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Risk map shows European 'hot spots' for pharmaceuticals in the environment

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A new tool has been developed which highlights 'hot spots' of pharmaceutical pollution in Europe, where human health and aquatic environments could potentially be affected. The results suggest that the substances and locations posing the greatest risk are not the same for the aquatic environment as for human health.

Both the pharmaceuticals we consume, and those that we dispose of unused, are found in the environment and may potentially affect human health and ecosystems. For example, the pharmaceutical ethinyl estradiol has been found to have a feminising effect on fish in the environment. Such evidence, combined with the presence of very low levels of some pharmaceuticals in drinking water and certain foods, has also raised concerns about the potential effects of pharmaceutical pollution on humans.

The study quantified and compared the risks of pharmaceutical pollution to the aquatic environment and to human health on a regional basis in Europe. Conducted under the EU PHARMAS project[1], it focused on 11 common antibiotics and seven antineoplastics - a group of anti-cancer drugs.

The researchers took European pharmaceutical consumption data and estimated environmental emissions for individual countries, taking into account how many unused drugs were returned versus how many were flushed away, and how many would have been excreted into sewage systems. Sewage treatment can result in emissions via liquid effluent and from the application of sludge to agricultural land, offering another potential route of exposure as grazing animals ingest pharmaceuticals in soil and crops.

These data were used to generate a grid of emissions per 100 square kilometres, to be used as a screening tool for assessing the exposure of humans and aquatic ecosystems to pharmaceuticals on a location-by-location basis. These exposures were compared to threshold levels to produce indicative figures of risk.

Antibiotics posed a risk to aquatic environments far higher (around 1000 times) than antineoplastics, with levofloxacin, doxycycline and ciprofloxacin posing the greatest risks. Densely populated areas, such as Northern Italy, London, Krakow and the Ruhr, showed the highest levels of risk. The types of antibiotic most commonly prescribed significantly affected the environmental burden, as some are more easily broken down and toxicity varies. For example, even though the greatest number of antibiotics is prescribed in Greece, the area with the highest aquatic risk is Northern Italy, around Milan. This is because high levels of levofloxacin are used in Italy, the high population density of the Milan region, and the extreme persistence and toxicity of this antibiotic.

Risks for human health not only depend on the pharmaceutical and location, but also on behaviour, such as consumption patterns. For example, risk will be affected by whether an individual eats locally-grown food or food sourced more widely, or whether their water comes from a well, is conventionally-treated, or bottled. The main pathways for human contact with traces of pharmaceuticals from the environment are via drinking water, fruit, vegetables, meat, milk, fish, surface water and soil. Infants in eastern Spain consuming locally-produced food and conventionally-treated drinking water had the highest risk of exposure, mainly via contaminated soil, as a result of sewage sludge application to agricultural land. By contrast, infants in Paris were at relatively high risk of exposure to pharmaceuticals in water.

The researchers suggest that the study is significant because it indicates that the substances and locations posing the greatest risk are not the same for the aquatic environment as for human health, as health risks are also influenced by behaviour. This is the first tool that can be applied to prioritise pharmaceuticals, locations and exposure groups to identify hot spots for monitoring, and substances for which additional data should be gathered.

1.PHARMAS is supported by the European Commission under the Seventh Framework Programme. See: www.pharmas-eu.org