Wastewater clues to illicit drug use

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A new chemical analysis of sewage is revealing more detailed information than ever about drug abuse trends.

The approach, pioneered by scientists at Bath and Huddersfield universities, can detect minute quantities of pharmaceuticals in waste water and could potentially reveal whether they originated as prescription drugs or illegal substances.

In the case of certain drugs, like cocaine, it can even indicate how the drug has been taken.

'It's a complicated process, but it's already telling us far more than other methods about illegal drug use,' says Dr Barbara Kasprzyk-Hordern of the University of Bath, lead author of the research which is published in *Science of the Total Environment*.

The analysis relies on the fact that most drugs are chiral – their molecules come in two varieties that are mirror images of each other that can't be superimposed: think of left and right hands. The mirror images in chiral molecules are called enantiomers. The human body metabolises these differently, and different chemical products end up being excreted as a result.

Prescription and illegally made drugs might have different ratios of enantiomers, so by analysing the different chemical products in waste water the researchers are aiming to work out what type of drug has been taken, and how it was made.

When this chemical analysis is studied alongside drug sales and prescription data for the communities using the wastewater treatment plants that have been tested, the results can be revealing.

'Because we know the estimated numbers of people being served by each waste water treatment plant, we can back-calculate daily loads from our samples and the total flow of waste waters,' explains Kasprzyk-Hordern. 'These are very sophisticated techniques that can detect minute amounts of chemicals.'

This approach is better than previous ways of estimating drug use from sewage, because of its potential ability to rule out substances that have been medically prescribed. It can also distinguish between the direct disposal of drugs (into toilets during police raids, for example) from their actual consumption.

It could also be particularly useful for drugs like amphetamine that can also effectively be made in the body when it metabolises a legitimate prescription drug.

Forensic scientists already use chirality to determine whether a drug is

legal or illicit in individual cases, but this approach has never been used on sewage before and could be a powerful tool for determining trends of drug use in populations, how drugs are being made and administered, and how potent they are.

In the case of LSD, for example, one enantiomer is more than 20 times more psychoactive than the other. The anti-inflammatory drug ibuprofen is prescribed in a racemic form – an equal mix – but one enantiomer is 100 times more potent.

Enantiomers can in some cases have completely different effects, and Thalidomide is a classic example. It was given to pregnant women in the 1950s to treat morning sickness; one enantiomer had the intended effect, but the other was highly toxic and caused serious damage to many unborn children.

This research is also a crucial step forward for understanding the effects of drugs in the environment – on both humans and wildlife.

'The consequences of chiral profiling are even wider,' explains Kasprzyk-Hordern. 'Environmental risk assessments for any potential contaminant currently don't account for chirality. So they could be significantly under- or overestimating the effects of these drugs in the environment.'

Earlier research by the same team has shown biological processes during wastewater treatment do not degrade the enantiomers of certain chiral drugs, such as antidepressants and beta-blockers, in the same way, so toxic forms can still end up in streams and rivers.

The work clearly shows that contamination from legal and illicit drug use is widespread in the environment, but we don't understand the toxic effects properly.

'It's crucial we adopt these methods early on,' says Kasprzyk-Hordern, 'because it takes so long between recognising the dangers of environmental hazards and regulating against them.'

In future the technique could even be used to control disease, say the researchers; if you recognise the biochemical signs of a disease in an area's wastewater, you could take early action to stop it spreading.

More information: Kasprzyk-Hordern, B, Baker, DR. Estimation of community-wide drugs use via stereoselective profiling of sewage. *Sci Total Environ* 2012, doi:10.1016/j.scitotenv.2012.02.019