Minutes of public meeting of the PFAS Scientific Advisory Panel on Teams
3:00pm – 5:30pm on Thursday 18 January 2024

Panel Members present:	Dr Steve Hajioff – Independent Chair Dr Tony Fletcher – PFAS and Health member Prof Ian Cousins – PFAS and Environment member
Subject Matter Experts present:	Prof Jane Hoppin, North Carolina State University Dr Gloria Post, New Jersey Department of Environmental Protection
	Dr Jamie DeWitt, Professor, Oregon State University
In attendance:	Grace Norman – Deputy Director Public Health *from 420pm* Sarah Tyler – Senior Policy Officer

Welcome

The Chair welcomed everyone and briefly outlined the running order of the meeting as per the agenda.

Introductions

Steve Hajioff is the Panel Chair – and has a background as a physician and a public health expert, in economics, and a retired Director of Public Health in an area of London with two major international airports and a variety of other environmental hazards. Steve Hajioff is not a PFAS expert and has worked in pharmaceuticals and supported policy makers to make evidenced based policy.

Tony Fletcher is the Health Panel Member – An Environmental Epidemiologist from London School of Hygiene and Tropical Medicine, and member of the Panel with experience of studies on the health effects of PFAS in several polluted communities.

Ian Cousins is the 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 human exposure of PFAS.

The Chair mentioned the meeting is usually joined by Grace Norman, Deputy Director of Public Health for the Government of Jersey, the Commissioner for this work, and a standing observer at these meetings and that she will join later.

Support staff, for programme administration and minute taking, were also in attendance.

Declarations of Interest

None.

Minutes of last meeting

There were no minutes to approve as the last meeting heard from Islanders and to ensure their clinical confidentiality is protected and the information is captured, the process takes longer than normal.

Additional findings from the last meeting

Discussions had been had between Government officers from Infrastructure & Environment and the Panel on the topic of potatoes being irrigated with water from within the plume area.

Subject Matter experts

The Chair asked the subject matter experts to introduce themselves to the meeting.

Professor Jane Hoppin is a professor at North Carolina State University, an Environmental Epidemiologist, and currently runs a large study of PFAS exposed people in North Carolina. She was also a panel member on US (United States) National Academies of Science, Engineering and Medicine that made recommendations for health care and follow up of PFAS exposed people. Most recently served on the International Agency for Research on Cancer (IARC) Panel that evaluated PFOA and PFOS for carcinogenicity.

Dr Gloria Post is a human health toxicologist and risk assessor in the State of New Jersey Department of Environmental Protection (NJDEP). Dr Post has worked in the NJDEP Division of Science and Research, since 1986, with responsibility for developing health-based guidelines for contaminants found in New Jersey's environment. She is also a member of the New Jersey Drinking Water Quality Institute (DWQI), an advisory group which recommends drinking water standards to the Commissioner of NJDEP Also, she was a member of a National Academies of Science and Medicine committee that planned a workshop on human health PFAS research for the federal government, the USEPA (United States Environmental Protection Agency) Science Advisory Board panel that reviewed the scientific basis for the proposed federal drinking water standards for PFAS, and the International Agency for Research on Cancer (IARC) recent evaluation of PFOA and PFOS.

Dr Jamie DeWitt is a professor of Environmental Molecular Toxicology at Oregon State University and Director of their Environmental Health Science Centre. She has worked with PFAS in the laboratory since around 2005, looking at what PFAS does to laboratory models and investigates the immune system response. Dr DeWitt has served in several different advisory capacities (as have Professor Hoppin and Dr Post) and serves as an expert witness for plaintiffs (*a person who brings a case to court)*. Most of her work includes looking at laboratory models, and she supports different organisations in decision making.

Presentations from subject matter experts

The Chair invited subject matter expert guests to present to the meeting to contribute to report 2 on the health effects of PFAS.

Professor Jane Hoppin

Professor Jane Hoppin gave a presentation entitled "What are the Human Health Effects of AFFF (aqueous film forming foam) & other PFAS". For further details of the project see GenX Exposure Study - GenX Exposure Study (ncsu.edu)

Summary notes from the presentation:

Professor Hoppin has been involved with a study of the contamination of Cape Fear River basin in North Carolina, which is the largest river in North Carolina on the East Coast of the USA. Cape Fear River basin supplies more than 1.5 million people with drinking water. The study followed 3 different communities: 1) those at the mouth of the river, who were drinking water downstream from a chemical manufacturing site, 2) those living near where a chemical manufacturing plant discharged into the river, and 3) a community upriver of the plant, to understand PFAS contamination and the baseline.

The study involved a group of 1,000 highly exposed people in North Carolina.

Professor Hoppin began by presenting some context about PFAS. PFAS is a large class of chemicals of more than 14,000 substances. In the US and other populations, 4 PFAS are commonly measured, PFOS, PFHxS, PFOA, and PFNA.

A factor which makes PFAS research challenging is that people are exposed to mixtures of multiple PFAS, and not to single type of PFAS, and each population is exposed to a different mixture of PFAS. Therefore, it is difficult to identify the role of each contaminant and different populations have different chemical profiles. Additionally, there is not good data on who has been exposed, or who should be tested, or for when clinical follow up is recommended. The work outlined by Dr Hoppin focused on health effects more broadly, focusing on PFOS, PFHxS, PFOA, and PFNA, which are all types of PFAS.

Jane Hoppin's presentation included what conclusions had been drawn on the health effects of PFAS – referenced in 3 Potential Health Effects of PFAS | Guidance on PFAS Exposure, Testing, and Clinical Follow-Up | The National Academies Press

Professor Hoppin reported that there are health effects which are outlined in the National Academies research above to have 'sufficient' evidence of an association between exposure and health:

- Decreased antibody response (in adults and children)
- Dyslipidemia (in adults and children)
- Decreased infant and fetal growth
- Increased risk of kidney cancer (in adults)

She also reported that there are other health effects where the research deemed that there is 'Limited suggestive evidence' of an association:

- Increased risk of breast cancer (in adults)
- Increased risk of testicular cancer (in adults)
- Liver enzyme alterations (in adults and children)
- Increased risk of pregnancy-induced hypertension (gestational hypertension and preeclampsia)
- Increased thyroid disease and dysfunction (in adults)
- Increased risk of ulcerative colitis (in adults)

The research also sought to identify what health care follow up could be required for people exposed to PFAS and identified blood levels that would warrant a health follow up, although noting that data for this was limited.

In the general population, PFAS in blood is reducing over time. The German HMB (human biomonitoring) work was used as a guide in this research to determine whether individuals should receive clinical follow up, as follows.

- Less than 2 ng/mL (nanograms per milliliter in blood) summed PFAS – adverse health effects are not expected and is recommended that people receive usual standard of care
- 2 to less than 20 ng/mL summed PFAS – HBM and this research determined that there is the potential for adverse effects in sensitive populations. Recommendations are to reduce PFAS exposure, screen for dyslipidemia, hypertensive disorders of pregnancy, and breast cancer, among other conditions
- More than 20 ng/mL of summed PFAS – A higher potential of adverse effects so the recommendations were to reduce exposure and test for thyroid function, kidney cancer, testicular cancer, and ulcerative colitis. Lipid test could start from age 2

To note these levels are not formally adopted, however they have been used in other research across the world.

The presentation went on to cover the evidence on reduced vaccine response and other effects on the immune system and how the body responds to infections. The potential health effects of PFAS are many and health outcomes change throughout the life course.

Human studies suggest PFAS exposure may:

- Increase risk of thyroid disease (noting that thyroid disruption would need a large sample size to test this further)
- Increase blood cholesterol levels
- Decrease the body's response to vaccines
- Decrease fertility in women
- Increase risk of high blood pressure and pre-eclampsia
- Lower infant birth rate
- Decrease fetal and infant growth
- Increase the risk of kidney, testicular and breast cancer (some or limited evidence for these, for example see IARC study)

Professor Jane Hoppin provided some resources and the Guidance on PFAS Exposure, Testing, and Clinical Follow-Up. National Academies of Sciences, Engineering, and Medicine, 2022. Full report here:
Front Matter | Guidance on PFAS Exposure, Testing, and Clinical Follow-Up | The National Academies Press

The Chair thanked Professor Hoppin and clarified that the US uses different units than Jersey for cholesterol levels.

Ian Cousins asked a clarification question about why PFOS was the predominant contaminant in the exposed communities around Cape Fear River, when would it normally be PFOA? Professor Hoppin indicated that further work was to be done on this. The Cape Fear River had been used as an industrial river since before the Civil War, there were nearby airports, textile manufacturers (contributing PFOA) and the largest military base in US was nearby (Fort Liberty). It is not understood why they have elevated PFAS levels. However, people with private well water supplies also had elevated levels compared to other areas in the US.

Dr Gloria Post

Dr Gloria Post gave a presentation entitled "New Jersey and other US Drinking Water Guidelines for PFAS." As a disclaimer, Dr Post said her presentation did not necessarily reflect the views of her department.

Dr Post gave an overview of New Jersey's PFAS work. New Jersey has developed drinking water standards (called Maximum Contaminant Levels = MCLs) for many types of containments since the 1980s.

PFOA was first reported in New Jersey's drinking water near an industrial source in 2005.
In 2007, the New Jersey drinking water guidance for PFOA was set at 40 parts per trillion (ppt), which was much lower than other US states' guidance at the time. In 2018, the New Jersey Maximum Contaminant Level (MCL) for PFNA of 13 ppt was established as the first drinking water standard for any PFAS in the United States. In 2020, New Jersey established MCLs for PFOA at 14 ppt and PFOS at 13 ppt

From Dr Post's work in New Jersey, she outlined why PFAS in drinking water is a concern.

- There is widespread occurrence of PFAS in drinking water throughout the state of New Jersey, and elsewhere in the US and worldwide.
- PFAS do not break down; they persist in the environment
- Some have long human half-lives (~2 to > 8 years), so they remain in body for many years after exposure ends
- Multiple types of animal toxicity, some at low doses
- Evidence for human health effects at low (general population) exposures
- Greater exposure from relatively low drinking water levels than from other common sources (food & packaging, consumer products)
- Drinking water is not commonly a major source for other persistent, bioaccumulative, and toxic chemicals, for example PCBs (polychlorinated biphenyls)
- Exposure is higher in infants, who are a susceptible subgroup, particularly those who are breastfed
- In conclusion, there is a need to minimize exposure to PFAS from drinking water

Dr Post presented detailed information on PFAS drinking water guidelines in the US, which vary among states.

The notable conclusions about the human data reviewed as part of the development of the New Jersey MCLs for PFAS were:

- There is consistency of results in different populations for some health effects
- There is concordance with effects in animal toxicology studies
- Serum concentrations can be used as a measure of internal exposure
- Although limitations precluded use of human data available at the time the NJ PFAS MCLs were developed, the human data justified concern for the increase in PFAS blood levels from drinking water exposure

In a more recent 2022 review that evaluated newer information, the DWQI agreed with the current USEPA (United States Environmental Protection Agency) conclusion that human data should be used for risk assessment of PFOA and PFOS. The DWQI concluded that the strongest human evidence was for increased cholesterol, increased risk of kidney cancer, increases in the liver enzyme ALT, decreased antibody response to vaccination, and decreased birth weight. The DWQI also agreed with USEPA that PFOA is likely to be carcinogenic to humans. In summary, the DWQI concluded that there are multiple lines of evidence to support health-based drinking water levels below the current New Jersey analytical limits of 6 ppt for PFOA and 4 ppt for PFOS.

Dr Post shared a list of publications for further information which included the NJDEP website about PFAS, available here: https://dep.nj.gov/pfas/

The Chair thanked Dr Post for her presentation and asked whether drinking water is the most important source of exposure to PFAS. Dr Post commented that it depends on the drinking water concentration and that there is a factor called a 'clearance factor' that relates the PFAS dose received (ng per kg body weight per day) to the PFAS concentration in the blood serum (ng per ml). The PFAS dose (ng per kg body weight per day) can be estimated from the PFAS drinking water concentration (ng per liter) and the average water ingestion (liters per kg body weight per day). The clearance factor is different for PFOA and PFOS. For PFOA, with ongoing ingestion of 10 ppt (part per trillion) in drinking water, there would be an increase in the blood serum level of about 100 times this, so the increase in PFOA in blood serum can be estimated to be 1000 ppt from ongoing exposure to 10 ppt PFOA in drinking water.

Ian Cousins asked about the methods and costs for the strict water quality levels in New Jersey. Dr Post commented that the levels used now in New Jersey are PFNA (13 ppt), PFOA (14 ppt), and PFOS (13 ppt), and that nothing regarding lower levels has been committed to in New Jersey.

Dr Jamie DeWitt

Dr Jamie DeWitt gave a presentation entitled, "Effects of PFAS exposure on the immune system". Dr DeWitt outlined the basic functions of the immune system which performs many tasks in the body:

- Helping to keep the body healthy
- Protecting the body from pathogens like viruses, bacteria, fungi, and other things that want to invade
- Helping the body to repair itself when injured
- Recognising and killing mutated cells that could become tumors/cancers

When the immune system is out of balance, it may lead to (a) immune suppression which is a reduced ability of the immune system to respond to a challenge from a level considered normal, regardless of whether clinical disease results, and (b) inappropriate immune stimulation which is inappropriate immune responses to common substances, e.g., allergic hypersensitivity, or responses to self-antigens, i.e., autoimmunity.

PFAS affects many bodily systems, and one implication to the immune system is a decreased response to vaccines, which is a marker of immune suppression. Immune suppression can, in turn, increase the risk of infections (for example, the flu) and certain types of cancers. Decreased responses to vaccines have been seen in people who have higher levels PFOA/PFOS in their blood and laboratory model studies also support this finding. However, PFAS can also lead to an imbalance where the immune system responds too strongly (inappropriate immune stimulation) to things like pollen. It can be challenging to study the effects of PFAS exposure on the immune system because of the basic role of the immune system in overall health, but "challenging" the immune system with a vaccine, for example, can give important clues.

Dr DeWitt also worked on the study in Cape Fear River, and she explained some of the compounds found there:

PFMOAA - $C_3HF_5O_3$

- perfluoro-2-methoxyacetic acid
- (mono-ether carboxylic acid)

- Dominant short-chain PFAS detected in Cape Fear River in 2018 at high concentrations and not in human blood

Nafion Byproduct 2 – $C_7H_2F_{14}O_5S$ a longer chain compound

- Perfluoro-4-methoxybutanoic acid
- (di-ether sulfonic acid)
- PFEA detected in Cape Fear River in 2018 at low concentrations and detected in human blood

PFO5DoA – $C_7HF_{13}O_7$

- Perfluoro-3,5,7,9,11-pentaoxadodecanoic acid
- (multi-ether carboxylic acid)
- PFEA not measured in Cape Fear River in 2018 and was detected in human blood of people drinking water from the river

Some PFAS have a shorter half-life in the body, so they are not always detected.

In Dr DeWitt's work, laboratory administered compounds were given to laboratory models (*Mice used)* over a 30-day period of exposure (as per harmonized test guidelines which is a guide acceptable to the WHO and other agencies across the world).

Animal studies on changes in a liver marker: Signs of toxicity were detected in liver markers, all tests elicited effects at the administered concentrations, effects which varied depending on the compound.

Changes in vaccine response: Changes were seen to vaccine response at the highest doses administered for all models, however not all changes were statistically significant, although raised some concern that these compounds were changing the ability of the immune system to do its job.

In summary, the overall potency based on the liver and the ability to suppress the vaccine response (and changes seen in the liver in the lab) is that PFO5DoA is the most potent and PFMOAA least potent. This could be due to the carbons and length of the chain, or the functional group, or how structure affects the biological half-life in organisms. *(Half-life is the time it takes for the concentration of a substance in the body or in the environment to reduce to half its initial value).*

The European Food Safety Authority (EFSA) calculated a tolerable weekly intake (TWI) for food for four PFAS (PFOA, PFOS, PFNA, PFHxS) of 4 ng/kg/day (nanograms per kilogram per day) based on decreased vaccine responses. The US Environmental Protection Agency used decreased vaccine responses as a health effect (also used cardiovascular and developmental effects) to calculate health protective levels, although the proposed limit of 4 ppt (parts per trillion) for PFOA in drinking water was based on risks of cancer.

Immunosuppression can therefore be seen as a public health risk. PFOA and PFOS exposure are expected to cause mild to moderate immune suppression, but they are well studied, so it is known humans will be at risk if exposed. For other PFAS that have not been as well studied, the risks are not as well known.

The Chair thanked Dr DeWitt for the presentation and asked whether there are effects on other immune response pathways (cellular immunity). Dr DeWitt mentioned a range of studies to note in this regard. Dr Post commented that the IARC study identified some human data for carcinogens.

Ian Cousins asked Dr DeWitt to clarify what laboratory models are for the purposes for the public listening. Dr DeWitt explained that in her presentation she referred to studies on mice, and she noted that the compounds that she discussed are related to the US exposure relevant to North Carolina and not raised in relation to the Jersey context.

A broader discussion then followed, of which a summary of the headlines from the discussion are as follows:

In terms of health effects and contaminants present in the environment, there is limited toxicity testing data available from the environment. It is a challenge to interpret concentrations in the blood when there is no toxicity data to compare it with.

A study was referred to, an AFFF (A*queous Film-Forming Foams)* dosing study using AFFF measuring different PFAS compounds in the formulation and administered in lab testing on mice. They found that the formulation was different to what was found in blood serum, showing internal transformation in different PFAS compounds. From the different compounds they could measure (in blood) there was no toxicological data from the environment. Therefore, it is difficult to determine which compound to study.

Exposure profiles were discussed, including the degradation of products and the changes in exposure in different areas. Different PFAS will degrade and travel differently in the environment. The primary source of contaminant is not necessarily the main source of PFAS the person is exposed to.

Variables in PFAS in serum could be explained by the level of local exposure e.g. in the USA example mentioned they were drinking the same water source and so researchers could see the exposure levels based on how long they had resided in the area and whether they had a water filter. Serum levels in the community can be useful to establish the exposure of concern.

There could be an issue in using reduced vaccine response as evidence of risk in the population, but this is an indicator that something may be happening to the immune system in general and may not be linked directly to PFAS. It is noteworthy that reduced vaccine response is a risk *marker* not a risk *factor*, (the factor is worth looking at but will not necessarily be a risk factor).

Regarding studies on common childhood infections being affected by the presence of PFAS in the blood, the evidence does not appear to be strong.

To note that after age 59 the human immune system competence declines naturally. Data in people who are immunosuppressed, or the elderly can be explored to compare data in exposed communities to see the level of immunosuppression in the exposed population.

There are many variables and factors which can make comparisons between populations difficult to understand and interpret, for example general viruses and colds and there are changes in virus profiles across communities. It can be difficult to measure the impact of PFAS on vaccines due to numerous factors.

Examples in Ronneby were mentioned along with the exposure and profile of this population.

The potency of PFAS was explored and the regulations in the USA set for individual PFAS. Different PFAS have different elimination rates. The relative potency of PFAS varies and lots of factors can affect this.

Some health effects have been seen in people with PFAS levels below 20 ng/mL (nanograms per millilitre) therefore this is not a totally robust threshold. The challenge in determining the numbers is where to start given the lack of thresholds. In a USA study, people would have high PFAS levels 20 years ago and they would be lower today. In general, PFAS levels in blood are coming down. In the USA, about 8% of the population exceed 20 ng/mL. Most of the population will be between 2 to 20 ng/mL. There is more work to do in the scientific community to understand these numbers and what the numbers should be.

The Chair then brought the discussion to a close.

Any other business
None.

Date of next meeting
8 February, 3pm.

Thank you and close
The Chair thanked the Panel, the expert guests, and the supporting staff.
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)