

Letter to our Readers

September 2003

Dear Colleague,

Evaluating Product Risks

While the specifics of exposure assessment vary under different regulatory programs, certain aspects are common to all.

Consumers are routinely exposed to chemicals in products as part of the accepted product use. The conscious application of cosmetics is one such example. The assessment and management of risks from such chemical exposures is, from both a scientific and regulatory perspective, a complicated matter. The table provides examples of types of products that release chemicals to which consumers may be exposed, the product marketing stage at which regulatory evaluation occurs, and some decision-making criteria used by regulatory agencies regarding management of potential risks from product use.

Data regarding release of the chemical into a relevant medium are often limited and a significant source of uncertainty.

The statutory mandates of the various agencies influence their approach to assessing and managing risks of chemicals released from products. In this article, we provide three examples of different approaches used to assess chemical exposures from products under various regulatory frameworks, illustrate the range in methodologies, and highlight some key uncertainties in this developing field.

The Food and Drug Administration (FDA) considers the safety and efficacy of a product in administering its regulatory programs. Dialkyl phthalates are a class of plasticizers used in products made from polyvinyl chloride (PVC), and occur in PVC medical products, such as dialysis bags and intravenous (iv) tubing, and children's toys and teethers. In an FDA safety assessment, the FDA estimated the daily di-(2-ethylhexyl)phthalate (DEHP) doses for adults and children undergoing medical procedures, using data on concentrations of DEHP released into biological materials (e.g., blood or nutritional solutions) and assumptions regarding usage patterns of these products. The FDA compared the resulting daily dose with tolerable intake values for DEHP, and concluded that most medical procedures involving the use of DEHP-

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Exposure to chemicals in consumer, health, and building products is as old as the history of commerce itself. However, even as our societal awareness of potential consumer exposures grows, the methods for evaluating these exposures are far from mature. Given the elaborate risk analysis methods imposed on hazardous waste sites where most risks are hypothetical, it is paradoxical that comparable approaches to product safety have not been as widely applied, so that the risks and benefits can be weighed with transparency and scientific rigor. This issue of *Trends* examines product safety, an issue of growing importance to manufacturers and consumers alike.

Contributors to this issue include Gradient Principals Dr. Barbara D. Beck on approaches for evaluating chemical risks from product exposures, Dr. Lorenz R. Rhomberg on potential health impacts on children due to product exposure, and my article on product disposal and the need to redesign products to avoid disposal issues by promoting more effective reuse. Dr. Rob Shimp, Associate Director of Corporate Sustainable Development at The Procter & Gamble Company, provides an industrial perspective on the need to understand product exposures as a critical element in a transparent risk characterization.

We hope you find this issue on product safety enlightening. We believe it's only the tip of an iceberg that will reveal itself in the coming years.

Yours truly,

Neil Shifrin
 Neil Shifrin, Ph.D.
 President

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Evaluating Product Risks

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containing products did not present a toxicological concern. This type of straightforward dose estimation and hazard comparison can yield significant insights into product safety.

The Consumer Product Safety Commission (CPSC) had a more limited database on direct exposures to children from diisononyl phthalate (DINP) released from toys and teething. The CPSC therefore relied on data on leaching of DINP into artificial saliva or into the saliva of volunteers chewing on PVC disks. These data were combined with information regarding frequency and duration of mouthing objects by young children to yield a daily oral dose of DINP. The CPSC then compared the daily dose to the acceptable daily intake value. The CPSC risk assessment concluded that exposures of children to DINP were unlikely to be a significant risk. In this example, a combination of experimentally-derived data was combined with established exposure factors and hazard data to assess risks.

In some cases, a significant amount of new scientific information needs to be developed to support a product risk characterization. A third example relates to exposures to wood used in decks or children's play structures, which is typically treated with preservatives to protect against fungal rot and insect damage. The U.S. EPA is developing a complex multi-pathway model (stochastic human exposure and dose simulation or SHEDS-wood) that incorporates information on release of preservatives to wipe or hand samples, combined with information on skin surface area contacting the wood surface, hand-to-mouth activity, salivary removal efficiency, and other exposure factors. In addition, the model uses probabilistic distributions of exposure variables and assesses risks for high and low exposure scenarios. The model is presently being applied to exposures of inorganic arsenic released from chromated copper arsenate (CCA) treated wood.

The approaches described above differ in a number of ways, including the use of empirical *vs.* experimental data to estimate release of the chemical from the product into the exposure medium of interest, the critical exposure pathways (iv, oral, multi-pathway), and the characterization of variability in exposures (scenario-specific differences, use of ranges, use of distributions). Data regarding release of the chemical into a relevant medium are often limited and a significant source of uncertainty. In addition, the scientific challenges in extrapolating from laboratory studies or studies in modest numbers of human subjects to large segments of the U.S. population add uncertainties to the assessment of potential products risks.

Not all assessments of product-related exposures are conducted for purposes of regulatory decision-making. Manufacturers also perform assessments to provide a sound basis for risk communication and to respond to potential claims in a litigation context. While it might be ideal to evaluate such risks prior to consumer use of a product, the recognition of a potential risk sometimes occurs only well after a product has been on the market. Nevertheless, assessing product risk before the product goes to market, even with limited data, is an important step that can be improved through application of existing methodologies in innovative and thoughtful ways.

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References:

- U.S. Food and Drug Administration, Center for Devices and Radiological Health (Rockville, MD). 2002. Safety assessment of di-(2-ethylhexyl)phthalate (DEHP) release from PVC medical devices.
- U.S. Consumer Product Safety Commission. 1998. The risk of chronic toxicity associated with exposure to diisononyl phthalate (DINP) in children's products. December.
- U.S. EPA, *et al.* 2002. SHEDS-Wood – Stochastic Human Exposure and Dose Simulation Model for a wood preservative exposure scenario: Technical manual.

COMPARISON OF REGULATORY RISK APPROACHES			
Agency	Example of Products Under Agency Purview	Stage at Which Evaluation Occurs	Decision-Making Criteria
Food and Drug Administration	Medical devices, such as catheters and implants	Pre-market and marketed products	Safety and efficacy
Consumer Product Safety Commission	Toys, cooking utensils	Marketed products	Significant risk
Environmental Protection Agency	Preservative-treated wood	Pre-market and marketed products	Risk benefit

Table comparing types of products, regulatory agencies, and regulatory criteria.

Chemicals in Products and Children's Health

Whether children are more sensitive to the toxic effects of certain chemicals remains a scientifically and politically charged issue.

In setting safe levels of exposure to chemicals, risk assessors typically apply a safety factor of 10 (*i.e.*, they reduce the acceptable exposure level 10-fold) to ensure that even especially sensitive members of the population are protected. Increasingly, the question is arising whether children might constitute an especially sensitive subpopulation even beyond the degree that this 10-fold reduction already addresses. In food and product safety, concern exists because children can have strong food preferences and may have behaviors (such as mouthing, hand-to-mouth activity, and playing on the floor or ground) that

could lead to especially high exposures to chemicals in foods, toys, household products, and soil.

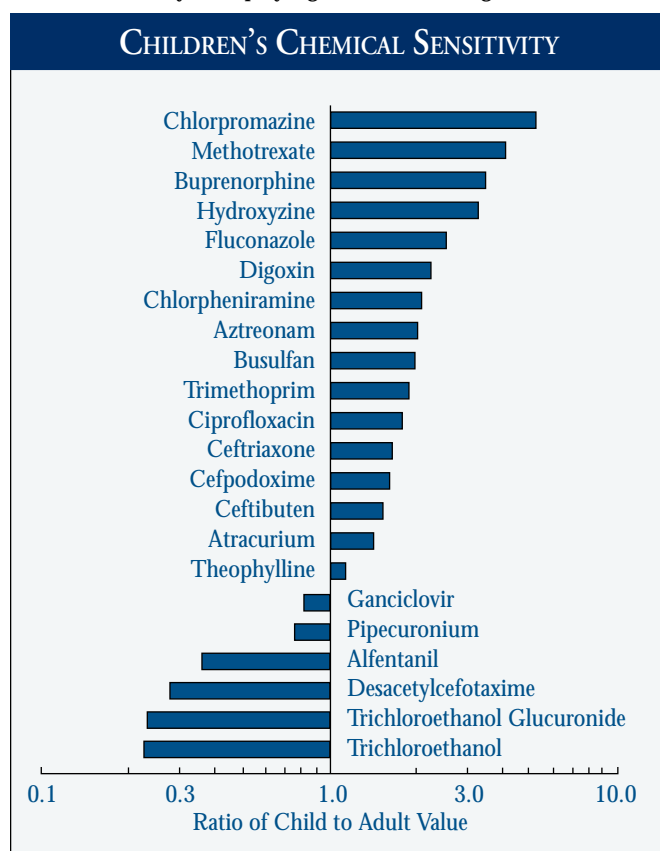
Much of this concern emerged during the regulatory risk analysis for Alar, a chemical formerly used to treat apples. Certain young children drink large amounts of apple juice, more than typically consumed by adults. The possibility was raised that children might be more sensitive to Alar's toxic effects, and so a higher dose combined with lower tolerance might put them at risk. Although the increased sensitivity was hypothetical, this concern was reflected in the 1996 Food Quality Protection Act (FQPA), in the form of a mandate for a federal regulatory

agency to make specific allowances for children's health protection. Under the FQPA (which applies only to pesticides), if toxicological testing is inadequate to demonstrate directly whether children have particular extra sensitivity, permissible exposures are reduced 10-fold – that is, extra sensitivity is assumed unless testing data show otherwise. Similar special children's risk procedures are increasingly being introduced in many areas of regulatory risk assessment. Earlier this year, for instance, the U.S. EPA proposed to increase effective potencies of certain putative carcinogens 10-fold for children 0-2 years of age.

Children can have higher exposures than do adults inhabiting the same environment. In addition to the intake-enhancing behaviors noted above, their higher metabolism means that children take in more air, food, water, and other liquids per unit of body weight than do adults. Such intake differences have long figured into Superfund site risk assessments, but an examination of the potential for especially high childhood exposures is making its way into risk assessments in a number of regulatory programs. In September 2002, the EPA finalized its *Child-Specific Exposure Factors Handbook* to aid in such analysis. The more controversial question, however, has been to what extent children should be presumed to be more toxicologically sensitive than adults to a similar amount of intake – and in particular whether an extra adjustment for possible early life-stage sensitivity is needed beyond the 10-fold sensitivity-variation allowance already in place. The debate on this question has been as much political as scientific.

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The evidence for toxicological sensitivity is mixed and tends to be case-specific, not revealing an overall tendency for early-life sensitivity.



Are children more sensitive? On a measure of the speed with which the body rids itself of a dose, children actually do this faster for most chemicals examined (bars to the right); for those few chemicals with slower clearance in children, the difference is at most a factor of three.

(From Renwick [1998] *Food Addit. Contam.* 15:17-35 as analyzed by Dourson, *et al.* [2002] *Regul. Toxicol. Pharmacol.* 35:448-467.)

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Potential Impacts of Product Disposal

The ultimate solution to waste disposal lies in redefining what currently constitutes waste.

One of the few manmade features visible from space is a landfill in New York. Despite such blemishes (50% of our waste is still landfilled), U.S. waste statistics are improving. After 70% growth in 40 years, municipal solid waste generation has stabilized for now at about 4.5 pounds/person/day due somewhat to a steady rise of recycling to 30% of generated waste. The American Chemistry Council estimates that industrial waste volumes have declined 2000-fold since the 1960s. But the effectiveness of waste minimization and recycling will have

For real change, we must consider all the chemicals in our products, their necessity for the intended service, and their compatibility with sustained reuse of the key molecules.

limits without a change in the way products are designed and the way resources are managed. Ultimately, waste issues are resource issues.

McDonough and Braungart (2002) argue that “doing better” through eco-efficiency will only delay, not avoid,

catastrophe. Downcycling materials, such as converting plastic bottles to park benches, may not ultimately be a good enough fate for our hydrocarbon resources. Instead, they argue, we must view all materials as part of two nutrient cycles, biological or technical, with a goal of full reusability of the molecules or components. Waste is food for the next cycle. Although energy is a key constraint presently, the ultimate success of full reusability of every product’s molecules/components lies in proper design of those products *i.e.*, designs for sustainability.

Because even seemingly benign products are not now designed for sustainability, they can be toxic to people or disruptive to the environment at some point in their life cycle, and especially in the disposal stage. Moreover, many products are designed such that even physical deconstruction into reusable elements is difficult, if not impossible. Try reusing components of your computer or car seat, for example.

For real change, we must consider all the chemicals in our products, their necessity for the intended service, and their compatibility with sustained reuse of the key molecules. Many companies are rethinking their entire businesses to effect these

changes and to report successfully on their triple bottom line – financial, environmental, and social equity. In so doing, these firms are realizing real competitive and financial advantages from redesign that avoids traditional disposal. In deciding whether to join in, companies must remember that the cost of the *status quo* is too high – depleted resources, toxic dumps, and lawsuits.

Numerous success stories are already evident, although mostly in the “doing better” category. Many manufacturing plants have converted to better catalysts and water-based solvent systems, which have resulted in safer products and less toxic process wastes. Mining wastes have been accepted as road-base material in some cases. Some office chairs have been newly designed with biodegradable soft and reusable hard components. Coatings and fabric care products have been redesigned to be safer during use and less disruptive to product reuse. In addition, some products such as carpeting and toner cartridges have been redesigned for take-back to allow their remanufacture.

Ultimately, it may be such purchases of a product’s service, rather than the product itself, that will go beyond doing better and offer a true paradigm shift – one that has as its end point a consideration of product disposition, and not merely product disposal.

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References:

McDonough, W. and M. Braungart. 2002. *Cradle to Cradle*. North Point Press, NY.

BY THE WAY...

The Food and Drug Administration has recently proposed new standards for dietary supplements to ensure that they do not contain contaminants or impurities, and are labeled to accurately reflect the composition and strength of active and other ingredients in the product.

Source: Federal Register: March 13, 2003, 68(49), 12157-12263.

What's New at Gradient

Congratulations to Gradient's Andy B. Bittner, who recently became certified in New Hampshire as a Professional Engineer.

Dr. Barbara D. Beck has been reappointed as Instructor in the Department of Environmental Health at the Harvard School of Public Health.

David E. Merrill has been appointed to the EPA Science Advisory Board (SAB) panel reviewing the technical validity of the "Multimedia, Multipathway, and Multireceptor Risk Assessment (3MRA) Modeling System for setting national risk-based regulations for the EPA's waste programs.

Upcoming Presentations

Nashville, TN. September 18-19, 2003. Manu Sharma, Andy Bittner, and Tarek Saba. "Optimization of Groundwater Pump and Treat Systems Using Numerical Modeling and the Monte Carlo Approach." Presentation at the 2003 NGWA Midsouth Focus Conference.

Amherst, MA. October 20-23, 2003. 19th Annual International Conference on Soils, Sediments and Water Poster presentations:

- Barbara D. Beck. "Comparison of a Probabilistic/Mechanistic (SHEDS) Approach to a Deterministic/Empirical Approach for Evaluating CCA-Treated Wood Exposures."

- Jennifer K. Saxe and Eric J. Wannamaker. "Does Disposed CCA-Treated Wood Influence Arsenic or Chromium Concentrations in Subsurface Drinking Water Supplies?"
- Manu Sharma, Andy Bittner and Tarek Saba. "Optimization of Groundwater Pump and Treat Systems Using Numerical Modeling and the Monte Carlo Approach."

Recent Articles

Brain, J.D., R. Kavet, D.L. McCormick, C. Poole, L.B. Silverman, T.J. Smith, P.A. Valberg, R.A. Van Etten, J.C. Weaver. 2003. Childhood leukemia: Electric and magnetic fields (EMF) as possible risk factors. *Environmental Health Perspectives* 111:962-970.

Gohlke, J.M., W.C. Griffith, S.M. Bartell, T.A. Lewandowski, E.M. Faustman. 2002. A computational model for neocortical neurogenesis predicts ethanol-induced neocortical neuron number deficits. *Dev. Neurosci.* 24(6):467-77.

Lewandowski, T.A., R.A. Ponce, J.S. Charleston, S. Hong, and E.M. Faustman. 2003. Changes in cell cycle parameters and cell number in the rat midbrain during organogenesis. *Dev. Brain Res.* 141(1-2):117-28.

Valberg, P.A. 2003. Ambient particulates and health effects. In "A Practical Approach to Occupational and Environmental Medicine" (Eds: Robert J. McCunney), Lippincott Williams & Wilkins, Philadelphia, pp. 835-850.

Chemicals in Products and Children's Health

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early-life sensitivity. The same high metabolism in children that produces greater intake can also lead to the body ridding itself of chemical substances more quickly than in adults. Some enzyme systems are less developed in the very young, but whether this causes relative sensitivity or protection depends on whether the biochemical processing leads to detoxification or toxicologic activation of the particular chemical in question. For some chemicals, compound-specific data show that children are indeed somewhat more sensitive (*e.g.*, lead and neurological effects), and this can be allowed for in risk assessments. But for many compounds, the data show no such extra sensitivity at early life stages. Case-by-case evaluation is clearly called for.

The difficult and controversial question remains whether, for those substances without a lot of early-life sensitivity information, the already-existing 10-fold sensitivity allowance is

sufficient, or whether there is scientific support for some additional "children's risk factor." This can only be resolved by a forthright and objective examination of the evidence for, and reasons behind, putative cases of extra toxicological sensitivity during childhood, and an assessment of whether existing conservative measures used to define acceptable exposures in the general population are sufficiently protective.

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References:

U.S. EPA. 2002. Child-specific exposure factors handbook. Office of Research and Development, National Center for Environmental Assessment. Washington, D.C. EPA/600/P-00/002B; NTIS PB2003-101678. September.

Guest Editorial: Ensuring Consumer Product Safety Using Risk-Based Decision-Making

A collaborative consideration of risk and benefits can lead to rational decisions about products.

Household consumer products use chemical technologies

Most companies believe that safety is a prerequisite for responsible business, and their approach to safety is based on the scientific assessment and management of risk.

to provide many contributions to society – improving the cleanliness of our homes, facilitating personal hygiene, contributing to health, and enabling more productive lifestyles. One expectation of such products is

that they will be safe, meaning their use will not adversely affect human health or the environment.

Most companies believe that safety is a prerequisite for responsible business, and their approach to safety is based on the scientific assessment and management of risk. Risk assessment is based on understanding two factors: 1) how “toxic” or “hazardous” a chemical is, and 2) how it is used, specifically the extent of exposure to humans or the environment. The goal is to ensure that people or the environment will not be exposed to harmful amounts of any substance we use. Where necessary, management actions are taken to reduce risks to acceptable levels. This may involve developing alternative technologies or modifying product designs to reduce toxicity and/or exposure. Risk management also involves consideration of scientific uncertainty (precaution), as well as the benefits of a technology.

Recently, some governments and public interest groups have expressed concern about using “risk” to establish safety. They have suggested that chemicals should be limited or banned on the basis of hazards alone, with little consideration of how they are used, or the benefits they provide. We recognize the attraction of such a “black and white” approach. However, we believe that it would cause chemicals that are being used safely to be unjustifiably characterized as “dangerous.” This will reduce the flexibility needed for innovative technologies that can improve the lives of people around the world.

In order to enable the manufacture of safe products, we believe industry and government should continue to base decisions on a balanced consideration of risks and benefits, ideally in a collaborative fashion. Partnerships, such as the Alliance for Chemical Awareness (www.chemicalawareness.com) in the U.S., and the Human and Environmental Risk Assessment initiative in Europe (www.heraproject.com), have facilitated both the development of and the use of common risk-based approaches as tools for decision-making, and have provided frameworks for communicating risk with the public. One example of these new communication strategies is Procter & Gamble’s “Science in the Box” Internet site (www.scienceinthebox.com), which provides information about several of our European cleaning products. Collectively, we believe these efforts, and those by others across industry, are helping to ensure the continued availability of safe and effective products that can improve lives.

Dr. Rob Shimp

**Associate Director, Corporate Sustainable Development
The Procter & Gamble Company**

In the next issue:

Vapor Intrusion – An Overview

TCE Toxicity Issues

Strategies for Evaluating Vapor Intrusion

Guest Editorial: Addressing Chlorinated Solvent Plumes

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