Conducting Environmental Sampling

Training module provided by the U.S. Centers for Disease Control and Prevention.

Outline

- Why include environmental lead sampling in lead prevalence studies?
- Examples of data that environmental lead sampling can provide
- How to do environmental lead sampling

Why do environmental sampling?

- Collection of air, water, soil and dust characterizes the sources of lead in the environment.
- It can be a component of a lead exposure prevalence study.
- It can allow comparison to local and international standards.
    - NB many of these standards (e.g. the U.S. Environmental Protection Agency action level for water of 15 parts per billion [ppb]) are pragmatic, meaning they can be reached using good lead control techniques, rather than being health-based. A health-based standard would establish a 'safe' level of exposure and this has not been identified for lead.

Many sources of lead can contribute to blood lead levels

- Gasoline (no longer a major source in most countries)
- Battery recycling
- Consumer products
- Some traditional medicines
- Unregulated or cottage industries
- Electronic waste, child labor
- Localized sources such as mines/smelters
- Lead paint

Ref C.iv.1

Instructor Note: Environmental sampling can be used to identify the major sources of lead in a child's environment and direct remediation efforts

What can environmental lead sampling tell you?

- Location of areas of lead contamination, enabling mapping of areas of high and low lead concentrations
    - Helps identify source(s) of exposure in population known to have high blood lead levels.
    - Identifies at-risk populations who should have blood lead levels checked.
    - Provides exposed populations with measures to reduce or stop exposure.
- Data can be used to direct and evaluate remediation efforts.

Initial procedures - outline

The next few sections describe the following issues:

- Important factors to consider
- Sampling form
- Labels

Important factors

- Talk to community members/heads of households to find out about likely areas of environmental contamination and of exposure; use this information to guide the sampling strategy.
- Randomly select households/sampling sites.
    - Calculate the sample size needed and use a simple randomization strategy to select households/sites where environmental media will be collected.
- Be sure to take a GPS reading at every participating household and wherever soil is sampled. Note the coordinates on the sampling form.
    - Provides data for mapping—helps to identify commonalities in geographic area of interest.
- Be sure the person responsible for environmental sampling has the correct labels by household enrollment number and knows where to place labels and which sample collection containers to use.
- Identify the areas to be sampled:
    - Painted surfaces e.g. walls, window frames.
    - Dust wipe areas (near entrance to home, child's play area, child's sleeping area, window frames).
    - Water samples (water storage vessel, tap, well).
    - Soil sample (bare soil where child plays).
- Write the sample identification (ID No.) and any notes on the sample collection form.

Sampling form – typical data fields

(Place sampling form label here)

Lead Prevalence Site – Sampling Form

Study Area Segment #: _____ **Date and Time** _____ **Team Members:** _____

GPS Coordinates at home entrance: S _____ ; E _____

	Dust Samples			Water Sample	Soil Sample
	Floor Near Front Door	Child's Sleeping Area	Floor Where Child Plays	Bottle / Tap	Composite Soil Sample
Sample ID					GPS Coordinates: S E
Floor Sample Surface (dirt, concrete, etc.)					
Floor Sample Surface Area (cm^2)					
Notes					

Instructor Note: Go over each of the boxes on the table

Labels are essential

- Each data source has a corresponding label. It is very important to attach the appropriate label to the correct data source.
- A typical set of labels is as follows:
  - Consent-C
  - Child Questionnaire—CQ
  - Household Questionnaire—HQ
  - Dust Floor—DF-1 (Front Entrance)
  - Dust Floor—DF-1 (Child's Sleeping Area
  - Dust Window—DW (Child's Sleeping Area)
  - Blood Sample—B
  - Soil—SO
  - Water—W
  - Environmental Sampling Form—ES
  - Extra 1—X1
  - Extra 2—X2

Instructor Note: A sample without a label is a wasted sample.

Labels are computer generated, bar coded sticky labels.

Labels connect environmental samples to the child who had the blood lead test.

Sample collection - outline

The next few sections describe how to carry out the following procedures:

- Paint analysis
- Water sampling
- Dust wipe sampling
- Soil sampling

Paint analysis

- Paint analysis can be done in-situ using portable x-ray fluorescence analyzer (XRF).
- Confirm XRF testing by sending duplicate samples (10%–15% of total) to a laboratory with the necessary proficiencies.
- Training in the use of XRF devices is essential.
- For further details about paint analysis, see Module C.ii.

Portable XRF

Instructor Note: Picture from Niton the manufacturer. Transporting XRF instruments across international boundaries may require additional approvals because of the cobalt source in the instrument.

Water sampling - supplies

The following items are needed:

- Gloves
- Water ID label
- 125-mL collection container
- Environmental sampling form

Water sampling - procedure

- If collecting multiple sample types, collect the water sample first and use the same gloves for the dust and soil sampling.
    - Levels of lead contamination in water are far lower than in dust/soil so cross-contamination is unlikely.
- Take the water sample from the source that the family is using for drinking/cooking.

Procedure:

- Place label on sampling container.
- Put on gloves.
- Fill the sample container with water from source.
- Seal the container.

> Instructor Note: Collect a grab sample from the water source the family is using for cooking and drinking on the day of your visit.
>
> For the purposes of a prevalence study, a grab sample can provide some useful information about lead in water. Water sampling for regulatory purposes is much more complex and beyond the scope of a prevalence study.

Dust wipe sampling - supplies

The following items are needed:

- Gloves (use gloves from the water sampling effort)
- Dust ID labels
- Sampling wipes
- Ruler or template (can be reused for each sampling frame)
- Sample container
- Baby wipe for dust sampling
- Rubbish bag

Dust wipe sampling – getting started

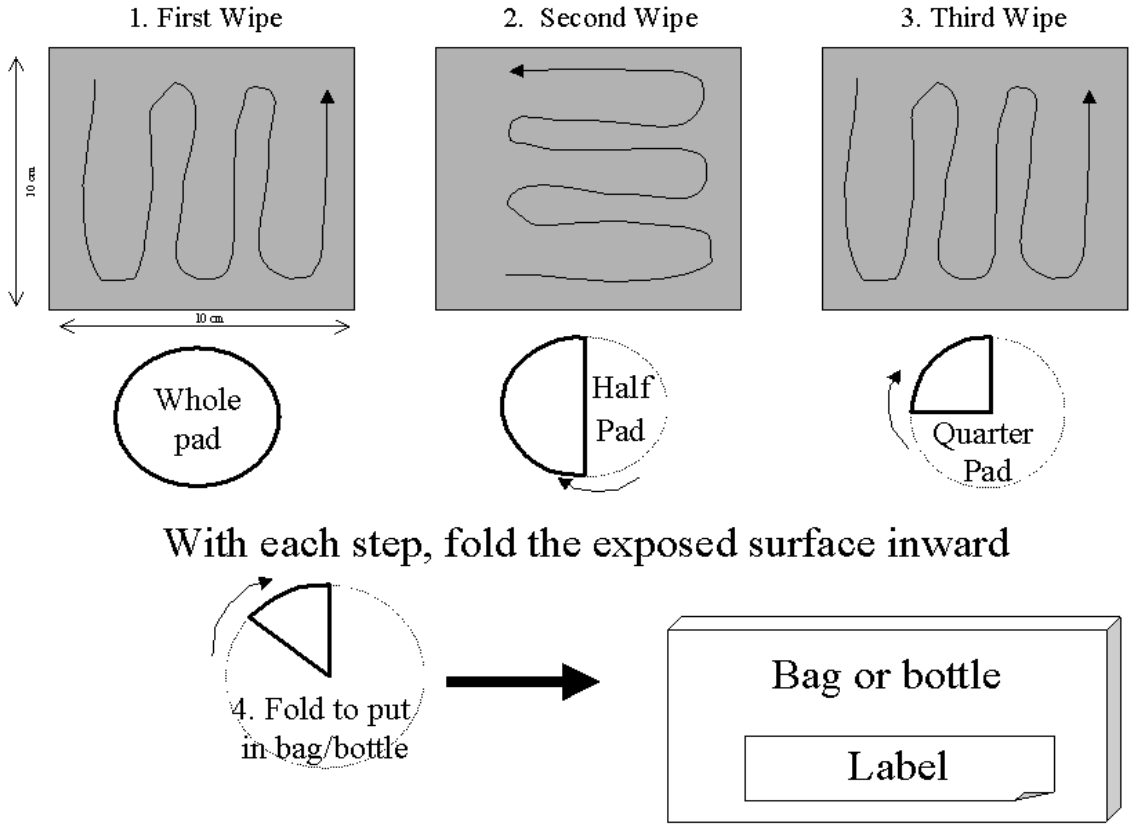
- Keep gloves on from the water sampling effort.
- Place 'DUST' label on sampling containers.
- Identify floor location near the entrance and the floor area where the child plays. Identify window near to area where child sleeps.
- Clear large debris from the sampling area before beginning the sampling. DO NOT clean the area before sampling.

Dust wipe sampling – floor wipe procedure

- If the entrance and play area locations are covered with fixed carpet/matting, choose an alternative area with a hard surface (e.g., wood floor, concrete, linoleum) and note the location on the sampling form. If there is a door mat, remove the mat and sample under it.
- Measure a 10-cm x 10-cm (100 cm^2) space with ruler for each floor location.
- Remove wipe from packet and obtain the sample as indicated in the Wipe Schematic section below. Use one wipe for the sample near the door and one wipe for the sample in the area where the child plays.
- Place each wipe into separate sample containers with separate labels.
- Fill in the sampling form.

Dust wipe sampling - schematic

The diagram below describes the procedure for taking a dust wipe sample. The procedure is the same regardless of the surface being sampled floor, window, etc.)



Soil sampling - supplies

The following items are needed:

- Gloves
- Soil ID label
- Sample scoop
- Large sealable bag (e.g., 4 liters/1 gallon)
- Rubbish bag

Soil sampling – getting started

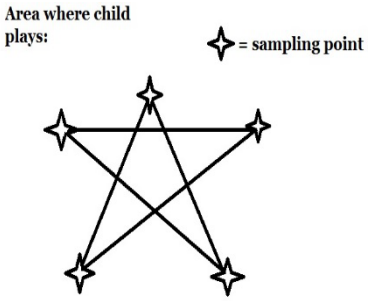
- Identify the area outside where children play (ask the parent or guardian).
- Sample only from areas that are not covered by grass—the area should be bare soil.
- Place soil sample label on sample bag.
- Put on gloves (or keep on gloves from water and dust sampling).

Soil sampling - procedure

- Take five discrete samples—take the sample from the top 1–1.5 cm (½ inch) of soil using the disposable scoop. (See next section for sampling schematic.)
- Put all five samples in the sample bag, filling the bag by at least a third, and manipulate it to mix the samples.
- Put the gloves in the rubbish bag.
- Fill in the sample form and note the GPS location of the soil sample.

Soil sampling schematic

- Composite sampling example (taken in the middle of the play area; 2- to 3-meter distance between points):



Instructor Note: Shipping soil samples across international boundaries may require additional forms from the laboratory and certification that the lab can irradiate the samples before they are opened to prevent introducing plant diseases or pests.

Air sample collection process

General Steps in collecting a particulate sample:

- Filter preparation: Filter is equilibrated (conditioned) to a specified temperature and pressure and then weighed before being sent to the field for sampling [typically done by an environmental laboratory].
- Filter transported to site.
- Filter placed in sampler inlet. Sample is run at specified date, time, and duration.
- Filter recovered from sampler, total flow of sample recorded from sampler. Sample is transported to lab (or location to be weighed).

Air sampling: Other issues to consider

- Filter preparation and laboratory liaison
- Impactor preparation
- Power outlets
- Ambient moisture
- Security of instrument
- Returning rented equipment

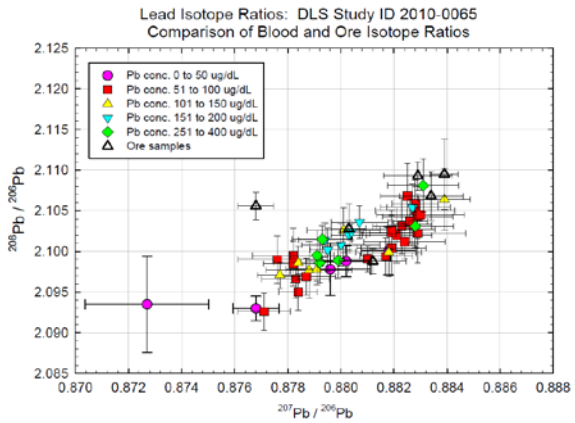
Instructor Note: The manufacturer will provide detailed written instructions and/or hands-on training. It is important to consider these other issues when placing and using the equipment. If the power supply cannot be assured, battery operated models are available. However, transport of lead acid batteries may be complicated across international boundaries. Make sure you can get them back!

Final steps

- Place all environmental samples together in one bag when completed.
- Take and record GPS points at each home and each soil sampling location. Record these points on the sampling form.
- Record sample IDs and any notes on the sampling form. Place a label on the sampling form as well.
- Make sure all samples are appropriately labeled.

Use of lead isotope ratios

- Four main isotopes of lead are 208, 206, 207, 204.
- Ratio of the isotopes varies by the source of the ore.
- Isotope ratio of soils represents mixing of lead from various ores used in gasoline, consumer products, and smelting.
- If isotope ratio in a lead source and in blood can be characterized, then this can be useful 'fingerprinting' of environmental pollution.



Reference C.iv.2

Instructor Note: This graph demonstrates that children with high blood lead levels in Nigeria, clustered to the right of the graph, have been exposed to soil samples with very similar isotope patterns. A field team member provided the sample to the left of the graph which indicates that this individual has not been exposed to this particular source of lead.

Laboratory quality control considerations

- Important that analytical results are reliable.
- Laboratory should have in place adequate quality assurance measures, for example
  - Standard operating procedures.
  - Documented training and monitoring of staff performance.
  - Use of certified reference standards.
  - Internal quality control procedures—daily checks of analytical accuracy.
  - Participation in external quality control programs.

Standard methods for sample analysis

Water sample analysis

- EPA Method 200.8
- https://www.nemi.gov/methods/method_summary/4665/

Dust and soil sample analysis

- EPA Method 6020
- https://www.nemi.gov/methods/method_summary/9186/

Air sample analysis

- Federal Reference Method – Appendix G to 40 CFR 50
- http://www.ecfr.gov/cgi-bin/text-idx?SID=e61b74afdf65ac8285dcb7c5fe874a06&mc=true&node=ap40.2.50_119.g&rgn=div9

Conclusions

Population based prevalence studies can

- Identify significant sources/new sources of lead in children's environments.
- Provide scientifically reliable estimates of environmental contamination and blood lead levels.

References

C.iv.1. Meyer PA, Brown MJ, Falk H. 2008. Global approach to reducing lead exposure and poisoning. Mutat Res 659(1–2):166–75.

C.iv.2. Komárek M, Ettler V, Chrastný V, Mihaljevic M. 2008. Lead isotopes in environmental sciences: A review. Environ Int 34(4):562–77.

C.iv.3. U.S. Centers for Disease Control and Prevention. Unpublished data.

C.iv.4. U.S. Environmental Protection Agency. 2001. Identifying lead hazards in residential properties. EPA 747-F-01-002. Available at URL: http://www.epa.gov/sites/production/files/documents/403fs01.pdf [accessed 2016 Aug 4].

Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Points of contact

Mary Jean Brown, ScD, RN. Chief, Healthy Homes and Lead Poisoning Prevention Program, Centers for Disease Control and Prevention (CDC)

Henry Falk, MD, MPH. Consultant, Office of Noncommunicable Disease, Injury and Environmental Health, CDC

Centers for Disease Control and Prevention, 4770 Buford Highway, NE, MS F60, Atlanta, GA 30341, USA