

## PERSONAL CARE PRODUCTS

## Triclosan Comes under Scrutiny

Triclosan, the antimicrobial agent marketed for its germ-fighting capability in personal care products, is coming under close scrutiny. In April 2010 the U.S. Food and Drug Administration (FDA) announced it is conducting a scientific and regulatory review of triclosan in FDA-regulated products, with publication of results expected in spring 2011.<sup>1</sup> The agency also is collaborating with the U.S. Environmental Protection Agency (EPA) specifically to study the potential endocrine-disrupting effects of the compound.<sup>2</sup>

Triclosan is a broad-spectrum antimicrobial agent developed over 40 years ago and first introduced as a surgical scrub. Over the last 20 years its use has grown rapidly in personal care products including soap, hand sanitizer, cosmetics, and toothpaste, as well as household products such as odor-fighting socks and germ-resistant sponges, kitchenware, and bedding. A 2001 U.S. study—the latest such data—found triclosan in 76% of 395 commercial soaps examined.<sup>3</sup> In 2008 the Environmental Working Group reported finding triclosan in more than 140 types of personal care and home products.<sup>4</sup> Data from the 2003–2004 National Health and Nutrition Examination Survey showed triclosan in 75% of urine samples analyzed.<sup>5</sup> Triclosan also has been found in rivers and streams<sup>6</sup> and in sewage sludge applied to agriculture.<sup>7</sup>

In January 2010, congressman Edward J. Markey (D-MA) wrote to the FDA and the EPA, urging the agencies to regulate triclosan and the biocide triclocarban.<sup>8</sup> However, future regulation of triclosan in the United States is far from certain. “The efficacy of triclosan-containing products in household and other nonhealthcare-related settings and the potential hazards associated with [these uses] are the subject of an ongoing scientific debate,” says Antonia Calafat, lead research chemist in the Organic Analytical Toxicology Branch of the National Center for Environmental Health, Centers for Disease Control and Prevention.

One area of debate involves the hypothesis that triclosan enhances the production of chloroform, which is classified by the EPA as a probable human carcinogen. A study published in 2007 illustrated that, under some circumstances, triclosan triggered the production of chloroform in amounts up to 40% higher than background levels in chlorine-treated tap water.<sup>9</sup> But another study published the same year showed no formation of detectable chloroform levels over a range of expected tooth-brushing durations among subjects using toothpaste with triclosan and normal chlorinated tap water.<sup>10</sup>

If you are buying a cow, make sure the price of the tail is included.

Tamil proverb

Studies also have yielded conflicting findings regarding links between triclosan and adverse health effects in animals. One study, for example, associated exposure to low levels of triclosan with disrupted thyroid hormone-associated gene expression in tadpoles, which encouraged them to prematurely change into frogs,<sup>11</sup> while another linked triclosan exposure with reduced sperm production in male rats.<sup>12</sup> In contrast, research published in February 2010 showed no effect of triclosan on the normal course of thyroid-mediated metamorphosis in bullfrog tadpoles at environmentally relevant concentrations.<sup>13</sup>

There is still less certainty about the potential for harmful effects in humans. A multiethnic longitudinal study of 1,151 U.S. girls identified small inverse associations for triclosan and high-molecular-weight phthalates with pubic hair stage, although the authors noted that “some or all of our findings may be due to chance.”<sup>14</sup> The FDA notes the compound currently is not known to be hazardous to humans, and, moreover, the agency does not currently recommend any changes to consumer use of triclosan-containing products.<sup>1</sup>

Scientists in Europe are less sanguine. In 2009 the European Union’s Scientific Committee on Consumer Products, which provides the European Commission (EC) with scientific advice, wrote that the toxicologic data suggest “the continued use of triclosan as a preservative at the current concentration limit of maximum 0.3% in all cosmetic products is not safe for the consumer because of the magnitude of the aggregate exposure.”<sup>15</sup> However, the committee noted that continued use in specific subcategories including toothpaste, soap, deodorant, face powder, and blemish concealer is considered safe. In March the EC called for an assessment of whether triclosan in cosmetic products can lead to the development of resistance by certain microorganisms.<sup>16</sup>

One manufacturer already asked European regulators to withdraw its application for the use of triclosan in plastic products that come into contact with food. In a 2009 letter to the EC, officials from Ciba Inc. wrote that the company “does not consider the use of the substance in plastics intended to come into contact with food appropriate any more.”<sup>17</sup>

As for whether triclosan actually improves products to which it’s added, the FDA asserts it has no clear evidence that triclosan in antibacterial soaps and body washes provides extra health benefits over washing with regular soap and water, although it acknowledged evidence that triclosan in toothpaste may help prevent gingivitis.<sup>1</sup> Paul DeLeo, senior director of environmental safety at The Soap and Detergent Association, maintains that antibacterial soaps with triclosan have been shown to work better than soap and water



Federal agencies are reviewing triclosan's safety but haven't called for altered usage.

when killing harmful bacteria, citing a study by researchers from The Dial Corporation.<sup>18</sup>

DeLeo notes that years’ worth of research demonstrates the environmental safety of triclosan as reflected in studies showing that 90–98% of the compound is typically removed by wastewater treatment plants. However, says Rolf Halden, an associate professor in the School of Sustainable Engineering and the Built Environment at Arizona State University, although triclosan may be effectively removed from wastewater, only about 50% is degraded during treatment.<sup>19</sup> “We are in a conundrum,” he says, “where we have all of this old data that shows that triclosan is safe, and all of this new data that shows the potential harm.” The challenge for the FDA and the EPA will be to figure out where the new data and the old intersect.

Catherine M. Cooney, a science writer in Washington, DC, has written for *Environmental Science & Technology* and *Greenwire*.

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## IMMUNITY

## Mercury Alters Immune System Response in Artisanal Gold Miners

The link between mercury and damage to human health is not new: scientists showed several decades ago that an organic form of mercury known as methylmercury causes adverse effects on human neurodevelopment. More recently, scientists have observed associations between immune system disorders and exposure to both organic and inorganic (elemental) mercury.<sup>1,2</sup> A new study of artisanal miners in Brazil could strengthen the link between mercury and immune system problems in humans.<sup>3</sup> The results of the small-scale cross-sectional study may also apply to other

communities exposed to low levels of inorganic mercury, the authors say.

People living downstream from artisanal gold mining sites in Amazonia, Southeast Asia, China, Mongolia, and sub-Saharan Africa are exposed to methylmercury via fish in streams and rivers polluted by small-scale gold mining operations. But public health specialists have long been concerned about more direct exposures to mercury for the miners themselves, who inhale vapors when they burn off mercury they have used to amalgamate gold during the recovery of the precious metal. They also can absorb mercury through their skin as they knead it into the soil sediment to amalgamate the gold—a job Renee Gardner of the Karolinska Institute in Sweden says is often given to children.

Gardner and Ellen Silbergeld of The Johns Hopkins University led a team of researchers attempting to tease out those direct effects of such inorganic mercury exposures. The team started with surveys of artisanal miners in

Brazil who worked with either gold, emeralds, or diamonds. The data gathered covered five encampments of artisanal miners, with nearly 250 men and women participating. The researchers collected blood, urine, and hair samples, and screened participants for malaria along with other factors such as residence time at the mining site.

The team measured two immunoglobins (proteins affiliated with autoimmune responses): antinuclear autoantibodies (ANA) and antinucleolar autoantibodies (ANoA). After accounting for infection with malaria, which also stimulates an immune response, their results showed a higher likelihood of ANA and ANoA being detected in miners currently working with gold compared with those mining for emeralds or diamonds, who do not use mercury in their work. However, a small number of gemstone miners—29% of whom reported using mercury in the past—also had detectable levels of ANA, ANoA, or both.

Past research<sup>2</sup> from some of the team members documented the effects of mercury on activated immune

cells in terms of the release of seven cytokines associated with pro- and anti-inflammatory effects in the immune system; that *in vitro* study guided the development of a panel of biomarkers that might characterize human immune sensitivity to mercury compounds. In the current study, mercury exposure correlated with significantly increased levels of three pro-inflammatory cytokines. The authors say these cytokines could serve as biomarkers of mercury-induced immune responses similar to those seen in lupus-like disease (systemic lupus erythematosus is an autoimmune disease that causes chronic inflammation).

“Since these immune changes that we saw were not related to whether or not miners were infected with malaria, the effects were most likely from exposure to mercury,” says coauthor Jennifer Nyland of the University of South Carolina School of Medicine. “We hope [the findings] can be applied to other individuals, as mercury is a global problem. Even if we stopped all small-scale mining in Africa or Brazil, there are still plenty of other sources of mercury”—including measurable mercury contamination in the western United States from historic gold mining.<sup>4,5</sup>

“I think the implications are important and may also relate to exposures in the United States from [mercury-bearing] amalgam fillings and religious uses of mercury,” says Philippe Grandjean of the Harvard School of Public Health, who was not involved with the study.

Grandjean says that although the new study points to inorganic mercury as a possible trigger of immune dysfunction, the miners’ long-term mercury exposures were not well documented, and malaria infection could still confound the team’s results. He also points out that although one mining community had high mercury vapor exposure alongside high malaria prevalence, others had low mercury exposure and little malaria; that makes the effects of malaria and mercury exposure difficult to tease out epidemiologically from this one study.

“What we have is a snapshot,” Nyland says of the latest study. Ideally, the team will expand their fieldwork into a larger-scale longitudinal study. They hope to establish partnerships in Brazil to prospectively study ongoing exposure to mercury in artisanal gold miners.

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Artisanal miners around the world, including this 13-year-old Senegalese child, use elemental mercury to extract gold particles from soil.

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## ENDOCRINE HEALTH

## Nitrate May Feed Thyroid Disorders

Thyroid cancer incidence has been rising substantially worldwide since at least the 1970s,<sup>1</sup> but the reasons remain murky. Trend data are scant for two other thyroid diseases, hyperthyroidism and hypothyroidism, but incidence estimates suggest each is at least 5 times more common than thyroid cancer.<sup>2,3</sup> Limited evidence has suggested substances such as polychlorinated biphenyls, polybrominated diphenyl ethers, bisphenol A, and triclosan may be playing a role in these disorders. Nitrate also may belong on that list of suspects, U.S. researchers now report.<sup>4</sup>

The new study is apparently the first to link nitrate ingestion and thyroid cancer. The authors found that the quartile of women who consumed drinking water containing an average concentration of nitrate-nitrogen<sup>5</sup> (NO<sub>3</sub>-N) greater than 2.46 mg/L—about one-fourth the EPA maximum contaminant level of 10 mg/L—were 2.18 times more likely to have thyroid cancer than the bottom quartile, whose water contained less than 0.36 mg/L NO<sub>3</sub>-N. Consuming water containing more than 5 mg/L NO<sub>3</sub>-N for more than five years increased the risk slightly more. The women in the highest quartile of daily nitrate ingestion from food were 2.9 times more likely to have thyroid cancer than the quartile who consumed the least, and were 24% more likely to report having hypothyroidism. Nitrate in food dominated total nitrate intake.

The study was based on records from women who were followed from 1986 to 2004 as part of the larger Iowa Women's Health study. The women were 55–69 years old at recruitment. The researchers had extensive self-reported demographic, behavioral, and medical data, but fewer data on overall diet and none on nitrate levels in individuals. Instead, they had to develop intake estimates based on local public water supply monitoring data and national food nitrate data. The small number of thyroid cancers—40 in the approximately 21,000 women analyzed—also is a limitation, although the findings were statistically significant.<sup>6</sup>

The numerous limitations make Lewis Braverman, a professor of medicine at the Boston University School of Medicine, somewhat

skeptical of the conclusions. “The evidence is fairly soft,” he says. He notes, though, there has been some evidence globally of a nitrate-related association with hypothyroidism, goiter, and other thyroid disorders in subjects such as pregnant women and children exposed to far higher nitrate concentrations than those reported in the present study.<sup>7</sup> Ongoing and planned studies, including one looking at men, may provide additional clues, says Mary Ward, lead author of the current study and a senior investigator at the National Cancer Institute.

Thyroid cancer is estimated to be the seventh leading site of new cancers in U.S. women, according to the American Cancer Society.<sup>8</sup> Incidence is about three times higher in women than in men, similar to the pattern worldwide.<sup>1</sup> Some experts are concluding that increased detection alone is not likely to be responsible for global increases.<sup>9</sup>

Synthetic fertilizer can be an important source of nitrate in water and food.<sup>10</sup> The foods that often have the highest concentrations of nitrate, such as spinach, kale, and beets, often are touted for their nutritional benefits. The women in this study who were hardest hit by thyroid disorders tended to be better educated, physically active nonsmokers—a group Ward says is more likely to eat vegetables.

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6. The 19-year span of the study and the changing accuracy and diagnostic patterns for thyroid cancer make it difficult to say how this incidence compares with national rates. But for one perspective, the American Cancer Society estimated 17,640 new thyroid cancers were diagnosed in U.S. women aged 75–90 in 2004, the year data collection for this study ended and the approximate age range for the women at that time. According to the U.S. Census Bureau, the U.S. female population for that age range was 9.8 million in 2004. That equates to 0.18% of the larger population of women aged 75–90 having thyroid cancer, compared with 0.20% in the current study.
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## The Beat

by Erin E. Dooley

### EPA Proposes New Coal Ash Rules

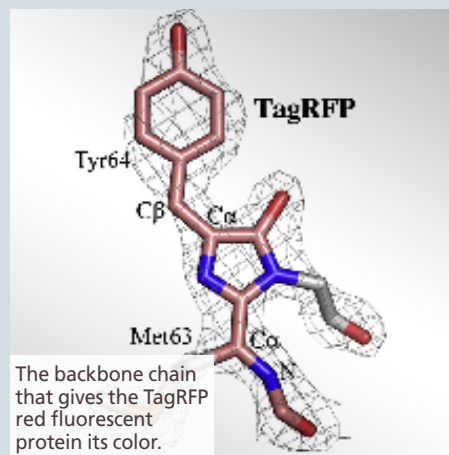
Amid growing concerns about the health impacts of coal ash, the waste produced at coal-fired power plants, the U.S. EPA on 4 May 2010 issued a prepublication version of two options for the management and cleanup of such facilities.<sup>1</sup> The agency is requesting public comments on two approaches to regulation

More stringent regulation as hazardous waste under Subtitle C of the Resource Recovery and Conservation Act (RCRA) would require the development of permit programs, allow for mandatory monitoring and federal enforcement, and more strictly control the use of impoundment liners and groundwater monitoring. Regulation as nonhazardous solid waste under Subtitle D puts more control in the hands of individual states. The EPA also seeks comment on potential refinements to the list of beneficial uses allowed. The proposals will be subject to the EPA's usual 90-day period for public comment upon publication in the *Federal*

*Register*; at press time, the proposals had not yet been published.<sup>2</sup>

### Study Shines Light on the Molecular Structure of Fluorescent Proteins

Researchers have determined the crystal structures of two key fluorescent proteins, one blue and one red, that can be used to highlight molecules in cells being studied.<sup>3</sup> This discovery could allow



scientists to more systematically design novel fluorescent proteins for pinpointing structures and processes in living cells, with more choices of color allowing the simultaneous observation of more individual processes within cells.

### Stream Quality May Predict Human Health

An interdisciplinary study by Nathaniel Hitt and Michael Hendryx looked at the relationship between human cancer mortality in West Virginia and the ecologic integrity of nearby stream ecosystems.<sup>4</sup> They found that people living near the most biologically impoverished streams—as reflected by the numbers and proportions of bottom-dwelling macroinvertebrates living there—had the highest cancer rates, even after adjusting for known risk factors such as smoking, income level, and urbanization. Spatial analyses also revealed more cancers in areas where more coal mining occurred. Their results suggested that proximity to coal surface mines can potentially lead to adverse effects in both aquatic and human communities.



## RESPIRATORY HEALTH

## Lung Damage Lingers after 9/11

Firefighters and emergency medical services (EMS) workers exposed on 11 September 2001 and in the months thereafter to pulverized building dust from the World Trade Center suffered significant reductions in their lung function—losses that persist 7 years on, according to new research.<sup>1</sup> “Lost lung function in most firefighters who inhale smoke, even from a chemical fire, normally recovers quite quickly,” explains study leader David Prezant of Albert Einstein College of Medicine. “Surprisingly, our research shows that the firefighters and EMS workers exposed on 9/11 and thereafter have enjoyed no such recovery.”

The researchers examined the FEV<sub>1</sub> of 12,781 firefighters and EMS workers for whom data were available before and several years after 9/11; every 12–18 months the personnel of these corps undergo routine health assessments that include this measurement. FEV<sub>1</sub> refers to the maximum volume of air that can be blown out in 1 second; it is one of the primary markers of lung function.

Exposure was estimated by analyzing when subjects first arrived at Ground Zero on 9/11 itself and for how long they were present in the months thereafter. The subjects were also subdivided into those who never smoked, always smoked, or smoked only after 9/11. The authors predicted the FEV<sub>1</sub> for each subject (adjusted for age-related decline, gender, height and race) for each 6-month period from 12 March 2000 to 11 September 2008, then determined how each actual FEV<sub>1</sub> measurements compared with the predicted values.

A persistent reduction in lung function was seen in all subgroups. Even among never-smokers, large and significant mean reductions in FEV<sub>1</sub> occurred over the first year, with greater reductions among firefighters than EMS workers. Over the next 6 years, FEV<sub>1</sub> failed to ever demonstrate significant recovery.

The results showed that of all the firefighters, those who entered Ground Zero the morning of 9/11 fared the worst. Paul Lioy, an

expert on the World Trade Center dust who was not involved in this study, explains these first responders encountered very high levels of a complex mixture comprising glass fibers (from disintegrated windows), high-pH cement particles, unquantified gases, and many other constituents. “It was a sequence of exposures that would depend on the time you were there initially, the time you spent there, and whether you were wearing respiratory protection,” he says.

After 7 years, however, time of arrival did not appear to influence eventual loss of lung function. According to the study authors, this suggests “although the intensity of the initial exposure may have been the critical determinant of acute inflammation and early reductions in lung function, the long-term course was more related to the population that was exposed than to the exposure.”

“The massive dust concentrations to which these people were acutely exposed has produced significant reduction in lung function, predominantly due to airway inflammation resulting in obstructive airways disease—asthma, chronic bronchitis, bronchiolitis,” explains Prezant. “For many, the lungs seem unable to recover from the inflammation caused.”

“No other situation has involved this type of dust in such huge, acute exposures,” remarks Omar Usmani of the National Heart and Lung Institute, Imperial College London & Royal Brompton Hospital. “Such loss of respiratory function would not be expected in people living in even very highly polluted places; the pollutants are different, and the exposure is chronic rather than massively acute. [Even] rescue workers attending urban earthquake disasters would typically not be similarly exposed. What this research shows is how much more prepared and vigilant we need to be in assessing, managing, and protecting the respiratory function of rescue workers exposed to the most extreme situations.”

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## Chesapeake Bay Enforcement Actions Now Online

In April 2010, the EPA announced a new effort to provide public online access to its work in enforcing federal pollution laws in the Chesapeake Bay region.<sup>5</sup> The move includes a new focus on targeting the sources responsible for contributing the greatest amounts of nitrogen, phosphorus, and sediment to the watershed. Last year is the

first time the agency has compiled enforcement statistics for the Chesapeake Bay region. According to the EPA, actions pursued since 2009 will keep more than 15 million pounds of nitrogen oxides out of the bay airshed along with 2,100 pounds of nitrogen and phosphorus and 82 million pounds of sediment out of the bay watershed once all the required controls are put in place.

## NRC Reports on Ocean Acidification

A recent National Research Council report states the increasing acidification of the world’s oceans, a result of CO<sub>2</sub> uptake, will continue to worsen if anthropogenic CO<sub>2</sub> emissions are not curbed.<sup>6</sup> Recent legislation calls for establishment of a national program to study and respond to the effects of ocean acidification. To date, the ocean has absorbed about a third of the anthropogenic CO<sub>2</sub> released as a result of human activities. The report describes six elements the authors consider key to a successful National Ocean Acidification Program.

## COSMOS Cell Phone Study Launched

More than 250,000 people are expected to be enrolled in a new 30-year European study,

COSMOS,<sup>7</sup> the largest of its kind to date, on the effects of cell phone use on human health. Although most of the research to date has found little link between cell phone use and health effects, there is some concern that cell phones have not been in common use long enough for such effects to be determined through studies. The new study will look not only at cancer, but also at stroke, heart disease, neurodegenerative diseases, headaches, sleep disorders, and tinnitus.

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