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PFC FACT SHEET: PFOS/PFOA TOXICITY

OVERVIEW

Perfluorooctane Sulfonic Acid (PFOS) and Perfluorooctonoic Acid (PFOA) are members of a group of perfluoroalkyl substances (PFASs) or Perfluorinated Compounds (PFCs) that are manmade, fully-fluorinated compounds.[1,2] Both PFOS and PFOA are used in a number of products, most notably firefighting foams such as Aqueous Film Forming Foam (AFFF) and stain resistant sprays as well as in the production of nonstick cookware and stain- or water-resistant fabric.[1,2] PFCs have also been found in food packaging.[3]

PFOS and PFOA are persistent in the environment because of their long carbon chains and because they are the stable end product of degraded chemical compounds.[3, 4] As a result of their environmental persistence, PFCs are very mobile in the environment; research has demonstrated measureable levels of PFOS in the environment and in organisms as far away as the polar ice caps.[3,4] Additionally, because PFCs biodegrade slowly, some research shows they are able to bioaccumulate in organisms higher in the food chain.[3] Organisms like humans that are higher on the food chain consume other organisms that are contaminated with PFCs; this consumption allows the PFCs in each lower-level organism to build up in the higher-level organisms.

EXPOSURE

According to the Agency for Toxic Substances and Disease Registry (ATSDR), blood samples from 2009-2010 showed a geometric mean of 9.32 micrograms of PFOS per Liter (ug/L) of serum and 3.07 ug of PFOA/L of serum in the general U.S. population.[5] Human exposure to PFCs primarily comes from drinking water[1,3,5] and from fish consumption,[3,4] and breast milk.[4,5] PFCs build up and remain in the body for years. Body burden levels are reduced slowly over time.[3,4,5] It takes about 4 years for half the level in the body to leave which occurs mostly through urination.[5] Different factors such as the amount of PFC in the blood and a body's efficiency in removing PFCs from the blood can affect the rate of removal. As a result of its long half-life in people, PFCs have the opportunity to bioaccumulate, which in turn increases its potential to adversely affect people's health.[3,4,5]

To help evaluate the risk of human exposure to PFCs, the EPA Office of Water issued a health advisory in May 2016 that set a limit of 0.07 ug/L (equal to parts per billion or ppb) for both PFOS and PFOA **combined** in water.[1] This level was based on a lifetime exposure to total PFCs. EPA testing since 2013 has shown that PFOA is present in 94 public water systems in 27 states. Although the amount of PFOA is lower than the EPA advisory levels, the prevalence of this contaminant in water means that over 6.5 million people have been exposed to PFOA in their drinking water.[6]

HEALTH EFFECTS

Human studies found similar results to animal studies, namely associations between PFCs and liver, hormone, and immune system function.[7] Some epidemiological studies have linked PFC exposure to kidney and testicular cancers in people[1,2,5,7,8,9,10] In addition, PFC exposure has been linked to hypertension in pregnant women,[5,9] slightly lower birth weight in

infants,[5,9] and elevated blood cholesterol levels.[5,7,8] Other studies have found that higher PFC levels are associated with a potential decrease in vaccine efficacy.[11,12]

However, the difficulty in interpreting the results of human studies leaves the effects of PFCs on the health of people disputed. In 2005, the EPA Science Advisory Board in its draft risk assessment of PFOA concluded that the evidence was suggestive of a cancer risk, but the scientific peer review group recommended that PFOA be considered "carcinogenic to himans."[2] The International Agency for Research on Cancer (IARC) has not assessed the potential carcinogenicity of PFCs,[5] but had listed PFOA as a "high priority" in their carcinogenic evaluations for 2010-2014.[13] The American Conference of Governmental Industrial Hygienists (ACGIH) lists PFOA is an A3 carcinogen, known to cause cancer in animals, but inconclusive with regard to its carcinogenic effects on people.[14] The National Toxicology Program is currently completing their analysis of the potential immunotoxicity of PFOS and PFOA.[15]

CONCLUSIONS

Although the human health effects related to exposure to PFCs have not yet been clearly established, research linking PFCs to hypertension, developmental, reproductive and immune effects and cancer demonstrates the necessity of addressing human exposure to these chemical substances.

Animal Health Effects

Study Organism	Results
rats	- liver, thyroid, and mammary gland tumors; thought to be carcinogenic to rats (PFOS)[10] - testicular, liver, and pancreatic tumors (PFOA)[9,16] - potential link between PFCs and tumor induction pathways[17,18] - newborn death (PFOS)[18]
mice	- liver toxicity (PFOS and PFOA) and developmental effects (PFOS)[16,18] - potential link between PFCs and tumor induction pathways[17,18] - newborn death (PFOS)[18]
monkeys	- liver toxicity (PFOS and PFOA)[10,18] and developmental effects (PFOS)[16]
rabbits	- reduced fetal weight and developmental problems (PFOS)[19]
quails and chickens	- lower hatchability and/or newborn survival (PFOS)[18,19]
frogs	- delayed growth and longer time to metamorphosis (PFOS)[18]

Human Health Effects

- associations between PFCs and liver, hormone and immune system function[7, 11,12,20]

- association between PFCs and hypertension in pregnant women and low birth weight in infants[9,20,21]

- association between PFCs and elevated blood cholesterol[5,7,8]

- potential link between PFCs and tumor induction pathways[17,18]

- potential link between PFOS exposure and bladder cancer[10]

- potential link between PFOA and testicular and kidney cancer[7,8,9]

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