PFAS, the "Forever chemicals": Where Do They Come From? Where Are They Going?

Kouji H. Harada *

Department of Health and Environmental Sciences, Kyoto University Graduate School of Medicine, Kyoto, 606-8501 Japan.
harada-hes@umin.ac.jp

Per- and poly-fluoroalkyl substances (PFAS) are organic compounds in which methyl or methylene carbon-bonded hydrogen atoms are replaced with fluorine atoms. It was developed commercially by 3M in the United States in the 1940s and has been used in a wide range of applications from daily to industrial products. PFASs such as perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) are chemically stable, while both of these substances are not biodegradable and persist in the environment for long periods. In Japan, since 2002, we have investigated the environmental contaminations of water, air, and food by PFASs, and exposures. PFOS contamination from airport wastewater was suggested because the fire extinguishing foam used at the airport remained in the sites and drainage. For PFOA, significant levels of contamination were observed in rivers in the Osaka (max: 87 000 ng/L). The source of contamination in Osaka was identified as a sewage treatment plant near a fluorochemical plant. In the indoor environment, PFOA and long-chain PFASs were detected in house dust, and fluorotelomer alcohols were also frequently detected in indoor air, and thus these PFASs seemed contained in daily supplies, such as cosmetics, food packaging, furniture etc. In recent years, I have investigated PFAS contamination around aviation-related facilities in Okinawa Prefecture and PFAS exposure of residents. Aqueous film forming foam extinguishing agents (AFFFs) have been used in aviation facilities as an effective extinguishing agent for fuel fires. Residents' PFAS exposure was investigated in response to requests from residents near Futenma air station of US marine corps. PFOS and PFHxS concentrations in the blood of residents were high compared with those in other regions. Usage of tap water was one major determinant of the blood concentrations of PFOS, PFOA, and PFHxS in residents. Those who used tap water had significantly higher PFAS concentrations than those who did not use tap water. Serum PFHxS was an unique characteristic in these areas while it was less than 1 ng/mL on average in surveys conducted by the Ministry of the Environment in main land of Japan. The year after these surveys, recommendation values for tap water were set in April 2020, and provisional guideline values for drinking water were set in May 2020 at 50 ng/L. Contamination by PFAS is not limited in the above-mentioned areas, but there are potential possibilities that there are still unidentified contamination sites, and it is necessary to identify facilities that can be sources of contamination. In addition, there have been few surveys of soil contamination where it tends to remain for a long time, and may transfer to groundwater and agricultural products. Identification of the newly introduced PFAS is also a major issue. The health effects on humans have been investigated by epidemiological studies, but it will be necessary to target the health effects of a wide range of populations from children to adults. Finally, PFAS was analyzed by LC, but GC analysis was attempted as an alternative method and PFOS isomers could be detected in quantifiable amounts. By this method, PFOS isomer composition is evaluated in epidemiological studies, and the bias with the evaluation value by the conventional method is estimated.