain and discomfort due to use of needles
- Dizziness and light-headedness
- Bruising, haematoma
- Damage to artery or nerve (rare)
- Infection
- Risk to the health professional of infection from donor
- Reduction in iron levels in donor, develop iron deficiency and iron deficiency anaemia
- Needle phobia

Mitigation on these risks include

- Using sterile technique to reduce infection
- Set criteria of frequency and body weight to reduce risk of light-headedness and iron anaemia
- Supplement with iron in therapeutic phlebotomy scenarios

There is indicative, but not strong, evidence that healthy people who give blood can experience additional health benefits. Non-alcoholic fatty liver disease and cancer risk may be slightly reduced, however the studies are small and it is not clear how well all other factors that could have an effect were controlled for. Researchers have also looked at the impact of phlebotomy on Alzheimer's disease and heart disease, but it is also not clear that there is a benefit from giving blood for these conditions.

Dr Hajioff summarised by commenting that phlebotomy does have risks associated with the procedure, and also has some benefits over and above impacting the PFAS levels, but it is not clear whether these would be seen in the real world.

Dr Hajioff commented that this analysis will be conducted for all other interventions suggested as part of this report so that the panel can make recommendations.

Dr Fletcher commented that the benefit can be estimated in terms of likely reduction in serum concentrations, but the panel cannot equate that to a risk reduction in terms of risk of disease or improved disability-adjusted life years (DALYs). Dr Hajioff agreed with the important point. He said that we are in a different position to the panel were in during preparation of Report 1 due to the IARC announcement regarding carcinogenicity of PFOA in the meantime, and therefore, we are now reducing a carcinogen. Dr Fletcher commented that IARC does not attempt to come up with quantitative dose response data, although the EPA did. They have a risk coefficient in the report, and these numbers could be used but Dr Fletcher recommends not conducting this analysis, partly because it is based on an estimation from different exposure types than that in Jersey, partly because it contains several assumptions, and partly because it does not look at the other health risks which may be more common. Dr Hajioff agreed and confirmed the panel would be determining reduction in body burden, and will have a discussion about what the health impacts might be overall including the caveats in any health impacts discussion. He continued to explain that some medications have wider health impacts, for example bile acid sequestrants lower serum cholesterol, which is an additional benefit of this intervention. This will also form part of the analysis.

Dr Fletcher asked whether the societal benefits should also be considered in this analysis. He questioned whether which is more inconvenient or expensive for the health service to deliver should be considered. Dr Hajioff agreed, and mentioned that it had been spoken about in the public meeting when this report was launched, and that the information was not yet available for this meeting on phlebotomy. He confirmed that the panel needs to consider how effective, safe, well tolerated, cost effective and how affordable it is for the system, and that all this information will form part of the analysis and discussion of each of the interventions to form a balanced judgement.

Prof Cousins indicated that from his preparation prior to the meeting, he learnt that many different techniques have been used to reduce body burdens for many different contaminants other than PFAS. He cautioned that there are treatments which work for other contaminants, but they will not work for PFAS. Dr Hajioff agreed, and explained that if toxins are excreted by the kidney, giving a diuretic can help flush it out of the body, however, because PFAS are reabsorbed in the liver, these medications would not have an impact on reducing PFAS body burden. Prof Cousins mentioned the case of an artificial fat found in Pringles, which was then subsequently used as a treatment for removing dioxins. It was removed from the market as it also stripped out other minerals. This material would not work for PFAS as PFAS is not dissolved in fats. Prof Cousins commented that a freshwater algae being investigated for other contaminant removal would also not work for PFAS. Dr Hajioff agreed that the panel should have this discussion, but that it should focus on areas where the mechanism would work for PFAS and data exists which can then be used for decision making.

Prof Cousins cautioned the public they should be cautious about trying other techniques that may exist, but that will not work for PFAS, and questioned the panel if they thought they

should have a section on this in the report. Dr Hajioff said that the panel should consider it in the discussion and recommendations section at the end of the process to avoid Islanders trying interventions which may be ineffective or result in harm.

Any other business

No other business was raised by the panel.

Date of next meeting

Friday 13 September 2024. It will be held 10am-1pm online. The panel will be meeting with Subject Matter Experts during this meeting and the panel will be in Jersey.

There will be an Islander meeting on Thursday 12 September 2024 in Les Ormes, as discussed earlier in the meeting

The Chair thanked everyone for their contributions, those watching the meeting and Adrian for his help during this meeting. A reminder to the public that this meeting has been recorded and the video will be available online on request by emailing the PFAS mailbox. This will take a couple of days to make sure the observers are anonymised.

There being no further business, the meeting was closed.

To note that the panel can be emailed via PFASpanel@gov.je.

Details of meeting dates and times can be found at PFAS in Jersey (gov.je)

Minutes of public meeting of the PFAS Scientific Advisory Panel on Teams 10am on 13 September 2024

Panel Members present:	Dr Steve Hajioff – Independent Chair
	Dr Tony Fletcher – PFAS and Health member
	Professor Ian Cousins – PFAS and Environment member
In attendance:	Julia Head – Senior Public Health Officer
	Grace Norman – Deputy Director of Public Health
Subject Matter Experts:	Dr Roger Klein
	Prof Kristina Jakobsson - University of Gothenberg
	Dr Axel Andersson - University of Gothenberg

Welcome:

The Chair welcomed everyone to the panel meeting, and reminded people the meeting was being recorded.

Introductions

The Chair and Panel members introduced themselves.

Dr Steve Hajioff, Independent Panel Chair: A background as a GP for 25 years and a retired Director of Public Health from an area of London with two major international airports and a variety of other environmental hazards and challenges. Not a PFAS expert but has done lots of work with National Institute of Care Excellence and other groups about translating science into policy. Dr Hajioff has also worked a lot in the pharmaceutical industry.

Dr Tony Fletcher, PFAS and Health Panel Member: Environmental Epidemiologist at the London School of Hygiene and Tropical Medicine, working on PFAS since 2006 and member of the panel with experience of epidemiological studies on the health effects of PFAS in contaminated communities in West Virginia in the United States, in the Veneto region, in Italy, and in Ronneby, and is the health expert on the panel.

Professor Ian Cousins, PFAS and Environment Panel Member: A Professor in Environmental Chemistry at Stockholm University, an expert on PFAS, appointed as the environmental expert on this Panel and whose expertise on PFAS is on the sources, transport, fate, and exposure of PFAS.

Support staff for programme management and administration were also in attendance.

The Chair noted that the meeting had 3 Subject Matter Experts in attendance who introduced themselves before speaking.

Declarations of Interest

No additional declarations.

Minutes of last meeting and matters arising

The Minutes of 11 July meeting were discussed.

Prof Cousins noted a clarification on a point in the minutes regarding biomonitoring.

In the July meeting the panel discussed whether it would be possible to gather information on environmental markers such as tap water and dust. Dr Hajioff commented that this would be not necessary, and that recording whether a household is on borehole or mains water is sufficient due to the bulk of the body burden of PFAS in the exposed population is from water. If a household is on borehole water, there could be differences in exposure levels. The minutes will be updated to reflect this clarification.

The Chair noted that he had received two questions from an Islander following the July meeting. The panel discussed the two queries and provided clarifications.

The first was regarding a comment Dr Fletcher made noting that there is a lot of variability in PFAS blood tests. Dr Fletcher clarified that it is not that the results are not trustworthy, but rather that the blood tests result in a precise number and in reality, there is some variability in the measurement. He explained that if a repeat blood sample was taken the next day, it would be expected to be a bit higher or a bit lower due to testing factors (applicable for all laboratories) and the variation within the person, affected by factors such as their level of hydration when the sample was taken. To get a good population average, it is necessary to look at the averages across many people, and explained that estimation from one person is not possible due to this inherent variability. The minutes will be updated.

The second comment related to the panel discussion about the results from the C8 panel. The Islander pointed out that the C8 panel dealt with a PFOA exposure, and this is different to the exposure in Jersey. The Islander questioned how much weight the panel should be giving to this work. Dr Fletcher answered the comment noting that the Islander is quite right with this comment and explained that the panel have clearly noted in the report where evidence relates to that exposed community. These studies are informative about PFAS in general, but mainly about PFOA in particular. The Islander is correct, but he hopes that it is clear in the report which is now available to be read as the question was submitted before the report had been made publicly available Dr Fletcher requests that any further comments are submitted to the panel.

The Chair noted one further matter arising on biomonitoring and indicated that he had been conversing with a colleague who is a professor of primary care diagnostics in the UK called Professor Willie Hamilton. The panel would like to engage him as a subject matter expert but for personal reasons, he is unable to attend online meetings. Therefore, Dr Hajioff has corresponded with him and will bring the evidence to a future meeting. There are some interesting findings around biomonitoring.

Additional findings since the last meeting

Dr Hajioff noted that a period of Islander input has been launched for Report 2 at public Islander events on Wednesday 11 September and Thursday 12 September. A discussion was held about the content of Report 2 at both meetings. Islanders and others have been invited to read the text of the report which is available online at www.gov.je/PFAS. Comments are invited by email by 4th October to PFASPanel@gov.je. The panel will

anonymise responses and publish all the questions and comments in an appendix to the final report, along with an explanation about what changes have or haven't been made.

Prof Cousins questioned if Report 2 was also going to be peer-reviewed and noted that he would appreciate viewpoints on the conclusions in the report. Dr Hajioff confirmed that the subject matter experts (SME) who contributed to the report have received a copy of the draft report and have been asked to comment. Comments from SME will be dealt with in the same manner as Islander comments.

Agenda item 5 – Input from Subject Matter Experts

The Subject Matter Experts introduced themselves to the panel:

Dr Roger Klein

Dr Klein has been working on issues of health in the fire service for a very long time. He reported that it became clear in around the year 2000 that PFAS was an issue for firefighters and that firefighting foams could result in environmental contamination. Dr Klein has been working on these foams particularly in Germany and Australia since then, and has contributed to the Jersey PFAS Panel previously.

Professor Kristina Jakobsson

Senior Professor in Clinical Environmental Medicine. She is a specialist in environmental and occupational medicine and has worked on PFOS since 2013. She will provide experiences from her recent work with the Danish Public Health Agency who had a large expert panel for assessment of scientific evidence and produced a report and advice for general population and general practitioners in PFAS exposure hot spots. She also has experience in PFAS exposure in a small municipality in Sweden. Prof Jakobsson has contributed to the Jersey PFAS Panel previously.

Dr Axel Andersson

Dr Andersson is a medical doctor and has been a PhD student in Prof Jakobsson's group for 3 years. He is currently focusing on conducting elimination trials in Ronneby in Sweden, studying the effects of cholestyramine and similar compounds on PFAS levels in the blood. He is also conducting additional studies on immunotoxic effects in adults such as whether the COVID-19 vaccine is affected by PFAS levels.

Dr Roger Klein

Dr Klein gave a presentation entitled "Plasma Donation". Dr Klein started his presentation by explaining that, with regards to the consequences of PFAS contamination of groundwater, he has come to understand that the problems can be quite substantial.

Dr Klein explained that there were concerns in Australia about PFAS exposure for the fire service and several studies were conducted which indicated that firefighters could have high levels of PFOS and PFHxS. The plasma levels of PFOS were far higher than the population levels and there was also a correlation between PFOS and PFHxS. The serum to plasma ratios for PFHxS, PFOS and PFOA were 1:1 and were concentration independent. Serum of plasma to whole blood ratios, (regardless of anticoagulant used) were approximately 2:1. This indicated that that the fluorochemicals are mainly bound to plasma proteins rather than red blood cells.

Dr Klein explained that in Australia it was found that downstream contamination of ground water from major incidents at airport training grounds could contaminate 10-20km. At one particular military airfield, weekly training with approximately 1000L foam a week was conducted over 25 years, resulting in 1.43 million litres of foam concentrate discharged to ground water over this time. This was a concern.

PFOS and PFHxS levels in firefighters were found to be linked (correlated) because PFHxS (C6) is a homologue of (has a similar structure to) PFOS (C8) and is an unavoidable contaminant of commercially produced PFOS. Around ~5-10% of a PFOS mixture is PFHxS. The biological half life of PFHxS is approximately twice that of PFOS meaning that after 30 years, there appears to be more PFHxS in groundwater than PFOS but this is because of the greater time PFHxS takes to break down.

The indications for concern for human health are from a German group called the Human Biomonitoring Group. They have derived two levels. HBM-I in 2016 set levels for PFOS of 5ng/ml plasma and PFOA of 2 ng/ml plasma. HBM-II in 2019 set levels for PFOS of 20 ng/ml plasma and PFOA 10 ng/ml plasma. It also set levels for women of childbearing age in 2019 for PFOS for 10 ng/ml plasma and PFOA 5 ng/ml plasma. HBM-I and HBM-II have trigger levels for action.

In Australia, many firefighters had levels above HBM-II. At the time, there were details in the literature which suggested that phlebotomy could reduce PFAS levels in blood. Other types of blood loss, for example menstruation, may impact PFAS levels too. A randomized controlled trial study was conducted to look at the effect of plasma and blood donations on levels of PFAS in firefighters in Australia. Dr Klein described the methodology and strengths and limitations of the study. The study indicated that for both PFOS and PFOA, plasma donation was more effective than blood donation, which was thought to be due to PFAS being found predominantly in the plasma. Testing was undertaken after donation was stopped and found there was some bounce back, although there was limited data.

Advantages of plasma donation:

- Does not deplete body iron stores, in comparison to whole blood donation
- Can be done more frequently than whole blood donation
- Is more effective than blood donation at reducing PFAS levels
- Removes major carrier of PFAS – serum albumin

Disadvantages of plasma donation:

- Intrusive and invasive
- Repetitive long term
- Requires traveling to a specialist centre
- Inconvenient long term

Dr Klein finished by reminding the panel that there are many PFAS compounds for which there is very little data. Questions were invited.

The Chair thanked Roger for his presentation and noted that he had heard Dr Klein explain that plasma donation appears to be more effective than whole blood donation due to the fact that the PFAS is stored in the plasma. Dr Hajioff noted that a reason for enhanced effectiveness might be due to the fact that it can be performed more frequently. Dr Hajioff explained that the panel have previously discussed what matters more to people, how quickly the PFAS goes down over a certain time period, or how many times the participant

needs to go through a procedure. He noted that Dr Fletcher modelled these differences between treatments and time for PFAS removal in Report 1 and did not find a significant difference between treatments in terms of effectiveness. Dr Hajioff asked Dr Klein his opinion on this matter. Dr Klein commented that the travel distances to perform plasma donation were far greater than blood donation and this may have led to lower participant engagement with plasma donation.

The panel discussed that the HBM-I and HBM-II figures are from a few years ago, and since they were reported, further information has come to light in recent years such as immunotoxicity and cancer. They noted that in Report 1 they used more stringent measures than HBM-I trigger values, but that the panel should confirm the threshold chosen in Report 1 is still valid. This threshold was 10ng/ml total across 8 types of PFAS. It was suggested that the aim should be to reduce the concentration down to the island background level.

Dr Klein was given the opportunity to comment and confirmed he had nothing further to add.

Prof Kristina Jakobsson

Prof Kristina Jakobsson gave a presentation entitled “PFAS exposure and screening, testing and biological monitoring”. She explained that her PFAS experience started in 2005 when she attended a PFAS workshop in Toronto. There was very little knowledge on human exposure at this time; it was understood that it was an issue with contamination globally, but there were no epidemiological studies.

In December 2013, one of the two waterworks in a small municipality in Sweden was found to be heavily contaminated with PFOS. About 30,000 inhabitants lived in the municipality, and approximately one third of the households had been drinking heavily contaminated mains water, caused by nearly use of firefighting foam from a military airfield. The length of time of contamination was unknown. This discovery triggered a lot of scientific research in the area. There is a summary of the research available at https://pfas.blogg.lu.se. The recent research continuing is on a mother-child cohort with PFOS at high levels in contrast to those with background levels.

In 2014 a rapid investigation study in children in the contaminated area showed high PFAS levels. These results led to a wider blood sampling programme in 2014-2016 to understand the exposure situation. About 1000 people attended in the first two weeks. Researchers found higher levels in older people suggesting that the exposure had been going on for quite some time. This information was used to conduct risk assessments based on knowledge at the time. Investigations were also started to understand the speed of elimination of PFAS from the body after the end of their high levels of exposure, and this let to lots of further research.

The PFAS levels in Ronneby were compared to average serum levels of background in Sweden, and to two other hotspots; Veneto (Italy) and C8 (USA). The exposures from people living with contaminated water at home in Ronneby were vastly in excess of comparator populations for PFOS, PFHxS and PFOA.

In 2014, the residents got information on their individual serum levels and how their level compared to others. The research team engaged in risk communication based on what was known at the time at a clinic with clinical, occupational and environmental medicine experts. A personal contact was made available during the blood sampling by mail, phone and at community events. Information was given to the local health care system on websites and via the media. No health related blood analysis was conducted, the only information shared

was only whether the person was at the higher end, lower end or in the middle of the group. There were no recommendations for health screening or for reducing breastfeeding. Participants were encouraged to go to their general practitioner as usual if they felt unwell. Doctors had been told of the current knowledge on PFAS.

10 years later, in 2024, there has been much research conducted and it is understood that there are associations *on a group level* between PFOS and blood lipids, especially cholesterol. Importantly, cholesterol is not a disease in itself, but is a risk factor for cardiovascular disease. Studies from Ronneby have found that there is an increased risk for two rare cancers (testicular cancer and kidney cancer) and that there can be decreased antibody response after childhood vaccinations. There is evidence from elsewhere that PFAS can be associated with *decreased* birth weight, but, importantly, not *low* birth weight, although this was not observed in Ronneby, where they had higher exposure levels than other studied locations. There are many other health effects which have been investigated around the world but the findings are highly variable between studies and so are not conclusive.

This is today's state of knowledge. There are areas of interest, especially cardiovascular diseases, based on the finding of increased cholesterol in PFAS exposed populations. We need to carefully follow the evidence in exposed populations and update our scientific understanding in light of new evidence.

Medical screening is relevant to biomonitoring in the healthy general population. Some significant health problems can be screened for, but an essential criteria of screening is confirmation that early detection of disease lead to more effective treatment outcomes, e.g. breast cancer in women. Screening for identification of risk factors which can be prevented or modified is also conducted, such as checking blood pressure or cholesterol.

It is a requirement of medical screening that health outcomes must be improved through the screening programme. There may be specific programmes that are directed to a defined group of people, and there is also opportunistic screening conducted during standard medical procedures, e.g. doctors check blood pressure.

A useful medical screening programme is one which can detect a high proportion of the health outcome, and also does not result in a lot of false alarms, and this is a balance. The programme should be safe to administer, reasonable in cost and widely available, and there must be an effective intervention that can improve the health outcome.

For blood lipids there are health checks in place for people over 40 in the UK. For testicular cancer, self examination is important to identify changes early. There is not a recommended screening test for kidney cancer. Society protects each other with good vaccination coverage. The maternity healthcare and child healthcare systems in place protect against decreased birth weight of babies.

With regards to testing PFAS levels, it is more helpful at a group than individual level. PFAS levels for an individual can neither predict future disease risk nor confirm that PFAS is the cause of a disease.

Testing drinking water shows whether there are elevated PFAS levels in the water, and human PFAS levels can be estimated from water concentrations. In Ronneby, this will guide whether further selective testing is necessary for understanding exposure. It may be that present drinking water levels would not reflect previous drinking water levels and in such a situation, investigation of serum levels in selected segments of the population can help

understanding. Similarly, if there are elevated levels of PFAS in locally produced food, in addition to calculating what it would mean to normal estimated intake, it can be helpful to test a selected group of high consumers for guidance on intake recommendations.

It is important that exposed populations receive clear risk communication and support. However, the right to know one's own blood PFAS level is not meaningful from a medical point of view, although it is understandable that people who have been exposed want to know.

Prof Kristina invited comments and questions from the panel.

The Chair explained that routine health checks for those aged over 40 are not provided in Jersey. He mentioned the panel made recommendations for testicular self-examination and good vaccine coverage across the whole population, as mentioned by Kristina. The panel has also made recommendations around breastfeeding.

Dr Hajioff reminded the panel that he had had a conversation with Professor Hamilton that there are no recommended screening tests for kidney cancer. Dr Hajioff and Prof Hamilton had discussed a potential test looking at microscopic blood in urine, however this test is not effective because out of every 1000 positive tests, 999 would be false alarms which would cause a lot of distress in a population and so this test would not meet the criteria for a screening programme.

Dr Hajioff explained that *lower* birthweight and *low* birthweight are different technical terms. Low birthweight below 1.5kg, as babies below that weight are at greater risk of experiencing complications. If PFAS exposure might reduce birthweight from 2.1kg down to 2.0kg, that is probably not associated with health problems. Prof Jakobsson agreed and explained that there is large variation in the population for baby birth weights.

Prof Cousins was grateful for the presentation, and was reassured that the panel recommendations align with Prof Jakobsson's evidence. Prof Jakobsson commented that these recommendations are in line with the Danish PFAS panel as well.

Dr Fletcher asked about the 'right' to know one's PFAS level and asked whether in Ronneby there had been much demand from participants to know their individual results. Prof Jakobsson explained that they had always given the results to participants, alongside information about the categories in which they fell, which were based on the levels of the first 1000 samples. This banding information was used to compare individuals rather than use the individual numbers.

Dr Fletcher commented that this is similar to what happened in Jersey in 2022 where the results were compared to the NHANES 95th centile from the USA data. Dr Hajioff commented that this would help the situation discussed at the beginning of the meeting with regards to variability in testing and small variations in a specific number. Having bandings relating to exposure would help people to understand where they fall.

Dr Hajioff picked up on the comment about the right to know and explained that in English Law, there is no right to know health information. There is a right to know the results of any test that has been done, but there isn't a right to require a test to be done in order to know that answer. The panel is not aware of the legal situation in Jersey though, and suggested that this could be investigated.

Prof Cousins asked whether Ronneby has information available about environmental contamination and clean up efforts which would help the panel in their preparation of Report 4? Prof Jakobsson indicated that she would be happy to help. The panel thanked Prof Jakobsson in advance.

Dr Fletcher commented that the population in Ronneby was exposed to a complex mixture of PFAS from AFFF which does not help researchers determine which is most toxic. However, the Ronneby exposure is very useful for the panel, because Jersey has a comparable situation of AFFF exposure. He explained that in the panel's second report on health, they have heavily relied on Ronneby evidence in the balance of evidence because of the similarities of the exposures, rather than relying on reports on individual PFAS chemicals, which cannot account for the mixture of chemicals. Dr Hajioff mentioned that the analysis Dr Fletcher had done on predicted exposure levels indicates that the exposures in Jersey and Ronneby would have been very similar at the time of contamination being identified, making the experiences and evidence from Ronneby very relevant to the Jersey hotspot.

The panel noted that Jersey had recognised the problem very early in the late 1990s prompted by the observation of foaming in the water and taken households off borehole water quite early. Government of Jersey intervened much earlier than other countries, and so the main exposure substantially dropped earlier.

Prof Jakobsson commented that it is important to note that blood PFAS levels have reduced significantly in recent decades and that levels found in hotspots now are similar to the levels in the general population in the late 1980s/early 1990s. The health effects observed in hotspot studies now are likely to be caused by exposure levels that were significantly higher than levels found today. Levels in the populations are much lower today and so any health effects seen are a worst case scenario from higher past exposures which is reassuring.

The panel thanked Prof Jakobsson for her inputs and commented that they were very helpful and interesting.

Dr Axel Andersson – Pharmacological PFAS interventions

Dr Andersson started by indicating that, in contrast to rodents and monkeys, the half lives of PFAS of humans are very long. This is one reason why interventions may be recommended in certain hot spot areas.

Cholestyramine impacts on enterohepatic recirculation (the circulation of biliary acids, bilirubin, drugs or other substances from the liver to the bile, into the small intestine and back to the liver). All humans have cholesterol in the blood which gets converted into bile acids allow intake of lipids in the intestinal system. Bile acids are stored in the gall bladder and excreted into the small intestines which help with digestion. Cholesterol is passively and actively transported back into the blood stream, hence a recirculation. Cholestyramine binds to bile acids, to stimulate the body to produce more bile acids. There is a hypothesis that cholestyramine may be used to enhance PFAS excretion, due to PFAS being in high concentrations in bile, but in low concentrations in faecal matter. This indicates that PFAS exits the liver through the bile acids and then gets reabsorbed due to either passive or active uptake which will increase faecal excretion. There have been several small studies which support this hypothesis. There are several side effects of cholestyramine including constipation, nausea, stomach pain, risk of lower uptake of other medications.

A new clinical trial, published in 2024, was run in a hotspot in Denmark called Korsør. Cows grazed grass polluted with firefighting foam, primarily high PFOS. Dr Andersson compared

the levels in serum with the Jersey results and found they were generally similar overall, but with much higher PFOS levels in Korsør. The researchers conducted a 12-week trial with cholestyramine with 45 individuals. The results found that the serum levels after 12 weeks of treatment were significantly reduced in comparison to the observation period in the same individuals. PFOS elimination was 63% on treatment compared to 3% in the observation period. The extent to which these findings can be applied to Jersey is unclear, and it may be that the rate of elimination would be lower in Jersey because PFOS levels now are lower than in the Korsør population.

Dr Andersson displayed a graph which showed that cholestyramine was considerably more effective than blood and plasma donation at reducing PFAS levels.

The second intervention that Dr Andersson described was Probenecid. This is an old gout medication and it works in the kidney. Probenecid inhibits the uptake of compounds, and potentially PFAS. There are side effects of nausea, headaches and interactions with other medications.

There was a trial in Ronneby (where the drinking water was polluted by firefighting foam, primarily high PFOS and PFHxS) to look at elimination both short term (1 week) and long term (12 weeks) use of probenecid. The results have not been published yet. The results of the short term, one week trial with probenecid indicate that there is no significant effect of probenecid treatment in PFAS excretion.

Dr Andersson concluded that the evidence currently suggests that cholestyramine is effective at lowering PFAS serum levels, but probenecid is not. It is unclear the effectiveness of treatment in lower PFAS serum levels, and it is also unclear in other dose schedules.

There will be a clinical trial about long term cholestyramine treatment in tablet form in a lower dose in Korsør. The risk benefit of treatment is not known. The treatment phase of this work has been completed and the analysis is underway, with the paper expecting to be published in early 2025.

Dr Andersson finished his presentation by reminding the panel that it is not known whether lowering PFAS levels improves the health outcomes for people, and this is an important limitation.

The Chair thanked Dr Andersson for his presentation. He asked if the Korsør paper reported on side effects and tolerability of the treatment with participants. Dr Andersson commented that this is published and that there were a number of participants who dropped out due to unpalatability of the treatment.

The Chair asked when the findings of the longer term study in Ronneby with the alternative medication will be published.

Dr Fletcher noted that in Korsør the researchers were looking at dose ranges of cholestyramine, and indicated that this is not the plan in Ronneby. He questioned whether if the participant took half the dose but for longer, would this result in a good reduction of PFAS serum levels but with fewer side effects? The Chair noted that it is not just about the side effects once taken, but the tolerability of the medication at point of administration because the unpleasant taste is difficult to avoid. Dr Andersson noted that the Korsør studies will be focusing on this. In his opinion there should be a dose response relationship with side effects, but also the effectiveness of lower doses needs researching also. Dr Hajioff noted that the capsule version of the drug may have different side effects, and that this medication

would be expected to be used for a relatively short period of time, rather than indefinitely, which may make it more palatable.

Dr Fletcher asked whether there was an increase in PFAS levels after the intervention was completed (as was found in the blood and plasma donation trial). Dr Andersson replied that this was not reported in the paper but there was a small amount of rebound. Dr Jakobbson commented that a challenge with interpretation is that evidence suggests that a lower PFAS level is better for health, but it is not clear whether it is the levels in the body that someone has *now* or *in the past* which impacts on health. Messaging about health risks must be communicated very carefully and clearly. Whenever elimination trials are starting, there is a need to follow up what is happening using different types of biomarkers. There is a need to figure out substantiable markers which are related to physiological process. Any trial starting should be seen as within scientific context and it should be made clear for participants that scientifically, we don't know what it means for the individual.

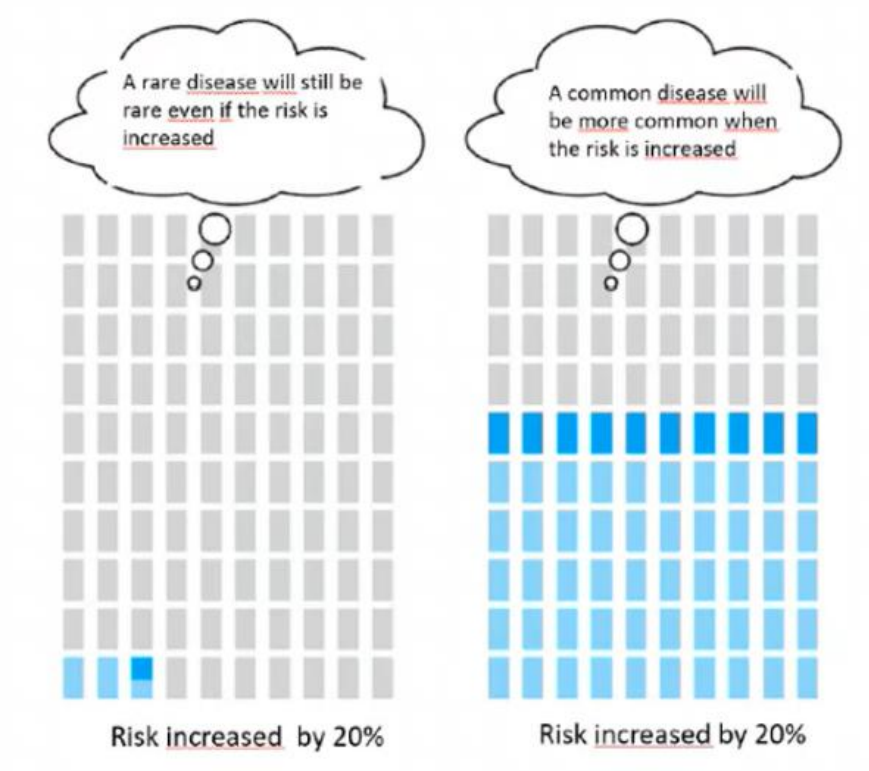
Dr Jakobbson explained that what levels of PFAS a woman transfers to her child is also an important question. Dr Hajioff agreed, and said that, given the context of the IARC findings around cancer, questioned whether the panel should assume that, as they are dealing with a carcinogen, what you have presently is more likely to be important than what you had in the past? To know about the change in cancer rates will take years, and due to this, due to the IARC findings, should be we be more precautionary and assume that there are more health effects? Dr Jakobbson asked if the mechanism of carcinogenesis is known, because this is important to understand. She noted that not knowing whether the PFAS are mutagens or tumour promoters makes it difficult to know the timing of follow up. Dr Fletcher commented that due to the cancer concern, there is a presumption that a threshold of no effect cannot be defined, and this is why the EPA is setting a level to be as low as practicable. Therefore, we cannot quantify the benefits of reducing exposure by half in terms of risk assessment, but we can argue that it should be better and therefore there is an advantage and a reduction in risk of ongoing disease. Dr Hajioff commented that this argument was discussed in Report 2 in the context of immunomodulatory mechanisms, but the time factor was still important. He noted that quite a few of the possible mechanisms still have a time factor.

Dr Jakobbson commented that the shape of the dose response curve is important not only for cancer, but for other effects. There are indications that there seems to be more marked changes in response in lower doses and not so steep at higher doses. This effect is not fully understood yet, but it has implications on the lowering serum levels. Dr Hajioff noted that he recalled a graph about cholesterol in report 1 which showed a rapid increase of cholesterol levels in blood at low PFAS concentrations and then it plateaued. It is very important for non-cancer complications but is difficult for the cancers. No data are available yet.

Grace asked Dr Jakobbson about screening. Screening is a process whereby people without a disease are screened for risk factors for disease. In the decision-making process about whether screening should be offered, does balance of risks and benefits change given the fact that Islanders in the plume area have been exposed to high levels? Dr Jakobbson explained that it depends what kind of health effects are considered. For rare diseases, an increase of 20% does not dramatically impact the incidence of the disease; a rare disease will still be rare even if the risk is increased. However, a common disease will be more common when the risk is increased by 20%. It is important to have a screening programme which covers everybody. It is necessary to work out whether the screening programme causes more problems than it solves. This depends on the test, are there a lot of false alarms, is it sensitive enough to pick up those who need to be picked up? You must be

guided by the diseases that you want to examine, and whether a highly exposed group would benefit from screening, or whether everyone would benefit.

Dr Jakobbson showed the panel the following image which is helpful for understanding the impact of an increased risk of disease:



Dr Hajioff noted that risk factors become irrelevant for diagnostic purposes if one has already got symptoms, and risk markers become more important.

Screening is a different matter. When screening, proportionality and the effect on wider society are important, but risk factors are important too. Risk factor screening can be done, e.g. there is a new screening test for lung cancer in smokers which is being piloted at the moment. Lung cancer has a big added risk of 13 times (1300% additional risk) in smokers. For a disease which only has a 10 or 20% increase in risk, like kidney or testicular cancers in the PFAS exposed population, it becomes harder to justify the disruption and dealing with the false alarms from this programme. It has to be on a case by case basis, looking at the condition and the exposure.

Dr Hajioff responded to an earlier point raised about routine health checks for everyone aged 40 and over and explained that this is not a service that Jersey currently runs but that there may be a case for a targeted screening programme in that higher risk group.

Dr Jakobbson reminded the group that just having a health examination does not change the health of the population; there needs to be access to appropriate interventions also. For cholesterol, for example, there should be weight management interventions, supporting diet and physical activity and medications. The evidence base consistently shows a health examination without interventions is not effective.

Dr Hajioff reminded the group that screening can cause significant harm. For example, in the USA, whole body CT and MRI scans identified incidental tumours which would not have gone on to cause an illness, and this over-diagnosis can cause physical and psychological harm to those affected. It is important that there is robust decision-making around screening programmes.

There were no further points for discussion. Dr Hajioff thanked the subject matter experts for their time and advice and help which has been immensely valuable to this process and looked further to conversing further to make the panel's response in Jersey better.

Any other business

No other business was raised by the panel.

Date of next meeting

Wednesday 9 October 2024. It will be held 10am-1pm online.

The Chair thanked everyone for their contributions, those watching the meeting and Julia for her support throughout the whole process. A reminder to the public that this meeting has been recorded and the video will be available online on request by emailing the PFAS mailbox. This will take a couple of days to make sure the observers are anonymised.

There being no further business, the meeting was closed.

To note that the panel can be emailed via PFASpanel@gov.je.

Details of meeting dates and times can be found at PFAS in Jersey (gov.je)

Minutes of public meeting of the PFAS Scientific Advisory Panel on Teams 10:45am on 9 October 2024

Panel Members present:	Dr Steve Hajioff – Independent Chair
	Dr Tony Fletcher – PFAS and Health member
	Professor Ian Cousins – PFAS and Environment member
In attendance:	Julia Head – Senior Public Health Officer
	Grace Norman – Deputy Director of Public Health
Subject Matter Experts:	Ann Christine Lyngberg – University Hospital of Holbæk

Welcome:

The Chair welcomed everyone to the panel meeting, and reminded people the meeting was being recorded.

Introductions

The Chair and Panel members introduced themselves.

Dr Steve Hajioff, Independent Panel Chair: A background as a GP for 25 years and a retired Director of Public Health from an area of London with two major international airports and a variety of other environmental hazards and challenges. Not a PFAS expert but has done lots of work with National Institute of Care Excellence and other groups about translating science into policy. Dr Hajioff has also worked a lot in the pharmaceutical industry.

Dr Tony Fletcher, PFAS and Health Panel Member: Environmental Epidemiologist at the London School of Hygiene and Tropical Medicine, working on PFAS since 2006 and member of the panel with experience of epidemiological studies on the health effects of PFAS in contaminated communities in West Virginia in the United States, in the Veneto region, in Italy, and in Ronneby, and is the health expert on the panel.

Professor Ian Cousins, PFAS and Environment Panel Member: A Professor in Environmental Chemistry at Stockholm University, an expert on PFAS, appointed as the environmental expert on this Panel and whose expertise on PFAS is on the sources, transport, fate, and exposure of PFAS.

Support staff for programme management and administration were also in attendance.

The Chair noted that the meeting had 1 Subject Matter Expert in attendance who introduced themself before speaking.

The chair thanked the Islanders for their input into Report 2. The panel are collating the comments and Report 2 will be revised in the light of the comments. All anonymised comments and the panel's responses will be included in the Appendix to Report 2. The comments will be displayed in sections by topic rather than by commenter. The report will be finalised and sent to Government for them to respond.

Declarations of Interest

No additional declarations.

Minutes of last meeting and matters arising

There were no minutes from the previous meeting to discuss due to the August and September meetings containing inputs from Experts by Experience and Subject Matter Experts. This requires additional review prior to minutes being discussed in the meeting.

Additional findings since the last meeting

Dr Fletcher spoke about a talk he recently attended where it was discussed about how AFFF contamination in the ground is very closely related to the locations of military air bases. Prof Cousins was aware of work in this area also but mentioned that there are also lots of countries who aren't doing anything. Dr Hajioff reminded the panel that it is important to remember that Jersey is one of the first to look into this issue properly, and that there are many countries which are not investigating. The issue is global and other countries will need to replicate the work in Sweden, Australia and Jersey.

Agenda item 5 – Assessment approach – Dr Steve Hajioff

Dr Hajioff presented the factors which the panel have agreed to take into account when looking at the ways to reduce the body burden of PFAS so that judgements have be made on their merits and detriments to enable a balanced view for recommendations.

1. Clinical effectiveness
    a. Considering how effective each intervention is to reduce the body burden of PFAS
2. Cost effectiveness
    a. Important to understand that the recommendations ensure that the most people get the most benefit. The measures of cost and effectiveness will be balanced. The panel pointed out that we cannot quantify the reduction of body burden in terms of diseases avoided. Cost per unit reduction for different options.
    b. The panel could potentially consider disability-adjusted life years (DALYs) – this will be discussed in a future meeting
3. Risks and side effects
    a. All interventions have the potential to cause side effects. The panel must be aware of these side effects during the deliberations as they may reduce the net benefit to the patient.
4. Tolerability
    a. How likely people are to feel comfortable with continuing with the intervention or how likely they are to stop the intervention due to side effects or practicalities for intervention options, e.g. necessity to go into hospital every week and the associated disruption
5. Equality of access

   a. Interventions should be available on the basis of need, not on other characteristics in the population
6. Costs
   a. Consideration must be taken on the practical implementation of interventions, and the upfront and ongoing costs of the enabling processes for each intervention
7. Speed of deployment
   a. Existing interventions may be deployed quickly, however other options may take longer to get in place due to equipment requirements or training.

Dr Fletcher asked about attempting to quantify the benefits of each intervention in terms of Disability Adjusted Life Years (DALYs) or Quality Adjusted Life Years (QUALYs), and indicated it would be difficult in this context. Dr Hajioff replied to suggest the panel investigate cost per unit reduction in PFAS for each of the options, and that this analysis could be performed during the preparation of this report. He agreed that the panel will not be able to look at the improvement in quality of life however. Dr Hajioff proposed looking at mapping the body burden of PFAS to the health outcomes as this will provide useful information about which intervention may be most cost effective.

Agenda item 6 – Dr Tony Fletcher

Dr Fletcher presented slides on possible interventions to reduce PFAS levels.

There is no further literature on phlebotomy since the review in Report 1 so phlebotomy will not be discussed further in this meeting.

There are three types of studies which are useful in helping to determine the impact of interventions on PFAS levels:

1. Observational studies
2. Interventional studies without a control group
3. Intervention studies with a control group

<u>Observational studies</u>

- Dietary fibre
- Drugs – probenecid, statins, bile acid sequestrants
- Blood donations

Diet is complicated as it is both a source of PFAS and also could be a way to detoxify as well. If there is ongoing exposure to PFAS from diet in a study population, then the benefit cannot be extrapolated to a population where exposure has largely stopped. The exposure scenarios are different. There are several food stuffs which seem to be associated with lower serum levels of PFAS. This has prompted several studies investigating dietary components which could reduce levels. High fibre diets compared to low fibre diets appear to have a benefit.

There are also observational studies looking at drugs such as statins and probenecid which affect reabsorption of chemicals in the kidney. Neither of these studies showed an effect. Studies have shown that Cholestyramine (a bile acid sequestrant drug) is associated with significantly lower PFAS levels including in the C8 studies. All PFAS were reduced, but the biggest drop is for PFOS.

There is a study which indicated that voluntary blood donors have a lower level of PFAS on average.

Overall, observational studies suggest that blood donations and bile acid sequestrants are likely to reduce PFAS levels, and high fibre diets have a quite a weak effect.

Interventional studies without control group

Interventional studies have confirmed the findings from the observational studies, showing that use of phlebotomy and bile acid sequestrants resulted in reductions of PFAS body burden. A reduction was seen from the use of cholestyramine in a highly exposed population in Canada. The same research group also conducted a dietary intervention study with chlorella pyrenoidosa, an extract from water weeds after the use of cholestyramine. This did not further reduce body burden in those exposed, there was no additional impact.

Intervention studies with control group

Several intervention studies were summarised in Report 1 summarised the findings of intervention studies investigating the impact of extracting plasma or whole blood removal, both of which interventions led to a reduction of body burden of PFAS.

Report 1 summarised the evidence for phlebotomy, and found that studies show that removal of a pint of blood results in a 1%-7% reduction of PFAS levels. As this is a wide range which is affected by a number of factors including imprecision in measurements and individual differences, the panel assumed that the average reduction per pint would be 4%. In order to compare different interventions, the table below shows the PFAS reductions assumed over a three-month period.

For example, the reduction from 1 phlebotomy session is similar to 1 plasma reduction session, however, it is only advisable to give whole blood once every 3 months, but possible to have plasma removal once a month.

Dr Fletcher presented a spreadsheet where he estimates the percentage reduction of PFAS in blood for 4 situations:

- Natural half-life (HL) reduction through excretion i.e. the baseline rate of reduction without intervention
- Bile acid sequestrant intervention
- Phlebotomy intervention
- Plasma donation

	% reductions over 12 to 13 weeks					
	pfos	pfhxs	pfoa	pfna		
HL approx	4	5	3	3		
% red 12 wks	3.1	2.5	4.2	4.2		
moller ref	3.3	3.5	2.4	-1.3		
moller 12 wks	63	19	22	40		
from report 1:						
1 phlebot	4	4	4	4		average
2x	8	8	8			
1 plasma don	4.5	4.5	4.5			28% / 6.4
2x	9	9	9			
diet?						

In addition to the evidence for blood or plasma removal, there are interventional studies that examined the effect of two medications. The panel heard about one of the studies in September's panel meeting by Dr Axel Andersson on probenecid. This study concluded that taking probenecid for 1 month did not have any effect on levels in blood or urine. The other interventional study is one on bile acid sequestrants which will be described later in this meeting.

In summary, the evidence suggests that bile acid sequestrants have the biggest benefit of reducing body burden, in comparison to natural excretion, phlebotomy or plasma donation. Additionally, Dr Fletcher finished by commenting that interventions to reduce PFAS in blood need to be done at the same time as stopping significant PFAS exposures.

Dr Hajioff thanked Dr Fletcher for his presentation. He suggested that some of these interventions could be used at the same time, and that the panel should discuss this further in the December meeting when setting recommendations for Report 3.

Dr Hajioff cautioned that within these recommendations there will be uncertainty in provable differences within individuals due to the variation between people. The panel would be recommending that interventions are made available rather than that individuals should access them.

Grace asked Dr Fletcher about the average calculation in the table. Dr Fletcher explained that this was his calculations because the study reported an average total reduction of 28% due to plasma donation, and that they had 6.4 sessions of plasma donation on average over a year, therefore Dr Fletcher had calculated the impact of one individual session for purposes of comparison.

Prof Cousins asked why there is such a big variation between elimination of each PFAS between individuals. Dr Fletcher explained that there are several hypotheses although none are proven:

1. Concurrent differences in diet e.g. high fibre which may help excretion, while certain food have higher loads of PFAS e.g. seafood
2. Genetic differences in individual's natural ability to mobilise, metabolise, excrete, reabsorb in the gut. Researchers have looked into gene impacts, but not found significant differences to date
3. Microbiome in gut – a healthy microbiome results in healthy digestion. Natural differences in a gut microbiome may explain differences in PFAS elimination rates. There is some data generated recently showing some associations between microbial populations and levels of excretion
4. Ongoing exposure to PFAS will vary between people

Ann Christine Lyngberg commented that the natural decline should be controlled for when looking at the intervention options as well, in order to truly see what the intervention benefit is. Dr Fletcher agreed, noted that he had done that in Report 1 and that it will be done for this analysis as well. It is not accounted for in the table contained in the minutes above, but will be addressed for the version in the report.

Ann Christine noted that discussions on excretion and absorption are being held within a working group she is a member of on a similar topic. She indicated that a liver specialist they consulted as part of this work had said that the acidity of the meal has an impact on the absorption of food. She also believes there are factors impacting this that we do not yet know.

Dr Hajioff thanked Dr Flecher for his presentation.

Agenda item 7 – Dr Ann Christine Lyngberg, Subject Matter Expert

Dr Hajioff welcomed Dr Ann Christine Lyngberg to the meeting and asked her to introduce herself to the meeting before presenting to the panel.

Dr Lyngberg has a medical background in public health and a research background in epidemiology. She is currently Chief Medical Officer for Occupational and Environmental medicine in Region Zealand, Denmark.

Dr Lyngberg's presentation was entitled "The Danish experiences".

Presentation PFAS
panel Jersey 9.10.202

In 2021, there was contamination with PFAS in Korsør, Denmark due to AFFF use at a firefighting educational facility. Nearby meadows had cow grazing, and ground water from the facility went down to the meadow where the cows were drinking it and got highly exposed. The people in the Cow Grazing Association (who ate the cattle grazed in this area) had high levels of PFOS and PFHxS in their blood at much higher levels than the Danish background population. There was also a very big variation between individuals despite their similar diets, indicating that there are factors that are not yet known about.

Dr Lyngberg explained about the research being conducted in this area. She explained that there are several studies that indicate a possible treatment. One of the studies was on rats,

that although it can't be directly extrapolated to humans, there may be useful information to apply.

An NHANES study from 2003-2016 found that PFAS was 80% lower among users of anion exchange resin/bile acid sequestrants such as cholestyramine. These stay in the gut and trap bile acids but also many other drugs and vitamins so it was hypothesised that these drugs could also trap PFAS in the gut and stop it from being absorbed.

Dr Lyngberg described a cholestyramine cross-over trial that her research team ran with the cow grazing association which was designed to assess the impact of the drug on PFAS levels. All participants received the drug for 12 weeks, randomised between those who received it before or after an observational period. The study only included people with PFAS levels above 97.5% centile level for the general population, which was 21ng/ml at that time. 45 people were included, and many experienced gastrointestinal side effects, resulting in some people not continuing with the intervention for the full 12 weeks.

Dr Lyngberg explained that statins are not thought to reduce levels of PFAS in blood, but there have not been any controlled trials on this topic to date. Dr Hajioff mentioned that there was a misunderstanding amongst Islanders that statins do not work in PFAS exposed people to treat high cholesterol. Dr Lyngberg confirmed that people should stay on statins if they have been prescribed them for high cholesterol, and that if their doctor recommends them then they should take them as they are much more potent for lowering cholesterol. There is no evidence that show that statins do not work for reducing cholesterol in PFAS affected populations. The advice in Denmark is to continue to take statins if the PFAS exposed patient is already taking them. Dr Hajioff thanked Dr Lyngberg for confirming that this is indeed a misunderstanding.

Grace asked to confirm what percentage of eligible cow grazers took up the offer of being involved in the study and the answer was around 60%.

Prof Cousins pointed out that the exposure in this scenario is different to in Jersey, as there is a longer, indirect exposure from water to cows to humans, rather than water to humans in Jersey. Therefore, due to the half life of PFHxS being faster than other PFAS compounds, less PFHxS may be found in the cow grazers than would be expected from direct water exposure. Dr Lyngberg had not noticed that difference, but did confirm that PFOS was the compound found in highest numbers both in the meat and in the cow grazers.

Grace asked why the 97.5 centile rather than 95th centile or another measure for determining eligibility for the study was used? Dr Lyngberg replied that this is standard practice in clinical practice reference ranges.

Eligibility for the study Dr Lyngberg described was above 21ng/ml for PFOS, as the other PFAS compounds were not above normal levels. The panel asked whether there was any disappointment amongst people who had levels lower than 21ng/ml who were excluded from the study? Dr Lyngberg explained that they had several meetings with people in the Cow Grazing Association to explain the health risks in terms of the additional absolute risk, which is small. This communication reassured people that their levels were within the normal range, and so there was no push back about not being eligible for the study.

The panel asked if the measurements in cow meat are available as they would be very useful to see for Report 4. Dr Lyngberg agreed to forward the panel those figures, and cautioned that these cows were highly exposed. As soon as the high levels were identified in

the cows, all members were told not to eat the meat. There are a range of levels available identified in different food stuffs from the Danish Health Department.

The results of the cholestyramine study are available in a paper authored by Moller *et al* (Substantial decrease of PFAS with anion exchange resin treatment – A clinical cross-over trial - ScienceDirect) The study found a 63% reduction of PFOS after the 12 week intervention period. Most people were given cholestyramine granules due to lack of availability of the tablet form, and the unpalatable taste was one of the reasons why many dropped out. Dr Lyngberg wishes to investigate a lower dose for a longer term to investigate whether this has an impact on side effects, however it is not yet underway. Dr Hajioff agreed that a lower dose may be effective for PFAS due to PFAS being present at lower levels than bile acids on which the dose has been set therapeutically.

The study found that there was an increase in PFNA and PFDA during the observational period – the reason is unknown although is thought to be due to an ongoing exposure from other sources, as PFNA and PFDA are not often found in AFFF.

Dr Lyngberg described the conclusions from the trial. This is the first trial looking at PFAS elimination using an ion exchange resin. There is no clear evidence that a reduction in serum PFAS results in a decrease in health risk or health effects, which is an important limitation of the science and needs to be further investigated.

Dr Lyngberg cautioned about whether it is ethical to offer an intervention for elevated PFAS levels at this point in time. For an intervention to be offered, the effects and side effects must be well understood, which is not the case for PFAS interventions. In the past medical history, there have been interventions recommended where no health benefits have been seen, and even some adverse effects, and it is important that these historic mistakes are not perpetuated and that decisions are evidence-based. For example, there is no evidence that interventions to reduce serum PFAS actually reduces the risk of adverse health effects, and this is important evidence required to make an informed decision. Dr Lyngberg reminded the panel that knowledge and data are necessary to make an informed decision, not assumption.

Dr Lyngberg explained the current situation in Denmark. There is not yet enough evidence to provide interventions, even in highly exposed hotspot populations. The research group in Denmark, of which Dr Lyngberg is a member, have spoken with affected residents and offered individual counselling. She reiterated that interventions cannot be provided if the benefits are not fully defined. There is though one group of the population which is offered an intervention however, which is highly exposed women of reproductive age who are planning a pregnancy in the future. Dr Lyngberg noted that as a medical doctor, she can treat these residents ethically in order to reduce PFAS exposure of the next generation, preventing the high exposure to an unborn person to compounds which are known to affect the immune system of children. The intervention is off label, and so requires and careful individual assessment and fully-informed consent.

Dr Lyngberg explained that for all other residents, if the PFAS is removed, the cancer risk might not be removed. Dr Hajioff agreed, and also mentioned that it depends on the mechanism of the cancer, whether it is a mutation or whether it suppresses the immune system's ability to fight new cancers, and this makes a difference.

Dr Lyngberg told that panel, that they have not, in the cow grazers, seen any cases of cancer which could be expected to be related to PFAS. Some residents had slightly elevated

cholesterol which could be due to PFAS exposure, however mentioned that diet and exercise has a bigger impact on cholesterol than PFAS. For these residents, the research team could not determine whether their diet (which was high in meat) is the cause of their high cholesterol or the PFAS from the meat.

The panel asked about the residents opinions about whether they believe their symptoms are related to PFAS, and whether they want intervention or not. Dr Lyngberg replied to say that there are of course people who want intervention that ethically she cannot provide. Instead Dr Lyngberg provides individual counselling as having the conversation with people puts their minds at rest.

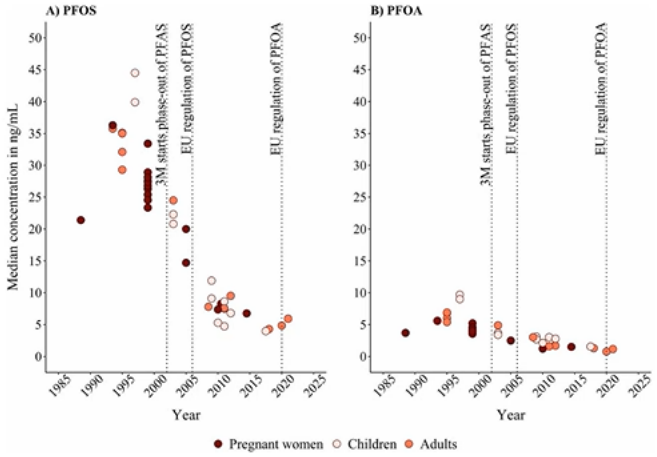
For the future, Dr Lyngberg explained that she wants further regulation to make sure that the levels of PFAS the population is exposed to are reduced.

On the subject of re-testing, Dr Lyngberg confirmed that the research group in Denmark do not offer re-testing for PFAS. This is for the following reasons:

- PFAS level has not been found to predict the health outcome of an individual
- Counselling and medical care for highly exposed individuals does not differ from that of low exposed or background population
- Tests or blood samples need to be actionable and to guide medical decisions and intervention. There is not a situation in which knowing a PFAS level will guide medical intervention
- Screening a population for PFAS is ad hoc screening and screening must adhere to WHO guidelines for screening, which PFAS screening would not meet.

Dr Lyngberg displayed a slide of PFAS time trends in Denmark. This is a published paper (Time trends in per- and polyfluoroalkyl substances (PFAS) concentrations in the Danish population: A review based on published and newly analyzed data - ScienceDirect) which summarises levels of PFAS in populations over time. PFOS has been reduced from 24-40ng/ml in the 1990s to around 4/5ng/ml in the 2020s. The average now in the cow grazers is the same as the average from 30 years ago in the general population. This slide indicates that PFOS does get excreted, and that regulations are important as they do work at reducing PFAS exposure.

PFAS time trends in Denmark



Time trends in per- and polyfluoroalkyl substances (PFAS) concentrations in the Danish population: A review

Dr Lyngberg moved on to discuss risk communication, focusing on population risk vs individual risk.

Several papers indicate there is a relative increase of 20-30% for kidney cancer among workers with massive, long time exposure of PFOA. Many patients when hearing this interpret it to mean 20-30% of the population will get kidney cancer, but that isn't what that increase means. When communicating risk for individuals, the lifetime risk and the increase must be considered and calculated together to find the 'absolute risk'. The lifetime risk of kidney cancer in Denmark is very low, 1.5% for men and 0.7% for women, or about 1.1% on average. In order to calculate the absolute risk, you have to take the lifetime risk and add another 20-30% on top of the lifetime risk. The table below shows how this risk is calculated, assuming there is an additional 30% risk caused by PFAS exposure. It shows that an extra 3 cases per 1,000 of the population of kidney cancer could be caused by high PFAS exposure.

	Lifetime risk for kidney cancer in Denmark (%)	Additional risk, assuming 30% extra risk from PFAS (%)	Total absolute risk for highly exposed populations (%)	Additional risk due to PFAS (%)	Number of expected kidney cancer cases in the general population, Denmark (per 1,000 people)	Number of expected kidney cancer cases in a highly exposed population (per 1,000)	Number of additional kidney cancer cases due to PFAS exposure (per 1,000)	Number of additional kidney cancer cases due to PFAS exposure, per 200 people
Men	1.5	0.45	1.95	0.45	15	19.5	4.5	0.9
Women	0.7	0.21	0.91	0.21	7	9.1	2.1	0.42
Average	1.1	0.33	1.43	0.33	11	14.3	3.3	0.66

This is why it was not a surprise to the research group that there were no extra kidney cancer cases in the cow grazing association population of 200 people, because for a population of that size, only an extra 0.6 cases would be expected. The risk with lower exposure levels than highly exposed workers is not known. It could be lower or the same, but it is unlikely to be higher.

For comparison, air pollution or passive smoking – which are other factors from the environment which affect cancer rates - increases the risk of lung cancer of 25-30% (i.e. a similar relative increase risk as PFOA for kidney cancer) which has a lifetime risk of 4.5% which is 3 times higher than the increased risk for kidney cancer. Therefore, it is 3 times more likely that someone would get cancer caused by air pollution or passive smoking than from high PFAS exposure.

Dr Hajioff agreed and also reminded everyone that getting a cancer doesn't necessarily mean that you will die from it either, the 5 year survival rate is important too. Dr Lyngberg agreed and told the panel that in Denmark it is around 85% of cases will recover from it.

When this was explained to the affected population in Denmark, the population understood that the additional risk is low and that they may not see the disease in their population.

Take home messages

1. PFAS elimination can be enhanced by administration of an anion exchange resin, but there is no evidence that this intervention decreases the risk of adverse health effects
2. Interventions should not be implemented at a population level without evidence of health benefits

3. Screening must adhere to WHO guidelines, and so should not be implemented for PFAS exposure as the criteria for screening are not all met
4. The additional risk (relative risk) caused by PFAS must be translated to individual absolute risk to enable people to understand their likelihood of developing a condition due to PFAS
5. There is not enough evidence to provide intervention to all highly exposed individuals. In Denmark, off label intervention is though offered to highly exposed women who are planning a pregnancy.
6. Retesting for PFAS is not offered in Denmark as test results are not actionable, i.e. they do not result in different individual action as a consequence of the result .

Dr Lyngberg finished her presentation and invited any other questions.

Prof Cousins asked if the testing data presented today is all published in reports and papers. Dr Lyngberg explained the majority is and additionally that there is a paper in development correlating meat intake and PFAS levels. The other numbers are public, but in Danish. Dr Lyngberg offered to discuss further on risk communication as it is an area that requires more focus. Dr Hajioff thanked her and agreed that it is very important.

Dr Fletcher asked if another source of PFAS was detected whether those individuals be tested. Dr Lyngberg replied that it would depend if there was information that could be learned from testing, or if it could drive action. There was another cow source with lower exposure measured in meat (2ng/g in comparison to180ng/g), and therefore blood levels could be estimated based on the blood levels in people exposed to 180ng/g. These levels were estimated to be near background levels and as appropriate action could be taken (stop ingesting the meat), no blood tests were offered as there would be no useful information gained.

In an exposure caused by a manufacturing facility in Veneto, Italy, the authorities offered testing to everyone, which was approximately 50,000 people. They also offered cholesterol testing, and this was very expensive.

Dr Lyngberg explained another example of testing of surfers in Jutland, Denmark. High PFAS levels in foam were discovered. It was discussed with the surfers, pointing out that there would be no individual health impact to being tested, but blood testing would help the researchers identify the exposure route. Approximately 20 people were offered testing, and very low levels were found in the blood.

Dr Hajioff explained that there are three potential benefits of testing:

1. Clinical benefit
2. Research benefit
3. Political benefit

He explained that there are risks from testing including that it is not known what tests mean in a non-symptomatic population. It often purely increases levels of anxiety in those who are tested.

Dr Lyngberg agreed and explained that for breast cancer, screening is conducted and this sometimes find tumours which wouldn't have developed into cancer but the tumours are treated as though they are cancer and therefore there is both psychological and physical harm caused by screening. This is an example of why it is important that screening decisions

are made with full understanding of the risks and health benefits, which is not the case with PFAS.

Dr Fletcher explained that some people could choose to use blood donation services to reduce their PFAS levels, and asked if this had happened in the cow grazing population because interventions are not being offered. Dr Lyngberg explained that the topic had been raised but that she discussed this with individuals, explaining that giving blood is a gift to someone else, and it cannot be a gift if it's given for the wrong reasons. She also said that if the contaminated meat had been distributed among all the supermarkets in Denmark, PFAS levels would not be increased in the general population, and the same is true for blood, because the increased levels would be diffused across the population.

Dr Hajioff mentioned that the panel had discussed this topic when investigating phlebotomy in Report 1. The only situation in which people with high levels donating blood could cause a problem for recipients would be if someone had very high levels of PFAS and a very rare blood type, and the PFAS-containing blood was stock piled and all given to one person who needed a lot of blood all at once. In this situation, there would be an increase for the person receiving the blood. The panel concluded that this was an unlikely situation.

Dr Fletcher asked if there was any bounce-back in PFAS levels in the crossover study after the intervention finished, as a consequence of it being redistributed from the body's organs to the blood. Dr Lyngberg replied to say that the research team considered that, had lots of discussions and calculated to detect any rebound, but there was no difference seen. Dr Fletcher noted that in the Italian data from Veneto, where they offered plasmapheresis, there was an initial big drop due to the intervention, but then levels increased again later. Dr Lyngberg agreed, and explained that there is redistribution between blood and organs but because cholestyramine is delivered daily, less rebound effect was likely. If it was a one off or less regular intervention (such as with blood removal), then the rebound effect may have been seen.

Dr Hajioff agreed and noted that it was an important point. Redistribution happens every day, not over months. There is a reduction on the redistributed portion every time. For phlebotomy or plasma donation, it is a single event and then takes a while to redistribute. The anion exchange resin approach helps to deplete the other reservoirs in the body during the intervention period.

Dr Hajioff thanked Dr Lyngberg for her fascinating presentation and discussion. Dr Lyngberg offered for the panel to contact her for any further questions.

Any other business

No other business was raised by the panel.

Date of next meeting

Thursday 7 November 2024. It will be held 10am-1pm online. The review of the literature on testing will be reviewed, along with testing for other potential consequences of PFAS exposure such as cholesterol, and the side effects and tolerability of different forms of intervention considered by the panel.

The Chair thanked everyone for their contributions, those watching the meeting and Julia for her support throughout the whole process. A reminder to the public that this meeting has

been recorded and the video will be available online on request by emailing the PFAS mailbox. This will take a couple of days to make sure the observers are anonymised.

There being no further business, the meeting was closed.

To note that the panel can be emailed via PFASpanel@gov.je.

Details of meeting dates and times can be found at PFAS in Jersey (gov.je)

Minutes of public meeting of the PFAS Scientific Advisory Panel on Teams 10:00am on 7 November 2024

Panel Members present:	Dr Steve Hajioff – Independent Chair
	Dr Tony Fletcher – PFAS and Health member
	Professor Ian Cousins – PFAS and Environment member
In attendance:	Julia Head – Senior Public Health Officer
	Grace Norman – Deputy Director of Public Health
	Programme support team from I&E

Welcome:

The Chair welcomed everyone to the panel meeting, and reminded people the meeting was being recorded.

Introductions

The Chair and Panel members introduced themselves.

Dr Steve Hajioff, Independent Panel Chair: A background as a GP for 25 years and a retired Director of Public Health from an area of London with two major international airports and a variety of other environmental hazards and challenges. Not a PFAS expert but has done lots of work with National Institute of Care Excellence and other groups about translating science into policy. Dr Hajioff has also worked a lot in the pharmaceutical industry.

Dr Tony Fletcher, PFAS and Health Panel Member: Environmental Epidemiologist at the London School of Hygiene and Tropical Medicine, working on PFAS since 2006 and member of the panel with experience of epidemiological studies on the health effects of PFAS in contaminated communities in West Virginia in the United States, in the Veneto region, in Italy, and in Ronneby, and is the health expert on the panel.

Professor Ian Cousins, PFAS and Environment Panel Member: A Professor in Environmental Chemistry at Stockholm University, an expert on PFAS, appointed as the environmental expert on this Panel and whose expertise on PFAS is on the sources, transport, fate, and exposure of PFAS.

Standing observer Grace Norman, Deputy Director of Public Health is present. Grace commissioned the panel on behalf of Government of Jersey. Support staff for programme management and administration were also in attendance.

Declarations of Interest

No additional declarations.

Minutes of last meeting and matters arising

There were no minutes from the previous meeting to discuss due to the August, September and October meetings containing inputs from Experts by Experience and Subject Matter Experts. This requires additional review by the experts prior to minutes being discussed in the meeting. Dr Hajioff apologised for the delay.

Additional findings since the last meeting

Dr Fletcher explained that Prof. Ian Cousins had organised a letter, signed by over 50 scientists including himself, which has been sent to the British Government urging them to regulate PFAS more strictly. This letter received media attention and was mentioned in the House of Commons. Dr Hajioff provided reassurance that the panel had previously discussed the ethical implications of participating in such advocacy, concluding it was appropriate for the experts to be involved and not a conflict of interest for their Jersey roles. The letter can be found at this link - PFAS letter from global academics to UK ministers_2024.pdf

Prof Cousins mentioned an interesting study where a German researcher dosed themselves with stable isotope-labelled PFAS for over a year. The study provided valuable data on human pharmacokinetics, despite being limited to one individual. It raised ethical and scientific discussions. Dr Fletcher added that the researcher did not need ethical approval for self-dosing and has since received approval to dose a dozen volunteers. Dr Hajioff noted that such self-dosing would not receive ethical approval in the UK due to different medical regulations. The study raises interesting questions and provides useful data, but more extensive research is needed for broader conclusions to be drawn.

Agenda item 5 – Dr Fletcher – Interventions literature review

Dr Fletcher has summarised the literature of interventions which reduce body burden of PFAS. There are three types of studies:

1. Observational studies
2. Interventions without control group
3. Interventions with control group comparison

Dr Hajioff reminded observers that the different types of study design have been summarised in Report 2. Dr Fletcher explained he has also briefly summarised them in the current paper.

Diet interventions

There have been several studies showing differences in PFAS levels related to diet.

- High fibre foods appear to have an impact on the elimination of some PFAS compounds, resulting in lower serum levels of these compounds.
- Probiotics to help have a healthy gut also appear to have an impact on some PFAS compounds.

Dr Fletcher took the panel through his report including a table detailing the extra reductions over 3 months for PFOS, PFOA and PFHxS for diet and probiotics in addition to the reduction due to natural half life. Dr Fletcher explained the mathematical calculation used to compare excretion of PFOS using half life, and presented a graph showing that there is an additional 9% reduction of PFAS levels in people who consume a high fibre diet. This

increase in PFAS excretion suggests that a high fibre diet could result in a reduction of 14 weeks over 20 years, in the time taken for PFAS levels to reach background. which is a modest difference. PFOS is the compound where the reduction appears to be most rapid.

Dr Fletcher explained the effect of medication including probenecid, bile acid sequestrants and statins on PFAS levels.

Probenecid

Evidence suggests that for Probenecid, which affects kidney uptake and reabsorption, had no effect on PFAS levels, but the bile acid sequestrant cholestyramine appears to show a dramatic effect on PFOS levels in studies in the C8 population and the general NHANES US population. Dr Fletcher displayed the effect of bile acid sequestrants on PFOS and PFOA in a graph which showed that the excretion rate is substantially faster than the effect caused by a high fibre diet. Statins had an inverse effect, meaning that people taking statins had a higher level of PFOS but it was not a statistically significant effect.

Dr Fletcher described a study which looked at probenecid in the population in Ronneby and showed no effects.

Bile acid sequestrants

Dr Fletcher described a study by Genuis *et al*. where bile acid sequestrants were used in a high PFAS exposure family and demonstrated a rapid excretion of PFAS following cholestyramine administration.

A clinical trial in Denmark was described where participants were randomised into observation groups and bile acid sequestrants treatment for 12 weeks. Participants had increased levels of PFOS, PFOA and PFHxS due to eating contaminated meat. This is a randomised study with controls in place, so this is a strong study design. There was a dramatic reduction of PFOS in particular in a 12 week intervention period.

Plasma interventions

An intervention study with control groups in Australian firefighters was conducted where participants were either given phlebotomy or plasma exchange. This study has been summarised already in Report 1. The fall in serum levels from phlebotomy varied from 2.4% for PFOS, 3.9% for PFHxS and 5.8% for PFOA, however this figure for the benefit on PFOA was very imprecisely estimated due to concentrations being low in the participants. The plasma removal procedure study showed the benefit (reduction of PFAS levels in serum) varies between 2 – 7%. An average of 4% reduction in PFAS levels was determined in Report 1 with some uncertainty.

Comparison of interventions

A table has been prepared to display the percentage reduction in PFAS serum levels over a period of 3 months, looking at all interventions which have data, including an option for doing nothing.

Option	Source of data	PFHxS	PFOS	PFOA
Do nothing	Ronneby half life study	3	4	5
Phlebotomy 1.5 procedure	Average impact of 4% per procedure	6	6	6
Plasma removal 3 procedures	"	12	12	12
Probenecid drug use	Ducatman study	0	0	0
Bile acid sequestrants drug use	Moller study	15	60	20
High fibre diet	Nhanes study	0	0.5	0.3
Probiotic supplements	Nhanes study	0	0.6	0.4

Dr Hajioff commented that haemodialysis is not included in this table, because it was considered as a theoretical intervention but no evidence was found in the literature. Dr Hajioff will present on this technique in next month's meeting. Dr Fletcher commented that there was a paper from Taiwan on haemodialysis which he will add to the discussion but that it will not change the conclusions.

The panel commented that preliminary results from ongoing studies described by Dr Andersson in September's panel meeting are consistent with these findings.

Agenda item 6 – Testing and retesting – Prof Ian Cousins

Prof Cousins presented the findings of systematic reviews (or a review of reviews approach) which is a well-established and reliable methodology in healthcare research. It is an efficient and appropriate method for summarising extensive literature within a limited timeframe. Large reviews have been conducted on PFAS testing in general and elevated exposure populations.

Reviews and studies were divided into categories based on exposure levels and types. Studies focused on populations near fluoropolymer manufacturing sites such as the Teflon factory in the US and 3M manufacturing plants. Other places of contamination include in North Carolina, Antwerp and the Veneto region in Italy. Separate studies on places experiencing AFFF contamination near airports and military bases such as in the US, Ronneby in Sweden and Australia were used. There is also an exposure in Denmark from consuming contaminated cows which is a more indirect exposure profile, but still covered. Prof Cousins has focused on PFOS, PFOA and PFHxS as these are the most relevant PFAS compounds for Jersey.

Prof Cousins explained that most studies that involved human testing aimed to understand exposure levels, how to mitigate the exposure and whether contamination levels are reducing, rather than being conducted for clinical management of patients. Most focused solely on exposure levels, however some studies included health information. Unlike Jersey, most studies have not asked participants about symptoms, and instead they include a large number of volunteers living in the area of interest and determine the levels in the population.

Prof Cousins reminded the panel that they had heard from subject matter experts in Sweden and Denmark who specifically do not recommend doing any re-testing of individuals, as there is no agreed follow up with the information. Health outcomes cannot be determined by the serum level on an individual level. Dr Hajioff agreed, and commented that this will be further discussed by the panel in the next meeting when discussing Dr Fletcher's thoughts on body burden of PFAS and disease risk.

Prof Cousins described the studies available in Australia, Sweden, Germany and the US, and concluded that the levels in the general population are remarkably similar, with the exception of Asia which has higher levels due to ongoing manufacture of PFOA and PFOS. The highest known exposures in the world are in fishermen in China consuming fish contaminated with PFOS. Dr Hajioff asked Prof Cousins to include the levels from different studies in this paper so that Islanders can compare their own levels with those from around the world.

Prof Cousins indicated that there are many occupational sources of exposure to PFAS, and that firefighting exposure has been determined to be the focus of this paper. Firefighting foam in Australia changed formulation away from long chain PFAS in 2005, so firefighters joining the service since then would have levels more similar to background levels than those who historically used the long chain PFAS AFFF.

Prof Cousins finished by summarising the evidence he had found regarding re-testing, indicating that the consensus from around the world is that retesting should not be conducted unless it is known how to interpret the data, and there are clear outcomes from the knowledge. Most testing around the world is conducted for research and epidemiological purposes, not for clinical management. Dr Hajioff agreed and reiterated that there is not clear evidence linking individual levels in blood and health effects.

Dr Hajioff thanked Prof Cousins for the paper, which will be very useful in the panel's deliberations.

Prof Cousins added that many of the studies he has summarised had a reference population nearby in order to compare to the contaminated population. He thought that it would be useful to do this in Jersey as well. Dr Hajioff agreed and reminded the panel that one of the recommendations in Report 1 was to generate a baseline population level of PFAS. It has not yet been put in place, and the panel may recommend this study is conducted again in Report 3, as it would be very useful information for the panel.

Dr Fletcher commented that when testing, some studies informed participants of their results and some participants were not informed due to the fact the results cannot be interpreted on an individual basis.

Dr Fletcher agreed with Prof Cousins when he noted that the ATSDR gathered measurements but not health data as it was a scoping study. He informed the panel that there is a second phase underway at the moment, a new study which is gathering health data including cholesterol and immune markers and specific clinical markers to look at associations. This will be useful in the future.

Dr Fletcher also commented on the Italian study which offered everyone living in the contaminated area (100,000 people) a test which included clinical markers such as PSA (for assessing prostate health) and cholesterol, and results were given to everyone who participated. This was done because it was thought to be a public health benefit to screen the population which might pick out health conditions in which they could offer interventions.

Some age groups have been offered further testing. There is a study looking at rates of decline to estimated half lives, and another to look at correlating changes in PFAS and cholesterol to see if there is a recovery to normal levels of serum cholesterol. Dr Hajioff asked Dr Fletcher to expand on this information in the next meeting in December.

Dr Hajioff thanked Prof Cousins and commented that this paper will be very useful in future discussions.

Agenda item 7 – Plasma removal – Dr Hajioff

Dr Hajioff presented a short paper which provided detail about the different types of blood plasma treatments that are used in medical practice. Plasma is the part of the blood that contains white blood cells, platelets, antibodies and proteins to transport other components such as iron around the body so it could be a good option for reducing PFAS.

Different types of blood plasma treatments were explained:

- Altruistic plasma donation is conducted once a month for the benefit of others who may not be able to remake their own plasma. It requires an apheresis machine to extract the plasma from whole blood and returns the rest of the blood to the body.
- Plasmapheresis also uses the apheresis machine, but the plasma is also treated to remove a contaminant from the plasma and then the plasma and blood is put back into the body. The contaminant must be able to bind to a substrate in order for the contaminant to be removed, and PFAS does not bind to substrates, so it is not expected that plasmapheresis would be effective for lowering body burden of PFAS.
- Plasma exchange is where plasma is taken out and another substance is put back into the body, which could be other people's plasma, colloid solutions or albumin. As the plasma is discarded, this technique could be more suitable for PFAS removal. However, donor plasma could not be used to replace the plasma removed, as this is a precious and finite resource which needs to be protected for medical emergencies. As plasma contains immune function and clotting factors, if this technique is conducted too regularly then it would be unhealthy for the participant.

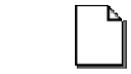
Dr Fletcher asked if these techniques could be conducted in a medium sized hospital or whether it is a specialised service. Dr Hajioff confirmed it is an unusual technology and is usually conducted in specialised suites in a large hospital. It is not a portable technology, and treatments are required to be carried out in hospital in a sterile environment.

Agenda item 8 – risks, benefits and costs of each intervention – Dr Hajioff

Dr Hajioff presented papers on the risks, benefits and costs of the following interventions:

- Plasma removal
- Bile acid sequestrants
- Probenecid
- Psyllium husk supplement

The papers are attached to the minutes. There is more information in the papers than included in the minutes.


plasma removal.pdf


bile acid sequestrants.pdf


probenecid.pdf


Psyllium husk.pdf

A similar paper will be available about haemodialysis but it is not yet ready for discussion. It will be discussed in the next meeting for completeness, however there is no evidence that haemodialysis works to reduce PFAS body burden at present. He reminded the panel that phlebotomy is not being considered in this section as it has already been reviewed in Report 1.

Plasma removal

Dr Hajioff presented the paper on plasma removal and described the procedure, eligibility criteria, common side effects, rare but serious complications, and long term safety considerations.

Grace asked about the frequency of one of the potential complications, the reduction in immunoglobulin levels in patients. Dr Hajioff replied that it was quite rare, but that it depends on the procedure being used. If the procedure is completed at high frequency and replacing the plasma with a substitute rather than plasma is conducted, then the likelihood of a reduction in immunoglobulin levels in patients increases.

Dr Fletcher asked how long the procedure takes. Dr Hajioff estimated approximately 1 hour, although does not have recent experience with the techniques.

Dr Hajioff moved on to detail the capital and revenue requirements for establishing and running the plasma donation service, including equipment and personnel, maintenance and regulatory compliance. He reiterated that there are sizable equipment and personnel requirements and the necessity of conducting the procedure in hospital. He noted that the costs in this paper do not include on-costs and so are systematic under-estimates of the actual costs, and estimated that the first year costs would be approximately £300,000, and around £250,000 for every year beyond the first year.

Bile acid sequestrants

Dr Hajioff presented a paper on bile acid sequestrants including information on Cholestyramine, Colestipol and Colesevelam. This class of drug was regularly used to treat high cholesterol for many years, prior to newer drugs such as statins or ezetimibe being available. They work by binding bile acids in the gut which prevents cholesterol from being absorbed. The side effects were described, including a comparative analysis of side effects and tolerability of each compound.

Dr Hajioff commented that there are dual benefits from using this class of compounds, as they work to prevent PFAS from being absorbed, and also work to lower cholesterol which is one of the potential adverse health effects of PFAS. There are also potential effects on the control of blood sugar and Colesevelam has been used in patients with type 2 diabetes. However, there is also the potential to prevent absorption of compounds such as vitamin A, vitamin D, vitamin E, vitamin K, folate and others, which can lead to malnutrition disorders.

The tolerability of cholestyramine is poor as it is unpalatable to consume and consequently adherence to treatment is often poor, however bile acid sequestrants in capsule form are better tolerated, particularly colesevelam, and are expected to result in improved adherence to treatment.

Dr Fletcher commented that the amount taken per day is very different for each of the bile acid sequestrants and asked why. Dr Hajioff replied that they are three different molecules and so act in slightly different ways.

The capital and revenue requirements were covered for each compound. Colesevelam in tablet form is the most expensive option at £730.20 annual cost and Cholestyramine is the cheapest at £350.40 per person per annum.

Probenecid

Dr Hajioff commented that as Dr Fletcher had already demonstrated that probenecid is not effective in PFAS removal, the panel should not spend a large amount of time on this option. Dr Hajioff presented the side effects and capital costs, explaining that as probenecid is an unlicenced medicine, it no longer has a list price in the UK. It was estimated to cost £800 per patient per year.

Psyllium husk supplement

Psyllium husk is a soluble fibre commonly used as a dietary supplement, used for laxative purposes in various gastrointestinal conditions. Dietary fibre has been associated with beneficial effects on cholesterol levels and glycaemic control. Dr Hajioff commented that the evidence presented for dietary fibre is from the diet, and the panel do not have evidence of the effectiveness of fibre supplements at reducing PFAS levels.

Dr Hajioff spoke regarding the side effects and capital and revenue requirements for psyllium husk supplementation intervention to reduce PFAS body burden. There are three options for administering this intervention, generic powder, branded powder and capsules, with costs ranging from £30.66 to £434.13 per patient per year.

Dr Fletcher commented that there is no literature directly on the impact of psyllium fibre gel on PFAS levels. He commented that in one study he reviewed, the researchers investigated a fibrous plant product and found no effect. This may have been because this population had previously used cholestyramine to reduce their PFAS levels, and so it was not a fair test of the effectiveness in populations with high levels of PFAS. There is no other literature on psyllium husk interventions, however the panel are aware that a study on psyllium husk in Denmark has received funding but has not yet commenced.

Dr Fletcher proposed that the panel consider including a recommendation about increasing the amount of fibre in the diet rather than using fibre supplements in a medical manner. Dr Hajioff agreed, and indicated that recommendations will be discussed further in the meeting in January. Dr Fletcher proposed that the panel could hear evidence from a researcher from Zoe with experience in dietary advice and dietary fibres. Dr Hajioff cautioned that speaking with more experts will delay the progress of the report and that due to his own expertise in this area, it may be that the panel has the required amount of knowledge in this area already.

Comparative costs for interventions

Estimated costs per 50 patients in the first year

Intervention	**Costs per annum**
Plasma removal	£150,000 – £200,000
Bile acid sequestrants	£8,760 - £18,000

Probenecid	£45,000
Psyllium husk supplements	£1,533 – £26,206.50

Grace commented that understanding the relative costs of each intervention is very important, however these estimates are likely to under-estimate the cost to Government as they do not include on costs, some implementation costs and the costs of evaluation and monitoring for any programme or intervention implemented. Dr Hajioff agreed, and indicated that Islanders and other stakeholders must be aware that there may be additional burden on the Government of Jersey and Islanders via taxes, as there are for delivering any new services.

Any other business

No other business was raised by the panel.

Date of next meeting

Wednesday 11 December 2024. It will be held 10am-1pm online.

The Chair thanked everyone for their contributions, those watching the meeting and Julia for her support throughout the whole process. A reminder to the public that this meeting has been recorded and the video will be available online on request by emailing the PFAS mailbox. This will take a couple of days to make sure the observers are anonymised.

There being no further business, the meeting was closed.

To note that the panel can be emailed via PFASpanel@gov.je.

Details of meeting dates and times can be found at PFAS in Jersey (gov.je)

Minutes of public meeting of the PFAS Scientific Advisory Panel on Teams 10:00am on 11 December 2024

Panel Members present:	Dr Steve Hajioff – Independent Chair
	Dr Tony Fletcher – PFAS and Health member
	Professor Ian Cousins – PFAS and Environment member
In attendance:	Julia Head – Senior Public Health Officer
	Grace Norman – Deputy Director of Public Health
	Programme support team from I&E

Welcome:

The Chair welcomed everyone to the panel meeting, and reminded people the meeting was being recorded.

Introductions

The Chair and Panel members introduced themselves.

Dr Steve Hajioff, Independent Panel Chair: A background as a GP for 25 years and a retired Director of Public Health from an area of London with two major international airports and a variety of other environmental hazards and challenges. Not a PFAS expert but has done lots of work with National Institute of Care Excellence and other groups about translating science into policy. Dr Hajioff has also worked a lot in the pharmaceutical industry.

Dr Tony Fletcher, PFAS and Health Panel Member: Environmental Epidemiologist at the London School of Hygiene and Tropical Medicine, working on PFAS since 2006 and member of the panel with experience of epidemiological studies on the health effects of PFAS in contaminated communities in West Virginia in the United States, in the Veneto region, in Italy, and in Ronneby, and is the health expert on the panel.

Professor Ian Cousins, PFAS and Environment Panel Member: A Professor in Environmental Chemistry at Stockholm University, an expert on PFAS, appointed as the environmental expert on this Panel and whose expertise on PFAS is on the sources, transport, fate, and exposure of PFAS.

Standing observer Grace Norman, Deputy Director of Public Health is present. Grace commissioned the panel on behalf of Government of Jersey. Support staff for programme management and administration were also in attendance. Dr Hajioff explained that the Regulation team are in attendance as they are taking over the process from January and it is important that they understand the process of the panel.

Declarations of Interest

No additional declarations.

Minutes of last meeting and matters arising

Dr Fletcher indicated that he had not fully reviewed the minutes due to illness. Dr Hajioff agreed that minor corrections can be taken after the meeting. If there are substantive corrections, then they should be brought back to the meeting.

August minutes

No matters arising. Minutes were signed off as true and accurate record of the meeting.

September minutes

Dr Hajioff commented that in some previous meetings the panel have used terminology differently which could cause confusion. 'Biomonitoring' was used by the panel to describe testing for the potential ***consequences*** of PFAS in the body, but this term is more routinely used in the literature to describe PFAS levels ***in*** the body. Therefore, the panel have changed their terminology regarding looking for things that could have been caused by PFAS such as cholesterol to "clinical testing". Where "biomonitoring" appears in minutes before the change (July 2024), the panel meant clinical testing and not PFAS level testing.

Prof Cousins commented that the first paragraph in the September minutes was confusing, as it references both biomonitoring and dust. Dr Hajioff agreed, and indicated it required an extra carriage return after the end of the first sentence. The minutes have been updated. The panel clarified their position on a discussion they had in July regarding the gathering of information about a household and whether tap water and dust samples should be gathered. They agreed that only gathering information on whether the household was on mains or borehole water would be sufficient to assess the potential for ongoing exposure. If households are on mains water, then exposure from water would be consistent across the island. If households are on borehole water, then there could be greater variation in the levels they are exposed to from water. As water forms the majority of the exposure in the exposed population around the airport, house dust is a smaller exposure source. The minutes have been updated to reflect the discussion.

Dr Hajioff commented that he is not sure what specific bile acid sequestrant preparation Dr Andersson was using in his study and asked Dr Fletcher if he knew. Dr Fletcher confirmed that cholestyramine powder was used in the study at the beginning but due to unpalatability and the fact that participants wanted to drop out of the trial, the participants were moved to capsules called Colestipol or Colesevelam. Dr Fletcher will speak with Dr Andersson to confirm the preparation used.

Dr Hajioff confirmed that the subject matter experts have approved these minutes.

Dr Klein has been unwell and best wishes have been sent by Dr Hajioff to him on behalf of the panel.

The minutes were accepted with slight changes as discussed in this meeting.

October minutes

No matters arising. Minutes were signed off as true and accurate record of the meeting.

November minutes

No matters arising. Minutes were signed off as true and accurate record of the meeting.

Additional findings since the last meeting

Dr Fletcher made some modifications to the elimination paper which was discussed in November's meeting based on the discussion in that meeting. Dr Fletcher has made some assumptions in the preparation of this paper and wished to discuss them with the panel; the paper was shown on screen.

Studies detailed in the report are either observational studies in the population, which are at risk of confounding, or interventional studies with or without a control group. The best studies to estimate the effect are those with a control group. Dr Fletcher commented that the panel have previously discussed how to present the impact of each intervention. The true half life is estimated from completely stopping exposure. This is displayed as a black curve on the graphs, but is purely theoretical as there is ongoing exposure to PFAS in the environment.

Dr Fletcher displayed his comments on diet in the paper, and concluded that diet does not make a large impact on elimination. The additional 9% excretion (considered to be from food) in addition to the normal rate of excretion is likely to be an overestimate, as there is a lot of uncertainty in this figure due to uncontrolled variables and different starting positions of PFAS levels in the study population.

Dr Fletcher has added information on haemodialysis to the paper. He described one study comparing people undergoing dialysis for kidney disease compared to two control groups, one without kidney disease and one with kidney disease but not undergoing dialysis. Those with kidney disease but not undergoing dialysis had a lower level of PFAS at the outset of the study than the controls. Comparing within kidney disease, the impact of dialysis in this study reduces serum levels from 4.2 to 0.29 ng/ml which is a similar magnitude to the cross sectional observational study with bile acid sequestrants. If this benefit was the same in healthy individuals without kidney disease, the benefit would be of similar magnitude to bile acid sequestrants. Dialysis is an invasive and onerous intervention and so it would be inappropriate to offer such an intervention to someone who does not have kidney disease, so the graphs have not been updated to include the impact of dialysis. Dialysis was discussed later in the meeting also.

Dr Fletcher continued to speak to his paper about studies estimating the benefits of phlebotomy. He explained about a study investigating the benefits of fibre, however due to the use of bile acid sequestrants in the same study, there is a concern about extrapolating from the results of this study to real life benefits of a high fibre diet alone for PFAS elimination.

Dr Fletcher moved on to summarise intervention studies on phlebotomy and plasma removal, including the Australian firefighters study discussed previously. This showed a drop due to phlebotomy and plasma removal. In Report 1, the Australian study, the intervention without control group and the pilot data from the Italian experience were summarised. It was a variable amount of reduction which was not consistent, and a global average benefit per phlebotomy procedure of approximately 4% was determined by the panel in Report 1. Dr Fletcher considers it sensible to stick with this figure.

However, during research for the current report, it appears that the benefit of plasma removal looks slightly greater than phlebotomy, and Dr Fletcher proposed that phlebotomy benefit should be modified to 3%, and plasma removal set at 4% to make a distinction between the two techniques. Dr Hajioff commented that this analysis is very complex and the demographics (age, weight, build) of individuals have effects on the amount of reduction

from a given intervention. Within an individual there can be significant variations too, for example how hydrated the participant is on a particular day can affect PFAS levels. The intervention study was conducted on a small part of the population with ongoing exposure. Dr Hajioff concluded there would be little benefit in reworking this calculation from Report 1, it is a reasonable estimate, and it would not make a large difference overall. Dr Fletcher agreed with the decision.

The second intervention study, the Danish study showing an effect of bile acid sequestrants, showed a dramatic reduction of PFOS and a lower benefit for PFHxS in terms of percentage fall. The figures from the Swedish study summarised by Dr Axel Andersson at a previous panel meeting are not yet available.

Dr Fletcher has prepared a summary for all interventions over a 3 month period. There are assumptions made during the preparation of the table, including assuming average 4% for both plasma removal and phlebotomy, and the frequency of interventions. The rate of offering these interventions may be lower in practice.

Option	Source of data	PFHxS	PFOS	PFOA
Do nothing	Ronneby half life study	3.8	5.6	6.7
Additional impact of:				
Phlebotomy 1.5 procedure	Average impact of 4% per procedure	6	6	6
Plasma removal 3 procedures	"	12	12	12
Probenecid drug use	Ducatman study	0	0	0
Bile acid sequestrants drug use	Moller study	15	60	22
High fibre diet	Nhanes study	0	0.5	0.3
Probiotic supplements	Nhanes study	0	0.6	0.4

Dr Fletcher also plotted a graph showing the impact of each intervention if taken for a year and by compound. He commented that the intervention must be undertaken for the whole year to achieve these reductions which may not be achievable for the population.

Overall, use of bile acid sequestrants was considered to have the most potential impact if fully implemented, especially for PFOS.

Dr Hajioff commented that he has been considering the cost effectiveness analysis so that a price per intervention can be calculated. He asked if it would be possible to calculate the time taken to achieve a 50% reduction in order to form a common currency across each intervention. The panel agreed that it would be possible based on the information available at present. The panel agreed this would be a useful exercise and Dr Hajioff requested Dr Fletcher complete this work.

Prof Cousins commented how effective bile acid sequestrants are, and that a reduction to background levels can be achieved very quickly. Dr Hajioff agreed, and commented that it demonstrates how important gut reabsorption is to the half life of these compounds.

Dr Fletcher reminded the panel that the table comes with a caveat, in that there may be a plateau effect, and the modelling assumes that the reduction is a compound effect, based on

the cross sectional data. Dr Fletcher commented that he must check whether the dose rate of the active ingredient is different between two different cholestyramine studies, as this would explain the difference between the results. Dr Hajioff indicated that the therapeutic cholesterol lowering dose was used in both studies, and a further study is planned with a lower dose which will have fewer side effects. Dr Fletcher predicted that the impact would be dose related but if side effects and costs were lower yet still resulted in a reasonable decrease of PFAS levels, it would be appealing.

Dr Hajioff commented that this work is extremely useful and important, and could also have an impact outside of Jersey as it may help inform what is done elsewhere in the world as well.

Agenda item 5 – Clinical testing review - Dr Fletcher

Dr Fletcher introduced clinical testing and showed a presentation. Clinical testing has three aspects:

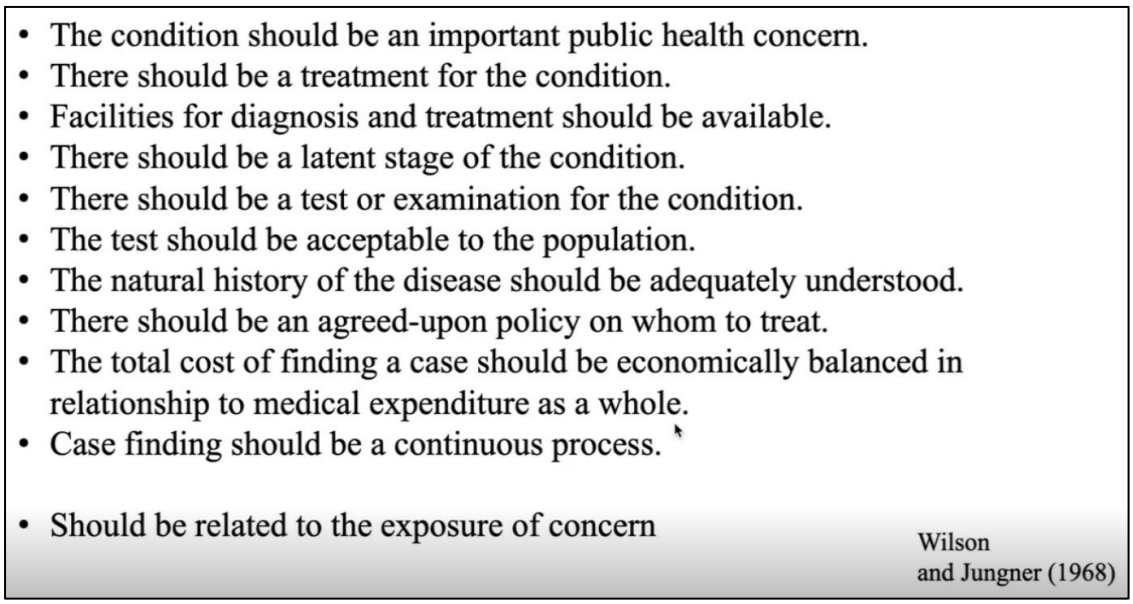
1. Detect if there is disease present, e.g. using scans or x-rays
2. Clinical blood or urine testing to identify markers of a disease e.g. PSA test
3. Clinical tests which do not identify a disease, but identify a risk factor for disease development, e.g. cholesterol levels

All these aspects must be considered by the panel in the PFAS context when considering whether it is appropriate to recommend clinical testing for people exposed to PFAS in the plume area. The purpose of offering testing to a population with raised PFAS exposure is to:

- Identify adverse effects in an individual with the benefit of earlier detection of diseases allowing early treatment and better individual outcome
- Gather information to analyse in relation to exposure to better understand the effects of PFAS
- Get a sample of the population to establish a representative average level for the indicator

There are comprehensive reviews which can guide the panel, for example the National Academies of Sciences, Engineering and Medicine (NASEM) report on Guidance on PFAS Exposure, Testing and Clinical Follow-up, which was published in 2022.

The internationally accepted criteria which need to be met for screening to be undertaken is included in this report and was summarised by Dr Fletcher:



Dr Fletcher summarised the health conditions related to PFAS exposure which are detailed in the NASEM report from general PFAS exposure, not specifically AFFF. He commented that different bodies have drawn different conclusions on different conditions, as the panel discussed in Report 2. The NASEM report concludes that screening for the identified diseases should be guided by the level of exposure for the individual. The authors used a pragmatic cut off of >20 ng/ml of the sum of PFAS. For this level, they recommend screening for cholesterol above age 2, thyroid testing, looking for signs and symptoms of kidney cancer, testicular cancer and ulcerative colitis. For the intermediate exposure range 2-20 ng/ml, they identify prioritising screening for high cholesterol, hypertensive disorders of pregnancy and screening for breast cancer. For the exposure range <2 ng/ml, they conclude no reason for concern and recommend normal screening programmes with no particular focus on PFAS conditions.

Dr Fletcher commented that this summarises the general approach to screening and how it has been converted to policies in the NAS report. He pointed out that the panel would not copy these guidelines in their report, but it is useful for them to review.

The C-8 medical monitoring programme was not a public health driven project, and instead came out of a legal case against the manufacturer. This is important as it affects the motivation for offering testing, screening or interventions. The C8 science panel, which Dr Fletcher was involved in previously, identified 6 diseases which showed evidence that they may be linked to manufacturing-related PFOS exposure (not AFFF). The C8 panel only looked where evidence existed. For the 6 diseases identified, the C-8 medical panel recommended conducting screening tests for 5 conditions for those who were exposed to PFAS. Guidance was given to General Practitioners to guide their work with patients. Pregnancy related hypertension was captured within normal screening for pregnant women in pre-natal visits. The take up for the screening tests was low. Many of the screening tests were completed as part of the routine medical surveillance in the US.

Dr Fletcher commented that there has been limited screening conducted in Ronneby in Sweden and none following on from the Flemish study where there was contamination from meat grazed on the contaminated land. Dr Fletcher has not yet summarised this information for the report but this will be included.

Dr Hajioff thanked Dr Fletcher for his presentation and commented that liver enzymes had been considered by the panel in Report 2 but that they felt that there was no evidence that elevated enzymes are related to liver disease. It was a blood test that is of no clinical importance. It was not one of the risk factors highlighted by the panel.

In relation to the diseases that were available for testing in the C8 report, Dr Hajioff provided the panel with more information about the effectiveness of approaches. Dr Hajioff cautioned that it is important not to misinterpret US information where services are not available in the same way as they are in Europe. There is no need for a targeted intervention in those which are exposed to PFAS if testing is routinely conducted anyway.

- Kidney cancer: Dr Hajioff also commented that he has had previous discussions with Professor Willie Hamilton who is an expert on cancer detection, and concluded that there is not a meaningful test for kidney cancer. Ultrasound testing can potentially be done, but it is not sensitive (i.e. good at finding true positives) or specific (i.e. good at finding true negatives) and so therefore may not identify early stage disease where is where it would be most useful in diagnosis. It is intrusive and relatively invasive.
- Testicular cancer: There is no test for testicular cancer apart from testicular self examination which was recommended by the panel in Report 2.
- Pregnancy induced hypertension: It is standard in clinical practice to screen for pregnancy induced hypertension in all pregnancies.
- Breast cancer: There is also breast cancer screening available everywhere in Europe including Jersey.
- Cholesterol: Dr Hajioff commented that there is universal cholesterol screening over age 40 in the UK, but not in Jersey.

Prof Cousins commented that there is overlap in the paper that he prepared on testing for PFAS, and that him and Dr Fletcher need to ensure that they include the same studies. For example, the Italian study also tested for health effects when they were testing for PFAS levels. He cautioned that the information does not need to be presented twice in the report, and that the overlap is carefully managed. Dr Fletcher agreed, and commented that there are also different policies, for example in the Swedish study, where they collected information on clinical markers for research purposes but the participants were not told their results. However, in the Italian study they were informed of their results as a public health service beyond the research context. Dr Hajioff agreed, and commented that this topic needs to be discussed in the next meeting in January in the context of the work in Jersey about the health of the individual. It is important that the panel focus in on the potential benefits to those individuals of having that testing. Prof Cousins pointed out that policies on informing participants of results are different around the world. Dr Fletcher agreed, reminding the panel that some believe that it is unethical to withhold results from individuals. Dr Hajioff commented that there are harms of conducting tests including anxiety, and the panel should consider proportionality. If there is something common within a PFAS population and many of the criteria discussed previously in the meeting by Dr Fletcher apply, then it may make sense to screen for this condition. For conditions which are very rare, but slightly more common in PFAS exposure, then offering screening would subject a lot of people to a procedure which causes discomfort, stress and anxiety, as well as costs, for minimal overall benefit. This aspect needs to be part of the consideration by the panel as well.

Dr Hajioff stated that in his opinion, the panel needs to discuss cholesterol testing and kidney cancer screening. The panel does not need to discuss thyroid or liver enzyme levels, because small changes are not related to disease states and so would not be useful.

Testicular screening has already been considered. Screening for breast cancer and pre-eclampsia are offered part of routine care to all eligible islanders, so do not need additional consideration by the panel for people in the plume area. The panel agreed to discuss the vaccine response, as it is another interesting but not clinically actionable scenario, but it wasn't clear about how to screen for this scenario.

Agenda item 6 – Risks, costs and benefits of Haemodialysis – Dr Hajioff

Dr Hajioff commented that risks, costs and benefits have been completed for all treatments discussed to date in a previous meeting, and this paper is specifically about the risks, costs and benefits of haemodialysis. He summarised the paper, introduced dialysis, and explained how the treatment which filters the blood through specialised equipment is used for those patients with serious kidney diseases. The procedure is conducted 3 times a week for the remainder of the patient's life. The sessions take several hours in a specialised hospital setting.

Dr Hajioff explained that it is difficult to separate the risks and benefits of the treatment between the kidney disease and the procedure. As dialysis is not used in healthy individuals, it is unclear whether the side effects will be present in healthy individuals. It is an unpleasant, invasive procedure, impacts on psychological wellbeing and is has a large impact on quality of life. Dr Hajioff explained the side effects in detail as described in the paper.

Dialysis is a large logistical undertaking needing specialist and non-specialist equipment to deliver, and specialist staff are required to conduct the procedure. The cost analysis conducted by Dr Hajioff concluded that the service would cost £1,380,000 per annum for 50 patients receiving 10 sessions each, excluding the cost of managing any side effects of the process. Dr Hajioff concluded that all aspects taken together indicate that haemodialysis is not a feasible option for intervention for PFAS exposure in the plume area. The panel agreed.

Dr Hajioff commented that this paper will form part of the report for completeness however it is highly unlikely that this intervention will be recommended for humane and cost reasons.

Agenda item 7 – Body burden – Dr Fletcher

Dr Fletcher indicated that this section introduces two issues, and raises three points.

The first section is a refresh on language referred to in the paper. It confirms that body burden refers to the amount of PFAS accumulated in the body, assuming the body burden is proportionate to the serum. It must be remembered that PFAS resides in other compartments in the body as well, for example, the liver, kidney and bile acid.

The second section refers to dose response relationships, and is a reminder that the studies which have been done attempt to characterise the dose relationship. In the available studies, dose response relationships are often displayed as a straight line (suggesting that there is a linear increase in PFAS based on exposure), but it depends on what is being measured in the study. Often, studies display this information differently from each other so this must be taken into consideration when comparing studies. Studies also show different effect patterns, for example having no effect on cholesterol at lower PFAS levels and then cholesterol increasing at a certain concentration, or effects at low levels then plateauing at higher concentrations of PFAS.

The final section of the paper covers whether or not, if exposure or body burden is reduced, then whether the health risks would be lower. It is important to note that it does not happen immediately due to a long half life. If there has been long term exposure, the individual will reach a steady state where the amount of PFAS which is being excreted is the same as the amount entering the body. Therefore, there may be a delay in the benefit of risk in terms of reducing the exposure. There is very little data on whether or not reducing exposure has been associated with a reduction in the health risks identified. Overall, the worldwide levels of exposure of PFOS and PFOA have been decreasing as legislative restrictions were implemented in the early 2000s. It is not known whether this reduction in global PFAS levels has been associated with a reduction in adverse health effects. It is known that for other examples such as smoking and ambient air pollution that stopping exposure does lead to a reduction in ongoing risk and reduction in disease and mortality. For immune effects, outcomes are improved if exposure is reduced. It is therefore plausible that if the exposures are reduced, the adverse risks associated with PFAS will reduce as well.

Two studies have been conducted on the dose-response relationship between PFAS and cholesterol; in the C8 population and an Italian study. In each, people had repeated measurements taken which showed that their PFOA levels were reducing. At the group level, there wasn't a clear reduction in cholesterol levels, thought to be because of other effects such as the population getting older in the time period, which would have counter-acted the benefit of lower PFAS levels. At the individual level, the more a participants' PFOA level went down, the more their cholesterol levels went down. There is some statistically significant (i.e. true) but small benefit in recovery of cholesterol levels when PFAS body burden was lowered.

In conclusion, Dr Fletcher commented that there are good reasons to be optimistic that there would be a health benefit from reducing exposure but it is hard to confirm or quantify.

Dr Hajioff thanked Dr Fletcher, and commented that in the paper, it is detailed that it is possible to prevent exposure by reducing body burden of women of childbearing potential. Any pregnancies occurring after a reduction in PFAS levels in the woman means the levels would be lower in the foetus and therefore would have lower risk to the foetus. Dr Fletcher commented that the long term effects of PFAS exposure may persist after exposure stops for the adult, as the effects may have been triggered when levels were higher.

Dr Hajioff commented that when the panel discuss the appropriateness of interventions, there are three groups they must consider:

1. Women of childbearing potential
2. People with elevated cholesterol
3. Everyone else, where lowering PFAS levels resulting in better health outcomes might be an assumption but not a provable assumption.

Dr Hajioff commented that it makes sense to consider these individually when considering interventions. The panel agreed.

Any other business

No other business was raised by the panel.

Date of next meeting

Wednesday 29 January 2025. It will be held 10am-1pm online.

The Chair thanked everyone for their contributions, those watching the meeting and Julia for her support throughout the whole process. He wished everyone a very Happy Christmas and New Year.

A reminder to the public that this meeting has been recorded and the video will be available online on request by emailing the PFAS mailbox. This will take a couple of days to make sure the observers are anonymised.

There being no further business, the meeting was closed.

To note that the panel can be emailed via PFASpanel@gov.je.

Details of meeting dates and times can be found at PFAS in Jersey (gov.je)

Minutes of public meeting of the PFAS Scientific Advisory Panel on Teams 10:00am on 29 January 2025

Panel Members present:	Dr Steve Hajioff – Independent Chair
	Dr Tony Fletcher – PFAS and Health member
	Professor Ian Cousins – PFAS and Environment member
In attendance:	Julia Head – Senior Public Health Officer
	Grace Norman – Deputy Director of Public Health
	Programme support team from I&E

Welcome:

The Chair welcomed everyone to the panel meeting, and reminded people the meeting was being recorded.

Introductions

The Chair and Panel members introduced themselves.

Dr Steve Hajioff, Independent Panel Chair: A retired Director of Public Health from an area of London with two major international airports and a variety of other environmental hazards and challenges, with 35 years in clinical medicine. An expert on translating science into policy, he has worked with Nice, the Greater London Authority, the EU, WHO and World Bank, several UK government departments and several international governments. Dr Hajioff has also worked extensively in the pharmaceutical industry.

Dr Tony Fletcher, PFAS and Health Panel Member: Environmental Epidemiologist at the London School of Hygiene and Tropical Medicine, working on PFAS since 2006 and member of the panel with experience of epidemiological studies on the health effects of PFAS in contaminated communities in West Virginia in the United States, in the Veneto region, in Italy, and in Ronneby, and is the health expert on the panel.

Professor Ian Cousins, PFAS and Environment Panel Member: A Professor in Environmental Chemistry at Stockholm University, an expert on PFAS, appointed as the environmental expert on this Panel and whose expertise on PFAS is on the sources, transport, fate, and exposure of PFAS.

Standing observer Grace Norman, Deputy Director of Public Health is present. Grace commissioned the panel on behalf of Government of Jersey. Support staff for programme management and administration were also in attendance. Dr Hajioff explained that the Regulation team are in attendance as they are taking over the process from January and it is important that they understand the process of the panel.

Declarations of Interest

No additional declarations.

Minutes of last meeting and matters arising

The December minutes were reviewed by the panel.

Dr Hajioff identified a typing error on page 6 and corrected the spelling of Professor Willie Hamilton's name. It has been updated in the minutes.

In matters arising, Dr Hajioff commented that Tony raised the Wilson and Jungner criteria for screening tests in the previous meeting, and the discussion is recorded in the minutes. An additional section for this report has been prepared on these criteria, giving more detail and explaining what they mean to help contextualise discussions around PFAS testing and clinical testing.

The minutes were signed off as true and accurate record of the meeting.

Additional findings since the last meeting

Dr Hajioff confirmed that there is a draft framework for Report 4 available and there is a public meeting planned to discuss this draft on 11 February 2025.

Prof Cousins commented that last week was a big week for PFAS news, with 10 articles in the Guardian alone and many other European newspapers. It was a coordinated effort led by La Monde newspaper in France called Forever Lobbying. One of the articles was about PFAS in Jersey.

Dr Fletcher explained that the Guardian article about Jersey described a misinterpretation regarding a recommendation for phlebotomy. Dr Fletcher commented that the panel did not recommend people had phlebotomy in Report 1, they recommended phlebotomy be made available on an interim basis until Report 3 had been finished and a more definitive judgment could be made on interventions for lowering blood PFAS levels.

Dr Hajioff confirmed that Report 1 was interim work, and Report 3 is the more definitive work. This will be published in the coming weeks. The science in this area has moved on and there has been interesting and useful work since Report 1 was published.

Grace also commented that as the Guardian article was not representative of the panel's findings, and that Prof Peter Bradley did an interview with ITV to correct the inaccuracies from the article.

Dr Fletcher also mentioned an Observer article published recently suggested a link between PFHxS and breast cancer. He confirmed that the study is not good quality as it has some significant methodological weaknesses, and there is no high-quality evidence of any PFAS being associated with an increased risk of breast cancer. The panel's conclusion in Report 2 – that there is not a known association between PFAS and breast cancer – is still appropriate. Dr Hajioff agreed, and confirmed that higher levels of breast cancer would have been seen in studies such as Ronneby if it were associated with PFAS exposure.

Agenda item 5 – Costs of phlebotomy analysis – Dr Hajioff

Dr Hajioff presented a paper on the costs of phlebotomy, using the same analysis technique which was used for the other intervention options in previous meetings. The paper was sent out in advance. Dr Hajioff spoke to the paper, explaining the costs including consumables

and staffing in order so that the phlebotomy intervention can be assessed side by side with the other interventions.

Agenda item 6 and 7 – Cost effectiveness analysis – Dr Hajioff

Dr Hajioff explained what cost effectiveness analysis means in a health and healthcare context. For PFAS interventions, it was most appropriate to conduct a health effectiveness analysis. The panel have examined how good the different interventions are at lowering PFAS body burden and how much it costs to achieve this reduction for each intervention. The findings compare cost effectiveness of each intervention, and are used for the panel to recommend the best option for people.

Dr Hajioff spoke to his paper which was prepared using Dr Fletcher's literature review, describing each comparison table and explaining the calculations and assumptions made for each. The tables are simplifications, as background exposure "top-up" has been excluded, because the main purpose of the calculations are to compare the different options against each other. He concluded that there is a big difference in the timeframes in reduction for each intervention across the three different PFAS compounds.

Capital costs for the different interventions are compared in the paper, with some interventions requiring capital costs. The most expensive bile acid sequestrant (Colesevelam) has been selected for the modelling as a worst case scenario. There is a wide range of costs between different interventions.

Dr Hajioff commented that for fibre supplements the evidence is based on people who have high fibre diets have lower PFAS levels, but the reason for this is not well understood. It could potentially be because these diets contain less of food items which have higher PFAS such as fish, meat and dairy products. It is also not known whether fibre supplements have the same effect as a high fibre diet.

Dr Hajioff prepared two tables showing the estimated impact of different interventions (phlebotomy, plasma removal, bile acid sequestrants and haemodialysis) on PFHxS levels and total PFAS. Probenecid and fibre supplements were excluded because they are not effective at reducing PFAS levels. The tables demonstrate the estimated time and cost to halve the level of PFHxS and total PFAS, and the relative cost effectiveness of each intervention. The analysis concluded that bile acid sequestrants halve the total PFAS levels and PFHxS more quickly and for the lowest cost than the other potential interventions.

All analysis up to this point had included the natural rate of decline of PFAS in the human body from excretion. Interventions that take the longest time to reduce PFAS levels include a greater proportion caused by natural decline. This means that it appears that more time consuming interventions may appear to be more impactful than they may actually be. Dr Hajioff shared additional analyses looking at the 'attributable' impact, which is calculated by taking out the natural decline and is not a real world scenario. This demonstrates the impact of background decline for those which take longer to have an impact such as phlebotomy. The cost effectiveness for total PFAS reduction when corrected for natural wastage indicates bile acid sequestrants are the most effective intervention, with plasma removal 10 times less effective.

In summary, bile acid sequestrants are the most cost effective solution, and they also work the fastest of all interventions considered by the panel.

Dr Fletcher commented that the theoretical analysis in the absence of natural decline would never happen. Particularly for the impact of fibre supplements as these speed up natural wastage. Dr Fletcher proposed a simpler way of displaying the impact, and displayed a slide containing a table to illustrate his point. Dr Fletcher added a column which is subtracting the additional reduction related to each of the interventions and calculated the amount of cost per nanogram per millilitre reduction in total PFAS.

Relative cost (12 months capital + revenue for 50 people) of different interventions to give a 1ng/ml drop in serum level

		Total PFAS	Drop (ng/ml) beyond no intervention	Cost for 12 months	Cost per 1 ng/ml drop	Ratio of cost of 1 ng/ml drop relative to BAS
No Intervention	12 months	22.2	0	0		
Phlebotomy	12 months	19.5	2.7	£125,000	46k	17
Plasma Removal	12 months	16.2	6.0	£275,000	46k	17
Bile Acid Sequestrants	12 months	6.6	15.6	£41,510	2.6k	1
High-Fibre Diet	12 months	21.9	0.3	£26,206	86k	33
Haemodialysis	12 months	9.2	13.0	£1,480,000	114k	44

Dr Fletcher explained that this additional analysis gives a similar outcome as Dr Hajioff's analysis, but he considers it more tangible and a better way to communicate the message. Dr Hajioff disagreed that this was as appropriate a methodology and expressed concern that looking at a 1 ng/ml, rather than a 50% drop obscured marginal differences, such as those between phlebotomy and plasma removal. The panel subsequently found problematic assumptions in the table and agreed to not progress it further.

It was agreed that fibre supplementation should not be included in any of the cost-effectiveness analyses because of the difficulty extrapolating high fibre diet to fibre supplementation

Dr Fletcher enquired as to why probiotics did not form part of this analysis. Dr Hajioff explained that only licenced medical products have been included, and there are no licenced prescribable probiotics products available and said that probiotics as an adjunct to other measures is possibly something the panel should consider in their recommendations

Agenda item 8 – Discussion and forming recommendations

<u>PFAS testing</u>

Dr Hajioff reminded the panel and audience that there must be a good reason for testing, and that it must benefit people's health and/or wellbeing.

The panel first considered who should be tested, based on Prof Cousin's paper including discussions with subject matter experts. There were 4 potential categories:

1. People who live/d in the plume area but who only didn't meet the criteria in 2022 due to lack of symptoms, or were eligible but untested for another reason (previously untested plume residents)
2. People who do not live in the plume area but who have been exposed occupationally
3. Retesting those who have been previously tested
4. Wider testing across the community

Each category was discussed in turn.

Previously untested plume residents

The panel confirmed, based on their research, that Jersey was unique in only testing those with symptoms to be tested. Other affected communities in areas with environmental contamination asked everyone to come forward for testing. Dr Hajioff commented that the testing in Jersey was done for a different purpose than other places, to identify if there were a problem.

Dr Fletcher explained that it had been considered a right for people in exposed areas to find out their level of exposure in the US and Italy, and that it is considered an ethical principle for people unwillingly and inadvertently being exposed to an environmental contaminant outside of their control, that they have a right to know how much exposure they have, as an abstract notion.

Dr Hajioff explained that the law worked differently in Jersey. He explained that there were ethical issues with the testing conducted in Italy, as there is a principle of non-maleficence, that a healthcare intervention does not do harm , and testing someone to find a level without a clear understanding of what it means, what the health implications are and for which there are no evidence-based interventions to reduce the level (which was the case in Italy at the time) will likely cause anxiety with no demonstrable health benefit.

Both the principle of non-maleficence, and the principle of beneficence (doing good or acting to improve the health and wellbeing of people) are important and valid, and the panel must take these principles into account when making recommendations for Jersey.

The panel agreed that they will write a recommendation about residents in the plume area (using 2022 eligibility criteria, excluding the criteria relating to health symptoms or conditions) who did not participate in the 2022 testing programme should be offered PFAS testing.

Occupational exposure

Occupational exposure can be wide, but given the nature of industry in Jersey, it only really applies to firefighters and those who may be involved in clean-up of contaminated areas. The date at which Jersey Airport and Fire Service ceased using PFAS-containing AFFF on flammable liquid fires is relevant information and should be determined. PFAS-containing AFFF were taken off the market in 2002, but there may have been stockpiles that were used later. Firefighters who used these foams may have higher serum levels, although they would

be expected to have reduced since exposure stopped. The primary exposure route is airborne from inhalation during spraying the foam.

Prof Cousins confirmed that the international evidence is from firefighters using Lightwater AFFF. In Australia, the 3M Lightwater foams were removed from use in 2004. The firefighters that used them in 1990s had high PFAS blood levels, thought to be from inhalation, although their protective clothing was also impregnated with PFAS. Firefighters recruited after 2004 had the same PFAS blood levels as background population, suggesting that dermal (skin) exposure from clothing is not significant. There is a potential that there are firefighters in Jersey who have higher PFAS blood levels if they used the foam. The panel asked to be provided with confirmation of when 3M Lightwater AFFF stopped being used; Grace agreed to take this as an action.

Other industries with potential occupational exposures exist, such as ski wax technicians, electronics manufacture, although it is not thought that these industries are present in Jersey. The feedback from Islanders will be sought on this matter.

The panel is in agreement that they will write a recommendation about those who have worked in firefighting and who used the 3M Lightwater foams prior to cessation of use if available should be eligible for testing. This will also include those who have been responsible for repeated cleanup of 3M Lightwater foams during those years.

Retesting those who have been previously tested

The panel have heard a lot of information from subject matter experts (SME) and there was a variety of opinions on retesting. Most of the previous testing programmes such as in Ronneby and Denmark were run to investigate whether interventions have been successful. They do not recommend testing for clinical purposes. In cases where there are legal settlements such as in the US, re-testing was offered as part of that settlement.

There are no situations internationally in which residents were systematically retested for clinical purposes, except following an intervention. There is no strong evidence for a systematic re-testing programme.

Dr Hajioff explained there are several reasons subject matter experts identified for repeat PFAS testing:

1. Establishing half lives for research purposes
2. Establishing effectiveness of an environmental intervention
3. Establishing effectiveness of a clinical intervention to reduce body burden
4. As part of a legal settlement

Otherwise, they recommended not to test.

In Italy, testing was done to establish the effectiveness of an environmental intervention. 50,000 people were tested across the population in the exposed area, and retesting was offered a few years later. This has been useful for tracking reduction in body burden in this population which reflected the interventions in this area to reduce exposure. Additionally, clinical markers were collected so that the researchers could investigate the impact of PFAS on cholesterol, to better understand the association between exposure and health.

The panel commented that they heard from SME that testing has the potential to cause anxiety and, the test results cannot be interpreted in a health risk context, so this harm cannot be offset against health benefits.

Additionally, there can be significant variation between measurements, based on how well the person is hydrated among other things, so, if multiple measurements are taken within a short time period (relative to the half life of the PFAS), any differences will still be within the margin of error and so would not provide meaningful information about changes in the blood for the individual.

The testing was offered in 2022, which is 3 years ago or roughly one half life for PFOA and PFOS, suggesting that re-testing may show a measurable decline levels on average at a population level, but it is less likely to for PFHxS, which have longer half lives. Average population levels might be informative to demonstrate reduction as a consequence of a new intervention, but the major intervention, the connection to mains water was in 2006, so before initial testing. On an individual level, however, there will be variability in the measurements, and so they cannot be interpreted meaningfully, and for some individuals, particularly those with a low exposure already, there will also be a levelling due to ongoing exposure from other sources.

Dr Fletcher commented that it would be beneficial to see to what extent the levels have fallen over a 3 year period in a research context. Dr Hajioff agreed, but reminded the panel that they have not been tasked with research, and but rather to consider the clinical benefit of re-testing in affected islanders. Testing is a medical procedure which has an impact on the individual and so therefore a retesting programme would have to be clinically appropriate in Jersey, with the potential to offer health gain. Failing that, retesting should only be considered within the context of a formal research and evaluation programme.

Dr Hajioff reminded the panel that one of the subject matter experts made it clear that blood testing should not be undertaken until environmental exposures are well understood, because it is not clinically appropriate to test humans as a proxy to measure environment levels of PFAS. Blood testing could be reconsidered once the environmental levels are known from Report 4.

Dr Hajioff summarised the discussion in that there has not been any interventions since the last testing in 2022, and there is not a convincing clinical reason to retest, although there might be research benefits which could be explored further in future. Re-testing is not meaningful at an individual level because of the high margin of error in the tests, and may increase anxiety in affected islanders, thereby causing more harm.

The panel agreed to not make a recommendation about re-testing of the population at the current time, but will review the question of re-testing at a later date once further information has been gathered about exposures within and outside of the plume area as part of Report 4.

Wider testing across the population

The panel considered whether it would be appropriate to offer testing to any islander for their individual purposes outside of the plume area. There are no other situations in which blood testing has been offered to a general population which is not in an area of known environmental contamination. This would be expensive, difficult to interpret, and does not provide information which is useful for health, because outside of areas of environmental contamination the association between PFAS exposure and health is not understood.

The panel agreed to not test more widely on an individual basis for individual benefit.

The panel agreed that broader community average levels outside of the plume area should be determined in Jersey, and that this is very important information. There is precedent, such as testing in Ronneby, and the USA, for population testing to enable a comparison between a hotspot exposure and the general population to better understand the extent of the exposure.

The panel agreed that they will write a recommendation about systematic, anonymous assessments to be made for average serum levels by parish in order to inform the endpoint of any clinical interventions, to better understand the effectiveness of environmental interventions, and in order to assess the nature of contamination outside of the plume area.

Clinical testing

Clinical testing refers to human testing related to health impacts linked to PFAS exposure. The panel considered whether this was appropriate at a population level. Dr Fletcher explained the Wilson and Jungner criteria for screening in a previous meeting, and this information will form part of the report. Dr Hajioff explained that there are three categories where there is reliable evidence of a potential health impact from PFAS, as discussed in Report 2:

- Raised cholesterol
- Kidney and testicular cancer
- Pre-eclampsia / pregnancy induced hypertension

Some of these conditions are tested for as part of routine care, and where this is the case, specific recommendations for screening of the plume islanders are not needed. This applies to pre-eclampsia / pregnancy induced hypertension, as this happens as part of standard maternity care. Therefore, there is no need to make a specific recommendation for screening in this area.

Cholesterol

Elevated cholesterol is a 'risk marker' for heart disease rather than a health issue itself. There is convincing evidence from Ronneby that cholesterol is raised by 5% in those with higher levels of PFAS in their blood. This is a modest shift, which is within the normal range for most people, and such a change is unlikely to be identified through screening.

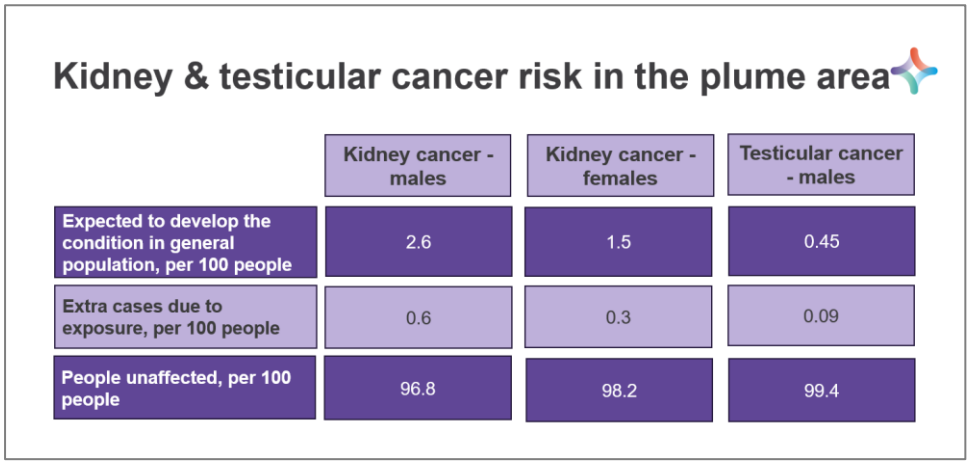
Dr Fletcher presented a slide that showed what the National Academy of Science, Engineering and Medicine (NASEM) recommended for human screening and the levels at which screening is recommended for the conditions they consider to be related to PFAS. Dr Hajioff reminded the panel that the context in the USA is different because of the legal case and the nature of the funding of their health system (i.e. that it is paid for by individuals or private insurance, rather than being state funded), that they are recommendations to physicians to consider testing rather than services offered and paid for by the government, and that the C8 contamination was different to Jersey and so some of the conditions listed have not been found to be associated with AFFF exposure.

In the UK, cholesterol is screened for routinely after the age of 40 as part of a multi-dimensional intervention known as NHS Health Checks which also includes other checks such as for high blood pressure, diabetes, and obesity. This programme is highly cost effective, however it is not known if cholesterol screening is on its own, is clinically effective or cost-effective, as there has not been an analysis of cholesterol screening in isolation.

On balance, the panel were of the view that it would be reasonable to consider testing cholesterol in people known to have elevated PFAS levels The panel have recommended encouraging doctors to assess cholesterol in people who have a history of PFAS exposure. However, the evidence is not strong enough to offer this screening to everyone.

Kidney and testicular cancer

The panel asked what the UK lifetime risk is and what the estimated additional risk is for the plume population over a lifetime. Grace showed a slide that showed the potential number of extra cases per 100 people in the plume area:



The panel discussed that the additional risk was over a lifetime and at any given moment, very few people would have kidney or cancer and even fewer people would have kidney cancer that might be attributable to PFAS exposure. This would mean that very large numbers of people would have to be looked at to detect a single case, and even more for an attributable case.

There is no screening test used internationally for testicular cancer, other than self-examination which was recommended in Report 2. Whilst kidney cancer is not routinely screened for internationally, the panel explored two potential tests. Testing urine for blood would produce 99 false positive results for every case found, and so is not suitable as a screening test. Scanning people using ultrasound or MRI would need to be at such a scale even to detect a single case, that it would not be practicable. The panel have previously recommended in Report 2 that a summary is produced for GPs to indicate where they should have a higher level of suspicion in PFAS exposed populations.

The panel agreed that there are not additional options that can be recommended in addition to what was included in Report 2, so the panel agreed to duplicate the previous recommendations about self examination for testicular cancer and for clinicians to have a higher index of suspicion for kidney cancer for people with high PFAS exposure.

<u>Interventions</u>

The panel have considered the available information on clinical effectiveness, cost effectiveness, data on adverse events and side effects, and concluded that bile acid sequestrants could be recommended as an intervention to reduce PFAS levels. Evidence suggests that it is an effective, safe and cost-effective intervention, and Colesevelam is well tolerated.

The panel does not recommend plasma removal therapies for PFAS exposed individuals on a general basis as it is an invasive intervention that can have significant side effects, it is less effective and less cost-effective than bile acid sequestrants.

The panel determined that phlebotomy could be offered as a second line intervention for those who cannot tolerate bile acid sequestrants. It is more invasive, less effective, and less cost-effective than bile acid sequestrants, but is more cost-effective than other interventions.

Probenecid is not effective and is therefore should not be recommended. Dialysis is not cost-effective, and has significant side effects, and not as effective as alternatives, and so should also not be recommended.

Probiotics and fibre supplements do not have the required evidence to be a primary treatment however a dietary change such as increasing the amount of dietary fibre and the use of probiotics and fibre supplementation can be considered.

Different population groups with elevated levels

There are four population groups that the panel have identified to be considered for eligibility of interventions to reduce PFAS levels:

1. People of childbearing potential who are known to have elevated PFAS – interventions would be to prevent primary exposure in future children, through the birthing parent having lower levels.
    a. The panel agreed that this group should be eligible for intervention.
2. People with high cholesterol who are known to have elevated PFAS levels – bile acid sequestrants lower both PFAS and cholesterol and therefore this group would have an additional benefit.
    a. The panel agreed to recommend considering the potential use of bile acid sequestrants for people with elevated PFAS and elevated cholesterol.
3. Islanders with known elevated PFAS with symptoms which are consistent with a PFAS associated illness. This includes those who were eligible for the 2022 cohort in terms of exposure. The panel reminded the audience that it is not possible to know within an individual whether a symptom is related to PFAS exposure or another factor.
    a. The panel agree that intervention eligibility should not be based on whether someone has symptoms because the evidence is not sufficiently clear to justify that, and therefore people this population group should not be offered an intervention simply based on symptoms.
4. All Islanders known to have significantly elevated serum PFAS.
    a. The panel recommend that for people who have demonstrated PFAS above a certain level in serum, bile acid sequestrants could be considered, expecting that this would be through their usual health care arrangements.

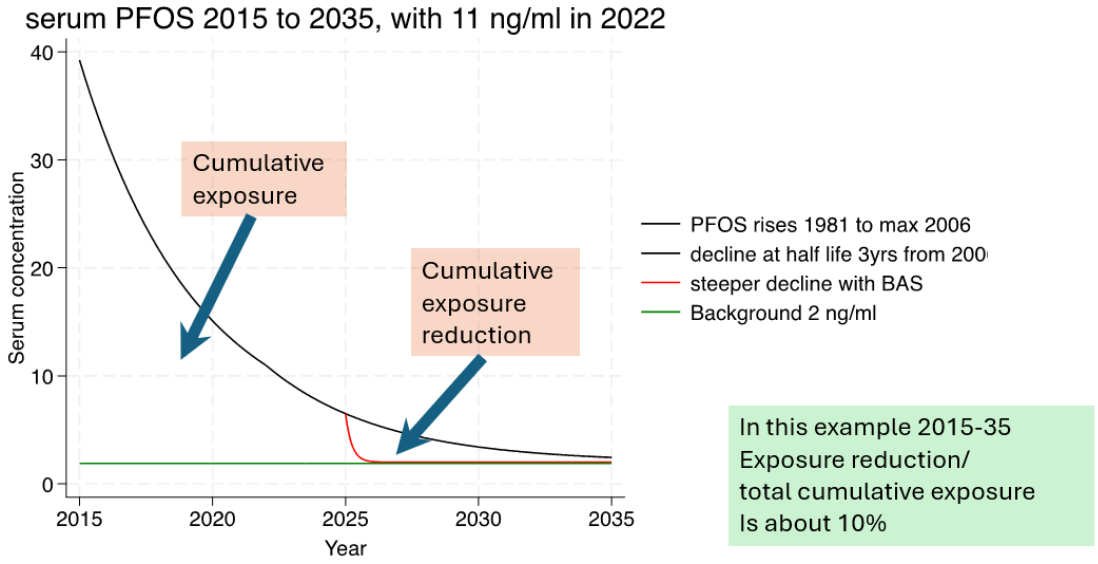
Start and stop levels for interventions

The panel confirmed that they will recommend that eligibility for the service should stop when someone reaches background levels. Until this is established in Jersey, a proxy from elsewhere may be used. The panel would like the opportunity to revisit this recommendation once the background level is understood, so that eligibility can be determined in the light of evidence obtained in the development of Report 4.

The panel considered start levels for an intervention. They reminded themselves that the phlebotomy start level defined in Report 1 was set at 10ng/ml based on HBM-II levels for all population. Prof Cousins indicated that as the levels are elevated in the mains water, it could be that a large amount of the population will be in this range.

Dr Fletcher showed graphs illustrating the international decline which has been occurring over the past 20 years in PFAS levels, and explained the expected additional decline from bile acid sequestrants for those in the plume area. He demonstrated that as the cumulative exposure was high in the past, that indicates the impact on health is likely to already have happened. Some studies have linked the risk of disease to the cumulative exposure, not the current serum levels now. The higher the start level is set, the greater impact the intervention (bile acid sequestrants) can provide per person, but if the level is set lower, there will be less for each individual to gain from the intervention.

If the risk is related to cumulative body burden, including past exposures, then getting rid of all the PFAS gets rid of some of the risk



From the Government testing programme in the plume area, the levels are known from 2022, but the main exposure stopped around 16 years earlier with the extension of mains water to the area. Therefore, for any given PFAS level in 2022, the levels are expected to be considerably higher from the early 2000s. It is important that this is taken into account when making decisions about interventions.

Grace commented that there could be two people – one exposed through the plume area and one not – who could both have levels of 20ng/ml, but in the plume islander it is presumed that their levels would have been much higher in the past, but there's no reason currently to think that non-plume islanders would have had higher levels previously, and she asked whether these two groups should be treated differently? Dr Hajioff agreed that there are differences, and explained that those who have not been in the plume can be expected to gain a greater benefit from intervention because they have not experienced the greater cumulative exposure from the past.

For women of childbearing potential, the panel will recommend that the start level of 10ng/ml across the sum of 8 PFAS remains, prior to island-wide background levels being established.

This is because the aim is to prevent exposure to the foetus, and so prior and cumulative exposure to the parent is less relevant in the decision making process. Setting a low threshold and providing the intervention until the stop point is reached should be effective at protect the foetus and preventing primary exposure.

For other population groups within the plume area and other Islanders who have high levels, the panel will recommend a start level of 20ng/ml across the sum of 8 PFAS. This would be very low for an intervention had the testing occurred when the environmental contamination was first identified, so this therefore takes into account that individuals in the plume area would be expected to have had much higher levels in the past.

Any other business

No other business was raised by the panel.

Date of next meeting

Thursday 27 February 2025. It will be held 10am-1pm online. This meeting will be the first for Report 4 into the environment.

There will be a public meeting with Dr Hajioff in Jersey on 11 February 2025 at 6pm to launch the potential structure of Report 4 to gather input from islanders.

The Chair thanked everyone for their contributions, those watching the meeting and Julia for her support throughout the whole process.

A reminder to the public that this meeting has been recorded and the video will be available online on request by emailing the Public Health mailbox on publichealth@gov.je. This will take a couple of days to make sure the observers are anonymised.

There being no further business, the meeting was closed.

To note that the panel can be emailed via PFASpanel@gov.je.

Details of meeting dates and times can be found at PFAS in Jersey (gov.je)

16 Appendix 2 – Islander input and panel responses

The panel received a very large volume of comments for this report, for which we thank those who took the time to submit their views. These comments (anonymised and with the names of people, companies and products redacted) are listed below, along with the panel's responses. We have grouped the comments by theme for easier reading. Some of the content sent to us neither related specifically to PFAS in Jersey, nor to the panel's remit and we have omitted that content in the interest of brevity. On a couple of occasions, someone made the same point several times in different parts of their submission; in those cases we have brought those points together into a single comment or we have discarded the recaps.

Islander input and panel responses	
PFAS testing	
In representing former and current serving firefighters in Jersey, the Fire and Rescue Service Association (FRSA) welcomes the PFAS Scientific Advisory Panel's Draft Third Report and specifically the recommendation that PFAS testing be offered to those who worked as firefighters during the period when firefighting foams containing PFAS of concern were in use. It is highly likely, if not certain, that exposure to PFAS during equipment maintenance and testing, training and attending operational incidents where foam has been used, will have affected a number of individual firefighters, having handled foam in all its forms – as concentrate, solution and finished foam.	Thank you for your response. You make a very important point. It was never our intent for the draft recommendation on people who were exposed through work to be taken narrowly. We will revise our recommendations to ensure that it is clear that all those who were regularly exposed to the foams in question in any form are clearly included.
you may want to expand this programme to the mechanics that worked on the vehicle foam pumping systems. I am a retired Fireman from Jersey Airport using PFAS in the early 1970's. I would like to see (in the latest Report) that all Firefighters going back to the 1970's, who handled PFAS given a blood test including States of Jersey Fire Service personnel who were given PFAS to use from Airport Fire Service Stocks. On one occasion while refilling a fire appliance I was splashed with neat (undiluted) PFAS, taking a mouth full, I spat it out and rinsed my mouth. I don't know how much I swallowed, but it didn't taste very nice. I was also living in the Plume Area of St Ouens Bay, using well water at that time. Due to these occurrences I would like to go on the Blood testing list.	Thank you for your response. You make a very important point. It was never our intent for the recommendation on people who were exposed through work to be taken narrowly. We will revise our recommendations to ensure that it is clear that all those who were regularly exposed to the foams in question in any form are clearly included.
I formerly worked on Airport Fire Service Foam Tenders but not for the Fire Service per se. I suspect I have high exposure. I note that	Thank you for your response. You make a very important point. It was never our intent for the recommendation on people who were exposed

engineering staff are not included in your proposals, only those engaged as firefighters or as part of the clean-up. I suggest that the scope of sampling be extended to any employee or former employee of Airport Engineering. I worked in Engineering from 1997 to 2011 and left the Airport in 2015. I lived only in St Ouen and St Peter but not in the area I associate with the plume.	through work to be taken narrowly. We will revise our recommendations to ensure that it is clear that all those who were regularly exposed to the foams in question in any form are clearly included.
I would recommend all firefighters, not just pre-2012 service have blood tests taken, as PFAS is in more than just foam for example, our extinguishers are currently AFFF as well as firefighters home location potentially affecting.	Thank you for your response. You have made an interesting suggestion and the panel did discuss this in our deliberations. For the purpose of this report, we are focusing on the longer chain PFAS that are known or likely to cause harm to humans and that stay in the human body a very long time. There are other, shorter chain PFAS that were also used in firefighting foam (including AFFF) in Jersey more recently. They appear from the science so far to be of considerably less concern for human health and are not the focus of our current work (although that may change in the future). We have considered the possibility that more recent firefighters might be exposed through the use of clothing and equipment that had in the past been saturated by older foams and/or contain PFAS but came to the view that this is highly unlikely to have a significant effect on the PFAS levels of people who use them as evidence internationally suggests blood levels in fire fighters who have used equipment/clothing but started working after AFFF stopped being used, do not vary markedly from the normal range. While we do not propose amending the recommendation to include those who started work after 2012 (because there is not a scientific basis to do so), it may be that those implementing our recommendations choose to exercise flexibility or choose to use those who started after 2012 as a control group or reference group.
Page 116 ff. Testing and retesting for PFAS: In Ronneby, ≈ 3500 people participated 2014-2015, approximately 30% participation rate from the contaminated waterwork area, and 5% in the minimally contaminated waterwork area. In 2016, all former participants were invited to a resampling (serum+ urine + faeces). Less than 10% of the original subjects	Thank you for your response. This is extremely interesting and could be extremely useful to those who are planning the implementation of this report. We will ensure that this is made available to them so they can use it in their modelling.

participated in the resampling. These observations stem from a municipality during the first 2 years after detection of the PFAS contamination. Almost 10 years later, there was very low interest in participation in a trial for lowering serum levels by pharmacological treatment (Andersson, submitted). In contrast, the Danish study (Möller et al 2024), which was performed about 2 years after detection of exposure, had a much higher participation rate.	
There is a group of islanders who organised private blood tests for PFAS in 2024. What actions would you recommend government should take for this group of people, and, if different, what about people who get tested privately in the future?	Thank you for your response. The panel have not made any restriction on a geographical basis to screening for potential consequences of PFAS exposure or to interventions to lower PFAS in the body. We have, however stipulated the criteria necessary for a test result to be considered valid. We cannot assess these results formally as we do not have individual permission from the participants, and nor do we know how the samples were handled and tested. Any testing activity that fully meets the criteria that we have outlined in our recommendations should be treated on the same basis, and the people offered the same screening or intervention in our view. Additionally, Report 4 is looking at PFAS in the environment. The panel will review the matter of wider community testing in the light of that information.
In relation to the recommendation about laboratories accreditation, please can you provide guidance about which pre-requisites a laboratory is required to fulfil in order for the analytical testing to be considered valid? For example, which ISO accreditation(s) or standards?	Thank you for your comment. In order to test for PFAS in humans in the UK, UKAS will have certified the laboratory to ISO/IEC 17025, and, as this may impact on individual interventions, ISO 15189. The scope of those accreditations must include PFAS testing. In the US or the EU, the regulators are different, but similar standards apply.

"That PFAS testing should be conducted at laboratories that have been accredited for assessing PFAS levels in human samples, with a full chain of custody and evidence of prevention of contamination from the point of sampling to the completion of the analytical testing. This is a prerequisite for test results to be considered valid." Could you clarify the intended recipients of this prerequisite? I presume that only results from XXXX Lab will be deemed acceptable. It would be beneficial to provide greater transparency regarding this requirement to avoid any confusion or misinterpretation.	Thank you for your comment. In order to test for PFAS in humans in the UK, UKAS will have certified the laboratory to ISO/IEC 17025, and, as this may impact on individual interventions, ISO 15189. The scope of those accreditations must include PFAS testing. In the US or the EU, the regulators are different, but similar standards apply.
"That background levels of PFAS in the wider community, by parish, be estimated by the analysis of altruistic blood donation samples, excess serum collected to perform other tests, or by other means. This should be undertaken on an anonymous basis." Regular blood donation can decrease the concentration of PFAS in the human body. If blood is being collected covertly from donor units for testing without the donors' consent, the resulting data could reflect significantly lower PFAS levels than those present in the broader population. This discrepancy would skew the government's understanding of baseline exposure. A more logical and transparent approach would be to implement a comprehensive, island-wide testing program. Such an initiative, which should reasonably be made available to concerned residents, would provide an accurate assessment of the true extent of PFAS exposure to islanders.	Thank you for your response. Every approach to assessing background levels has advantages and disadvantages. Blood donation testing is solely an example. Generally speaking, anonymous seroprevalence surveys are the least likely to be seriously biased, and these are commonly used in many countries as the primary means to determine background levels; NHANES, for example. The anonymised, opportunistic analysis of blood taken for other purposes is commonplace, unlinked anonymous surveys for HIV and Hepatitis B/C have been conducted in the UK in pregnant women for many years, and several others are also in place worldwide for a variety of health risks. Additionally, Report 4 is looking at PFAS in the environment. The panel will review the matter of wider community testing in the light of that information.
Page 119 Comments on the lack of information on background levels in the Jersey population. The suggested convenience sampling of anonymous serum has serious disadvantages; the most obvious is that there will be no information on important determinants of exposure: age, sex, and a lifelong history of residence and source of water (own, municipal, known plume area etc) at home and at work. If outliers are found, it will not be possible to deduce the possible source of contamination, and whether the individual actually represents " pure" background or not. A better alternative would be to consider a stepwise investigation, combining an open	Thank you for your response. The purpose of this testing is twofold. Firstly, it is to establish a median level in the population that can inform the cessation of any PFAS-lowering intervention. Secondly, it is to give an early indication of any likely exposure in other Parishes so that potential sources of that exposure can be identified and appropriate remediation undertaken. This would require a relatively small number of persons from each Parish to be within an acceptable margin of error. By anonymous we dd not mean to imply there would no information on the donor. Perhaps we should have referred to it as pseudonymous

sampling for "plume" *and* other islanders as a first step, followed by rapid analysis and evaluation. A first evaluation after 500 participants (plume+ other), who provide the necessary background information, would give valuable information on how to proceed. In a first step investigation, a limited age range may be proposed for non-plume participants to achieve a more homogeneous sample	with no method for relinkage. At the time of setting aside the sample, basic data like age, sex and Parish of residence would be attached to the sample number, so that can be linked with the serum result. All other identifiers would be discarded after the sample is taken. This is envisaged as an initial step to offer preliminary data in a timely manner. A more exhaustive and time-consuming programme like that which you suggest may be of benefit further down the line and we will give it further consideration as more data emerge. Additionally, Report 4 is looking at PFAS in the environment. The panel will review the matter of wider community testing in the light of that information.
I acknowledge the publication of the Third Report of the Independent PFAS Scientific Advisory Panel and appreciate the effort taken to investigate the serious health and environmental concerns arising from PFAS contamination on our island. However, I raise the following concerns in response to the third PFAS Report: There is a clear need for widespread PFAS blood testing, the suggestion of anonymous testing would however seem unreasonable and some might say unethical especially for the purpose of transparency. The current approach (which doesn't include wider testing) leaves the true scale of contamination unknown and risks those who remain unaware of their exposure to elevated potential harms.	Thank you for your response. This matter was discussed at some length in the panel meetings, and the matter is thoroughly referenced in the text of the report. The international experts we received evidence from were unanimously of the view that, unless it is for research purposes, there is no case for serum testing in the absence of clear evidence of unusual environmental exposure. Outside the area of known contamination, evidence is not yet clear. Report 4 is looking at PFAS in the environment. The panel will review the matter of wider community testing in the light of that information.
That PFAS testing be offered to those who met the 2022 PFAS testing criteria but did not choose to participate in the programme and also to those who did not have a relevant condition or symptoms but met the other criteria for the 2022 programme. Several countries have implemented PFAS (per- and polyfluoroalkyl substances) testing programs to support communities exposed to PFAS chemicals, particularly in response to contamination of drinking water, soil, or other environmental sources. As we are all now fully aware, every single person living in Jersey for the last 40years has been exposed to PFAS chemicals through their drinking water, food and environment. Children being born today in Jersey have considerably elevated levels of PFOS & pfhxs in their blood. This [was] proved last year. Testing should not be limited; it should	Thank you for your response. This matter was discussed at some length in the panel meetings, and the matter is thoroughly referenced in the text of the report. The international experts we received evidence from were unanimously of the view that, unless it is for research purposes, there is no case for serum testing in the absence of clear evidence of unusual environmental exposure. Outside the area of known contamination, evidence is not yet clear. Report 4 is looking at PFAS in the environment. The panel will review the matter of wider community testing in the light of that information.

be offered to all islanders concerned about their exposure.	
My wife wants her blood tested, but the science panels report doesn't say if there should be testing for concerned residents. What does the science panel think about testing all residents? Shouldn't we all be given the chance to find out if we've been polluted too?	Thank you for your response. This matter was discussed at some length in the panel meetings, and the matter is thoroughly referenced in the text of the report. The international experts we received evidence from were unanimously of the view that, unless it is for research purposes, there is no case for serum testing in the absence of clear evidence of unusual environmental exposure. Outside the area of known contamination, evidence is not yet clear. Report 4 is looking at PFAS in the environment. The panel will review the matter of wider community testing in the light of that information.
Residents living outside the so-called "plume" of PFAS contamination are currently excluded from government-supported blood testing. Offer Free, Universal PFAS Blood Testing: Every resident in Jersey should have access to free blood tests to determine PFAS exposure levels—not only those living inside identified contamination zones (plumes). For example, residents who rely on private boreholes outside current plume boundaries should also have easy access to testing, as their exposure risk could still be significant.	Thank you for your response. This matter was discussed at some length in the panel meetings, and the matter is thoroughly referenced in the text of the report. The international experts we received evidence from were unanimously of the view that, unless it is for research purposes, there is no case for serum testing in the absence of clear evidence of unusual environmental exposure. Outside the area of known contamination, evidence is not yet clear. Report 4 is looking at PFAS in the environment. The panel will review the matter of wider community testing in the light of that information.
How is the clinician meant to know the Pfas levels in the blood if the patient has been refused a test or tested anonymously ? The patients and the clinicians should know if patients present with Pfas related symptoms that more caution in testing and investigation has been advocated by the Panel and the Health service. In my discussions with a consultant haematologist there is no clear line advice from the Directors or Managers. All that was provided when he enquired was a copy of the second report. This is not guidance from the centre as it is a document to help form Policy and introduce better practise created for the consideration of the Minister and his team. It is advice that can be applied or not as in the case of the first report, where in publicly stated briefings and meetings he was being led solely by the science, when the science was finally	Thank you for your response. This matter was discussed at some length in the panel meetings, and the matter is thoroughly referenced in the text of the report. The international experts we received evidence from were unanimously of the view that, unless it is for research purposes, there is no case for serum testing in the absence of clear evidence of unusual environmental exposure. Outside the area of known contamination, evidence is not yet clear. Report 4 is looking at PFAS in the environment. The panel will review the matter of wider community testing in the light of that information.

reported, the Minister chose a path they had not recommended.	
Despite growing evidence that PFAS has travelled far beyond the initial contamination zones, the Health Ministry has not offered testing or support to residents elsewhere—even when they offer to pay privately. There is no system allowing doctors or residents to easily request PFAS blood testing. Residents are not empowered with tools or information to monitor their own exposure, even when presenting to GPs with possible PFAS-related symptoms.	Thank you for your response. This matter was discussed at some length in the panel meetings, and the matter is thoroughly referenced in the text of the report. The international experts we received evidence from were unanimously of the view that, unless it is for research purposes, there is no case for serum testing in the absence of clear evidence of unusual environmental exposure. Outside the area of known contamination, evidence is not yet clear. Report 4 is looking at PFAS in the environment. The panel will review the matter of wider community testing in the light of that information.
In Veneto, the government offered free blood testing to all residents living in areas affected by PFAS—not just those living inside narrow contamination zones. This ensured no one at risk was left unaware of their health status. How Jersey Can Use This Experience: Expand testing beyond identified contamination plumes, ensuring that all potentially exposed residents can access free blood tests.	Thank you for your response. This matter was discussed at some length in the panel meetings, including hearing from leading researchers at Veneto and Ronneby. The matter is thoroughly referenced in the text of the report. The international experts we received evidence from were unanimously of the view that, unless it is for research purposes, there is no case for serum testing in the absence of clear evidence of unusual environmental exposure. Outside the area of known contamination, evidence is not yet clear. Report 4 is looking at PFAS in the environment. The panel will review the matter of wider community testing in the light of that information.
Key Actions Taken in Ronneby: Every resident had access to free blood testing to determine their PFAS exposure. Testing revealed exceptionally high PFAS levels, confirming the urgent need for community-wide health actions. Like Sweden, Jersey should provide immediate access to blood testing for all potentially exposed residents, not only those in recognized contamination plumes.	Thank you for your response. This matter was discussed at some length in the panel meetings, including hearing from leading researchers at Veneto and Ronneby. The matter is thoroughly referenced in the text of the report. The international experts we received evidence from were unanimously of the view that, unless it is for research purposes, there is no case for serum testing in the absence of clear evidence of unusual environmental exposure. Outside the area of known contamination, evidence is not yet clear. Report 4 is looking at PFAS in the environment. The panel will review the matter of wider community testing in the light of that information.
Clinical examination, clinical testing and screening	
Regular Long-term Health Checks. The government should regularly monitor the same	Thank you for your response. It is important to distinguish what is done for the purposes of

group of residents over several years to see how their health changes due to PFAS. For example, people tested now should be re-tested every year or two to detect health problems early and to see how these problems develop or improve over time.	research and what is done to improve the health of affected persons. Our remit, in this report, is on testing and interventions that may improve the health of Islanders, not on answering research questions. In the text of the report, we looked at all the potential conditions that were found, in report 2, to be associated with AFFF- derived PFAS exposure to a significant degree and all the potential tests to screen for those conditions. We then assessed them against the internationally recognised Wilson and Jungner criteria to see what was appropriate. We have recommended all relevant tests that met those criteria. There being no evidence of benefit from retesting for the individual, and it potentially being a driver of anxiety, we have not recommended retesting.
"That clinicians, when seeing people with known PFAS exposure, should consider testing for serum cholesterol." There exists a wide range of testing and monitoring protocols that general practitioners (GPs) should be informed about. Please refer to the attached clinician's guide from the United States as an example. Why has this resource, or a comparable one, not been distributed to our GPs to enhance their awareness and practice?	Thank you for your response. It is important to distinguish what is done for the purposes of research, what is done as part of a legal settlement and what is done to improve the health of affected persons. Our remit, in this report, is on testing and interventions that may improve the health of Islanders, not on answering legal or research questions. One of the recommendations of report 2 was the development of a clinician's guide on PFAS that is relevant to the type of exposure in Jersey. This is currently in development and will be distributed when it is complete.
"That when PFAS-exposed people exhibit symptoms which are consistent with kidney cancer or testicular cancer, clinicians should have a higher level of suspicion of cancer than in unexposed populations." This statement is highly questionable and lacks sound reasoning. Given that the entire island population is exposed to PFAS, the logical course of action would be to implement testing to measure individuals' PFAS levels. This could inform strategies to reduce those levels, potentially mitigating the risk of cancer development from the outset. As we all know, Jersey has a very high level of cancer, particularly rare cancers!	Thank you for your response. The purpose of the recommendation is to remind clinicians of the greater risks in those with known significant PFAS exposure of developing these cancers. Even with the increase, the overall risk remains low, and so testing PFAS universally just to raise the suspicion of clinicians would be disproportionate and the harms from such a programme would outweigh any potential benefits manyfold. There are many factors in the development of cancers, and it would be unwise to assume that PFAS is responsible for any excess cancers without looking to genetic and lifestyle factors that are much stronger determinants of cancer development.
"That regular testicular self-examination should be considered in PFAS-exposed populations."	Thank you for your comment. Testicular cancer is predominantly a disease of younger men and,

Once again, that is every male island wide. Perhaps you want to look at the cases of testicular cancer in young men in Jersey; quite sure they do not all live in the deemed plume areas.	even with the potential increase associated with PFAS exposure, overall risk is still very low. Testicular cancer rates have been increasing internationally over the past half century, but most research points to other causes, rather than PFAS. Some countries do recommend universal testicular self-examination. Our remit is PFAS-related health risk and its mitigation, so a universal recommendation falls outside that. We will ensure this information is passed on to Public Health for consideration as part of implementation.
In addition to PFAS exposure, the incidents at which firefighters will have responded to receive such exposure will, by their very nature, already be an exposure risk to fire contaminants as the products of combustion. The International Agency for Research on Cancer (IARC), a World Health Organisation (WHO) body, declared in July 2022 that occupational exposure as a firefighter was now classified as carcinogenic (a preventable cause of human cancer). IARC reported that positive associations were observed for mesothelioma and cancers of the bladder, colon, prostate, and testis, and for melanoma and non-Hodgkin lymphoma. As a result, it was announced that occupational exposure as a firefighter was classified as "carcinogenic to humans" on the basis of "sufficient" evidence for cancer in humans (Class 1). It is noted that the PSAP's report considers the cancer risk associated with PFAS exposure and certain cancers as being somewhat aligned with the additional risk outlined above in respect of the evidence *"suggesting a probable increase in the incidence of kidney and testicular cancers among populations exposed to certain PFAS. The panel also noted some evidence indicating an increased risk of bladder cancer, though this was less clear. In contrast, common cancers such as breast, colon, and prostate cancers did not show a significant increase in incidence across the most relevant research studies, providing some reassurance. Nevertheless, a link not having been clearly found does not mean that a link is not there. The panel noted that there were also concerns expressed by Islanders about rarer cancers and concluded that, although there is not yet*	Thank you for your comment. The multiple cancer-associated compounds to which firefighters are occupationally exposed are associated with an increased risk of several cancers, over and above any effects that may be associated with PFAS exposure. Many of the cancers you refer to have not been found to be associated with PFAS in the research to date, but a watching brief is necessary as more research emerges. While our remit only extends to the effects and management of PFAS and we cannot make recommendations beyond that, the panel gratefully acknowledges the important work undertaken by firefighters and the risks they are exposed to regularly, including from environmental factors such as asbestos and particulate matter, as well as any risks from PFAS.

evidence to give a clear answer on rare cancers, there is also insufficient evidence to rule out any potential risk from PFAS exposure." The FRSA consider the recommendation for PFAS testing of firefighters to be an appropriate opportunity to instigate regular screening of firefighters for the cancer risks posed not only by PFAS but by fire contaminants from the incidents at which PFAS foam was required – exposure to carcinogens, from the fire itself or the firefighting foam used to extinguish it and which may cause the same or similar disease, demonstrates a hand-in-glove relationship with cancer risks that firefighters are exposed to. It is hoped that the Government of Jersey accept the recommendations of the report and initiate appropriate and ongoing health screening for both current and former firefighters in recognition of the carcinogenic occupation in which they are employed.	
Apply effective policies already in use in other countries, such as routine public health screenings, proactive testing beyond obvious contamination zones, and transparent public communication. Jersey could, for example, use similar proactive public testing and clear communication strategies that have worked successfully in Ronneby, Sweden, to reassure and inform the community. Adopting these global lessons will ensure Jersey acts swiftly, transparently, and effectively to protect public health from PFAS contamination. Establish ongoing health monitoring programs for residents, not just one-time testing. Residents tested now should be routinely checked in future years, enabling early detection and better management of potential PFAS-related health issues, such as cholesterol problems, thyroid conditions, or immune system disorders.	Thank you for your response. This matter was discussed at some length in the panel meetings, including hearing from leading researchers at Veneto and Ronneby. The matter is thoroughly referenced in the text of the report. The international experts we received evidence from were unanimously of the view that, unless it is for research or legal purposes, there was not a case for screening for health conditions beyond that highlighted in the report. It is important to distinguish what is done for the purposes of research and what is done to improve the health of affected persons. Our remit, in this report, is on testing and interventions that may improve the health of Islanders, not on answering research questions. In the text of the report, we looked at all the potential conditions that were found, in report 2, to be associated with AFFF- derived PFAS exposure to a significant degree and all the potential tests to screen for those conditions. We then assessed them against the internationally-recognised Wilson and Jungner criteria to see what was appropriate. We have recommended all relevant tests that met those criteria. There being no evidence of benefit from retesting for the individual, and it potentially being a driver of anxiety, we have not recommended retesting.

	We believe our processes to be among the most transparent in the world and we are proud that we have livestreamed meetings and regular public engagement events. Nevertheless, there is always more that can be done, and we will reflect further on that. PFAS testing can only provide information about the level of PFAS in the blood; it cannot provide any information about or detect health conditions; anyone with symptoms of ill health should visit the GP or another medical professional about their symptoms.
Following the initial testing, Italian authorities provided regular, ongoing health checks to affected residents. This enabled early detection of potential health problems such as hormonal disruptions or immune system issues, providing better health protection over time.	Thank you for your response. This matter was discussed at some length in the panel meetings, including hearing from leading researchers at Veneto and Ronneby. The matter is thoroughly referenced in the text of the report. The international experts we received evidence from were unanimously of the view that, unless it is for research or legal purposes, there was not a case for screening for health conditions beyond that highlighted in the report. It is important to distinguish what is done for the purposes of research and what is done to improve the health of affected persons. Some of the activities in Veneto were undertaken for legal reasons. Our remit, in this report, is on testing and interventions that may improve the health of Islanders, not on answering research questions or addressing legal cases. In the text of the report, we looked at all the potential conditions that were found, in report 2, to be associated with AFFF- derived PFAS exposure to a significant degree and all the potential tests to screen for those conditions. We then assessed them against the internationally recognised Wilson and Jungner criteria to see what was appropriate. We have recommended all relevant tests that met those criteria. There being no evidence of benefit from retesting for the individual, and it potentially being a driver of anxiety, we have not recommended retesting. Additionally, Report 4 is looking at PFAS in the environment. The panel will review the matter of wider community testing in the light of that information.
The PFAS contamination case in Ronneby, Sweden, provides important examples of effective community protection and legal	Thank you for your response. This matter was discussed at some length in the panel meetings, including hearing from leading

accountability that Jersey should closely follow. The tests uncovered clear health issues among residents, including raised cholesterol levels, increased cases of polycystic ovary syndrome, and significant PFAS levels in children—up to 50 times higher than unaffected communities.	researchers at Veneto and Ronneby. The matter is thoroughly referenced in the text of the report. The international experts we received evidence from were unanimously of the view that, unless it is for research or legal purposes, there was not a case for screening for health conditions beyond that highlighted in the report. It is important to distinguish what is done for the purposes of research and what is done to improve the health of affected persons. Many of the activities in Ronneby were undertaken as part of a research programme. Our remit, in this report, is on testing and interventions that may improve the health of Islanders, not on answering research questions or addressing legal cases. In the text of the report, we looked at all the potential conditions that were found, in report 2, to be associated with AFFF- derived PFAS exposure to a significant degree and all the potential tests to screen for those conditions. We then assessed them against the internationally recognised Wilson and Jungner criteria to see what was appropriate. We have recommended all relevant tests that met those criteria. There being no evidence of benefit from retesting for the individual, and it potentially being a driver of anxiety, we have not recommended retesting.
Introduce regular and specific blood tests for residents exposed to PFAS to spot potential problems early. For instance, if a resident living near contaminated water sources frequently feels tired or becomes ill, regular blood checks can determine if PFAS exposure might be causing these symptoms. By following these clear and practical steps, Jersey can better protect the blood health and overall well-being of its residents, ensuring they have the medical support and clear information they deserve. In their second report the Panel recommended that clinicians treating patients presenting with Pfas related conditions such as testicular cancer should be more cautious if the patient had high levels of Pfas in their blood.	Thank you for your response. In the text of the report, we looked at all the potential conditions that were found, in report 2, to be associated with AFFF- derived PFAS exposure to a significant degree and all the potential tests to screen for those conditions. We then assessed them against the internationally recognised Wilson and Jungner criteria to see what was appropriate. We have recommended all relevant tests that met those criteria. There being no evidence of benefit from retesting for the individual, and it potentially being a driver of anxiety, we have not recommended retesting
Interventions to lower PFAS (including post-intervention testing)	
Can you provide guidance about the provision of interventions to ‘women of child bearing potential’ please? What ages does this cover? Should the Islander have an intent to conceive	Thank you for your comment. These are important questions which partially relate to the implementation of the recommendation (which is beyond the panel’s remit). Colesevelam is not

over what timescale to be eligible for the intervention?	licensed below the age of 18 and, while that doesn't prevent prescribing, the prescribing clinician should make an assessment of risk and benefit on an individual basis. Similarly, phlebotomy is not usually offered below that age. The question of intent to conceive is a complex one, for a variety of reasons, we have not made that a requirement; likewise, we do not believe it is helpful to set a maximum timescale. Because of the variable efficacy person to person of all interventions, it is wise to intervene early, rather than witing for a pregnancy to be planned. A minimum timescale before conception is important, however, so that, after the intervention is stopped, appropriate nutritional supplements, including folate, can be given and levels normalised prior to conception.
Please can the panel explain the sorts of situations in which phlebotomy should be offered instead of bile acid sequestrants?	Bile acid sequestrants work three or four times faster than phlebotomy in lowering PFAS and have fewer side effects, like anaemia, that might be problematic for pregnancy. For that reason, we recommend BAS as the first line intervention. Phlebotomy should only be used if the person is allergic to BAS, cannot tolerate them when they try taking them, is on medicines with which they are compatible or would benefit from phlebotomy to treat a condition (like haemochromatosis) separate from their PFAS levels. In all other situations, BAS are preferable.
How often should patients be reviewed/monitored by a clinician once taking BAS?	This will vary on the basis of the intervention and the specific group to which the person belongs. Because BAS work much more quickly, you may see a clear reduction in PFAS at 6 months, and it is worth testing at that point. For phlebotomy, however, the interval to detect a meaningful decrease in PFAS levels will be longer; perhaps 12 months on average. Phlebotomy will also require monitoring of blood count for anaemia and, potentially of iron levels; that can become depleted with repeated venesections. BAS do not require specific health monitoring.
What constitutes an appropriate re-testing timescale for those on bile acid sequestrants or receiving phlebotomy? Every 6 months, or something else?	This will vary on the basis of the intervention and the specific group to which the person belongs. Because BAS work much more quickly, you may see a clear reduction in PFAS at 6 months, and it is worth testing at that point. For phlebotomy, however, the interval to detect a

	meaningful decrease in PFAS levels will be longer; perhaps 12 months on average. Phlebotomy will also require monitoring of blood count for anaemia and, potentially of iron levels; that can become depleted with repeated venesections. BAS do not require specific monitoring.
That people taking colesevelam or having phlebotomy to reduce PFAS, should have periodic repeat PFAS blood tests to check on the effect of treatment. This recommendation isn't very clear. How often is periodic? and, will other vital signs be monitored, ie: cholesterol, iron deficiency, etc dependant on treatment offered?	This will vary on the basis of the intervention and the specific group to which the person belongs. Because BAS work much more quickly, you may see a clear reduction in PFAS at 6 months, and it is worth testing at that point. For phlebotomy, however, the interval to detect a meaningful decrease in PFAS levels will be longer; perhaps 12 months on average. Phlebotomy will also require monitoring of blood count for anaemia and, potentially of iron levels; that can become depleted with repeated venesections. BAS do not require specific monitoring.
The final recommendation in draft report 3, pg 6, is “That when an individual’s serum PFAS levels reach the median background levels, further colesevelam prescribing or therapeutic phlebotomy should not be undertaken.” It is unclear from this statement when taken with the 2nd recommendation on page 6: (“That background levels of PFAS in the wider community, by parish, be estimated by the analysis of altruistic blood donation samples…”) if these background levels are by Parish or the whole Island? If by Parish then some Islanders would continue to be eligible for treatment whilst those in a different Parish with the same serum levels of PFAS would not. If not by Parish then why analyse the data by Parish? Are the background levels for all the classes of people, including but not limited to, identified in 5a and 5b above all to be merged together? If they are then a person in one of the areas impacted by the PFAS deposits around the airport and who is on a local water source could end up on the treatment indefinitely. Plus those on JW supplies in the same area could have their treatment curtailed whilst still suffering from higher PFAS levels than would have been the case had those on local wate not been included in deriving the background levels.	Thank you for your comment. I think that there have been some misunderstandings here, and the panel are grateful to you for giving us the opportunity to provide clarification. The background testing in recommendation 2 (whether it be from donated blood, laboratory samples taken for other purposes or another method) serves two functions. The first function is to estimate a median islandwide background level to inform when PFAS-lowering interventions might stop. The second is to give medians by Parish, to give an indication of geographical variation and highlight any anomalies that might require environmental source identification in that Parish. This second function is to inform Report 4 and does not relate to PFAS lowering interventions. These anomalies could include an elevated level across the board in a given Parish (suggesting a widespread exposure there) or a large variation within that Parish, suggesting that there may be an issue with one or more contaminated private water supplies. Either way, it will be a catalyst for further investigation.

If they are not to be merged i.e. there will be separate background levels for those on and not on JW supplies, then the altruistic element becomes problematic as the person's water source is not identified when blood samples are taken. Requesting this data at the time of sampling destroys the altruistic element.	
Page 6 and subsequent paragraphs on recommendations for testing and interventions. The report is lacking a thorough discussion on passive or active testing and information for young women. (see also Page 125) Colesevelam is recommended to be made available to women in fertile ages with >10 ng/ml of PFAS. Those eligible (= with > 10 ng/ml – but how would you know your levels if not tested?) should receive information to be able to make an informed choice about a colesevelam intervention. Should there be an active campaign for testing of young women from the plume area? "Those eligible should receive information" - does this imply active recommendations to young women to test for S-PFAS levels, i.e., when contraceptives are prescribed? Which instance should give teenagers information to make an informed decision about whether they wish to take colesevelam? Given that precaution (not evidence of risk) guided the exclusion of women who might become pregnant within a period of approximately a year or more (see p 115) from any colesevelam intervention, it is the young girls and women who should be in focus. Moreover, given the variation in intervention efficacy, it would be reasonable to plan interventions to lower PFAS levels at an early stage, not when a pregnancy is actually planned.	Thank you for your response, you raise some important issues. Your comments about intervention efficacy are well made, and we agree with your suggestion that intervention should be as early as possible, and not at the point of planning a pregnancy. We also agree that it would be wise for there to be a delay of several months before conception is attempted; to ensure that there is no possibility for overlap and that essential nutrient levels have equilibrated through supplementation (such as folate and fat-soluble vitamins). You raise the issue of contraception, and we should ensure that participants are clear that oral contraception is unreliable with BAS and alternative precautions should be taken. Finally, we have recommended offering testing to all persons in the area of increased exposure who have not yet been tested. We will raise with the public health team the issue of targeting testing messages to women and girls of childbearing potential.
Page 3. Intervention guidance: This report focuses on measures to reduce body burden. "Testing results may help medical professionals or public health workers decide if measures to reduce body burden are appropriate". Interventions to reduce body burden are directed at exposure to PFAS. Unfortunately, we have little evidence that lowering of PFAS levels reduces adverse health effects; even lowering of cholesterol levels is about reducing a risk factor.	Thank you for your comment. This is a matter we discussed at some length. Because the effect on lowering PFAS body burden on future health is unclear, we have not recommended interventions to lower PFAS widely, only where it is to prevent prenatal exposure of future children or where there is a clear additional benefit.

Page 8: section Final thoughts: Is really " using the right medicine" (= bile acid medicine) the first step for people in Jersey to stay healthy and worry less about PFAS? I would have given " stopping PFAS from coming back into our water and food" the highest priority, and thus mentioned it first. Moreover, expressions like " the right medicine" and "how to help" imply that medication is needed.	Thank you for your comment. We will revise the wording to describe "interventions" rather than "medicine". We agree with you about environmental exposure, however that is a matter for Report 4.
Page 124: Inclusion and stop levels. The proposed inclusion levels of 10 (fertile women) and 20 ng/ml are reasonable as a preliminary limit. A rapid investigation of background levels as suggested above would serve as a guide for correction/confirmation. For a stop value, knowledge about background serum levels would be of interest. Notably, background levels will likely vary by age. Using background levels, the criterion for stop would be related to contemporary exposure. However, especially for women of childbearing age for whom the intervention is directed to their offspring, it would be more appropriate to use a serum level corresponding to the calculated TWI from the EFSA CONTAM panel, thus lower than the inclusion level. This is a health-based criterion.	Thank you for your comment. Your suggestion to use the EFSA recommendation to limit adult serum levels to 7 ng/ml (for the sum of 4 PFAS) is a helpful starting point for a stopping value. This may need to be revised when we have a better understanding of background levels now and trends in Jersey.
That when an individual's serum PFAS levels reach the median background levels, further colesevelam prescribing or therapeutic phlebotomy should not be undertaken. What is the median background level? Here is America's as at today's date: "Based on the latest trends and without new data contradicting the decline, the median background level of PFOS in the U.S. population today, April 2, 2025, is likely in the range of 3.0 to 3.5 ng/mL. This estimate assumes continued reduction from the 2017–2018 baseline and aligns with the Agency for Toxic Substances and Disease Registry (ATSDR) reports showing PFOS levels stabilizing at low single-digit nanograms per millilitre in recent years."	Thank you for your comment. We are aware of the background levels in the US and the EU. We have used typical European recent population averages to help estimate background levels. US values have tended to be higher. Based on likely background values and and EFSA target values we are proposing 7ng/mL (Sum across PFAS) as a stop value. This may need to be revised when we have a better understanding of background levels now and trends, in Jersey.
Thanks very much for circulating the report and investing so much time into finding solutions. I'm particularly engaged by the Blood donation option because it looks to be a notable 'win/win' for individual and society! Maybe you could make it clearer that the donated blood is safe to use? So help yourself by helping others.	Thank you for your comment. We are recommending bile acid sequestrants as the first line intervention as they work markedly faster than blood donation. We only recommend phlebotomy when someone can't take the bile acid sequestrant medications. We reviewed the safety of donated blood in Report

	1. In every reasonable circumstance, blood donated by a person with elevated PFAS will not place the recipient at risk; they would need several units from the same person with very high PFAS for it to raise their body burden.
While the recommendation for therapeutic phlebotomy is welcome, it is insufficient alone. I would suggest that a broader review of all possible interventions is given, informed by global best practices and emerging detoxification methods. It would be more fitting to consider a wider spectrum of healthcare solutions to aid those affected, including: - Access to specialist consultations also made available to the wider community who may have been impacted; - Exploration of treatment options such as plasmapheresis.	Thank you for your comment, you appear to have misunderstood the content of the report and its recommendations. Firstly, we have not recommended phlebotomy, it is only recommended for clinicians to consider as a possible fallback option when a person is allergic to or can't take bile acid sequestrants. Secondly, we have looked at all potential intervention options and reviewed them; including plasmapheresis; which takes around three times as long to work as bile acid sequestrants and carries far more risks. Access to specialist consultations was a recommendation in Report 2 and this service is already in place.
In addition the suggestion of Bile Acid Sequestrants being a viable option, this is a little misleading as there haven't been sufficient studies conducted to validate this statement, furthermore, there will be instances where this option would not be suitable.	Thank you for your comment. Bile acid sequestrants have been the subject of two clinical trials, which we heard about. This is more than either phlebotomy (one trial and one small case series), plasmapheresis (one clinical trial) or any other interventions. All interventions can be unsuitable for some people. This is why we have made a backup recommendation for people who are allergic to or cannot take BAS. They can be offered phlebotomy.
I would also call for the wider community who know they have been impacted to be included in the provisions for treatments rather than ring fencing this to the plume area only. There are people who have been tested and were found in some cases to have higher PFAS blood levels than some within the plume.	Thank you for your comment. We have not recommended any ring-fencing of interventions to lower PFAS. They will be available regardless of place of residence, as long as the other criteria are met.
The report does not incorporate clear blood-test threshold guidelines already established by respected bodies like the U.S. National Academies of Science. For example, these guidelines suggest taking immediate action if blood PFAS levels reach specific measurable points (e.g., 2 ng/mL or 20 ng/mL), allowing residents elsewhere to understand their risks clearly and quickly. Clearly adopt and communicate internationally accepted blood-test thresholds for PFAS exposure, like those used in the United States. This helps Jersey	Thank you for your comment. This is a little puzzling. The report does take into account NAS and HBM2 guidance on thresholds on the start of interventions and the start levels are set as those thresholds or better. The stop levels are higher than the NAS lower level, but that is because the background levels in Jersey appear, from the panel's modelling, to be slightly higher and there is no point intervening to below background, as discussed in the report.

residents quickly understand their personal health risks and what medical action they might need to take.	
The Panel's first report recommended that blood PFAS levels above a certain threshold could be reduced through phlebotomy (removal of blood)—a safe and proven method used internationally. However, this recommendation was not followed. Instead, the Health Ministry chose a pharmaceutical approach, despite no proven alternative treatment being available for PFAS removal at the time.	Thank you for your comment. The phlebotomy recommendations from Report 1 were made on an interim basis until this report was complete. It is unfortunate that there were implementation difficulties, these were due to health services factors, rather than a lack of will on behalf of Government, I am given to understand, but those recommendations are now largely obsolete as they are superseded by these recommendations. Bile acid sequestrants have been the subject of two clinical trials, which we heard about. This is more than either phlebotomy (one trial and one small case series), plasmapheresis (one clinical trial) or any other interventions. They work markedly faster than other interventions and have fewer risks associated with them. All interventions can be unsuitable for some people. This is why we have made a backup recommendation for people who are allergic to or cannot take BAS. They can be offered phlebotomy.
Thank you for submitting Report 3. I believe it appears to reflect a biased perspective, seemingly designed to encourage the use of potentially hazardous medications while minimizing government expenditure. This represents yet another affront to individuals who have endured decades of harm from PFAS poisoning due to governmental actions and thereafter their lack of action.	Thank you for your comment. The intervention we have recommended is markedly faster working than any other intervention to reduce PFAS levels and carries a lower risk of serious adverse consequences and side effects. That it is cheaper also is an added bonus. The prescribing clinician always makes a judgement about which intervention they prescribe is likely to be most effective and have the fewest adverse effects. We have given a clear indication of the evidence, but it remains a prescriber's decision.
Thus, I find it problematic to use the expression "Monitoring efficacy of treatments." For me, as a medical doctor, and probably also for lay people, a treatment is a medical intervention aimed at treating an observed health effect in an individual. Thus, I recommend substituting the word "treatment" with "intervention" wherever it is used in the document.	Thank you for your comment. Your point is well made, and we will adjust the terminology in the report accordingly.
That colesevelam be made available, on a case by case basis, to women of child bearing potential (who are not currently pregnant nor planning to be pregnant during any course of	Thank you for your comment. While much of this is a reminder of the current wording of our recommendations, you do ask a question about what is meant by "impact on offspring". In this

treatment) who have been found to have a total across 8 measured PFAS compounds (PFHxS PFOS PFOA PFHpS PFNA PFPeS PFDA MeFOSAA) of at least 10 nanograms per millilitre of blood serum. Those eligible should receive information explaining the potential impact on future offspring so they can make an informed choice about whether they wish to take colesevelam. Please provide a full explanation of the potential impact on future offspring? That, for those people who otherwise meet the criteria for an intervention but for whom colesevelam is not an appropriate intervention, therapeutic phlebotomy be considered as a second line offer. That colesevelam be considered as a lipid lowering therapy in people who have elevated cholesterol and who have been found to have a total across 8 measured PFAS compounds (PFHxS PFOS PFOA PFHpS PFNA PFPeS PFDA MeFOSAA) of at least 20 nanograms per millilitre of blood serum. That clinicians consider, for people who have been found to have a total across 8 measured PFAS compounds (PFHxS PFOS PFOA PFHpS PFNA PFPeS PFDA MeFOSAA) of at least 20 nanograms per millilitre of blood serum, whether there is any particular benefit from the prescribing of colesevelam in a case by case basis. Note: these recommendation were included and followed by a brief restating of the potential side effects of colesevelam and of phlebotomy. These contained no additional information that was not already covered in the report's section on treatment side effects and that part has been omitted for conciseness.	instance, we mean that those future offspring will not have been exposed to PFAS at higher levels through the placenta or in breast milk and will therefore have lower PFAS in their bodies. The potential risks of having higher than average levels of PFAS in the body are discussed in Report 2.
Other comments relevant to this report	
I would like to begin by sincerely thanking you for the opportunity to provide comments on the Draft Third Report of the Independent PFAS Scientific Advisory Panel for Jersey. Your work represents an essential and deeply valued contribution to the public understanding of PFAS contamination and its implications for environmental and human health. Please find attached my full submission, prepared in response to the invitation for public feedback. I have sought to approach the issues constructively, combining international	Thank you for your response. The panel welcomes all feedback.

evidence, lived experience, and policy analysis. My aim is to assist in strengthening the report's scope, clarity, and real-world impact — particularly for those Islanders whose voices may not always be heard. Thank you again for your careful attention to this vital issue, and for your dedication to an evidence-based approach to public health and environmental protection in Jersey.	
[An Islander] has written a report regarding blood testing that she arranged which makes for very shocking reading if it's all true. The governments "scientific" report doesn't mention xxxxx's work at all. Have you seen it before? The average median levels of pfhxs + pfos from xxxxx's testing is 14,000 v 24,000 in the government testing. I was surprised that the difference wasn't much bigger since the chemicals went into the water people were drinking from near the airport + the people xxxxx tested haven't ever lived around the airport. But, I also know thanks to the bbcs "more or less" that you need statistics to know if a number is big or small or different from another number. How does the pfas levels from xxxxx's testing compare to the governments testing?	Thank you for your response. This is a complicated matter. You are right to highlight the potential statistical issues between comparing two numbers, but there are other issues as well. In any analysis, it is important to know that the numbers are what they appear to be, that, in a comparison, like is being compared with like, and that any findings can be extrapolated to the wider population. Using data from volunteers can be tricky because we can't be sure that those people are similar to the general population. This is why we have recommended random, anonymous testing to get a baseline level for each Parish. We have described in our recommendations the prerequisites for any testing to be considered reliable, these include a clear auditable chain from the moment the sample is taken to the point the laboratory does the measurement. The lab must also be properly certified for testing PFAS in samples taken from humans. Because we are not part of people's clinical care team, we also need proof that every person has given their express consent for their data to be used in our deliberations. We can't consider anything that doesn't meet those criteria. We will know a lot more when the testing recommended in this report has been undertaken.
The Panel appears to have decided that short-chain PFAS are irrelevant to their work. The Panel's brief made no mention of disregarding this whole class of PFAS. The Panel, along with many authorities and "safe limits" for PFAS now treat them as a collective, i.e. monitoring and risk are assessed against the sum of concentrations of all PFAS. By ignoring shorter chain PFAS such as TFA (whose concentrations in our water sources is completely unknown) this is completely contrary to the ethos of summation of all PFAS	Thank you for your comment. The panel were commissioned to assess the health and environmental impacts and any potential remediation of the PFAS that relate to the use of aqueous film forming foams at Jersey Airport. We are particularly concerned about PFAS that meet three criteria; that they hang around in the environment for a long time, that they remain in the body for a long time and that there is reasonable evidence that they may cause harm to humans. This is what we are focusing on at this time; we do not want to delay work on

is a determining risk factor. The reason by the Panel put forward to justify ignoring short-chain PFAS is that they don't accumulate, to the same degree as long-chain PFAS, in the human body. By itself this is insufficient justification. It could be that short-chain PFAS are present in much much greater quantities, than long-chain PFAS, in the environment and don't need to accumulate much to lead to harm.	things with known or likely health risks while we look at things where health implications are unknown. We are aware that there are other PFAS, some from other sources, that are in use all over the world, and recognise that they may need to be the subject of further work in the future.
That PFAS testing be offered to those who worked as firefighters during the period when firefighting foams containing PFAS of concern were in use, and to those who were involved in the cleanup of the foams as part of their job. PFAS of concern? Isn't all PFAS of concern?	Thank you for your comment. The panel were commissioned to assess the health and environmental impacts and any potential remediation of the PFAS that relate to the use of aqueous film forming foams at Jersey Airport. We are particularly concerned about PFAS that meet three criteria; that they hang around in the environment for a long time, that they remain in the body for a long time and that there is reasonable evidence that they may cause harm to humans. This is what we are focusing on at this time; we do not want to delay work on things with known or likely health risks while we look at things where health implications are few or are unknown. We are aware that there are other PFAS, some from other sources, that are in use all over the world, and recognise that they may need to be the subject of further work in the future.
There was discussion during the Panel meeting that harm to the body is in effect not affected by when PFAS were ingested but rather it is the time integral of serum levels, aka area-under-the-curve. This I find troubling: It takes no account of "repairs" that the body can make to diseased organs. Furthermore without knowing the precise mechanism by which chronic disease is caused for each PFAS and for each organ how is it possible to come to that conclusion? The area-under-the-curve represents the body's total exposure to the PFAS but completely disregards whether that exposure period was this year or whether it was say 20 years ago. That would seem to only be appropriate for some particular harm-causing mechanisms. I understand that the jury is still out as to which mechanisms are at play in the various harm scenarios. It also infers that irreparable damage may	Thank you for your comment. I think that we have either miscommunicated or you have misunderstood the intent of the discussion. The key issue is that it is completely unknown the extent to which damage is done when PFAS is first in the body or when it has remained in the body for some time. It is also not clear if that damage is reversible. Using the example of cancer, some cancer-causing compounds cause cancer through promoting genetic mutation in the body, and therefore taking them out of the body won't affect any mutations that are already there from turning into cancers later. Other compounds interrupt the body's self-repair mechanisms so that cancers that would normally be nipped in the bud by the body, go on to develop into tumours. Such interference with the immune system may stop when the PFAS is gone (or it may not). Similar uncertainties exist with the other potential effects of PFAS exposure. It is

already have taken place and that late-stage intervention to rapidly reduce serum PFAS may be nugatory.	therefore not clear that reducing PFAS would benefit that individual's health directly. We have not, therefore made a recommendation that any intervention be offered widely.
Lastly, I have voiced my concern that many islanders are not aware of the extent of the issue, which at this juncture we note to be wider that the plume. Many are unable to attend the public meetings or are unaware that they are even taking place. I have formally requested that these meetings be broadcast but I understand that this isn't an option due to logistical reasoning. I would however like to repeat that this information is not reaching the wider public who are also receiving mixed messages via the Media on the extent of the issue. This is a concern where public health and transparency is concerned. Therefore I would request that consideration is given to how to better inform the public so that they are better informed on how to protect themselves from drinking unfiltered water which we note is contaminated.	Thank you for your comment. All of our panel meetings are livestreamed, and the recordings are made available on request. We shall raise the issue of further public engagement again. On the subject of water filtering, we are considering the matter in Report 4.
PFAS contamination is not merely a scientific issue it is a public health emergency and a matter of environmental concern. As a member of the Jersey community, I will continue to advocate for the recognition, transparency, and action that this crisis demands.	Thank you for your comment. We believe our processes to be among the most transparent in the world and we are proud that we have livestreamed meetings and regular public engagement events. Nevertheless, there is always more that can be done, and we will reflect further on that.
Adopt transparent communication practices, openly sharing test results, health data, and government actions with residents. This helps build public confidence and empowers residents to advocate for their own health.	Thank you for your comment. We believe our processes to be among the most transparent in the world and we are proud that we have livestreamed meetings and regular public engagement events. Nevertheless, there is always more that can be done, and we will reflect further on that. Human test results must, of course, be dealt with in a way that respects clinical confidentiality. Environmental testing is a matter for Report 4.
This report, commissioned by the Department of Health, addresses the harm caused by PFAS pollution and its impact on human health. Specifically, it considers the perceived or experienced violations of Article 8 of the Human Rights Act—the right to respect for private and family life—due to inadequate medical treatment related to PFAS exposure. However, the panel tasked with this report lacks	Thank you for your comment. We are a scientific advisory panel and are not commissioned, nor constituted to consider legal matters. We are a little puzzled by the phrase "inadequate medical treatment" and unclear what "treatments" you believe should be offered; we have already recommended the most clinically effective intervention for PFAS lowering to prevent pre- and postnatal exposure. We have

the necessary expertise to properly assess the public's concerns regarding Article 2—the right to life—as it relates to protection from PFAS exposure.	not widely recommended any intervention beyond that because there is no clear evidence that such an offer would improve people's health. This in accordance with international standard practice.
The Panel's draft report currently overlooks several key ethical and medical issues that significantly impact Jersey residents dealing with PFAS contamination. Addressing these areas will ensure a fairer, more compassionate, and more complete approach:	Thank you for your comment. The panel is puzzled by this comment as section 2.2 discusses key ethical issues in detail and medical issues are discussed in great detail through the remained of the report. It is on these bases that our recommendations were derived.
The Draft Third Report of the Independent PFAS Scientific Advisory Panel for Jersey represents a necessary step toward addressing a significant environmental and public health crisis. It provides valuable data from environmental testing and biomonitoring and acknowledges relevant international studies. However, viewed against global best practices—particularly the proactive responses to similar crises in Ronneby, Sweden, and Veneto, Italy—the current draft remains overly cautious, limited in scope, and incomplete in addressing critical public health and environmental justice issues.	Thank you for your response. This matter was discussed at some length in the panel meetings, including hearing from leading researchers at Veneto and Ronneby. The matter is thoroughly referenced in the text of the report. The international experts we received evidence from were unanimously of the view that, unless it is for research or legal purposes, there was not a case for widespread PFAS testing or screening for health conditions beyond that highlighted in the report. It is important to distinguish what is done for the purposes of research and what is done to improve the health of affected persons. Our remit, in this report, is on testing and interventions that may improve the health of Islanders, not on answering research questions. We have recommended all tests that have a robust evidence base for the context in Jersey, and which meet the internationally agreed criteria for an appropriate screening activity. As for interventions, we have gone considerably further in our recommendations than either Veneto or Ronneby. For these reasons, we find this response puzzling.
The experience of the Veneto region in Italy offers valuable insights into how Jersey can more effectively address its own PFAS contamination crisis. The Italian response provides practical examples that Jersey could adopt immediately. Authorities communicated clearly and transparently, holding public meetings and providing easily understandable information to residents. This approach ensured communities were informed, engaged, and able to actively participate in addressing the crisis. Enhance transparency, regularly providing clear, accessible, and consistent communication	Thank you for your response. This matter was discussed at some length in the panel meetings, including hearing from leading researchers at Veneto and Ronneby. The matter is thoroughly referenced in the text of the report. The international experts we received evidence from were unanimously of the view that, unless it is for research or legal purposes, there was not a case for widespread PFAS testing or screening for health conditions beyond that highlighted in the report. It is important to distinguish what is done for the purposes of research and what is done to improve the health

about contamination status, health risks, and protective measures.	of affected persons. Our remit, in this report, is on testing and interventions that may improve the health of Islanders, not on answering research questions. We have recommended all tests that have a robust evidence base for the context in Jersey and which meet the internationally agreed criteria for an appropriate screening activity. As for interventions, we have gone considerably further in our recommendations than either Veneto or Ronneby. Additionally, we believe our processes to be among the most transparent in the world and we are proud that we have livestreamed meetings and held regular public engagement events. Nevertheless, there is always more that can be done, and we will reflect further on that. For these reasons, we find this response puzzling.
Establish clear health monitoring and treatment programs based on findings from blood tests, especially for vulnerable groups like children, pregnant women, and residents with high exposure.	Thank you for your comment. Neither our reviews of the scientific literature, nor our engagement with PFAS experts from around the world indicated any specific testing or intervention that is appropriate for children. There was likewise insufficient evidence to make differential recommendations for those with higher exposure. As discussed in the report, while there is an increase in preeclampsia or hypertension in pregnancy related to PFAS in some studies, it is screened for as part of routine medical care and therefore no recommendation was needed. This is clearly stated in the report.
Introduce specific health protections for children, pregnant women, and vulnerable individuals. Young children, who are more sensitive to environmental toxins, should have dedicated health checks and monitoring programs to ensure their safety as they grow.	Thank you for your comment. Neither our reviews of the scientific literature, nor our engagement with PFAS experts from around the world indicated any specific testing or intervention that is appropriate for children. There was likewise insufficient evidence to make differential recommendations for those with higher exposure. As discussed in the report, while there is an increase in preeclampsia or hypertension in pregnancy related to PFAS in some studies, it is screened for as part of routine medical care and therefore no recommendation was needed. This is clearly stated in the report. Additionally, Report 4 is looking at PFAS in the environment. The panel will review the matter of wider community testing in the light of that information.

To avoid possible misunderstanding, I believe it is important that the terms of reference of the panel must define what it covers and what its expertise it does not cover	Thank you for your comment. Our terms of reference are summarised at the beginning of the report. We have the expertise to make scientific assessments around PFAS, health and the environment and make recommendations for policymakers. Our remit does not include the assessment of existing law or any historical legal matters.
Comments that relate to Report 2	
Mental Health and Well-being Issue: The emotional impact of living with contamination, uncertainty, and health fears is not acknowledged in the report. Recommendation: Provide mental health support and counseling specifically for residents affected by PFAS contamination. Residents feeling anxious, fearful, or uncertain about their health or future due to contamination deserve psychological support and reassurance.	Thank you for your comments. These points are important, and have already been discussed in our second report (which you may not have seen). We have already made a recommendation along the lines that you suggest in report 2.
Special Care for Children: Issue: The draft report does not consider how PFAS might specifically harm children's growth, development, or long-term health, even though international research highlights that children can be particularly vulnerable. Recommendation: Create dedicated health monitoring and support programs for children living in contaminated areas, ensuring early detection and treatment of any health impacts that PFAS may cause as they grow.	Thank you for your comments. These points are important, and have already been discussed in our second report (which you may not have seen). The evidence on PFAS in children to this point does not identify conditions specific to children for which monitoring would be appropriate, but, if that were to change, then recommendations may need to be reviewed
Connect Blood Test Results Clearly to Health Conditions Provide clear, easy-to-understand explanations about how PFAS exposure could lead to health conditions such as anaemia (low red blood cells), immune issues (frequent infections), or other conditions related to blood health. Residents should understand not just test results but how these results affect their daily lives.	Thank you for your comments. These points are important, and have already been discussed in our second report (which you may not have seen). You allude to certain health conditions for which there is currently not sufficient evidence in humans; such as anaemia and frequent infections. You may find it helpful to review the content in report 2. However, as noted in Report 2, it is not possible to assign a number or probability of how much harm is associated with a level of PFAS in blood
Easy-to-Follow Advice for Doctors and Patients: Develop simple, practical decision-making tools or charts that help doctors and patients understand when medical action is needed. For example, if a resident's blood test result shows a specific PFAS level, doctors should easily	Thank you for your comments. You made the same points in several places in your response, and we have brought them all together here so that the final report is clearer for the reader. These points are important, and have already been discussed in our second report (which you

know the next steps, such as recommending additional screenings for thyroid disorders or cholesterol monitoring. The report fails to provide Jersey's doctors with easy-to-use tools or clear guidance for making shared decisions with patients about PFAS exposure risks. For instance, doctors in Jersey currently have no straightforward instructions about when they should recommend extra health checks or specific treatments based on patients' exposure levels. There is no clear guidance provided for doctors on how often they should monitor these blood-related health issues in residents exposed to PFAS. Give clear and simple instructions to local doctors on how to regularly check and interpret blood test results in PFAS-exposed individuals. Doctors in Jersey need to know what signs to look for, when to do further testing, and how to advise residents on protecting their health. Give local doctors clear and straightforward guidelines about what steps they should take if their patients show signs of PFAS exposure. Doctors should have easy-to-follow procedures that include what tests to order, when to refer to specialists, and how to advise patients on protecting their health. Doctors have not been given clear guidance to help them identify symptoms of PFAS exposure or how to treat patients who may be affected. Clinicians remain unsupported, patients remain unrecognized, and health conditions that could be linked to PFAS go undetected or unrecorded.	may not have seen). We recommended an advice service for doctors and patients and a written knowledge summary. The first of these is already in operation and the second is in already being prepared, based on report 2.
The report acknowledges important blood markers, like immune system indicators and cholesterol levels, helping link PFAS exposure to possible health impacts in Jersey residents. It references relevant international studies about how PFAS can affect blood cells and immune function, helping residents understand potential risks to their health. The report does not discuss specific blood-related health problems that PFAS exposure can cause, such as low blood cell counts (anaemia or leukopenia), problems with blood clotting, or negative impacts on bone marrow—the part of the body responsible for making blood cells.	Thank you for your comments. You made the same points in several places in your response, and we have brought them all together here so that the final report is clearer for the reader. You refer to content in this response that is not actually present in the draft of report 3. You also make some assertions that do not accord with the scientific evidence. These matters have already been discussed in our second report (which you may not have seen).

It fails to connect changes in blood test results directly with practical, real-world health issues residents might face, such as feeling unusually tired due to anaemia or experiencing frequent infections due to immune system suppression.	
The panel has gathered comprehensive environmental sampling and biomonitoring data that significantly enhance local understanding of PFAS exposure in Jersey. The report appropriately references international epidemiological studies, including recent meta-analyses, which contextualize Jersey's findings within broader global data. Inclusion of local biomonitoring data increases the practical relevance of the report's conclusions for residents. The report relies heavily on cross-sectional data, limiting the ability to draw robust conclusions about cause-and-effect relationships between PFAS exposure and health outcomes. There is inadequate consideration of potential confounding factors, such as socioeconomic status, lifestyle differences, and co-exposures to other environmental toxins, which may significantly affect the interpretation of health outcomes. The report does not sufficiently address dose-response relationships, particularly at lower exposure levels characteristic of Jersey's population, limiting the practical value of its health risk assessments. There is limited transparency regarding uncertainties, variability in individual susceptibility, and the specific limitations of existing epidemiological studies, reducing public confidence in the findings. Considering Other Factors Clearly. Health studies must also account for other factors that might affect residents' health—such as age, income levels, diet, or exposure to other chemicals. For example, if two neighbourhoods have different health outcomes, it's important to understand if differences in health are caused by PFAS exposure or something else, like housing conditions or access to healthcare. Clear Information on Low-Level Exposures: Studies should clearly explain how even small amounts of PFAS exposure can impact health. Jersey residents need to understand whether	Thank you for your comments. You made the same points in several places in your response, and we have brought them all together here so that the final report is clearer for the reader. You refer to content in this response that is not actually present in the draft of report 3. The other matters you raise have already been discussed in our second report (which you may not have seen). This was consulted on and published in 2024. It is available online. That second report draws mostly on large cohort studies, but cross-sectional studies and animal toxicological data are also drawn upon where stronger epidemiological studies do not exist. Confounding factors are discussed there. In terms of honest communication, we believe our processes to be among the most transparent in the world and we are proud that we have livestreamed meetings and held regular public engagement events. Nevertheless, there is always more that can be done, and we will reflect further on that.

drinking water with low levels of PFAS (as might be found in private wells or boreholes outside known contamination plumes) poses health risks over time. Honest Communication about What Isn't Known: Authorities should openly discuss any uncertainties or gaps in knowledge about PFAS exposure and health effects. Residents deserve to know what is well-understood, what remains uncertain, and what steps are being taken to improve this understanding—such as clearly stating if it's unclear exactly how PFAS exposure might influence rates of certain diseases like thyroid problems or immune disorders in Jersey. This approach will ensure residents have practical, meaningful information that can guide everyday decisions—such as choosing whether to connect to mains water, whether to seek medical testing, or how to advocate effectively for community safety.	
Comments that relate to Report 4	
I note that there is not a recommendation to stop exposure making treatment somewhat farcical! Please provide a recommendation of how to STOP your exposure if you live on the island of Jersey in order to assist those who elect for treatment.	Thank you for your comment. The remit for this report does not include PFAS exposure; that matter is dealt with in Report 4 on PFAS and the environment. Work on Report 4 is currently underway.
It has been assumed and incorrectly stated by the Panel that the airport stopped using PFAS in 2006 after their manufacture and sale was stopped in 2002. Wrong. Angus Fire continued manufacturing and selling PFAS decades after this and Jersey airport continued using them into 2020.	Thank you for your comment. The remit for this report does not include PFAS in the environment; that matter is dealt with in Report 4 on PFAS and the environment. Work on Report 4 is currently underway, and recommendations will be made when that work is complete. We would be grateful for any further information that you have about precisely what was used when.
The current draft report does not discuss or recommend any changes to Jersey's laws or systems of environmental oversight. This silence on legislative reform is a significant weakness in the government's PFAS response and leaves the Island vulnerable to continued contamination, confusion, and injustice.	Thank you for your comment. The remit for this report does not include PFAS in the environment; that matter is dealt with in Report 4 on PFAS and the environment. Work on Report 4 is currently underway, and recommendations will be made when that work is complete
For islanders with very high levels of PFAS, could there be other / different sources of PFAS they are still being exposed to, and what would you recommend that government do to investigate that? What would be considered a	Thank you for your comment. The remit for this report does not include PFAS in the environment; that matter is dealt with in Report 4 on PFAS and the environment. We do plan to consider the range of potential sources of PFAS in Report 4 Work on Report 4 is currently

high enough level of PFAS in blood that the cause should be investigated?	underway, and recommendations will be made when that work is complete. You raise some important questions. It is very difficult to give a definitive threshold for environmental investigation before we have looked a bit more at the environment in Report 4, it is also difficult to extrapolate from one individual to a wider area. It is likely that there will be a lot of variation too in the circumstances of specific cases. In addition to considering this matter in Report 4, we will highlight it to the Public Health and Environment teams.
Open and Transparent Information:Provide clear, accessible information online and in public forums about PFAS contamination. Jersey residents should easily be able to find out if their area is affected, what steps they can take to protect their families, and how the government is addressing the contamination.	Thank you for your comment. The remit for this report does not include PFAS in the environment; that matter is dealt with in Report 4 on PFAS and the environment. Work on Report 4 is currently underway and recommendations will be made when that work is complete
From discussion with some of the PSAP principals it is evident to me some significant assumptions have been made but not explicitly stated. Some of these assumptions are incorrect. Many of these are themes running through all reports. The “plume area” is oft referred without actually stating what and where it is. There are numerous plumes . A time sequence (attached here as “P176-Plumes.pdf” Page 9 of). A possible consolidated but historic plume ex Jersey Water (attached as “JW-Resources-PlumeArea” Page 6 of). Some principals use “plume area” to mean all areas of Jersey impacted by direct airport PFAS contamination i.e. not distributed by JW. Thus including the sizeable Pont Marquest catchment area (shown on the attached “JW-Resources-Catchmnts.pdf” page 8 of the preceding URL)	Thank you for your comment. The remit for this report does not include PFAS in the environment; the matter of the precise geographical plume is important and is being dealt with in Report 4 on PFAS and the environment. Work on Report 4 is currently underway and recommendations will be made when that work is complete. Where we have used the term “plume”, it is in a broad sense, meaning “area of suspected higher contamination”. We have amended the glossary of this report accordingly.
The plume area, which ever is chosen, is NOT the extent of the direct pollution yet that it is has entered folk-lore and the Panel have at times gone along with this. The plume areas were and remain purely monitoring zones. Indeed the map in 1c above explicitly states this.	Thank you for your comment. The remit for this report does not include PFAS in the environment; the matter of the precise geographical plume is important and is being dealt with in Report 4 on PFAS and the environment. Work on Report 4 is currently underway, and recommendations will be made when that work is complete. Where we have used the term, it is in a broad sense, meaning

	"area of suspected higher contamination". We have amended the glossary of this report accordingly.
I suggest that the 'plume' may extend from the Aero Club along the stream, possibly toward St Aubin's Harbour.	Thank you for your comment. The remit for this report does not include PFAS in the environment; the matter of the precise geographical plume is important and is being dealt with in Report 4 on PFAS and the environment. Work on Report 4 is currently underway, and recommendations will be made when that work is complete. Where we have used the term, it is in a broad sense, meaning "area of suspected higher contamination". We have amended the glossary of this report accordingly.
The Panel have assumed that there are just two classes of Islanders – those who lived and/or worked in a plume area using local water sources but who moved to JW supplies around 2006 and those who have always been on JW supplies. But there are others: Those who lived and/or worked in a plume area and who continue to use local water sources and not JW supplies. draft report 3 page 2 pg 3: "The extension of mains water in 2006 reduced some direct exposure.." - no reduction for these still using local water draft report 3 page 113 pg 1 "for people with past exposure, for example in the plume area, their serum levels are very likely to be steadily falling". Where is the evidence for this implicit assumption? There is an assumption on the part of very many not just the Panel that as time passes the concentration of various PFAS, at places within a plume, will fall. This after all was the basis for deriving the monitoring areas, aka plume. Evidence proves this incorrect (attached a chart of PFOS levels at one particular plume location which identifies a more than 9-fold increase, 2µg/L in 2000 to 19µg/L in 2017 as "PFAS-Variation v Time.xls"). Certainly not a fall. Apologies for not fully identifying the source – Environment have deemed it Personal Data. This assumption carries forward draft report 3 page 115 pg 3 "We do not have data for how much background levels have fallen over time, presumably falling..."	Thank you for your comment. The remit for this report does not include PFAS in the environment; the matter of what the nature and extent of human exposure is important and is being dealt with in Report 4 on PFAS and the environment. Work on Report 4 is currently underway, and recommendations will be made when that work is complete. We will also have more information on the trends over time in environmental PFAS in Jersey. As to the assumption about reducing background serum levels, that is based on that being the case across international time trend serosurveys. The basis for our assumption that exposure has fallen for people in the plume area who transferred from borehole to mains supplies, comes from the fact that measured borehole concentrations are generally much higher.
I would also suggest that concrete may provide an otherwise impossible-to-obtain historical record of contamination. For instance;	Thank you for your comment. The remit for this report does not include PFAS in the environment; the matter of assessing PFAS

foundations poured on a certain date most likely will have evidence of contamination if there was any. Blocks made locally will be the same. Cement used to build walls will usually have been made with local tap water. I do not know if such a test is possible but it may prove useful to pinpoint exposure hotspots.	historical levels in the environment is important and is being dealt with in Report 4 on PFAS and the environment. Work on Report 4 is currently underway, and recommendations will be made when that work is complete. We will consider the feasibility of what you suggest as part of that report.
The attempt, draft report 3 page 114 pg 1, to estimate the background serum PFAS levels for people in Jersey clearly only applies to those now on JW supplies and not the whole population. In addition it assumes that the sources of most of the pollution will not be used in future. JW are on record, during a Panel meeting, of saying that not using the boreholes and Pont Marquest Catchment Area is not sustainable in the long term.	Thank you for your comment. The remit for this report does not include PFAS in the environment; the matter of the sources of PFAS exposure is important and is being dealt with in Report 4 on PFAS and the environment. Work on Report 4 is currently underway, and recommendations will be made when that work is complete.
The report frames PFAS exposure as largely "historical," yet ongoing contamination especially near the airport contradicts this narrative. Continued environmental testing and proactive measures must be prioritised to prevent further harm.	Thank you for your comment. The remit for this report does not include PFAS in the environment; the matter of the sources of PFAS exposure is important and is being dealt with in Report 4 on PFAS and the environment. Work on Report 4 is currently underway, and recommendations will be made when that work is complete. In this report we note that for those who have transferred from contaminated boreholes the exposure has substantially decreased.
Jersey's panel has not adopted successful international policy examples. The European Union, the United States, and Sweden have already implemented stricter rules and clearer public communication about PFAS contamination, but Jersey's approach remains limited and cautious.	Thank you for your comment. The remit for this report does not include PFAS in the environment; that matter is dealt with in Report 4 on PFAS and the environment. Work on Report 4 is currently underway, and recommendations will be made when that work is complete
Implement a public register and notification system informing residents whenever PFAS-contaminated materials (like sewage sludge) are applied near their homes or communities. People should have the right to know exactly where contaminated materials are placed so they can safeguard their families and their property.	Thank you for your comment. The remit for this report does not include PFAS in the environment; that matter is dealt with in Report 4 on PFAS and the environment. Work on Report 4 is currently underway, and recommendations will be made when that work is complete
Jersey regularly incinerates PFAS-contaminated biosolids without monitoring air emissions specifically for PFAS-related toxins. Burning PFAS waste can release harmful chemicals into the air, posing an unknown health risk. • Recommendation: Establish immediate	Thank you for your comment. The remit for this report does not include PFAS in the environment; that matter is dealt with in Report 4 on PFAS and the environment. Work on Report 4 is currently underway, and recommendations will be made when that work is complete

monitoring of air emissions from incineration facilities to measure and publicly report PFAS-related pollution, protecting the public from unseen risks Recent data indicates Jersey's sewage sludge has PFAS levels far exceeding safety guidelines recommended internationally (e.g., U.S. EPA guidelines show that even 1 ppb of PFOA/PFOS can pose health risks; Jersey's sludge contains significantly higher levels, up to 50 ppb).Immediately revise Jersey's sewage sludge management practices. Reduce PFAS contamination at its source and discontinue spreading heavily contaminated biosolids on land, minimizing further environmental damage and health risks.	
Keeping the locations of PFAS-contaminated sludge applications secret prevents residents from protecting their families, homes, and land from long-term contamination risks. This secrecy can significantly reduce property values and leave future property owners facing costly clean-ups.: Require full transparency about locations where PFAS-contaminated materials are applied. Providing public access to this information protects current and future residents' health, livelihoods, and property investments.	Thank you for your comment. The remit for this report does not include PFAS in the environment; that matter is dealt with in Report 4 on PFAS and the environment. Work on Report 4 is currently underway, and recommendations will be made when that work is complete
An average of 280 cubic metres of biosolids per month are incinerated using the Jersey Electricity Company (JEC) chimney, which sits at the entrance to St. Helier's harbour—immediately adjacent to Jersey's affluent waterfront residential and business developments. There is no published air monitoring for PFAS byproducts, despite international concern about the dangers of incinerating fluorinated compounds. This raises concerns not only about direct inhalation risk but also about PFAS entering marine ecosystems via fallout near the port and bay	Thank you for your comment. The remit for this report does not include PFAS in the environment; that matter is dealt with in Report 4 on PFAS and the environment. Work on Report 4 is currently underway, and recommendations will be made when that work is complete
Concerning perceived or experienced violations of human rights are article 2 not providing adequate protection from harmful hefas as a result of removing the waste chapter from the island plan resulting in Jersey no longer having a waste management plan to protect us from all pollutants including pfas entering the water system the panel's expertise is assessing the	Thank you for your comment. The remit for this report does not include PFAS in the environment; that matter is dealt with in Report 4 on PFAS and the environment. Work on Report 4 is currently underway, and recommendations will be made when that work is complete

health harm and treatment due to exposure to pfas in accordance with Human Rights and children's rights article 8 This waste has been deposited on low-lying foreshore at La Collette, on our international protected Ramsar- marine Wetlands site. This site plays a critical role in the international food chain, and the threat of a severe southerly storm combined with a high tide presents an imminent ecological disaster. The Marine management plan for our internationally protected ramsar marine Wetlands prepared by an independent environmental health environmental planning department strategic and regulators identified the Threat of pollution from lacollette waste dump onto the ramsar site however the updated marine Wetlands management plan prepared by a conflict of interest combined department of infrastructure responsible for dumping the waste and the environmental health and environmental planning department responsible for protecting the ramsar from the waste dumped at love Collette have updated the management plan which has removed any reference to the Threat of pollution from the la collette	
...but its scope does not include perceived or experienced violation of Human Rights and children's rights article 2 for not adequately protecting islanders and visitors from exposure to pfsa from a variety of sources, including experienced and at risk airport contamination of streams and ponds and national park protected wetlands and groundwater contamination of seaweed from st ouens beach from airport and then either dumped on farmland or another seepage from the airport onto the beach and becoming airborne in wave spray and then carried by the westerly prevailing winds across the island incinerator flue or ash water treatment works contamination of seaweed from St. Aubins Beach from sewage works and then either dumped on farmland or incinerated or another incinerator 100,000's tons of mixed hazardous waste La Collette waste dump Seepage from La Collette waste dump is taken	Thank you for your comment. The remit for this report does not include PFAS in the environment; that matter is dealt with in Report 4 on PFAS and the environment. Work on Report 4 is currently underway, and recommendations will be made when that work is complete

to the water treatment works Seepage waterfront, hazardous waste landfill dump onto the beach contaminated seaweed from seepage waterfront, hazardous waste landfill dump and sewage works dumping of contaminated sewage sludge on fields etc as well as pfas entering into the water supply from either wells or mains This should be covered by independent env health and env planning regulators with the necessary expertise, enforcing the jersey waste management plan, which no longer exists since the waste chapter was removed from the 2022 - 25 bridging island plan	
The draft report currently misses several important environmental issues, leaving Jersey residents exposed to continuing health risks from PFAS contamination. Addressing these gaps urgently is essential to protecting public health and the environment:	Thank you for your comment. The remit for this report does not include PFAS in the environment; that matter is dealt with in Report 4 on PFAS and the environment. Work on Report 4 is currently underway, and recommendations will be made when that work is complete
Issue: Jersey still imports and uses at least four pesticides known to contain PFAS (xxxx, xxxx, xxxx, and xxxx). However, no routine monitoring or specific regulations control their use or environmental impact. Recommendation: Immediately halt or restrict the import of pesticides containing PFAS and introduce regular monitoring to detect and limit environmental contamination from these substances.	Thank you for your comment. The remit for this report does not include PFAS in the environment; that matter is dealt with in Report 4 on PFAS and the environment. Work on Report 4 is currently underway, and recommendations will be made when that work is complete
PFAS-contaminated sewage sludge is spread on farmland across Jersey without publicly disclosing where and when it happens. Residents living nearby cannot take precautions, and contamination may spread silently through soil, water, crops, and livestock. Recommendation: Implement a transparent public notification system showing exactly where and when sewage sludge containing PFAS is spread. Residents must have the right to know and object, protecting their health and property.	Thank you for your comment. The remit for this report does not include PFAS in the environment; that matter is dealt with in Report 4 on PFAS and the environment. Work on Report 4 is currently underway, and recommendations will be made when that work is complete