Health Consultation

Evaluation of Concerns Regarding Elevated Blood Lead
Levels and Contaminated Water in a Children's
Wading Pool

RANDOLPH, NORFOLK COUNTY, MASSACHUSETTS

Prepared by the
Massachusetts Department of Public Health

March 16, 2010

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

Evaluation of Concerns Regarding Elevated Blood Lead Levels and Contaminated Water in a Children's Wading Pool

RANDOLPH, NORFOLK COUNTY, MASSACHUSETTS

Prepared By:

Massachusetts Department of Public Health Bureau of Environmental Health
Environmental Toxicology Program
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

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SUMMARY

Introduction:	ATSDR/MDPH aims to provide families with the best information possible on any public health concerns associated with lead in the environment and children's health. This health consultation was conducted because a family residing in Randolph, MA contacted the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH), with concerns about their children's blood lead levels (BLLs) identified through routine screening by their pediatrician (20 and 24 µg/dL).
Conclusion:	ATSDR would conclude that children accidentally swallowing lead contaminated water from the family's wading pool over a 2-3 week period may have harmed children's health because of the high lead concentration in pool water and elevated BLLs. This presented an urgent public health hazard during the 2-3 week period. Current and future accidental swallowing of water while playing in the pool will not likely result in harmful effects because the pool water was emptied out, the source of lead removed and fresh water supplied. MDPH concludes that given that the likely source of lead was eliminated, and exposures were short-term, it is unlikely that long term harmful effects would be expected.
Basis for Decision:	An MDPH/BEH Childhood Lead Poisoning Prevention (CLPPP) inspector collected environmental samples from the children's residence (i.e. drinking water, pool water and residential soil) to evaluate potential sources of lead in the children's environment. Samples were analyzed for lead by the MDPH William A. Hinton State Lab Institute (SLI). Lead was not detected in drinking water samples, and, for the most part, lead concentrations in residential soil were below available guidelines. Lead was measured in the pool water at levels (98,600 ppb) several orders of magnitude greater than the EPA drinking water action level for lead (15 ppb), prompting further evaluation . The source of the lead contamination in the pool water, leaded scuba weights used to hold down the filter lines, was identified on scene via XRF screening by the inspector. The inspector immediately advised removal of the lead weights and that the pool water be emptied and replaced with clean water. Using a model (the U.S. EPA Integrated Exposure Uptake and Biokinetic Model for Lead in Children, or IEUBK) that takes information on environmental concentration and estimates resulting BLLs in children, MDPH determined that the lead contaminated pool water was the likely source of the children's elevated BLLs.

Next Steps:	❖ The pool was immediately emptied, scuba weights discarded, the pool was thoroughly cleaned and refilled with clean water. ❖ The MDPH will continue to monitor the children's BLLs through follow up testing conducted by their pediatrician and through routine screening conducted by the MDPH/BEH/CLPPP.
For More Information:	If you have concerns about your health, you should contact your health care provider. You may also call MDPH at 617-624-5757 and ask for information on Lead Exposure.

I. Introduction/Background

A family living in Randolph, MA contacted the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH), Childhood Lead Poisoning Prevention Program (CLPPP), in August of 2009 because two of their three children, ages 3 and 5 ½, had recent blood lead level measurements much higher than previous tests indicated. Specifically, blood samples collected on August 10-11, 2009, resulted in venous blood lead levels (BLLs) of 20 µg/dL for the 3 year old and 24 µg/dL for the 5 ½ year old. Previous BLLs in these children, taken on August 21, 2008 for the 3 year old and October 11, 2006 for the 5 ½ year old show venous BLLs of 1 µg/dL and 2 µg/dL, respectively.

In response, an MDPH/BEH/CLPPP inspector went out to the children's residence to evaluate possible sources of lead in the children's environment. While at the residence, it was discovered that a lead weighted scuba belt was being used to hold down filter lines in the children's outdoor wading pool (the presence of lead in the weights was confirmed by the inspector on site using XRF). Upon inspection, the lead weights crumbled. The children's pool was an inflatable above ground wading pool, approximately 2-3 feet high, 7 feet long, and 4 feet wide. The scuba weights were put in the pool in approximately mid-July, and the water had been completely changed out (pool dumped and refilled) about 2-3 weeks before the CLPPP inspection. The family was advised not to continue use of the pool at that time. A sample of pool water was collected for lead analysis.

In addition to taking the pool water sample, the MDPH CLPPP inspector collected drinking water and soil samples at the children's residence. According to records in the town of Randolph assessor's office that were accessed by CLPPP staff, the family residence was built in 1996 on a lot containing another house that was previously torn down. Since the current house was built in 1996, no paint samples were taken from the residence. [Note: in 1978 paint manufacturers were no longer allowed to use lead in residential paint.] The family has lived at this residence approximately 5 years.

All environmental samples were brought to the MDPH William A. Hinton State Lab Institute (SLI) for analysis. The MDPH/BEH Environmental Toxicology Program (ETP) assisted the BEH/CLPPP in the interpretation of the lab results for the environmental samples in the context of potential exposure and to determine whether these media might be a likely source of the children's elevated (BLLs).

III. Review of Environmental Sampling Data

Methods for screening chemical concentration data in environmental media

Health assessors use a variety of health-based screening values, called comparison values (CVs), to help decide whether compounds detected at a site might need further evaluation. These comparison values include ATSDR Environmental Media Evaluation Guides (EMEGs), Reference Dose Media Evaluation Guides (RMEGs), and Cancer Risk Evaluation Guides (CREGs). When ATSDR CVs are not available, EPA Risk Based Concentrations (RBCs) can be used. These values have been scientifically peer-reviewed or derived from scientifically peer-reviewed values and published by ATSDR and/or U.S. EPA. EMEG, RMEG and RBCs values are used to evaluate the potential for non-cancer health effects. CREG values provide information on the potential for carcinogenic effects.

If the concentration of a compound exceeds its comparison value, adverse health effects are not necessarily expected. Rather, these comparison values help in selecting compounds for further consideration. For example, if the concentration of a chemical in a medium (e.g., soil) is greater than the EMEG for that medium, the potential for exposure to the compound should be further evaluated for the specific situation to determine whether non-cancer health effects might be possible. Conversely, if the concentration is less than the EMEG, it is unlikely that exposure would result in non-cancer health effects. EMEG values are derived for different durations of exposure according to ATSDR's guidelines. Acute EMEGs correspond to exposures lasting 14 days or less. Intermediate EMEGs correspond to exposures lasting longer than 14 days to less than one year. Chronic EMEGs correspond to exposures lasting one year or longer. CREG values are derived assuming a lifetime duration of exposure. RMEG values also assume chronic exposures. All of the comparison values are derived assuming opportunities for exposure in a residential setting.

While no ATSDR comparison value or EPA RBC level is available for lead in water, the EPA has set an action level for lead in public drinking water supplies at 15 parts per billion (ppb), equivalent to 15 µg/L (40 CFR Part 141 Lead and Copper Rule). The action level for lead was set at 15 ppb because EPA established that this was the lowest level reasonably and technologically feasible for water systems to control.

In addition, no ATSDR comparison value or EPA RBC level is available for lead in soil. However, recently published Regional Screening Levels for Chemical Contaminants at Superfund Sites developed by Oak Ridge National Laboratory (ORNL) under an interagency agreement with U.S. EPA lists a screening level for lead in residential soils of 400 ppm (ORNL, 2008). This screening level is equivalent to the U.S. EPA hazard standard[1] for residential soil (U.S. EPA, 2001). This hazard standard is derived to protect 95% of similarly exposed children in a population predicting a blood lead level not exceeding the U.S. Centers for Disease Control and Prevention's (CDC) level of concern of 10 µg/dL. The Massachusetts Department of Environmental Protection (MDEP) has set a soil standard for lead at 300 ppm under the Massachusetts Contingency Plan (MCP), Massachusetts General Law Chapter 21E (M.G.L. c.21E). However, residential properties are considered exempt from the requirements under 21E for lead in soil as long as the soil is not removed from the property (Millie Garcia-Serrano, Deputy Regional Director, Southeast Regional Office, MDEP Bureau of Waste Site Cleanup, written communication, November 25, 2008; and Jay Naparstek, MDEP, personal communication, September 29, 2009).

[1] The EPA risk reduction goal for contaminated sites is to limit the probability of a child's blood lead concentration exceeding 10 µg/dL to 5% or less after cleanup (U.S. EPA, 2007).

In addition, many metals occur naturally in soils throughout the U.S. or have accumulated through human activities over the decades and centuries. Typical background levels are reported in the literature, including those reported by ATSDR toxicological profiles, the U.S. Geological Service (USGS) and the MDEP for Massachusetts. For example, the USGS reports typical background lead levels in eastern U.S. soils ranging from <10 ppm to 300 ppm (Shacklette and Boerngen, 1984).

<u>Soil</u>

A total of 4 soil samples were taken from the residence, 2 from an "old" soil mound on the property that had collected for a number of years, and 2 from "new" soil recently delivered to the property to even out the soil in the backyard. The samples were collected and submitted to SLI with intact chain of custody on 8/17/09. Soil was analyzed using microwave digestion followed by flame atomic absorption spectroscopy (FAAS) and results were 300.1 parts per million (ppm) and 182.4 ppm, for the old soil mound samples, and 125.0 ppm and 131.4 ppm for the new soil samples, respectively. These soil levels are below the U.S. EPA screening level for lead in residential soils (400 ppm) and consistent with typical background ranges.

<u>Drinking Water</u>

Tap water samples were taken from the residence, consisting of the three 1000 mL samples collected over time: a first draw of standing water (0 minutes), a second draw of running water (2 minutes), and a third draw of running water (5 minutes). Water samples were collected and submitted to the state lab with intact chain of custody on 8/17/09 and analyzed by acid extraction followed by graphite furnace atomic absorption spectroscopy. All three samples were ND for lead (detection limit of 0.67 ppb). The EPA action level for lead in drinking water is 15 parts per billion (ppb), equivalent to 15 µg/L (40 CFR Part 141 Lead and Copper Rule).

Pool Water

A single pool water sample was collected on 8/17/09 and submitted to the state lab with intact chain of custody. The lead analysis for the water sample was performed by FAAS, and results indicated a lead concentration of 98.6 ppm (mg/L), or 98,600 ppb, several orders of magnitude above the EPA action level for drinking water of 15 ppb.

IV. Evaluation of potential exposure pathways

Pathway analysis

The pathway analysis consists of five elements: a source of contamination, transport through an environmental medium, a point of exposure, a route of human exposure, and a receptor population.

Exposure to a chemical must first occur before any adverse health effects can result. Five conditions must be met for exposure to occur. First, there must be a source of that chemical. Second, a medium (e.g., water) must be contaminated by either the source or by chemicals transported away from the source. Third, there must be a location where a person can potentially contact the contaminated medium. Fourth, there must be a means by which the contaminated medium could enter a person's body (e.g., ingestion). Finally, someone must actually come in contact the chemical (ATSDR, 2005).

A completed exposure pathway exists when all of the above five elements are present. A potential exposure pathway exists when one or more of the five elements is missing and indicates that exposure to a contaminant could have occurred in the past, could be occurring in the present, or could occur in the future. An exposure pathway can be eliminated if at least one of the five elements is missing and will not likely be present.

Completed exposure pathway

A completed exposure pathway existed in the past for ingestion of lead contaminated pool water by children in this family. The source of the lead was likely the leaded scuba weights used to hold down filter lines in the children's wading pool. Water, the medium, was likely contaminated by the deteriorating leaded scuba weights. During play, a child could have ingested the contaminated pool water which would've been absorbed by the child's GI tract.

Eliminated exposure pathways

It is worthwhile to note that dermal absorption of lead in water is not a significant exposure route.

Because lead was not detected in the drinking water samples and soil concentrations of lead were below available guidelines and consistent with background levels, there are no completed pathways for soil or drinking water.

Current and future exposure pathways do not exist to pool water because the pool was immediately emptied, scuba weights discarded, the pool was thoroughly cleaned, and refilled with clean water.

V. Discussion

Because no MRL or RfD is available for lead, to evaluate the potential for health effects a pharmacokinetic model is used and is discussed further, below.

IEUBK model

Young children less than six years old are the most sensitive population with regard to exposure to lead because of their greater hand-to-mouth activity, greater absorption of lead into their bodies, and greater sensitivity to lead exposures. In humans, the main target for lead toxicity is the nervous system. Lead exposure is of greatest concern for young children because children exposed to lead, primarily due to the presence of lead paint in houses built before 1978, may experience neurological damage (including learning disabilities) and behavioral changes. The U.S. Centers for Disease Control and Prevention (CDC) define BLLs over 10 µg/dL as a level of concern for children ages 7 and younger. While BLLs above 10 µg/dL are considered elevated, some studies have reported neurobehavioral effects in children associated with BLLs below 10 µg/dL (ATSDR, 2007).

Exposure opportunities to lead for young children are assessed using the U.S. EPA Integrated Exposure Uptake and Biokinetic Model for Lead in Children (IEUBK) (U.S. EPA, 2009). This model combines physiologically based assumptions (e.g., the relationship between lead uptake and blood lead levels) along with exposure assumptions (e.g., daily amount of water ingestion) to predict blood lead concentrations in young children exposed to lead from several sources and by several routes. The model mathematically and statistically links environmental lead exposure to blood lead concentrations for a population of children (0-84 months).

The IEUBK model is designed to evaluate exposures lasting over 90 days, therefore, in evaluating exposure in this case where the pool was in use for less than 3 months, U.S. EPA recommended that a 90 day exposure scenario for acute exposure to lead in pool water be used in this analysis (personal communication with Mark Follansbee, U.S. EPA Technical Review Workgroup, 9/1/09). U.S. EPA cautioned that using IEUBK this way to evaluate acute exposure scenarios may yield results that are highly variable, however, the model may be used as a rough screening tool to evaluate the likelihood of an alternate source (i.e. pool water) contributing to the children's measured BLLs.

Based on the worst case exposure scenario reported by the family, an estimated daily lead concentration ingested by the children playing in the contaminated pool water was calculated (see Appendix B for calculations), and the IEUBK model was used to predict geometric mean BLLs. For 3-4 year old children, the IEUBK model predicted a worst case geometric mean BLL of 61 µg/dL, meaning that more than 99% of similarly exposed children would be expected to have BLLs of 10 µg/dL or greater. For 5-6 year old children, the IEUBK model predicted a worst case geometric mean BLL of 56 µg/dL, and again more than 99% of similarly exposed children would be expected to have BLLs of 10 µg/dL or greater. While it is clear that exposure to lead concentrations in pool water at these levels could result in BLLs at least as high as those reported here (20 and 24 µg/dL), the IEUBK results should be viewed qualitatively due to the instability of predicted BLLs at exposures of less than 90 day duration and that the model has not been empirically validated to evaluate exposures resulting in BLLs greater than 30 µg/dL. The model is used in this instance to provide additional qualitative information that exposure to lead in the pool water likely contributed to the observed BLLs.

It should be noted that a third child, a twin of the 5 ½ year old child, was screened on August 7, 2009, and did not test with an elevated BLL (capillary level of 8 µg/dL; no venous re-test because level was below 10 µg/dL). The family reported that this child typically does not play in the pool, lending further support to the likelihood of pool water as the source of the elevated BLLs. Follow up BLL testing should show decreased BLLs since the identified source of lead exposure (i.e. contaminated pool water) has been removed. In addition, the 3 and 5 ½ year old children were being treated by their pediatrician with iron supplements to block lead absorption and help bring down BLLs. Tests conducted in September 2009 indicate that the children's BLLs are declining: capillary test results for both the 3-4 year old and the 5 ½ year old were 11 µg/dL, measured on 9/18/09 and 9/11/09, respectively. Thus, the children's BLLs were unlikely to have been elevated more than 6-8 weeks, i.e., from the start of contamination/exposure to the September BLL testing. Health effects reported in the literature are based on persistent elevated BLLs or based on associations found in studies lacking information on how long BLLs have been elevated. Thus, given the short exposure period and prompt reduction in BLLs for both children, it is unlikely that long-term health effects would be manifested. The family should continue to work with the pediatrician to monitor BLLs or other health concerns.

VI. Conclusion

ATSDR requires that overarching conclusion category statements be used to summarize the findings of a health consultation. Conclusion category statements are selected from site-specific conditions such as the degree of public health hazard based on the presence and duration of human exposure, contaminant concentration, the nature of toxic effects associated with site-related contaminants, the presence of physical hazards, and community health concerns.

Therefore, based on MDPH's evaluation of the available environmental data (i.e. soil, drinking water, and pool water), health outcome data (i.e. BLLs), and the exposure pathway analysis, ATSDR would conclude that:

- incidental ingestion of lead contaminated pool water while playing in the pool between mid-July 2009 and early August 2009 could have harmed children's health. This presented an urgent public health hazard over the 2-3 weeks between mid-July and early August.

However, MDPH concludes that given the short duration of exposure and prompt reduction in BLLs, it is unlikely that long term harmful effects would be expected.

ATSDR would conclude that incidental ingestion of pool water while swimming and playing currently and in the future will not likely result in harmful effects. This conclusion is based on the leaded scuba weights being discarded immediately after the contaminated pool water was sampled, and the pool was thoroughly cleaned and water completely changed out before re-use by the children.

VII. Recommendations

- MDPH recommends continued monitoring of the children's BLLs through follow up testing conducted by the children's pediatrician and through screening conducted by the MDPH/BEH CLPPP.

VIII. Public health action plan

The Public Health Action Plan contains a description of actions to be taken by the ATSDR and/or the MDPH subsequent to completion of this health consultation. The purpose of the Public Health Action Plan is to ensure that this health consultation not only identifies public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. Included is a commitment on the part of the ATSDR/MDPH to follow up on this plan to ensure that it is implemented.

The public health actions that have been implemented by MDPH are as follows:

The source of the lead contamination in the pool water (i.e. leaded scuba weights) was identified by an MDPH CLPPP inspector on the scene via an XRF screen and, therefore, the weights were removed immediately from the pool. The pool was thoroughly cleaned and water completely changed out before re-use by the children. As reported by the family, the children are currently being treated by their pediatrician with liquid iron supplements to help bring down BLLs. Follow up testing in September 2009 indicates that the children's BLLs are declining (both children re-tested had capillary levels of 11 µg/dL, down from venous levels of 20 and 24 µg/dL in August 2009 for the 3-4 and 5 ½ year olds, respectively).

Public health actions that will be implemented include:

MDPH will continue to monitor the children's BLLs through follow up testing conducted by the children's pediatrician and through screening conducted by the MDPH/BEH CLPPP.

VIX. References

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PREPARER

This document was prepared by the Bureau of Environmental Health of the Massachusetts Department of Public Health. If you have any questions about this document, please contact Suzanne K. Condon, Bureau Director of BEH/MDPH at 250 Washington Street, 7th Floor, Boston, MA 02108.

CERTIFICATION

The Health Consultation, *Evaluation of Concerns Regarding Elevated Blood Lead Levels and Contaminated Water in a Children's Wading Pool, Randolph, Norfolk County, Massachusetts*, was prepared by the Massachusetts Department of Public Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the Health Consultation was initiated. Editorial review was completed by the cooperative agreement partner.

Technical Project Officer, CAT, CAPEB, DHAC, ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this Public Health Assessment and concurs with its findings.

for Greg Ulirsch

Team Lead, CAT, CAPEB, DHAC, ATSDR

Appendix:

A: Exposure Calculations

Exposure assumptions used to calculate the concentration to input into the IEUBK model were based on exposure information reported to MDPH: two of the children, ages 3 and 5 ½, played in the pool for approximately 2-3 hours per day for 3-4 days per week. Reportedly, the third child, the 5 ½ year old twin, typically does not play in the pool.

U.S. EPA recommended that MDPH input the daily ingestion rate of the lead contaminated pool water in the alternate source field of the IEUBK model rather than as a percent of daily drinking water intake (personal communication with Mark Follansbee, U.S. EPA Technical Review Workgroup, 9/1/09). U.S. EPA also recommended that MDPH set the bioavailability of the alternate source (i.e. pool water) at 50% (the same as drinking water) using the intake rate by children of water from swimming (50 mL/hour) listed in the updated EPA Child Specific Exposure Factors Handbook (2008).

Based on the conservative exposure estimate of 3 hours in the pool per day for 4 days per week (worst case exposure reported to MDPH), and using a 90 day exposure scenario averaged over a year, daily lead intake was calculated and added as an input (in the alternative source field) at 50% bioavailability in the IEUBK model. The following is the calculation:

(98.6 mg/L)(0.150 L/day)(4 days/7 days)(90 days/year)(1 year/365 days)(1000 µg/mg) =

2084 µg / day

Based on an exposure estimate of 2 hours in the pool per day for 3 days per week (the minimum exposure reported to MDPH), and using a 90 day exposure scenario averaged over a year, daily lead intake was calculated and added as an input (in the alternative source field) at 50% bioavailability in the IEUBK model. The following is the calculation:

(98.6 mg/L)(0.1 L/day)(3 days /7 days)(90 days/year)(1 year/365 days)(1000 µg/mg) =

1042 µg/day

All other inputs to IEUBK were left at the following default values:

Outdoor soil lead concentration: 200 µg/g
Outdoor air Pb concentration: 0.1 µg/m3
Lead concentration in drinking water: 4 µg/L
Dietary lead intake (3-4 year old): 2.04 µg/day
Dietary lead intake (5-6 year old): 2.05 µg/day