Moos Family Speaker Series

The Global Problem of Pharmaceutical Pollution

Remaining questions from the webinar chat answered by Dr. Alistair Boxall

Q: Has anyone looked at prevalence of antibiotic resistance in areas where the antibiotic concentration levels are high?

A: Yes, there are many studies that have looked at levels of resistance in systems with high antibiotic concentrations, including downstream of wastewater treatment plants, in soils receiving biosolids and manures and at manufacturing sites. Many of these studies show elevated levels of resistance although it is not always clear what is driving this.

Q: How are waste pharmaceuticals handled by pharmacies and collection sites?

A: In the UK and I imagine it will be the same in the US, the waste medicines are taken to a hazardous waste incinerator where they are incinerated at high temperatures. One of the problems we have in the UK is that we don't have many of these incinerators so the waste medicines have to be transported up to 200 miles for destruction which introduces additional environmental costs. We have done a little bit of work on an onsite treatment method using a system the size of a chest freezer that would sit in a local pharmacist or hospital and allow on site destruction. The paper is available here: https://link.springer.com/article/10.1007/s00267-016-0728-9

Q: Is excretion after ingestion and use as directed by health care providers a significant factor in pharmaceuticals going into wastewater?

A: Yes, this is actually the biggest contributor to what goes into the environment. We estimate that around 43% of the pharmaceuticals prescribed enter the environment by this route. Around 18% is thrown into the trash or flushed down the toilet. About 3% is returned to the pharmacies via take back schemes. The remainder (36%) is broken down in our bodies.

Q: I'm wondering if pharmaceuticals are showing up in a plant food chain? In particular, being a Minnesotan, I am thinking of wild rice and cranberries.

A: Yes, there are many studies showing that pharmaceuticals can be accumulated by crops. This occurs when biosolids are applied to land or where wastewater is used to irrigate fields. We have done some work on this that can be found in this paper: https://pubs.acs.org/doi/10.1021/jf404282y. There is also some interesting work from Israel where they monitored an anti-epileptic drug in the urine of two groups of people. The first had a diet of typical supermarket food and the second a diet taken from areas where crops are irrigated with wastewater. They found elevated levels in the 'wastewater

irrigation' group. More can be found here: https://pubs.acs.org/doi/10.1021/acs.est.5b06256. The levels are quite low so we think the risk to your health is quite low.

Q: How does abundance of the compounds correlate with stability? i.e. is ibuprofen less stable than metformin and is that why we see less?

A: The occurence in rivers is driven by three main factors: usage, stability, and how strongly the molecule sorbs to suspended solids. Ibuprofen is quite well removed by wastewater treatment systems. A molecule like metformin is less well removed.

Q: Are you able to compare the concentrations in places that have drug disposal programs (like France or as you showed in Minnesota) to those that do not? Evidence that these programs really do improve water quality?

A: Take back schemes on their own would have only a limited effect on water quality as the main route of entry of these substances is from use and excretion by the patient. There are studies showing elevated levels in surface waters and ground waters close to waste dumps so this would improve. If we want to really bring levels down though, we need a multi-pronged approach including: the development of environmentally benign drugs (this is something the industry are working on), changes in prescription practices (personalized medicine would help), improved treatment of domestic and hospital wastewater and take back schemes.

Additional Resources:

- Find a disposal site for unwanted medications in Minnesota
    - Find a site outside of Minnesota
- Tips for managing unwanted medications
- Global Monitoring of Pharmaceuticals Project
- Research on contaminants of emerging concern in aquatic ecosystems used by Minnesota tribal communities
- Research on pharmaceuticals and chemicals of concern in Minnesota lakes