New research: Perchlorate in drinking water is more dangerous than previously understood

May 27 2020, by Marissa Shapiro

Credit: CC0 Public Domain

Vanderbilt researchers have discovered that perchlorate, an environmental pollutant found in many sources of drinking water in the

U.S., inhibits the uptake of iodide, an essential component of thyroid hormones, in a more pronounced and fundamental way than commonly considered.

This discovery was published May 25 in the journal *Nature Structural & Molecular Biology* just as the Environmental Protection Agency (EPA) announced its decision to not regulate the levels of perchlorate in drinking water.

Dr. Nancy Carrasco, professor and chair of the Department of Molecular Physiology and Biophysics, and the paper's leading author believes it's a decision that may endanger public health in many communities across the U.S.

"The end effect of perchlorate exposure on thyroid hormones is that the transport of iodide is impaired," Carrasco said. "Much less iodide will be transported. Now that we understand exactly what perchlorate does, we can clearly see that contamination of drinking water with this chemical is more worrisome than previously thought."

Thyroid hormones, which are crucial to human development, deliver the signals needed to promote healthy growth beginning at the earliest stage: uterine life. Its production relies on the sodium/iodide symporter (NIS), a key protein present in thyroid cells that actively transports iodide from the bloodstream into the thyroid gland. Humans receive iodide through their diet (think of iodized salt).

The new study demonstrates that perchlorate exposure fundamentally alters the mechanism by which NIS transports iodide into the thyroid, making it less efficient. This work builds on Carrasco's groundbreaking cloning of NIS, which revealed how the protein ushers iodide from the bloodstream into the thyroid.

Even what would be considered low concentrations of perchlorate significantly decrease iodide transport and the resulting production of thyroid hormones. Because of thyroid hormones' outsize influence on human cognitive and physical development, the populations most vulnerable to perchlorate-contaminated drinking water are pregnant women, nursing women, developing fetuses, and newborn babies.

Pregnant women exposed to perchlorate risk unintentionally exposing their fetuses to significant harm. Typically, iodide is transported by NIS from the placenta into the fetus' bloodstream, enabling the fetus to produce thyroid hormones. When a pregnant woman drinks perchlorate-contaminated water, the fetus does not receive or produce enough thyroid hormones to develop into a healthy baby. Because NIS is also present in the lactating breast, nursing newborns receive both more perchlorate and less iodide when the mothers have been exposed to perchlorate. This causes the newborns to produce less of their own thyroid hormones. As a result, the central nervous system and other tissues can be irreversibly damaged in infancy if the iodide deficiency is not treated.

According to the EPA, perchlorate is a naturally occurring chemical compound found in the arid regions of the U.S., in fertilizer deposits in Chile, and in potash ore in the U.S. and Canada. The chemical is used to manufacture rocket fuel and explosives. Because perchlorate dissolves easily and is mobile in water, it is frequently detected in water supplies near sites where rocket fuel is used or made.

The first author of the paper is graduate student Alex Llorente-Esteban. Research instructor Andrea Reyna-Neyra, Ph.D. also participated in the study.

The Carrasco laboratory and their collaborators have previously shown that NIS has at least a ten-times greater affinity for perchlorate than for

iodide—meaning that if there were equal concentrations of iodide and perchlorate in the bloodstream the protein would bring perchlorate into the thyroid in far greater quantities than iodide.

More information: Alejandro Llorente-Esteban et al. Allosteric regulation of mammalian Na+/I− symporter activity by perchlorate, *Nature Structural & Molecular Biology* (2020). DOI: 10.1038/s41594-020-0417-5

Provided by Vanderbilt University