Blood-lead climbs as old bones decline

Young children tend to suffer more from lead's toxic effects—ranging from IQ deficits to gastrointestinal distress—than their parents do. But two new studies suggest an adult's reduced lead sensitivity is a transient stage that diminishes and may even disappear in the elderly. Reported last week at a federally sponsored lead conference in Columbia, Md., these and other new findings are contributing to a growing appreciation of bone's role in lead toxicity.

Though the body may store 95 percent of its lead burden in bone, physicians usually gauge contamination by blood levels — that circulating pool of the contaminant available to poison soft tissues such as the brain. In fact, scientists have generally considered bone's sequestration of lead as a detoxifying mechanism. However, data now indicate bone is anything but a permanent, inert lead-storage site.

How long the skeleton binds lead depends largely upon bone type, researchers from the University of Lund Hospital in Sweden reported at the conference. Their X-ray fluorescence assays of male lead-smelter workers put the usual half-life of lead in spongy bone, like vertebrae, at less than five years, while its half-life in dense, compact bone, like fingers, can last two to four times longer.

However, certain physiological conditions — mainly pregnancy, lactation and menopause — can foster dramatic bone loss. To indirectly investigate the effects on lead release, researchers from the Environmental Protection Agency, the National Institute of Environmental Health Sciences and the Environmental Defense Fund compared blood-lead levels recorded in 2,981 U.S. women during the second National Health and Nutrition Evaluation Survey (NHANES II). They found that women who never had children — and therefore never shed significant bone and bone-bound lead to developing offspring — carry far more lead into old age than those who had been pregnant.

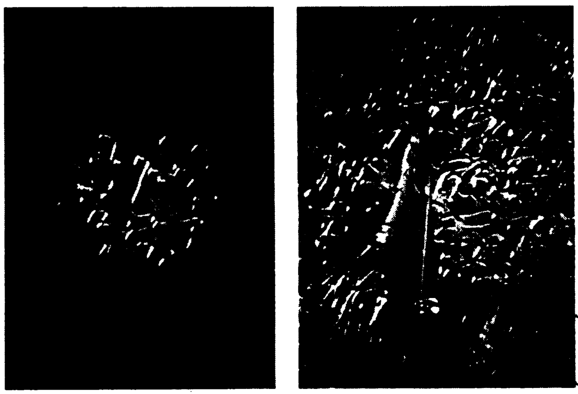
Blood-lead levels in postmenopausal women were 12.6 percent higher than those in premenopausal women — an increase the researchers interpret as largely reflecting the release of lead through osteoporosis. But among childless women, postmenopausal blood-lead increased 22 percent — twice that of women who had been pregnant. The increase was more dramatic in white women, whose postmenopausal blood-lead increase was three times higher than that of blacks.

To further investigate age-related lead vulnerability, Deborah A. Cory-Slechta, a toxicologist at the University of Rochester (N.Y.) School of Medicine, exposed young (21-day-old), adult (8-month-old) and old (16-month-old) rats to lead in drinking water for 9½ months at daily rates of 0, 2 or 10 milligrams per kilogram of body weight. She reports that the oldest animals shed more of their accumulated lead from bones, redepositing much of it in soft tissues such as the kidney, liver and brain. Lead-fostered chemical changes in blood — measured by several key chemical markers — also occurred after briefer exposures and to a far greater extent in the oldest rats.

These findings suggest older women face a potentially large and previously unrecognized lead risk, says Environmental Defense Fund toxicologist Ellen Silbergeld, who led the new analysis of NHANES data. She says the data indicate that even low-level lead exposures, accumulated over decades, may be released "in potentially toxic amounts" during the massive osteoporotic bone loss that frequently begins in the first five years following menopause. The Rochester findings now suggest that this period may be precisely when hormonal and other dramatic physiological changes foster a renewed sensitivity to lead toxicity.

— J. Raloff

An appetite for liquid-crystal spaghetti


Palffy-Muhoray

A liquid-crystal filament, a few microns in diameter (left), grows into a spaghetti-like tangle that gets swallowed up by small, compact lumps (right).

Ordinarily, when a liquid cools it becomes a solid. Some substances, however, go through an intermediate, liquid-crystal phase, settling into an arrangement lying somewhere between the regular order found in crystalline solids and the disorder in liquids. A new material shows how dramatic and unusual the change of state from a liquid to a liquid crystal can be.

Slowly cooling the pure-liquid form of this particular material initially produces tiny filaments visible under an optical microscope. Each filament grows longer and longer by adding material not to its ends but everywhere along its length. As the pace of growth accelerates, the filaments lengthen rapidly and fold into convoluted patterns. Within a minute, the entire field of view fills with a spaghetti-like tangle.

Then another curious thing happens. Suddenly, one or more small, compact lumps resembling flattened meatballs appear among the strands. The lumps quickly suck up the strands, clearing space for new filaments to form and grow. More and more lumps develop until the whole material finally ends up in a single, conventional liquid-crystal phase.

"When I first saw it, I found it quite unbelievable," says Peter Palffy-Muhoray of Kent (Ohio) State University. "I think it's the most complicated phase change in a pure material that I have ever heard of. It looks like a biological system." Palffy-Muhoray described the discovery in St. Louis this week at a meeting of the American Physical Society.

He and his collaborators are studying the new material as part of a general effort to gain a better understanding of how phase changes occur and how patterns form from liquids that themselves appear to have no structure.

Like many liquid-crystal materials, the new substance consists of long, linear organic molecules. Each molecule has a body of three benzene rings along with several other groups of atoms and a hydrocarbon tail containing 10 carbon atoms in a chain. Other members of the family, having the same body but fewer carbon atoms in their tails, show nothing of the new sibling's bizarre behavior. They all settle into a liquid-crystal phase known as smectic A, in which the molecules line up to form orderly layers, standing erect in each layer.

Slow cooling of the new material appears to encourage formation of filaments, in which a number of molecular layers wrap themselves around to form a liquid-crystalline tube with a small volume of liquid trapped at its core. As cooling continues, more material "freezes" onto the outside of a filament, but the newly arrived molecules get pulled into the filament's interior and then diffuse along the layers making up the tube. Instead of getting thicker, the filaments get longer. Researchers are less certain about the formation, structure and behavior of the voracious lumps.

"I think there is a great deal of exciting physics to be done in this area," Palffy-Muhoray says. "We need detailed measurements of the dynamics of these interfacial phenomena. We also need to assess the effects of impurities." *— I. Peterson*