Science, Technology Assessment, and Analytics

SCIENCE & TECH SPOTLIGHT:

SUBSTITUTION OF HAZARDOUS CHEMICALS

GAO-25-107796, November 2024

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WHY THIS MATTERS

Chemicals improve our lives through use in products and services, and the number of chemicals in use continues to grow. Sometimes a chemical is determined to be hazardous to people or the environment, yet replacing it with another chemical may introduce new hazards. Understanding the risks and tradeoffs associated with chemical substitution could benefit industry, regulators, and consumers.

KEY TAKEAWAYS

- It can take years to fully understand whether a chemical is hazardous to people or the environment.
- Removing hazardous chemicals quickly from the market can lead to replacement with substitutes whose safety risks are largely unknown.
- Developing best practices and using approaches such as artificial intelligence and manufacturing less- or non-toxic chemical substitutes using green chemistry could help reduce future chemical substitution risks.

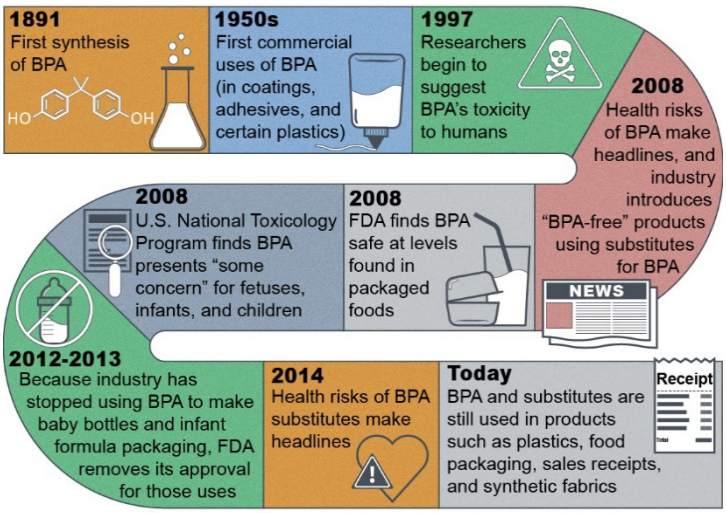
THE SCIENCE

What is it? When a chemical used in industrial processes or consumer products raises concerns due to known or suspected harmful effects on humans or the environment, regulators or the market may push for replacing it with a substitute chemical. The U.S. Environmental Protection Agency (EPA) reports there are over 42,000 chemicals currently manufactured, processed, or imported in the U.S., as of May 2024.

What are the risks? Because a hazardous chemical may be quickly removed from the market, a substitute could be used that is not well understood and potentially may be found to be equally or more harmful to human health or the environment.

For example, bisphenol A (BPA)—used in plastics and other products—raised safety concerns when laboratory testing indicated potential harmful effects related to reproductive systems, obesity, and cancer. Despite decades of study, there is still no consensus about whether BPA exposure is safe at the levels at which people are exposed, and it continues to be used in some products. While some companies have replaced BPA, there are increasing concerns about the health risks of substitutes that are chemically similar to BPA. Thus, consumers may not fully understand safety risks when buying some products labeled "BPA-free."

Figure 1. Timeline of Health Risk Research Conducted on BPA



BPA = Bisphenol A FDA = U.S. Food and Drug Administration

Source: GAO analysis and illustration. | GAO-25-107796

Another example involves chlorofluorocarbons (CFC), which were used as refrigerants and in aerosols. When researchers found that CFCs were damaging the earth's ozone layer, regulators acted to ban them. However, some of the substitutes have since been identified as potent greenhouse gases, which

contribute to climate change. EPA now has a program to assess substitutes for ozone-depleting substances like CFCs.

CHALLENGES

- **Understanding long-term effects.** Harmful chemical effects may not become apparent for years. In addition, the health risks of a chemical may depend on factors such as a person's health, as well as the amount of time and quantity of exposure. Similarly, the environmental risks of a chemical (e.g., the risks to plants, animals, or water sources from pesticides) may depend on factors such as intended use, application amounts, and disposal methods.
- **Trade-offs by manufacturers.** Companies may choose to use a new chemical as a substitute, although they may avoid doing so, in part, because of the regulatory risk review process. Companies may also opt to use an existing chemical as a substitute, but that may not eliminate the potential for similar safety concerns as the original chemical. When deciding among alternatives, companies likely will weigh product performance, costs, and approval timelines in addition to safety.
- **Transparency.** Various federal laws require manufacturers to disclose some information about chemicals in products, but there are exceptions. Marketing labels such as "BPA-free" do not require regulatory approval and may lead consumers to choose products containing substitutes that may not be any safer.

OPPORTUNITIES

Developing best practices and using approaches such as artificial intelligence and green chemistry could help reduce future chemical substitution risks.

- **Best practices for evaluating alternatives.** Stakeholders, including companies and regulators, could establish common criteria and best practices to help ensure more consistent assessment and documentation of the safety of chemical substitutes.
- **Artificial intelligence (AI).** Researchers are developing AI tools to predict the toxicity of new chemicals based on data for existing chemicals. Industry has already used AI to screen potential candidates and help design new, safer substitute chemicals.
- **Green chemistry.** Some companies have begun to manufacture less- or non-toxic products using sustainable processes to reduce or eliminate the use of hazardous substances.

POLICY CONTEXT AND QUESTIONS

- How could stakeholders balance the urgency of removing a hazardous chemical from the market with allowing enough time for informed decisions about its substitution?
- How could consumers be better educated about risks from hazardous chemicals and their substitutes?
- What kinds of resources could help support the development and approval of safer substitute chemicals?

SELECTED GAO WORK

Persistent Chemicals: Technologies for PFAS Assessment, Detection, and Treatment, GAO-22-105088.

Chemical Innovation: Technologies to Make Processes and Products More Sustainable, GAO-18-307.

SELECTED REFERENCES

Organisation for Economic Co-operation and Development, *Guidance on Key Considerations for the Identification and Selection of Safer Chemical Alternatives*, (OECD Publishing, 2021).

"Risk Evaluations for Existing Chemicals under TSCA," U.S. Environmental Protection Agency, last modified May 6, 2024, https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/risk-evaluations-existing-chemicals-under-tsca.

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