Journal of Medical Toxicology (2018) 14:117–119
https://doi.org/10.1007/s13181-018-0661-9

EDITORIAL

Microplastics and Human Health: Our Great Future to Think About Now

Amy V. Kontrick[1]

Received: 16 April 2018 / Accepted: 17 April 2018 / Published online: 23 April 2018

> "There's a great future in plastics. Think about it. Will you think about it?" Mr. McGuire's advice to Benjamin in Mike Nichols' *The Graduate* (1967).

Who knew that "great" would be such an understatement. Since World War II, the production and use of plastics have increased exponentially and become part of everyday life. Plastics are found in food wrappings, beverage containers, toys, cars, and cosmetics. The ubiquitous presence of plastics in our lives makes them essentially unnoticed, unrecognized, and forgotten. And this is exactly why we all need to start thinking about them with more deliberate attention.

In 2015, it was estimated that 320 million metric tons of plastic was produced, yet much of it is intended for single use and then disposed rather than recycled or incinerated [1]. The problem of plastic pollution and its enduring impact was dramatically brought to light with Charles Moore's discovery of the Great Pacific Garbage Patch in 1997 [2]. The threat to marine life from our plastic pollution has been described in the popular media, including the New York Times, the recent BBC series *Blue Planet 2*, and Earth Day 2018 was dedicated to changing human attitudes and behavior about plastic [3]. However, the threat of plastics to human health gets relatively little coverage in clinically focused medical journals.

More recently, the discovery of microplastics has raised concerns among scientists. Microplastics (MPs) are defined as plastic pieces measuring < 5 mm, and although not as visible to the eye as discarded water bottles on a beach, MPs astoundingly "make up 94% of an estimated 1.8 trillion pieces of plastic in the patch" and have been found in all forms of marine life from zooplankton to whales [2, 4–6]. It is important to understand that MP pollution is composed of *primary* and *secondary* microplastics. Primary MPs enter the environment as manufactured components used in many common items such as cosmetics and personal care products [7]. Secondary MPs enter the environment through fragmentation and degradation of larger plastic items from exposure to UV light, freezing, wind, wave action, and abrasion [7, 8]. Another important source of secondary MP pollution occurs from the breakdown of synthetic fibers and discharge into the environment through waste water from washing machines [9]. The potential health problems from MPs can be thought of in the same way we think about silicosis or byssinosis from naturally occurring inorganic and organic particulates. Except the obvious difference with MPs is there is nothing natural about them.

Due to their small size and persistence, MPs have been found throughout our environment. They have been found in all forms of marine life; in table salt, honey, sugar, and beer; in organic fertilizers; in the dust in our homes; and most alarmingly, in bottled and tap water samples [4, 8–15]. The ubiquity of MPs creates problems to our ecosystem in several different ways.

First, and most obviously, the physical impact of MPs creates devastating injuries to many forms of marine life from concretion of accumulated MPs (a.k.a. "plastic bezoars") in gills and intestines, thus interfering with feeding habits that unnaturally lead to death. Second, plasticizers in MPs have been linked to abnormal growth and reproductive problems from endocrine disruption in multiple animal models [8, 10, 16, 17]. Third, studies have shown how organic pollutants like pesticides leach into organisms that ingest MPs. Fourth, a study this year described how MPs deliver dangerous metals like lead and cadmium to coastal ecosystems [18]. It is postulated many of these toxic effects of MPs cause GI irritation, alteration of the microbiome, disturbance in energy and lipid metabolism, and oxidative stress [8, 10, 16, 17, 19–21]. Bioaccumulation from these effects of MPs can have far reaching impact throughout the food web and alter our delicate ecosystem and contribute to a loss of biodiversity [22].

The long-term impact of MPs on human health remains largely unknown since most studies to date have been limited

✉ Amy V. Kontrick
a–kontrick@northwestern.edu

[1] Department of Emergency Medicine, Northwestern University Feinberg School of Medicine, Chicago, IL, USA

to the impact on marine life consuming MPs directly. It is clear, however, that humans are exposed as these particles are found in our seafood and water supply, in the air we breathe, and in the dust in our home. How the damaging effects of MPs on marine, freshwater, and land ecosystems impact human health still needs to be discovered. Some important questions include the following:

> Do inhaled particles lodge in our airways?
> Are inhaled or ingested particles a chemical or physical irritant (or both)?
> Do inhaled or ingested particles serve as a stimulator of inflammation?
> How exactly do MPs deliver toxic chemicals, heavy metals, or other pollutants into the body?
> Do they alter metabolism or increase oxidative stress?
> Are there unique implications for developing fetuses or children?

The wide distribution of MP pollution throughout our environment, the ease with which we create more each day through our daily activities, and the varied way in which humans are exposed demand a better understanding of the impact of MP pollution on our health. As Rachel Carson wrote in *Silent Spring*, "If we are going to live so intimately with these chemicals–eating and drinking them, taking them into the very marrow of our bones–we had better know something about their nature and their power" [23]. Although Carson was specifically writing about insecticides and pesticides, the implication for plastics in all of its forms is similar.

Currently, there are more questions than answers. The scientific community must lead this debate. As we have seen with lead and other chemical pollutants, the consequences can be far reaching, widespread, and enduring. As we have seen with the vaccine debate, the popularization of controversial, bad science can also be far reaching, widespread, and enduring. Medical toxicologists are uniquely qualified to address these questions and better inform the public and policymakers. The specialty of medical toxicology includes front line clinicians, cutting edge researchers, and policy leaders who work in clinics, hospitals, academic centers, and even at the CDC. As Beauchamp argued in a JMT commentary a few years ago, "toxicologists have an *obligation* to members of the public, health educators, policy makers… and healthcare professionals" to use their expertise to frame these debates [24]. Now is the time. Will you think about it?

Sources of Funding None

Compliance with Ethical Standards

Conflicts of Interest None

References

1. Wright SL, Kelly F. Plastic and human health: a micro issue? Environ Sci Technol. 2017;51:6634–47.
2. Parke L. The Great Pacific Garbage Patch isn't what you think it is. Available from: http://news.nationalgeographic.com/2018/03/great-pacific-garbage-patch-plastics-environment. Accessed 12 April 2018.
3. Earth Day 2018. Available from: http://www.earthday.org . Accessed 12 April 2018.
4. Dris R, Gasperi J, Mirande C, Mandin C, Guerrouache M, Langlois V, et al. A first overview of textile fibers, including microplastics, in indoor and outdoor environments. Environ Pollut. 2016;221:453–8.
5. Haag M. 64 pounds of trash killed a sperm whale in Spain, Scientists Say. New York: The New York Times; 2018.
6. Besseling E, Foekema E, Van Franeker JA, Leopold MF, Kuhn S, Bravo Rebolledo EL, et al. Microplastic in a macro filter feeder: humpback whale Megaptera novaeangliae. Mar Pollut Bull. 2015;95(1):248–52.
7. Sharma S, Chatterjee S. Microplastic pollution, a threat to marine ecosystem and human health: a short review. Environ Sci Pollut Res. 2017;24:21530–47.
8. Auta HS, Emenike C, Fauziah SH. Distribution and importance of microplastics in the marine environment: a review of the sources, fate, effects and potential solutions. Environ Int. 2017;102:165–76.
9. Prata J. Airborne microplastics: consequences to human health? Environ Pollut. 2018;234:115–26.
10. Bouwmeester H, Hollman P, Peters RJB. Potential health impact of environmentally release micro- and nanoplastics in the human food production chain: experiences from nanotoxicology. Environ Sci Technol. 2015;49:8932–47.
11. Karami A, Golieskardi A, Choo CK, Larat V, Galloway TS, Salamatinia B. The presence of microplastics in commercial salts from different countries. Sci Rep. 2017;7:1–9.
12. Karami A, Golieskardi A, Choo CK, Larat V, Galloway TS, Salamatinia B. Microplastic and mesoplastic contamination in canned sardines and sprats. Sci Total Environ. 2018;612:1380–6.
13. Santillo D, Miller K, Johnston P. Microplastics as contaminants in commercially important seafood species. Integr Environ Assess Manag. 2017;13(3):516–21.
14. Schymanski D, Goldbeck C, Humpf HU, Furst P. Analysis of microplastics in water by micro-Raman spectroscopy: release of plastic particles from different packaging into mineral water. Water Res. 2017;129:154–62.
15. Weithmann N, Möller J, Loder MGJ, Piehl S, Laforsch C, Freitag R. Organic fertilizer as a vehicle for the entry of microplastic into the environment. Sci Adv. 2018;4:eaap8060.
16. Kim S, Eom S, Kim H-J, Lee JJ, Choi G, Choi S, et al. Association between maternal exposure to major phthalates, heavy metals and persistent organic pollutants, and the neurodevelopmental performances of their children at 1 to 2 years of age-CHECK cohort study. Sci Total Environ. 2018;624:377–84.
17. Zhang H, Zhou Q, Xie Z, Zhou Y, Tu C, Fu C, et al. Occurrences of organophosphorus esters and phthalates in the microplastics from coastal beaches in north China. Sci Total Environ. 2018;616-617:1505–12.
18. Munier B, Bendell L. Macro and micro plastics sorb and desorb metals and act as a point of trace metals to coastal ecosystems. PLoS One. 2018;13(2):e0191759.
19. Deng Y, Zhang Y, Lemos B, Ren H. Tissue accumulation of microplastics in mice and biomarker responses suggest widespread health risks of exposure. Sci Rep. 2017;7:46687. https://doi.org/10.1038/srep46687.
20. Devriese LI, De Witte B, Vethaak AD, Hostens K, Leslie HA. Bioaccumulation of PCBs from microplastics in Norway lobster (Nephrops norvegicus): an experimental study. Chemosphere. 2017;186:10–6.

21. Ziccardi LM, Edgington A, Hentz K, Kulacki KJ, Driscoll SK. Microplastics as vectors for bioaccumulation of hydrophobic organic chemicals in the marine environment: a state of the science review. Environ Toxicol Chem. 2016;35(7):1667–76.
22. Deudero S, Alomar C. Mediterranean marine biodiversity under threat: reviewing influence of marine litter on species. Mar Pollut Bull. 2015;98:58–68.
23. Carson R. Silent Spring. 2002 ed. Boston: Houghton Mifflin Harcourt; 1962.
24. Beauchamp G. The toxicologist's role in community outreach: engaging fellows in education and advocacy efforts. J Med Toxicol. 2016;12:1–2.