A cross-sectional study of the association between arsenic consumption from private drinking water supplies and measured biological levels in the population of Cornwall, UK

Project Update - June 2014

Background to the study
Between 2011 and 2013, Public Health England (PHE), the British Geological Survey (BGS), with later involvement from the University of Manchester (UoM), worked together on a two-phase sampling programme of private water supplies (PWS) in Cornwall. Results were collected for around 500 households and showed that, in the case of arsenic (As) alone, nearly 6% of drinking-water samples exceeded the 10 µg/L Prescribed Concentration or Value (PCV) as prescribed by the Private Drinking Water Supply Regulations, 2009. These findings, in addition to the well documented high environmental arsenic concentrations in the region, warranted further investigation into the potential uptake of this element by the local population. This is an issue that has long been recognised and investigated previously, however no study has targeted PWS users, a possible vulnerable sub-group. This project will be the largest arsenic biomonitoring study conducted in the UK, and serves as a pilot for similar studies in other areas of the UK where exposure from PWS is a potential concern.

Recruitment of volunteers
Households that were previously involved in the PWS water sampling campaign were sent a letter inviting them to participate in a follow up biomonitoring investigation. Participants from households with high arsenic content measured in their water were prioritised and targeted by follow up telephone calls. In total 214 participants from 129 households volunteered for the study and if they met the study participation criteria (including being 18 years or older and not having a related health condition), they were recruited to the study. They were sent information on their expected participation and an appointment was made for the field sampling team to visit and take biological and environmental samples.

Field survey
In November 2013, sampling teams from BGS visited participants in their homes to collect consent forms, personal activity information and biological and environmental samples. A sample of urine, toenail clippings and a small cutting of hair from the nape of the neck was requested from participants and an electronic exposure assessment questionnaire was completed with the volunteer by a member of the sampling team. The questionnaire asked participants about the activities that they undertook such as outdoor activities that could explain variations in exposure to arsenic in the environment. Environmental sampling was conducted to use in conjunction with biomarker results in an attempt to assess the relevance
of various exposure routes. A tap water sample from the private supply was taken to capture the exposure level relevant via this pathway to the time of biomonitoring. Where possible, a garden topsoil sample, indoor dust wipe sample and a small amount of rice (a foodstuff known to contribute to population arsenic intake) were collected from each household.

**Analysis of samples**

BGS and UoM are currently analysing the samples in their laboratories. All samples are given a unique identifier and personal details have been removed. The identifiers however allow the results to be linked and fed back to the participant. A detailed sample preparation and validation process takes place. Inter-laboratory comparisons will compare the results of analyses as a validation of the levels of chemicals in the samples.

Sample preparation and analyses for these multiple media take some time and the analysis of all samples is scheduled to be complete later in 2014. The results of the water samples are ready and the biological samples are being analysed currently. Following these analyses, soil, rice and dust wipes will then be analysed.

Interpretation of the results will include linking the chemical components of the biological and environmental samples with the responses of the exposure questionnaire. This interpretation will be fed back to participants, alongside public health advice in the case of high exposures.

**Results of the water samples taken during the biomonitoring study**

The results of the water samples are ready to be sent back to householders. The water samples collected during the biomonitoring study in 2013 showed similar levels of arsenic and other naturally occurring substances as those found in the previous sampling campaigns (2011-2013). Analysis of the water samples suggests that 41 households (32%) had elements in their private water supplies at levels which exceed current UK drinking water standards. Exceedances of eight chemicals were found, including arsenic, aluminium, copper, iron, lead, nickel, manganese and antimony.

Drinking water from 15 households (12%) exceeded the arsenic PCV. Since households with high arsenic levels were targeted for recruitment, there is a higher proportion of households with arsenic exceedances than the previous studies. A summary of the exceedances of drinking water standards are set out in Annex A.

**Communicating the results to householders and stakeholders**

Participants will shortly receive the results of their drinking water samples. In the same approach as the previous studies, households will be sent the results of their water samples by means of a letter, giving the results for the elements where exceedences of the PCVs exist in the study population. A public health advice sheet will be included if any of the chemicals in the water sample exceed a PCV. Around 15 householders with very high chemical levels will be contacted personally with tailored advice. Advice on mitigation measures is provided by Cornwall Council.

Results of the analysis of biological samples will be sent separately, later on in the year. For high urine levels, information from the exposure questionnaire will be used if possible, to highlight possible routes of exposure. Any participants with high urinary arsenic levels will be encouraged to visit their GP for a further examination and re-testing.
Results of the environmental samples will help to explain any relevant exposure from the local environment. The results from household dust wipe samples and rice samples will complement research conducted by the British Geological Survey and University of Manchester investigating possible exposure routes of arsenic from the environment.

Project updates and results of the study are being circulated to relevant stakeholders, including the Cornwall County Council, public health and environmental health departments, the Drinking Water Inspectorate, Environment Agency, South West Water, PHE colleagues (CRCE and the local PHE Centre- Devon, Cornwall and Somerset) and the project funders NERC.

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ANNEX A- List of Exceedances of PCVs in the 129 drinking water samples taken for the biomonitoring study (November 2013)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>PCV</th>
<th>Number of drinking water samples exceeding PCV</th>
<th>Exceedance range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium</td>
<td>200 (µg/L)</td>
<td>7</td>
<td>217-530 (µg/L)</td>
</tr>
<tr>
<td>Arsenic</td>
<td>10 (µg/L)</td>
<td>15</td>
<td>11-233 (µg/L)</td>
</tr>
<tr>
<td>Copper</td>
<td>2000 (µg/L)</td>
<td>2</td>
<td>5345-5462 (µg/L)</td>
</tr>
<tr>
<td>Iron</td>
<td>200 (µg/L)</td>
<td>6</td>
<td>200-4120 (µg/L)</td>
</tr>
<tr>
<td>Lead</td>
<td>10 (µg/L)</td>
<td>3</td>
<td>10-91 (µg/L)</td>
</tr>
<tr>
<td>Manganese</td>
<td>50 (µg/L)</td>
<td>15</td>
<td>56-972 (µg/L)</td>
</tr>
<tr>
<td>Nickel</td>
<td>20 (µg/L)</td>
<td>6</td>
<td>21-131 (µg/L)</td>
</tr>
<tr>
<td>Antimony</td>
<td>5 µg/l</td>
<td>1</td>
<td>30 (µg/L)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>55</strong></td>
<td></td>
</tr>
</tbody>
</table>

*several households had more than one exceedance. 41 households (32%) in total had exceedances.

There were no exceedances of the boron, chromium, cadmium, selenium, sodium, barium and uranium PCVs.