COMMENT

KEVIN FRAYER/GETTY

A farmer spays pesticide on an apple tree in Hanyuan, China.

Rethink how chemical hazards are tested

John C. Warner and **Jennifer K. Ludwig** propose three approaches that would help inventors to produce safer chemicals and products.

Around the world, safety regulations are being revised as new information about the health and environmental effects of chemicals becomes available. In June, US President Barack Obama signed the first bill to reform the Toxic Substances Control Act since its enactment 30 years ago. The revised act mandates greater public transparency and the timely assessment of existing chemicals by the US Environmental Protection Agency (EPA). Elsewhere, the European Union's REACH (registration, evaluation, authorization and restriction of chemicals) legislation and similar laws are also evolving.

Improved regulation is necessary to protect people and the environment from harmful substances. But it does little for inventors who face the perplexing task of creating safer chemicals and products[1]. In the current system, safety information is gathered after ▶

a chemical is invented, or in many cases, after it is incorporated into products and distributed to the public. The molecular interactions of chemicals within products are unaccounted for, meaning that ingredients lists may be misleading as sources for product safety information. Such factors make it nearly impossible for an inventor to avoid the risk of creating an unsafe chemical or product.

The evaluation and communication of chemical and product safety needs to change. Three approaches are proposed here to start a conversation between scientists, business representatives and policymakers about our future public and environmental health.

THREE WAYS FORWARD

Standardize chemical-safety tests. Controversy on chemical safety often arises when organizations, from corporations to research centres and government agencies, test the same compound using different methods. One technique may suggest that a compound is hazardous, another that it is benign. For example, glyphosate, a widely used herbicide, was in 2015 deemed a "probable human carcinogen" by the International Agency for Research on Cancer[2]. Many other regulatory agencies, including the European Food Safety Authority, conversely concluded that the herbicide was "unlikely to be carcinogenic". The discrepancy lies in the different studies taken as evidence, which leaves the public more confused about the safety of glyphosate than before.

Standardized tests reduce the use of replacement chemicals that are as problematic as, or worse than, the original substance. For example, some structural analogues of bisphenol A (BPA), which are used in a variety of plastic products, have similar toxicity and hormonal effects to BPA[3]. Likewise, hydrofluorocarbons and hydrochlorofluorocarbons are often used as substitutes for chlorofluorocarbons (CFCs), ozone-depleting chemicals that were used widely as refrigerants and aerosol propellants. Although not as harmful as CFCs, the substitutes still damage Earth's ozone layer[4].

Further, by knowing which tests must be carried out in advance, inventors will save time and money, making it easier to rationalize the large investment necessary to develop a material.

Creating a set of nationally or internationally standardized safety tests will require input and compromise from industrial, academic and governmental organizations, such as the American Chemistry Council, the Environmental Working Group and the EPA. Everyone will endorse some tests, such as those for physical chemical properties. Others will be difficult to agree on or are yet to be established, such as those for endocrine disruptors, a type of hormone-mimicking molecule[5]. Information gaps will need to be identified, such as methodologies for testing the various phases of materials. A mechanism to periodically review and amend the list of tests should be put in place, based on existing processes for evaluating individual molecules used by the EPA, REACH, corporations and government bodies.

Test finished products. Ingredients entering a manufacturing process do not necessarily represent the chemical composition of the final product. Some molecules disappear; others interact to form new compounds when exposed to different substances or changes in temperature and pressure. A better way to understand a product's impact on human health and the environment is to test the final product. For example, one study that screened a sample of pizza box[6] revealed many unidentifiable compounds, raising questions about the content and safety of everyday products.

"The molecular interactions of chemicals within products are unaccounted for."

A product could be graded on a scale of 1 to 10 (1 being benign and 10 being highly toxic) based on its performance in a series of standard tests in different categories. Consumers would be informed of product safety and suppliers need not reveal trade secrets. If a product's performance in one or more of the tests is unacceptable, the manufacturer can look down its supply chain, identify which material is problematic, and make modifications.

Make test results public. The quantitative results of chemical and product tests should be disclosed and presented in an unbiased way. Organizations, including government agencies, non-governmental organizations and trade associations should create policies and processes to interpret the data. For example, a product might be scored for carcinogenicity, emissions and endocrine-disrupting potential. If all products in a commercial category provide this information, a consumer can make an informed decision by comparing the numbers. Consumer or non-governmental organizations should prepare guidelines on what scores one should look for.

It is important to ensure consumers know that no product is without risk. Producers with 'unacceptable' product scores would have to explain to the public why they feel that the exposure of humans and the environment to a substance is justified. Government agencies and other groups can ban products or product categories that score poorly.

PATH TO PROGRESS

The first step towards better chemical safety is to create a list of desired endpoints — the information we would like to know about a product, such as liver toxicity, ozone depletion or carcinogenicity. There shouldn't be so many goals that the task of achieving them is impossible, or so few that it is meaningless.

Step two is to identify specific tests for each endpoint. Where consensus cannot be achieved, a mechanism for reaching agreement must be developed.

Third, we must develop protocols to define sample preparation and methods of analysis. The main goal is to create criteria that can be used to audit laboratories that perform the assays. Different states of matter and various product types should be anticipated.

Finally, scientists should convene regularly to evaluate the current state of the art and science, and make decisions based on new knowledge that challenges existing tests or offers improvements. For example, this year marks the twentieth anniversary of the first Green Chemistry Gordon conference; such meetings would be good forums for discussing commercial successes and remaining challenges in sustainable chemistry.

Overhauling chemical regulation is a daunting task, but we need a better way of protecting human health and the environment. ■

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CORRECTION

The Comment article 'Stop the privatization of health data' (J. T. Wilbanks & E. J. Topol *Nature* **535,** 345–348; 2016) wrongly stated that the Enlite device sends insulin into the blood when it detects a drop in glucose; in fact, it stops a pump releasing insulin. And 23andMe's latest fundraising round was US$115 million, not $150 million.