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Definition of Occupational Lead Toxicity in Greece

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We read with interest the article of Kosnett et al. (2007) in which the authors offered medical recommendations for the health management of lead-exposed adults. These recommendations were intended to apply to all workers who have the potential to be exposed by lead ingestion, even in the absence of documented elevations in air lead levels. Based on the literature and their experience, Kosnett et al. recommended that individuals be removed from occupational lead exposure if a single blood lead level (BLL) exceeded 30 µg/dL or if two successive BLLs measured over a 4-week interval were ≥ 20 µg/dL.

The definition of occupational lead toxicity is difficult because it is not possible to determine a precise BLL below which symptoms never occur, or a BLL at which symptoms are always reported. Moreover, individual susceptibility should always be recognized. Several attempts have been made over the years to define lead toxicity among adult workers based mainly on clinical investigations [Agency for Toxic Substances and Disease Registry (ATSDR) 2007].

In Greece the occupational exposure to lead is regulated by the *Presidential Decrees 94/1987* (1987) and *338/2001* (2001). According to these decrees, the diagnosis of lead toxicity in adult workers is based on the integration of data obtained from the patient's medical history, a physical examination, laboratory tests, and tests of specific organ function. An employee with a BLL of ≥ 40 µg/dL and exposure to lead at concentrations > 75 µg/m³ of air per 8-hr time-weighted average (TWA) require environmental and medical intervention (action levels). The maximum acceptable BLL for an adult worker is 70 µg/dL (BLL > 70 µg/dL should result in removal from lead exposure), but the permissible airborne exposure limit is < 150 µg/m³ per 8-hr TWA. *Presidential Decree 94/1987* (1987) prohibits "prophylactic" chelation for the prevention of elevated BLLs. Although these standards have provided guidance that has been beneficial for Greek occupational health physicians, they have not been substantially changed since 1987 [action level, BLL ≥ 50 µg/dL; maximum acceptable level, BLL = 70 µg/dL; permissible airborne exposure limit, air lead (workplace) < 150 µg/m³ (8-hr average)]. Therefore, a

reformation of these standards is needed in Greece, on the basis of recent health effects studies, such as those on standards or regulations of health agencies.

Prevention of lead toxicity is a collaborative effort between primary care clinicians and public health agencies. Primary prevention is best achieved through the use of engineering controls, personal protective equipment, and good work practices. The occupational health physician can have the greatest impact on prevention through worker education and instruction in proper personal hygiene techniques. Also, the observance of up-to-date guidelines would contribute to the elimination of occupational lead toxicity in Greece.

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Editor's note: In accordance with journal policy, Kosnett et al. were asked whether they wanted to respond to this letter, but they chose not to do so.

Serum PFOA Levels in Residents of Communities Near a Teflon-Production Facility

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In a recent article, Tillett (2007) reported on research by the University of Pennsylvania NIEHS (National Institute of Environmental Health Sciences) Center of Excellence in

Environmental Toxicology (CEET). CEET deputy director Edward Emmett described analyses of perfluorooctanoic acid (PFOA) in blood serum collected during mid-2004 from residents of towns near DuPont's Teflon production facility in Parkersburg, West Virginia. Results of the analyses, which identified PFOA levels "60-75 times higher than in the general population," were presented at a community meeting in October 2005, and "[DuPont] began offering bottled water to all residents being serviced in the Little Hocking Water District within days" of the meeting (Tillett 2007).

If the criterion for offering bottled water was high serum PFOA levels in residents of West Virginia and Ohio towns with PFOA-contaminated drinking water, then DuPont should have offered bottled water to Little Hocking, Ohio, and other towns well before October 2005. There would have been ample reason for concern about high serum PFOA levels because by 2001 there were reports in the scientific literature of animal studies that showed PFOA to be a developmental and liver toxicant, as well as a multisite carcinogen (Morgan and Cory-Slechta 2006).

In July 2004, the U.S. Environmental Protection Agency (EPA) sued DuPont for failure to file with the agency reports on PFOA required to be submitted under section 8(e) of the Toxic Substances Control Act [TSCA 8(e)] (U.S. EPA 2004a). In December 2004, a count was added (U.S. EPA 2004b) covering the company's failure to submit data obtained in July 2004 indicating that 10 community residents exposed to PFOA-contaminated drinking water in the area near Parkersburg, West Virginia, had serum levels of PFOA ranging from 15.7 to 128 ppb (mean, 67 ppb) (U.S. EPA 2004b). The U.S. average serum level of PFOA is approximately 5 ppb (U.S. EPA 2004b).

Each of the 10 individuals in the 2004 group was exposed to PFOA through drinking water provided by the Lubeck (WV) Public Service District (LPSD) where, according to DuPont,

[the level of PFOA in the drinking water] averaged approximately 0.5 ppb over the last several years. All ten of the individuals tested claim to have stopped using the contaminated public drinking water as their primary source of drinking water approximately three years ago. (Bilott 2004)

The concentration of PFOA in LPSD water (0.5 ppb) was well below recent levels in Little Hocking, but serum PFOA levels were still several times greater than 5 ppb. Also, given the half-life of PFOA in humans of approximately 4 years, it is likely that the high serum levels in the test group reflected exposures through drinking PFOA-contaminated water > 3 years before

Census reported just 7.6% built before 1939 (U.S. Census Bureau 2000).

Miranda et al. (2007) were unable to include 25% of records; missing these data could have biased the results. For example, if a higher proportion of the missing children were from Seymour Johnson Air Force Base, which is annexed to the city of Goldsboro and which receives water from the Goldsboro Water System, this could have overestimated the effect of switching to chloramine if the missing children had lower blood lead levels. Children who reside on military bases tend to have lower lead exposures, regardless of the housing stock (Stroop et al. 2002).

Miranda et al. (2007) should have considered the possible impact of Hurricane Floyd. The September 1999 hurricane left many homeless; flooding, demolition, and construction activities could well have affected children's blood lead levels to a greater extent in Goldsboro compared with the rest of Wayne County. Indeed, the raw blood lead level data show an increase county-wide in the year 2000, supporting an effect of the hurricane.

The analysis conducted by Miranda et al. (2007) is interesting, and additional studies with individual-level exposure measurements should be conducted. However, their study does not provide a basis for recommending a broad alteration of blood lead screening strategies. States need to do better to ensure that blood lead screening strategies are inclusive, especially for low-income children who are at the greatest risk of undetected elevations in blood lead levels. The recommendation of Miranda et al. (2007) to exclude certain children based on water-disinfection practices could have substantial unintended impacts. In accordance with recommendations of the U.S. Preventive Services Task Force (2007), a more prudent approach to prevent lead exposure via drinking water is that municipalities ensure careful corrosion control and remove lead service lines and distribution pipes, regardless of the method of residual disinfectant used.

The author is an employee of the City and County of San Francisco Department of Public Health; her position is funded under a work order from the San Francisco Public Utilities Commission, which switched to chloramine for residual disinfection in 2004. The San Francisco Public Utilities Commission had no role in the preparation, review, or approval of this letter.

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Blood Lead and Water Treatment: Miranda et al. Respond

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In response to our study (Miranda et al. 2007), in which we found an association between age of housing, water treatment practices, and blood lead levels, Weintraub concludes that

a more prudent approach to prevent lead exposure via drinking water is that municipalities ensure careful corrosion control and remove lead service lines and distribution pipes, regardless of the method of residual disinfectant used.

Unfortunately, this approach has fallen notably short as evidenced by tests of residential tap water in Washington, DC (Edwards and Dudi 2004), Greenville, North Carolina (Renner 2005), and in 2006, in Durham, North Carolina (Biesecker 2006). Each of these cities had increased levels of lead in tap water following a change in water treatment practices necessitated by a switch to chloramines for disinfection.

We stand by our hypothesis that the effect of chloramines on blood lead levels would be less important in newer housing stock. Weintraub cites a U.S. Environmental Protection Agency Fact Sheet (U.S. EPA 1993) as evidence that older buildings would pose less, not more, of a lead risk because of the protective effect of mineral deposits coating the inside of the pipe. However, as the U.S. EPA noted, lead levels decrease as a building ages only “if the water is not corrosive.” An increase in the

corrosivity of treated water after a switch to chloramines may expose lead that was shielded by mineral deposits (Schock 1990). This supports our reasoning that newer housing without lead service lines or lead solder and low-lead fixtures would pose less exposure risk.

We did not use an ecologic study design in our analysis. Our outcome variable was an individual measure of blood lead level, and our explanatory variables were either individual or census-level measures. We did not attempt to infer an individual-level association of variables from an association demonstrated only for aggregated variables.

We coined the phrase “Wayne Water Systems” to represent the collection of water systems in Wayne County, North Carolina, that do not use chloramines. “Wayne Water Systems” includes the five water systems that make up the Wayne Water Districts, as well as the five other active community water systems (Fremont, Fork, Pikeville, Mt. Olive, and Southern Wayne) in the county. We should have noted this in the text.

With respect to the categorical analysis, stratifying housing age by 25-year categories did not lead to misclassification of the housing, in spite of grouping together houses built before and after the ban of lead solder in 1986. We performed model iterations with several different age categories of housing and presented the best-performing model. We did run a model with housing built after 1986 as a referent group, but we found the variable of 1976–1986 statistically insignificant.

We based our finding that 15.6% of the housing stock in Wayne County was built before 1925 on tax parcel data, which we consider to more accurately represent housing age than homeowner responses to age-of-housing questions posed by the U.S. Census. We would have preferred to include all blood lead records, but it was not possible because we could not geocode incomplete addresses. However, when we compared the blood lead levels of children from geocoded and nongeocoded addresses, we did not find a significant difference. Records of children from Seymour Johnson Air Force Base were included in the analysis.

In July 2006, the U.S. EPA proposed changes to the Lead and Copper Rule that would require water systems to notify, and obtain approval from, state regulatory agencies before changing a water treatment process (U.S. EPA 2006). As the U.S. EPA noted, if a water system notifies the state after changes have already been made, there may be little or no opportunity to minimize any corrosion problems to prevent lead from leaching from plumbing components. We

suggest the use of housing age as a simple metric for states to use in designing a water monitoring program, and expanding blood lead screening in advance of changes in water treatment practices.

Weintraub states that our recommendations “to exclude certain children” based on water disinfection practices could have “substantial unintended impacts.” This is a misrepresentation of our recommendations. Based on the Wayne County results (and those in Washington, Greenville, and Durham), we recommended that local health departments expand their scope of targeted screening in the years following the introduction of chloramines as a supplement to, not a replacement of, existing programs that are in place to provide blood lead screening services to children at risk of lead exposure. We also suggested that health departments might target more intensive outreach and education to residents of older housing, a strategy that would help focus

limited resources on residences where additional lead sources may also be present.

Our recommendations are consistent with the U.S. EPA’s rationale for revising the Lead and Copper Rule to require advance notification of water treatment changes, and with recommendations by water chemistry experts to closely monitor water lead levels after changing to chloramines for disinfection.

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