Plastics, human health and environmental impacts: The road ahead

Plastics have been with us for more than a century, and by now they're everywhere, for good and for ill. Plastic containers and coatings help keep food fresh, but they can also leave behind neurotoxins such as BPA in the human body. PVC is used for everything from pipes and flooring to furniture and clothes, but it contains compounds called phthalates that have been implicated in male reproductive disorders. Studies have also shown that childhood exposure to environmental pollutants can have significant negative effects later in life, including reduced labor force participation and even earnings.

To reduce plastic waste and negative effects, recycling programs have been implemented in many parts of the United States, but remain underutilized. Much is due to the nature of plastic itself, which often can only be "downcycled" rather than recycled — a torn plastic bag might eventually be transformed into a lunch tray, but it will never be a plastic bag again. Many cities and states have begun more serious efforts to restrict their use, but the subject remains a matter of considerable debate. While plastics also contain substantial energy, the vast majority ends up in landfills. Immense quantities of plastic are also sent to the developing world together with e-waste, where "recycling" frequently involves open-air burning.

No sector illustrates the inherent contradictions of plastic more than health care. A 2014 research review published in the Reviews on Environmental Health, "Plastics and Environmental Health: The Road Ahead," notes that plastic is an ideal material for single-use disposable devices, because they're "cost-effective, require little energy to produce, and are lightweight and biocompatible." Yet the chemical compounds within plastic can damage human health. In their work, the scholars, Emily North and Rolf Halden of Arizona State University, summarize relevant research findings on the benefits, dangers,

disposal of, and future innovative potential for plastics. The study received funding from the National Institute of Environmental Health Sciences, a government research body.

The findings include:

▪ On average, 300 million tons of plastic are produced around the globe each year. Of this, 50% is for disposable applications such as packaging.

▪ Plastics make up 85% of medical equipment. IV bags and tubing alone constitute up to 25% of hospital waste. In all, U.S. hospitals discard approximately 425,000 tons of material annually.

▪ Plastics manufacture makes up 4.6% of the annual petroleum consumption in the U.S., using roughly 331 million barrels per year. None of this energy is recovered when plastics are disposed of in landfills, and very little is recovered when plastic waste is incinerated.

▪ Recycling plastics poses major logistical difficulties, including effective sorting (which increases costs) and the mixing of different plastic streams affecting the resultant post-consumer products.

▪ In 2008, 34 million tons of plastic was disposed in the United States. Of this, 86% ended up in landfills. However, “disposal of plastics in landfills is ultimately unsustainable and diminishes land resources fit for other uses of higher societal value. Incineration results in the release of carbon dioxide, a greenhouse gas, and of other air pollutants, including carcinogenic polycyclic aromatic hydrocarbons (PAHs) and dioxins.”

Because of the omnipresence of plastics, the complexity of the substances that they release into the environment and the potential interaction of these substances, many questions exist on the safety of plastics for humans and the environment:

▪ Detectable levels of bisephenol A (BPA) from plastics have been found in urine of 95% of adults in the United States. While the U.S. Food and Drug Administration approves the use of bisephenol A (BPA) for most food applications, in July 2012 the FDA amended its regulations to disallow the use of BPA in baby bottles, sippy cups and formula packaging. (Note: the reasons have a complicated regulatory and chemical industry-related backstory; the FDA, which continues to update its policies, notes that the “scientific field is evolving rapidly.”)

▪ A 2010 study in the Annual Review of Public Health found that BPA has endocrine-disrupting properties. Tests indicate the possibility of health risks such as early sexual maturation, decreased male fertility and aggressive behavior. However, “the health risks of BPA are fiercely debated and, after more than 70 years of study, are still not fully understood. The stakes are high because exposure is ubiquitous and BPA-containing products are a multi-billion-dollar enterprise.”

▪ di-(2-ethylhexyl)phthalate (DEHP), often used in polyvinyl chloride (PVC) products, leaches out easily and has been found to have a number of negative impacts: “Several rodent and human studies have found correlations between DEHP exposure and harmful health effects, including changes to the female and male reproductive systems, increased waist circumference and insulin resistance.”

▪ Environmental exposure to plastic-related chemical compounds does not occur in isolation but as a “cocktail effect,” with unknown cumulative impacts. Components of plastics currently being studied for their health effects include polyhalogenated flame retardants, polyfluorinated compounds (known as PFOS or PFOA) and antimicrobial compounds such as triclosan and triclocarban.

▪ Because plastics are found throughout the globe, there are effectively no populations that haven’t been exposed to them. “Studies have demonstrated the presence of steady-state concentration of plastics’ components in the human body, thereby reflecting the ongoing balance of constant exposure, metabolism and excretion of these compounds. This situation implies that in today’s plastics-enabled society, there are no control groups to be found to analyze the effects on human health from low-level, environmental exposures to plastic constituents. Everybody is being exposed to some degree at any given time from gestation through death.”

Biodegradable plastics hold promise, but are not currently a perfect solution:

▪ Biodegradable plastics are more expensive to produce, and many use plant resources such as corn or molasses, thus creating competition for food supply.

▪ Commercial facilities test biodegradable plastics at 58 degrees C and 60% relative humidity, whereas at-home composting mechanisms may not meet these conditions and may therefore produce incomplete biodegradation.

▪ Pilot “curbside composting” programs in Boulder, Colo., increased waste diversion from landfills from 40% and 69%, indicating that consumers are willing to use better disposal methods if available.

▪ Strategies are possible to balance the need for durable plastics in some applications, and biodegradable compounds in others: “Plastics of low volume for medical applications may rely more on fossil fuel and be designed for durability, whereas high-volume uses for consumer products will have to be sourced from renewable material stocks and be programmed for rapid environmental decay (i.e., biodegradability). This strategy could prevent irreparable environmental damage from disposable plastic products, while maintaining and maximizing the benefits of plastics in specialized cases, like medicine and public health.”

The authors state that a critical examination of how we should be using plastics is necessary, suggesting that we use them to yield truly important benefits but turn to alternatives and reusable products where possible: “Although there have been great benefits from using plastics, especially in the health care

sector, there needs to be a second revolution of plastics in which life-cycle considerations are integrated with production and consumption decisions to handle the voluminous present-day flow of plastics, most of which being destined for disposal after single use."

Related research: A 2012 study published in the Review of Environmental Economics and Policy, "Alternative Policies to Increase Recycling of Plastic Water Bottles in the United States," explores how to improve recycling rates. The researchers, from Duke University and Vanderbilt University, used survey data from more than 600 respondents in 2009 to examine the effects of different recycling regimes on the recycling rates for plastic water bottles.