Lead poisoning from metallic teapots traditionally used
by North African populations

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Abstract. When children are found in Brussels with high blood lead level (PbB), over 200 µg/l, the LICB conducts an environmental study to determine the source of lead responsible for the intoxication. The study consists in filling a risk questionnaire, followed by a family interview and an investigation of the housing. Standard samples of lead sources are collected (dust, paint chips and water). If this first investigation is negative, further investigations are carried out. In one particular case of lead intoxication, which concerned in a family of Moroccan origin, no standard source could be identified. Our case study finally concluded that tea infusions prepared in a traditional North-African metallic teapot had caused lead poisoning. This investigation began with a single intoxication case of a young child (age 18 months, PbB 495 µg/l). However, it quickly appeared that 18 other members of his family had also been contaminated (PbB ranged from 155 to 455 µg/l). Faced with this relative unknown lead hazard, the LICB decided to collect and analyse the leachability and content in lead of this kind of vessel (8 teapots from different origin were tested). The lead contents measured in the metallic teapots ranged from 3.2% to 84%. The lead concentrations found in brewed tea varied from 230 to 5070 µg/l in function of the lead teapot content and of number of daily preparation.

1. INTRODUCTION

A pediatrician from the Brussels “Hospital des Enfants Reine Fabiola” (HUDE) diagnosed a severe lead intoxication (PbB 495 µg/l) in an 18 months-old child of Moroccan origin. Therefore, a systematic blood lead level detection was carried by HUDE for all family members of the intoxicated child. The results showed that 19 individuals, including 6 young children (aged less than 6 years), suffered from various levels of lead poisoning [1]. The LICB performed an environmental assessment of the family home to find the source of lead.

Children absorb up to 50 % of ingested lead (compared to 10 to 20 % for adult) and are more at risk than adults due to their natural hand-to-mouth activity or pica behavior (-ingestion of non-food items). Moreover, children’s developing nervous system is more sensitive to lead and elevated blood lead is, in most cases, asymptomatic or exhibits mild nonspecific symptoms [2]. In 1991, the Centers for Disease Control (USA) proposed as a new guideline a maximum blood lead level for children of 100µg/l [3]. The PbB measured in the other adult family members, although less critical, is relatively high for non-occupational intoxications (a maximum PbB of 339 µg/l was measured).

During the preliminary investigation, which focused on the first intoxicated child, all the standard lead sources (dust, tap water, wall paint chips) were negatively tested. After further discussions with the family, it was concluded that the intoxications were caused by tea infusions brewed in an old, heavy traditional Moroccan teapot. The tea was prepared daily and drank by all the family members, young children included.

Considering the wide and frequent use of this type of contaminated lead vessel, the LICB decided to control the lead levels and the leachability of lead that occurs during the brewing of tea in traditional metallic teapots. Height such teapots were analysed for this study.
2. MATERIALS AND METHODS

2.1 Brewing tea sample preparation

At least 1 infusion was prepared in each teapot. Two different methods were used for preparing tea. In method 1 used for the first two teapots, the infusion was limited to 3 minutes and the volume to 200ml (Table 1). This method is very similar to the one traditionally used in Morocco [4]. This method had to be modified to replicate the standard family preparation. This meant to fill 2/3 of the teapot at least and let the tea infuse for at least 30 minutes. This also allowed for soft soldering, which connect the spout to the teapot body and which is generally very rich in lead, to entirely plunge into the liquid.

Low lead content samples (tap water, some tea infusions) were analysed by graphite furnace Atomic Absorption Spectrophotometry (AAS), Varian SpectrAA 400 with Zeeman-corrected system. Most of the tea infusions were analysed by flame AAS, Varian SpectrAA 10, as were the teapot metal samples (see section 2.2). Tea infusion prepared in a Pyrex beaker has a low lead content (< 5 ppb). The limit of quantification (LOQ) for lead in teapot was in the order of 0.02% and for lead in tea, approximately 100 ppb (flame AAS) and 5 ppb (furnace AAS), respectively. The uncertainty of the results adds up to a maximum of 5%.

All analyses were carried out using external calibration. Standard reference material analyses were used to assess the quality of results, i.e. powdered lead-based paint SRM 2580 and 2581. The laboratory tests were always within the uncertainty of these certified materials.

2.2 Teapot metal samples preparation

Lead concentration of teapot chips was measured using the following method: a small hole is drilled in the lid and the spout (Fig. 1), and then the chips are collected and finely grounded in a small agate mortar. About 50 mg of the powdered chips are reacted with concentrated nitric acid in a 50 ml Pyrex beaker covered with a watch glass and heated overnight to 70°C on an electric plate. After digestion, 15 ml of hot ultra pure water are added to the samples to dissolve any metals precipitates. The samples are analysed by flame AAS, Varian SpectrAA 10.

3. RESULTS AND DISCUSSION

3.1 Tea infusion

If lead could be present in some tea variety, only traces of lead were detected in tea infusion [5]. All measurements of tea infusion prepared in the traditional metallic teapots presented quite high lead contents (from 230 µg/l to 5070 µg/l - Table 1). The lowest result (230 µg/l) is ten times higher than the limit (25 µg/l in 2003) set for drinking water by a recent EU directive [6].

Replication was tested for one teapot (n°4) between in tea infusion and in boiling water (Table 2). Replicates carried out on the same day show a lowering trend in results. However, those carried out on different days give rather stable or higher results. Trends in leakage could originate from an effect of washing off the surface in the different preparation, but no clear explanation can be found for the recovery of lead content after several days. There is a factor of 2 to 5 between lead contents of tea infusions and boiled water samples. For these first results, it is concluded that tea infusions have a possible “chelating” or corrosive effect on the metal, which allows an increased leakage of the lead from the teapots.

The daily tolerable dose recommended by the Joint FAO/WHO Expert Committee on Food Additives is 3.5µg/kg of corporal weight [7]. For a child of 6 kg, the daily intake should not overpass 21 µg of lead. If the child is drinking 0.5 l of tea containing the highest measured concentration (5070 µg/l brewed in a teapot bought in a Moroccan souk) his daily lead intake is 120 times higher than the daily-tolerable dose. It certainly equals, in some cases, a massive ingestion of lead-based paint chips as in cases of children with pica, which is considered as one of the major causes of childhood lead poisoning [8].
These results show that people drinking tea daily from this kind of teapot could suffer from chronic or acute intoxication.

Table 1. Lead results from tea and teapots analyses.

<table>
<thead>
<tr>
<th>Teapot n°</th>
<th>Sample n°</th>
<th>Tea infusion Lead (µg/l)</th>
<th>Teapot spout Lead (%)</th>
<th>Teapot lid Lead (%)</th>
<th>Method for tea infusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.1</td>
<td>2380</td>
<td>71.4</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2.1</td>
<td>722</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>3.1</td>
<td>370</td>
<td>4</td>
<td>3.2</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>4.1</td>
<td>1170</td>
<td>77.9</td>
<td>&lt;0.02</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>5.1</td>
<td>5070</td>
<td>63.2</td>
<td>58.1</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>6.1</td>
<td>3540</td>
<td>83.6</td>
<td>&lt;0.02</td>
<td>2</td>
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<tr>
<td>7</td>
<td>7.1</td>
<td>439</td>
<td>4.2</td>
<td>4.4</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>8.1</td>
<td>594</td>
<td>4.4</td>
<td>4.8</td>
<td>2</td>
</tr>
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</table>

Table 2. Replicates analyses for teapot n°4

<table>
<thead>
<tr>
<th>Sample n°</th>
<th>Tea infusion Lead (µg/l)</th>
<th>Day of Analysis</th>
<th>Method for tea infusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>1170</td>
<td>Day 1</td>
<td>2</td>
</tr>
<tr>
<td>4.2</td>
<td>1007</td>
<td>Day 7</td>
<td>2</td>
</tr>
<tr>
<td>4.3</td>
<td>807</td>
<td>Day 7</td>
<td>2</td>
</tr>
<tr>
<td>4.4</td>
<td>449</td>
<td>Day 7</td>
<td>2</td>
</tr>
<tr>
<td>*4.5</td>
<td>* 245</td>
<td>Day 21</td>
<td>2 - Water</td>
</tr>
<tr>
<td>*4.6</td>
<td>* 195</td>
<td>Day 21</td>
<td>2 - Water</td>
</tr>
<tr>
<td>*4.7</td>
<td>* 163</td>
<td>Day 21</td>
<td>2 - Water</td>
</tr>
<tr>
<td>*4.8</td>
<td>* 572</td>
<td>Day 28</td>
<td>2 - Water</td>
</tr>
</tbody>
</table>

* Boiling water

3.2 Teapot’s spout and lid

The teapot spout and lid metal analyses show two categories of lead content (Table 1 and Fig. 2). The spouts of four teapots (n° 1, 4, 5, 6) have a very high lead content (from 63 % to 84%, Table 1) compared to the relatively lower and more homogeneous lead content in the spouts and lids of teapots n° 3, 7 and 8 (approximately 4 %, Table 1).

Analyzing other metals in teapot n° 3, relatively high concentrations of copper and zinc were found (respectively 47% and 32 %, Table 3). This would seem to indicate that this teapot, and most probably the two others, was made of an alloy of which lead is not the principal component.
Table 3. Lead, Copper, Zinc and Iron results for teapot’s lid n°3.

<table>
<thead>
<tr>
<th></th>
<th>Lead</th>
<th>Copper</th>
<th>Zinc</th>
<th>Iron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tea infusion (µg/l)</td>
<td>370</td>
<td>785</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teapot lid (%)</td>
<td>4.0</td>
<td>47.1</td>
<td>32.1</td>
<td>0.4</td>
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</tbody>
</table>

This type of alloy seems to correspond to most of the teapot tested in a Moroccan study (4) where lead was not measured. The design, the weight or the origin cannot be used to define the lead content. Anyhow, even at 4% of lead content, the leakage in drinks is a source of intoxication that has to be avoided.

4. CONCLUSION

Although an abundant literature is dedicated to the subject of lead intoxication, new sources are still reported. A recent Canadian study revealed that inexpensive children’s jewelries such as necklaces, trinkets and rings, might contain very high lead levels [9].

For this study, the literature search on metallic teapot toxicity yielded only two articles, the first [4] focuses on other metals and the second [10] states that preliminary tests suggested that teapots coming from Morocco and Mauritania could present a serious lead hazard.

It must be pointed out that the present results are based on a relative low sampling and that this draft work needs further research. In any case, whichever teapots and methods are take into account, all tea brewed in these kinds of vessels contain relatively high levels of lead. This should be brought to the attention of all those professionals in contact with young children together within the framework of screening programs.

Acknowledgments

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References