JRC Technical Notes

Technical Digest on Lead in Drinking Water

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Summary

There is growing evidence that the scale of problems with lead in drinking water has been under-estimated in Europe, due to inadequate monitoring. Particularly in the older districts of towns and cities, where lead pipes can be common, infants may still be at risk from a range of developmental defects, including reduced IQ. Approaches for establishing the national position and options for corrective action are outlined.

Disclaimer

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Scope

The Technical Digest explains why lead in drinking water may still be a threat to public health in Europe. It is aimed at Senior Health Officials to raise awareness and to promote an initial basis for assessing the extent of problems.

The Technical Digest is a product of the work performed in COST Action 637 on metals and related substances in drinking water. The main objective of the Action is to stimulate better control of metals in drinking water and to minimise environmental and health impacts. The Action aims to contribute to the implementation of the European Drinking Water Directive and to the Environment and Health programme of the European Commission and the Protocol on Water and Health of the United Nations – World Health Organisation. The Joint Research Centre of the European Commission provides scientific input in the COST Action but is also the link to the policy Directorate Generals of the European Commission. COST stands for European Cooperation in Science and Technology and is the oldest and widest European inter-governmental network for cooperation in research. COST is supported by the EU RTD Framework programme (www.cost.esf.org).

Public health concerns

The effects of chronic lead poisoning are well documented and identify a wide range of possible clinical conditions, often making medical diagnosis difficult. Adverse health effects include: interference with haemoglobin biosynthesis; interference with calcium and vitamin D metabolism; gastrointestinal irritation; dullness; restlessness; irritability; poor attention span; headaches; muscle tremor; abdominal cramps; kidney damage; hallucination; loss of memory; encephalopathy; hearing impairment, gonad dysfunction, and violent behaviour. Lead can accumulate in bone and fatty tissue, with subsequent release, particularly during the latter stages of pregnancy. Most attention has been directed towards the retardation of child development, especially reductions in IQ.

Numerous case studies have correlated exposure to lead with the concentration of lead in blood, and blood lead concentrations to clinical effects. Such quantification is difficult due to the wide range of exposures and human tolerances that complicate such studies, but general effects can be clearly demonstrated. Less well established is the potential for pre-natal mortalities, bearing in mind that lead compounds were used historically (1) to induce abortion, at lead dosages equivalent to the concentrations of lead in drinking water that can occur in highly plumbosolvent water supply areas (2) .

Historically, lead exposure was linked to food, paint, petrol and drinking water. Lead in paint and petrol were removed in the mid-1980s. At this time, leaded solder for jointing copper pipes and jointing food cans was also banned. In consequence, any remaining problems are likely to be due to drinking water, although concerns continue to be voiced in the United States about the potential for exposure from soil and dust. The main source of lead in drinking water is due to the continued use of lead pipes, although lead leaching from brass fittings and galvanic corrosion of lead-copper joints can be problematic in some circumstances.

The basis of the current World Health Organization (WHO) Guideline Value of 10 µg/l for lead in drinking water, as an average concentration, is that lead accumulation should be avoided and that blood lead concentrations should be kept well below the level of 10 µg/dl that is generally regarded as the threshold for concern. The WHO has established the Guideline Value on the basis of a provisional tolerable weekly intake of 25 µg/kg body weight, using the weight of an infant of 5 kg, a consumption of drinking water of 0.75 l/day and an exposure contribution of 50% from drinking water.

Regulatory background

The current European Drinking Water Directive

Presently, the Member States of the European Union have to comply with the second Drinking Water Directive (98/83/EU), which became a legal requirement from December 2003 (unless an agreed deferment applies). It sets an interim standard for lead in drinking water of 25 µg/l and a standard of 10 µg/l that becomes a legal requirement from December 2013. Both standards relate to the average weekly concentration of lead ingested by consumers, the same basis as the WHO Guideline Value. These standards apply at the point, within premises or an establishment, at which the drinking water emerges from the taps that are normally used for human consumption. Member States must take account of the occurrence of peak levels of lead that may cause adverse effects on human health and ensure that all appropriate measures are taken to reduce the concentration of lead in water intended for human consumption as much as possible during the period needed to achieve compliance with the standards. Samples should be taken so that they are representative of the quality of the water consumed throughout the year and taken so as to be representative of a weekly average value ingested by consumers. Sampling and monitoring methods were supposed to be applied in a harmonised fashion but the Member States failed to agree a harmonised monitoring method (3). In consequence, some EU countries have either not sampled for lead in drinking water at all or have used inappropriate sampling methods (2).

Revision of European Drinking Water Directive

An ad-hoc Working Group of regulators from EU Member States has recently put forward recommendations to the European Commission for revision of the Directive in relation to sampling and monitoring (4). In summary, the Working Group has recommended (as relates to lead in drinking water) that:

- Risk assessment and risk management strategies, including improvement plans, are put in place in the management of water supply systems;
- Operational monitoring, additional to compliance monitoring, is undertaken in order to properly establish risks; it can be noted that some Member States interpreted the Directive as if the specified compliance monitoring frequency was sufficient;
- Compliance monitoring is based on random daytime sampling of one litre of water without prior flushing at the consumers' tap during working hours;
- Attention must be given to metal leaching from domestic pipe-work systems, in particular to lead.

Protocol on Water and Health

The UN/WHO Protocol on Water and Health sets a number of legal obligations for its 24 participating States (5) in relation to the prevention and control of

“water-related disease”. Article 2 (1) defines “water-related disease” as “any significant adverse effects on human health, such as death, disability, illness or disorders, caused directly or indirectly by the condition, or changes in the quantity or quality, of any waters”. The health impact of lead in drinking water clearly falls within this definition and the Protocol requires:

- adequate supplies of wholesome drinking water - Article 4(2)(a)
- effective systems for monitoring situations likely to result in water-related disease – Article 4(2)(e)
- preventative action to avoid incidents of water-related disease, with special consideration for vulnerable people – Articles 5(e) and 5(k)
- establishing and publishing local targets, that need to be achieved or maintained for a high level of protection against water-related disease – Articles 6(2) and 6(3)
- preparation of water-management plans and schemes for improving water supply – Article 14(a)

The Protocol’s Working Group on Water and Health, at its meeting in Geneva in July 2009, adopted proposals to include lead in drinking water as a target health parameter, as a common indicator across the 24 Parties to the Protocol. Initial benchmarking and improvement planning processes are on a voluntary basis and are now being encouraged by the UN/WHO.

Evidence of problems

A European research network, with representation from 28 countries (COST Action 637, www.meteau.org), has collated information on lead in drinking water from across Europe and disseminated its findings at three International Conferences over the period 2007 to 2009. The principal conclusions were that:

- most lead in drinking water comes from lead pipes;
- the extent of houses still supplied through lead pipes ranges from <5 to 50% at the national level;
- in the older districts of many cities and towns, the extent of houses still supplied through lead pipes might be as high as 90%
- all drinking water is sufficiently plumbosolvent (dissolves lead) to be capable of exceeding the WHO Guideline Value when in contact with lead pipes, unless corrosion inhibitors are dosed to the water supply
- the partial removal of lead pipes by water companies does not necessarily solve the problem at the point of use by consumers, and there is growing evidence that it can even increase lead concentrations for several months due to physical disturbance of pipe deposits
- in many parts of Europe, problems are still being missed due to inadequate sampling
- where sampling methods are adequate, the WHO Guideline Value is being exceeded in many parts of Europe, unless corrosion inhibitors are dosed to the water supply.

Assessing the national position

Guidelines for benchmarking problems with lead in drinking water have been prepared by the EC Joint Research Centre, COST Action 637 and the World Health Organization (6). These guidelines are based on risk assessment to identify a representative number of water supply areas that are then surveyed by random daytime sampling to determine priorities for corrective action.

Options for protecting public health

The ultimate goal is the removal of all lead pipes from water supply systems. However, there are a range of difficulties to overcome:

- split legal responsibilities between water suppliers and home owners
- a reluctance of home owners to cooperate because of the disturbance and cost involved

The alternative is to dose ortho-phosphate, the most effective corrosion inhibitor, to water supply systems to reduce their plumbosolvency. Ortho-phosphate doses are water system specific and if optimised can achieve over 99% compliance with the WHO Guideline Value, with risk reductions in the range 100 to 500 fold.

You can obtain comprehensive technical guidance from the Best Practice Guide on the Control of Lead in Drinking Water (7) to be published in April 2010 by the International Water Association (www.iwap.co.uk).

Recommendations

The extent of risk to public health from lead in drinking water should be assessed, as a matter of high priority.

Optimised ortho-phosphate dosing should be considered as the means of securing rapid public health protection.

Strategies for encouraging the removal of all lead pipes should be implemented.

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