Heavy metal concentrations, stable lead (Pb) isotope ratios and variation of selected biomarkers in human milk, hair, blood, urine and fecal samples from the vicinity of the lead-zinc mine in Kabwe, Zambia

Output 2 - Activity Report and Future Plan
By YABE John – Research Manager

Collaborative research between the University of Zambia and Hokkaido University (Japan)
Funding: JICA and JST
Duration: 2016-2020
Site: Kabwe City, Central Province, Zambia
Lead metabolism and critical BLLS

Lead Exposure Route

- Ingestion
- Inhalation

Circulates in blood (35 days) and excreted in feces and urine

Accumulates in soft tissues and bone

Clinical signs/symptoms are non specific
Clinical diagnosis of lead poisoning is difficulty

Blood Lead Levels (BLLs)

<table>
<thead>
<tr>
<th>Children</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Death</td>
<td>150</td>
</tr>
<tr>
<td>Encephalopathy</td>
<td>Nephropathy</td>
</tr>
<tr>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Frank Anemia</td>
<td>Male Reproductive Effects</td>
</tr>
<tr>
<td>50</td>
<td>Female Reproductive Effects</td>
</tr>
<tr>
<td>40</td>
<td>Elevatd Blood Pressure</td>
</tr>
<tr>
<td>30</td>
<td>Erythrocyte Protoporphyrin (men)</td>
</tr>
<tr>
<td>20</td>
<td>Erythrocyte Protoporphyrin (women)</td>
</tr>
<tr>
<td>10</td>
<td>Developmental Toxicity</td>
</tr>
<tr>
<td>5</td>
<td>↓ Hemoglobin Synthesis</td>
</tr>
<tr>
<td></td>
<td>↓ Vitamin D Metabolism</td>
</tr>
<tr>
<td></td>
<td>↓ Nerve Conduction Velocity</td>
</tr>
<tr>
<td></td>
<td>↑ Erythrocyte Protoporphyrin</td>
</tr>
<tr>
<td></td>
<td>↓ Vitamin D Metabolism (?)</td>
</tr>
</tbody>
</table>

Chelation therapy
Output Two Objectives

- Measuring blood Pb concentrations in mother (venous and cord blood) and child pairs in Kabwe
- Measuring Pb levels (blood, urine and feces) in children
- Measuring Pb concentrations in breast milk
- Measuring biomarkers to determine the effects of exposure
- Neurodevelopment assessment of Pb exposure in children
- Cognitive assessment – IQ analysis
- Assessing effects of Pb on Quality of Life
- Assess the socio-economical impact of Pb pollution in Kabwe
Blood screening Oct 2016 – Post remediation

Makululu
N = 53

Kasanda
N = 24

Chowa
N = 37

Mining Area Dump Site
BLL measurements – LeadCare II

- 2016 BLLs results in 3 townships
- 114 blood samples (both boys and girls)
- Children up to 10 years old
- BLLs ranged from 7.80 – 64.3 μg/dL
- BLLs exceeded the CDC guideline (5μg/dL)
- Negative correlations between age and BLL
Preparations
- 40 clinics/health centers were sensitized
- Neighborhood Health Volunteers were engaged to mobilize the communities

Health Personnel and Training
- 16 local nurses were contracted
- 4 local laboratory technicians were contracted
- Training on ethical considerations and sampling procedures was conducted

Sampling Teams
- 4 groups

Output Two – Activities (Jan – August 2017)
Blood sampling protocol

**Father & Mother**
- 5 mL with heparin
- Transfer: 1.5 mL × 2 tubes (in 2 mL tube)
- Pb conc. & Isotope analysis
- LeadCare II
  - BLL measurement (using only 50 μL)

**Child above 5 years**
- 5 mL with heparin
- Transfer
- 2 mL of remaining blood
- Centrifuge (4000 rpm, 10 min)
- Plasma Transfer
  - 0.5 mL × 1 tube (in 1.5 mL tube)
  - Blood biochemistry

**Child less than 5 years**
- 2 mL with heparin
- Transfer
- Transfer: 1.5 mL × 1 tubes (in 2 mL tube)
- Pb conc. & Isotope analysis
- LeadCare II
  - BLL measurement (with only 50 μL)
# Samples collected (July – August 2017)

<table>
<thead>
<tr>
<th>Sample Type</th>
<th>300µL blood</th>
<th>1.5 mL</th>
<th>1.5 mL</th>
<th>Plasma</th>
<th>ER</th>
<th>Urine</th>
<th>Fecal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tube Type</td>
<td>2 mL tube</td>
<td>2 mL tube</td>
<td>2 mL tube</td>
<td>1.5 mL tube</td>
<td>1.5 mL tube</td>
<td>15 mL tube</td>
<td>30 mL tube</td>
</tr>
<tr>
<td>Total</td>
<td>1239</td>
<td>1220</td>
<td>1107</td>
<td>1013</td>
<td>1013</td>
<td>1005</td>
<td>393</td>
</tr>
</tbody>
</table>

- BLLs results in 40 areas
  - Minimum - ND
  - Maximum – 162.3 µg/dl
  - Average – 21.8 µg/dl

- Critical levels
  - > 5 µg/dl – 882 (69%)
  - >45 µg/dl – 188 (15%)
  - > 60 µg/dl – 80 (6%)
### On-going and future plans

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
</tr>
</thead>
</table>
| **Sample analysis** | - MTA application for July-August samples to be done  
- Official reports of results is on-going |
| **Neurodevelopment - School of Public Health** | - Children below the age of 3  
- Assessment on-going |
| **Cognitive and IQ assessment - Special Education, School of Ed** | - School going children above the age of 3  
- Assessment still at planning stage |
| **Socio-economic assessment – Economics Department, School of HSS** | - Households have been identified  
- Assessment on-going |
## Achievements and challenges

### Broad surveillance
- Conducted successfully
- BLL measurements done with LeadCare II

### Ethical clearance and MTA
- Expired on 30th August 2017
- Applied for renewal and granted
- MTA application granted for Oct 2016 and Jan-May 2017 samples

### Collaborations
- PureEarth - Obtained 2014 BLL results and using their LeadCare II
- World Bank - Held joint meetings, MOU being drafted

### Challenges
- Sample size – not met during broad surveillance
- Participants expecting treatment and thus affecting response