

Human health implications following detection of oxycodone in mussels collected in Washington State

The Washington Department of Fish and Wildlife, in collaboration with the Center for Urban Waters (University of Washington Tacoma), reported detecting contaminants of emerging concern (CECs) in transplanted mussels collected in 2012/2013 from locations near urbanized areas around Puget Sound. In 2018 investigators reanalyzed mussel tissues collected in 2012/2013 and identified over 200 pharmaceuticals, including trace amounts of antidepressants, antibiotics, detergents (synthetic surfactants), cardiac medications, and the chemotherapy drug melphalan, among others.^{1,2} They also found traces of oxycodone in mussels taken at 3 of 18 locations (17%). The finding of an opioid in mussels received extensive media coverage.²⁻⁹

CECs in water

Pharmaceuticals enter the aquatic milieu through human consumption and subsequent excretion in urine or when people flush pills into the wastewater system.^{3,5,10} Effluent released from wastewater treatment plants into nearby aquatic environments has been shown to contain a variety of CECs.^{5,11-13} Conventional wastewater treatment partially removes pharmaceuticals, including opioids.¹⁴ Concentrations of CECs in wastewater have been used to monitor shifting patterns of opioid use in the US,¹⁵ Spain,¹⁶ Croatia,¹⁷ Norway,¹⁸ and Australia¹⁹ (in the case of oxycodone^{20,21}).

CECs in mussels

Mussels are useful sentinel species because of their wide geographic distribution and ability to

bioaccumulate contaminants from surrounding waters.^{22,23} Unlike finfish, mussels do not have the ability to filter out or metabolize pharmaceuticals, including oxycodone. A recent Ontario study compared oxycodone concentrations in water against those in mussels, leading to the calculation that mussel tissue accumulates 9.86 times (84% CI, 0-24) the concentration of oxycodone in water.²²

Environmental implications

Detection of CECs, including opioids, in water and mussels is ecologically important as they affect the growth of organisms, their hormone systems, and reproductive capacity.^{3,9,24-27} Few studies have investigated the effect of CECs on the marine environment, and nearly all have focused on marine mammals²⁸ and on risks associated with long-term exposure to compounds with bioaccumulation potential, such as endocrine disrupting compounds.²⁹

Human health implications

In spite of the ecological risk, the likelihood of adverse effects to humans from consuming shellfish contaminated with oxycodone appears negligible. First, mussels in the Washington State study were collected near urbanized areas and not from protected commercial shellfish beds.^{1,3,6} Second, the potential dose of opioids from this source would be extremely low: investigators provided us with macerated mussel oxycodone concentration results at their Seattle and Sinclair Inlet/Bremerton sites of 1.5 ng/g, 1.2 ng/g, and 0.68 ng/g of meat (oral

communication with James West, Marine Resources Division, Washington Department of Fish and Wildlife, 25 June 2018).³⁰ We calculate that for a person to ingest 10 mg of oxycodone, given the highest reported concentration of 1.5 ng/g, they would need to consume 6700 kg of mussel meat, or about 466 660 mussels. Finally,

there are no known case reports of adverse events from the consumption of shellfish contaminated with opioids. Clinicians can advise patients that they are at little risk of hazardous exposure to opioids from consumption of commercial mussels.

CECs in the environment

Although there is minimal risk to humans from mussels contaminated with trace amounts of opioids, the Washington study illustrates the larger issue of CECs in the environment and their potential adverse human health impacts. CECs of greatest concern include those which may not pose an immediate effect through acute exposure, as most of these contaminants are found in relatively small concentrations, but rather through long-term exposure, particularly for compounds with a high bioaccumulation potential.³¹ Key questions include the long-term safety profile of pharmaceuticals that bioaccumulate in marine environments, as well as the potential synergistic effect of exposures to mixtures of pharmaceuticals.^{10,32} Clinicians can help limit the entry of pharmaceuticals into the environment, and ultimately into the human food chain, by advising patients to return expired/unused medications to their local pharmacy.

Pharmaceuticals enter the aquatic milieu through human consumption and subsequent excretion in urine or when people flush pills into the wastewater system.

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While adverse health impacts have not been associated with the consumption of drinking water or seafood contaminated with pharmaceuticals,^{29,32} further research should include specific populations at increased exposure risk due to dietary practices, including Indigenous populations.³³ While there has also been concern about drinking water contaminated with CECs, there is minimal evidence of adverse effects.²⁹ Concentrations of pharmaceutical compounds in contaminated water are typically orders of magnitude below levels considered acceptable.³²

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Competing interests

The authors have no commercial interests or funding that present a conflict of interest for this article.

References

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