Beach Bug Bingo

Toward Better Prediction of Swimming-Related Health Effects

Swimming is a popular pastime in the United States. The 2000–2002 National Survey on Recreation and the Environment reported that each year an estimated 89 million Americans swim in recreational waters including lakes, oceans, streams, rivers, and ponds. But swimming waters may also be contaminated by human sewage from treatment plants and runoff, raising the risk of gastrointestinal (GI) illness in swimmers. The recommended test for measuring contamination requires culturing fecal indicator bacteria, which means that beach managers must wait 24 hours for results. This built-in delay is problematic, potentially exposing swimmers to unhealthy water quality and sometimes resulting in unnecessary beach closures. Now a team of federal researchers has shown that a rapid method for measuring water quality can accurately predict swimming-related health effects [***EHP* 114:24–28**].

The researchers conducted health surveys of beachgoers at two public beaches, one on Lake Michigan and one on Lake Erie, and compared them with thrice-daily water quality measurements along transects at the beaches. They evaluated water quality using a modified version of the polymerase chain reaction method (QPCR) to quantify indicator bacteria in water samples. The advantage of this method is that it can provide results in two hours or less. The researchers chose *Enterococci* and *Bacteroides* as their indicator organisms.

Wave of the future? If validated, a modified polymerase chain reaction method may become useful for earlier identification of hazardous beach water conditions.

Survey participants were interviewed as they left the beach; follow-up interviews were conducted by telephone 10 to 12 days after the beach visit. When researchers compared results of the water quality tests to participant reports of GI and other illnesses, they found a significant trend between increased reports of GI illnesses and *Enterococci* at the Lake Michigan beach and a positive, though statistically insignificant, trend for *Enterococci* at the Lake Erie beach. *Bacteroides* did not prove to be as powerful in predicting illness, with an insignificant positive trend found only at the Lake Erie beach and no trend at the Lake Michigan beach.

When results from the two beaches were combined, the trend for *Enterococci* and GI illness remained statistically significant, a finding that held true even when samples collected at 8:00 a.m. were compared to daily averages. Beach managers could thus test early-morning samples to assess water quality and, if necessary, close beaches before the majority of swimmers were exposed.

In spite of the promising nature of the findings, the authors caution that much research remains to be done before the results can be generalized. One of the key remaining questions relates to the method itself: QPCR relies solely on the presence of DNA to quantify organisms, so pathogens are detected even if they are dead and thus harmless. QPCR may therefore suggest a problem with the water when in fact there is none. The authors say additional studies should help determine if the approach is robust enough to be used in water quality regulations. **–Nancy Bazilchuk**

Exploring the Roots of Diabetes

Bisphenol A May Promote Insulin Resistance

Poor diet and lack of exercise are known contributors to the epidemic of type 2 diabetes spreading around the world. Now researchers have implicated another possible culprit in the rise of the disease [***EHP* 114:106–112**]. A team of Spanish and Mexican researchers reports discovering that the endocrine-disrupting chemical bisphenol A (BPA) causes insulin resistance in mice similar to that seen just before the onset of type 2 diabetes.

Type 2 diabetes occurs when insulin receptors throughout the body fail; this is known as insulin resistance. Complications of diabetes include heart disease, kidney failure, blindness, and nerve damage. The World Health Organization estimates that at least 154 million people around the world have type 2 diabetes, and predicts that number will more than double within 25 years.

Endocrine disruptors mimic the natural sex hormone 17β-estradiol (E_2), which is involved in the development of sexual traits. Scientists have known for years that BPA and other endocrine disruptors can diminish sperm production, accelerate the onset of puberty, and damage sexual organs. But they had not studied a link between the chemicals and glucose metabolism, even though increases in E_2 are known to cause insulin resistance.

The researchers chose to study BPA because its use is so widespread. Since the 1950s, it has been used in plastics for water bottles and jugs, baby bottles, toys, and the linings of food and beverage cans. People ingest BPA that leaches from containers into foods and

Jeremiah Deasey/iStockphoto

drinks. Studies in the United States showed that BPA appeared in the blood and urine of 95% of people tested.

The researchers tested BPA's effect on glucose regulation by measuring glucose and insulin levels in adult male mice treated with BPA injections, then comparing them with levels in mice treated with E_2 and a control group treated with corn oil. BPA caused oversecretion of insulin in mice at a dose of 10 micrograms per kilogram body weight per day (μg/kg/day) via a rapid mechanism, taking only 15 to 30 minutes. Treatment over a course of four days with 100 μg/kg/day induced the insulin resistance that precedes type 2 diabetes. E_2 had the same effects at the same doses. Glucose metabolism remained stable in the control rats.

These results are novel because the mechanism reported is the lesser known of the two major pathways used by estrogens and other steroids. It involves signaling rapidly initiated from the plasma membrane rather than the nuclear transcription pathway depicted in most textbooks.

The BPA dose high enough to cause insulin resistance in mice was in the same range as the 50 μg/kg/day reference dose established by the U.S. Environmental Protection Agency, which is based on a lowest-observed-adverse-effect level of 50 milligrams per kilogram per day. The researchers see the newly discovered link between BPA and insulin resistance as one more reason the agency should at least consider lowering the lowest-observed-adverse-effect level. They further suspect that because other endocrine disruptors mimic E_2, they too may hinder glucose metabolism. **–Cynthia Washam**

Refreshing news. Although some questions remain, a new data analysis fails to confirm fears that fluoridation of drinking water results in higher blood lead along with stronger teeth.

Hypothesis Decay?

Blood Lead–Fluoridation Link Not Confirmed

Numerous studies of various populations have shown that adding fluoride to drinking water prevents dental decay. However, a 1999 study in Massachusetts and a 2000 study in New York reported associations between the use of silicofluoride compounds in community water systems and elevated blood lead (PbB) concentrations in children. Now a team of researchers has tested the hypothesis generated by the Massachusetts and New York studies against findings from two other studies and found no cause for concern [***EHP* 114:130–134**].

As of 2000, the Centers for Disease Control and Prevention estimated that more than 162 million Americans were receiving fluoridated water. In the United States, several agents are used for fluoridation, including silicofluoride compounds (sodium silicofluoride and hydrofluosilicic acid) and sodium fluoride. Researchers with the Massachusetts and New York studies hypothesized that the silicofluoride compounds in tap water might enhance lead leaching from pipes and increase lead absorption from the water itself. Elevated PbB concentrations in children are associated with a host of cognitive, developmental, and behavioral impairments so serious that lead-based paint was banned in the United States in 1978 and lead water pipe solder was banned in the 1980s.

The current research group evaluated the relationship between water fluoridation method and PbB concentrations in children by conducting a large-scale statistical analysis of two other preexisting studies: the 1992 Fluoridation Census and the Third National Health and Nutrition Examination Survey (NHANES III). In analyzing data from NHANES III and the 1992 Fluoridation Census, the team improved on prior analyses by log-transforming raw PbB concentration and by including information on possible confounding factors missing from the Massachusetts and New York studies. These included poverty status, urbanicity, duration of residence, and year in which the dwelling was built.

The NHANES III sample was comprehensive, representing more than 52 million U.S. children. This survey also oversampled young children, older adults, non-Hispanic blacks, and Mexican Americans to ensure that population estimates for these groups would be statistically reliable.

The team found that, overall, the PbB concentrations of children who lived in counties receiving silicofluorides did not differ significantly from the PbB concentrations of children living in counties without fluoridated water. This was true even when researchers controlled for the year in which children's homes were built. Given these findings, the team states there is no support for concerns that silicofluorides in community water systems cause higher PbB concentrations in children.

Kati Neudert

Toxics, toxics everywhere . . . Many studies have looked at the health effects of arsenic in Bangladeshi well water. New data now show that manganese in the water may also cause adverse effects.

Karen Robinson/Panos Pictures

However, the investigators acknowledge that their analysis has limitations. For example, NHANES III did not measure the lead content of drinking water consumed by study participants. Also, the team did not control for factors such as density of older housing, and they were unable to control for the solubility of lead in pipes affected by different temperatures and water hardness.

Because of these limitations, the investigators cannot completely rule out a link between water fluoridation method and lead uptake in children, particularly in children living in older dwellings. They speculate that other studies, possibly those including chemical investigation and animal toxicology, could yield additional valuable data. They conclude that efforts to prevent dental decay via the use of fluoridated drinking water should continue unless a causal effect of specific fluoridation methods on PbB concentration is demonstrated by additional research. **–John Tibbetts**

Manganese in Drinking Water

Higher Doses May Hamper Intellectual Function

Manganese is an essential nutrient for humans, but its excessive consumption can cause adverse health impacts. Past studies have linked inhalation of excessive manganese to neurotoxicity in adults. Now a group of U.S. researchers suggests that ingesting high doses of manganese in drinking water can hamper intellectual function in children [***EHP* 114:124–129**]. These effects were seen most strongly on scales that measure performance aspects of intellectual function.

The same group had earlier observed a negative impact of water arsenic on intellectual function among children in Araihazar, Bangladesh. Though the manganese concentration in the water these children drank was much higher than its arsenic content, the independent impact of manganese on intellectual function could not be verified. The present study included 142 10-year-old children (including 54 children from the earlier study) who consumed well water with average concentrations of 793 micrograms per liter (µg/L) manganese and 3 µg/L arsenic.

The children's intellectual function was assessed on six tests (similarities, digit span, picture completion, coding, block design, and mazes) drawn from the Wechsler Intelligence Scale for Children, Version III. Results were summed to create Verbal, Performance, and Full-Scale raw scores. These tests were chosen as they could be applied to Bangladesh's rural context with minimal alteration. The results showed that manganese concentration had a significant negative dose–response association with all three raw scores.

The researchers found that children in exposure groups 1 (manganese lower than 200 µg/L) and 4 (manganese higher than 1,000 µg/L) differed significantly from one another for Verbal, Performance, and Full-Scale raw scores. Compared to group 1, children in exposure groups 2 (manganese between 200 µg/L and 500 µg/L) and 3 (manganese between 500 µg/L and 1,000 µg/L) had lower Full-Scale and Performance scores, but the differences were not statistically significant. Verbal scores of the children in groups 2 and 3 also did not differ significantly from those in group 1. Due to the lack of measures of intelligence standardized for use in Bangladesh, the team could not calculate IQ points lost.

Though the children's waterborne manganese intake was lower than the highest safe daily dose (6 milligrams per day) estimated by the U.S. Institute of Medicine, the authors write that additional dietary exposure could have pushed the total daily dose above this value. Moreover, bioavailability of manganese from food is very low, while it is high from drinking water. This could have contributed to neurotoxicity seen in children drinking water with higher amounts of manganese.

The authors point out that their findings are relevant in the United States as well. Data collected by the U.S. Geological Survey have shown that about 6% of domestic wells contain manganese concentrations higher than 300 µg/L. Based on these data and their study results in Bangladesh, the researchers suggest that some U.S. children may be at risk for manganese-induced neurotoxicity. **–Dinesh C. Sharma**