Title

The Contrast Cleanup: Assessment of the level of gadolinium-based contrast agents (GBCA) in the university/hospital wastewater chain

Problem statement

The number of CT and MRI scans increase. This also increases the use of contrast media given to patients necessary to perform the scans. Contrast media, such as GBCA, are excreted in patients' urine and end up in the wastewater stream. Although there is more focus on the adverse effects of contrast media on the environment (especially in waste-, surface-, river- and drinking water), there is only limited data available on the actual levels of GBCA at various points of the wastewater chain of Leiden university and its teaching hospital, LUMC, which have a common sewage water collection system.

Current data, like the RIWA (association of River Water companies) report of 2013, is often outdated or investigate contrast media that have been banned by the European Medicines Agency. With the renewed focus on the environment comes a need for new, accurate data. The results for waste water could be matched to the results for river and drinking water for a complete evaluation of the level of GBCA in the water chain.

More than 50% of the administered GBCA will be excreted in urine in normal households, flowing to a variety of wastewater treatment plants. The measures to reduce GBCA contamination taken by the Leiden University and the LUMC may serve as model to guide reduction of water contamination by all households.

Research question(s)

- To determine the level of GBCA in the waste waters of from a large university and hospital
- How the level of GBCA in water changes on route from the university and its hospital to the waste water treatment plant (WWTP/AWZI) and eventually to the North Sea.

Other the research possibilities:

- To determine the level of GBCA in surface and river waters in a wide area around a the LUMC (in ditches, small streams, Leiden's canals, Oude Rijn and Korte Vliet rivers, De Kaag and Valkenburg and Braassemermeer lakes).
- How the level of GBCA in surface/river waters will be influenced by/correlate with the level of GBCA in wastewater.
- The influence of GBCA in surface or coastal water or water flora and fauna

Expected type of work

Desk research phase:

- Systematic survey on literature on GBCA in waste water and surface water around hospital
- Analysis where in the hospital waste water chain selective water sampling could take place, to discriminate waste water flows from separate parts of the hospital/university

Analytical phase:

- Sampling and analysis of GBCA levels in wastewater at several places in the university and hospital collection puts on route to the treatment plant, and in the affluent and effluent streams of the wastewater treatment plant Leiden Noord (via our collaboration with RIWA Rijn).This research project is carried out in collaboration with the Dutch network 'de Groene OK' and the RIVM. Some basic knowledge about the use of pharmaceutical drugs is preferable.

Other remarks

Project is further supported by professionals from:

- Netherlands Assessment of Contrast Media in Aquatic Environments (NACA)
- Hoogheemraadschap Rijnland
- Institute for Inland Water Management and Waste Water Treatment (RIZA)
- Het Waterlaboratorium
- Department of Toxicology University of Maastricht
- Department of Ecotoxicology University of Leiden
- Department of Chemistry University of Münster (D)

Depending on the exact nature of the project, the students could be supported and/or supervised by professionals of one or more of the above institutions or working groups.

References

- Brünjes R, Hofmann T. Anthropogenic gadolinium in freshwater and drinking water systems. Water Res. 2020 Sep 1;182:115966. doi: 10.1016/j.watres.2020.115966
- Macke M, Quarles CD Jr, Sperling M, Karst U. Fast and automated monitoring of gadolinium-based contrast agents in surface waters. Water Res. 2021 Dec 1;207:117836. doi: 10.1016/j.watres.2021.117836.
- Rogowska J, Olkowska E, Ratajczyk W, Wolska L. Gadolinium as a new emerging contaminant of aquatic environments. Environ Toxicol Chem. 2018 Jun;37(6):1523-1534. doi: 10.1002/etc.4116.
- Kools SAE, Roskam GD, Verheul MRA, et al. Magnetic Resonance Imaging (MRI) contrast in het aquatisch milieu. Vereniging van Rijnwaterbedrijven RIWA, 2013. https://www.riwa-rijn.org/wp-content/uploads/2015/04/RIWA_Rapport_MRI_POD_01.pdf

Commissioner details

Organization / Department: LUMC Radiology & RIWA Rijn
Name: Aart J. van der Molen, A. van Eijk, Gerard Stroomberg
Email: a.j.van_der_molen@lumc.nl; stroomberg@riwa.org