Public Health England

Protecting and improving the nation's health

Information on lowering of the lead intervention concentrations for children and pregnant women in England

This advice brings together the most up-to-date information on lead poisoning. It describes the signs and symptoms which should be looked for, the investigations to establish whether lead poisoning has occurred, how cases should be managed, the possible main sources of lead that may remain in the home and other indoor environments and provides sources of further advice and information

What is the new intervention concentration?

From July 2021 the Blood Lead Concentration (BLC) threshold, referred to as the 'public health intervention concentration' (but often referred to as the 'blood lead action level') at which public health action is recommended, is changing. Previously, Public Health England (PHE) has used an intervention concentration of ≥0.48 µmol/L (≥10 µg/dL), regardless of age. This intervention concentration will be lowered to ≥0.24 µmol/L (≥5 µg/dL) for children under 16 years and pregnant women. The higher threshold of ≥0.48 µmol/L (≥10 µg/dL) will still apply to adults.

Why is the public health intervention changing?

The public health intervention concentration is being changed for two reasons:

Firstly, at BLCs between 0.24 – 0.48 µmol/L (5 – 10 µg/dL), there is strong evidence for adverse effects on cognitive function in children, as well as the occurrence of externalising behaviours (for example aggression, hyperactivity), and delay in sexual maturation or puberty onset in adolescence.[1] There is also evidence for adverse health effects to the foetus of *in utero* lead exposure at maternal BLC <0.48 µmol/L (<10 µg/dL). Therefore, a precautionary approach to minimise *in utero* exposures is advised.

Secondly, although population exposure to lead has decreased significantly due to successful primary prevention efforts, there is still an estimated 2% of children that have a BLC ≥0.24 µmol/L (≥5 µg/dL). These children are more likely to be exposed to a higher, definable source of lead that can be identified and mitigated, rather than multiple very small exposures that may occur in the wider population. Evidence strongly suggests that high lead exposure in

[1] It is also important to note that there is no evidence of a threshold for lead-induced developmental neurotoxicity in children. For example, BLCs of as low as 2 µg/dL have been reported to cause developmental neurotoxicity.

England is associated with multiple facets of inequality, including economic, health, age, and ethnicity dimensions. Therefore, reducing harm from lead exposure in these children is likely to positively impact on these inequalities.

Why is lead exposure important and why should we test for lead?

Exposure to lead is harmful to young children and the developing foetus. BLC is measured to determine recent exposure to lead, and alongside clinical evaluation, helps to guide clinical and public health interventions.

Symptomatic lead poisoning in children is most likely to present with anorexia, abdominal pain, constipation and headache. Weight loss or failure to thrive has also been reported. Children may also display increased irritability and reduced concentration. Anaemia may develop in more severe cases as a result of lead- induced inhibition of haem synthesis. Lead-induced anaemia may be normochromic or microchromic and normocytic or microcytic. Lead-induced encephalopathy is now very rare but still seen occasionally in very severe cases of poisoning.

During pregnancy lead crosses the placenta and can have a similar effect on the developing foetus. Exposure to high concentrations of lead in pregnancy has also been linked in some studies to miscarriage, impaired intrauterine growth, and premature labour. It is therefore recommended that pregnant women avoid exposure to high concentrations of lead, for instance by using protective equipment if stripping old paint, or at work if they are at risk of lead exposure.

What are the most common sources of exposure in children with elevated blood lead concentrations in England?

Lead can be absorbed by ingestion of lead-containing particles or inhalation of lead dust or fumes. Ingestion of lead-containing paint remains the most common source of exposure identified in children with elevated BLCs. Although lead paints have been banned completely (except for some restricted use on listed buildings) from use in the UK since 1992, lead was frequently used in domestic paints up until the mid-1960s (with a few minor uses continuing into the 1980s). Children may therefore be exposed by eating paint (pica) in older properties, such as peeling layers of paint from skirting boards, banisters, windowsills, radiators etc. Renovation or redecoration is a further means of exposure if removal of old paint involves production of lead flakes or dust (e.g. through sanding) or fumes produced (e.g. from heat stripping) that may be ingested or inhaled.

Lead ingestion may also occur from sucking or chewing painted objects such as toys that do not comply with the EU Toy Safety Directive (Council Directive 2009/48/EC) and may therefore contain lead-based paint. Cooking with lead-glazed earthenware has also caused lead poisoning by ingestion.

Lead may also be a contaminant in traditional or natural remedies and supplements, spices and cosmetics. Soil and water are other potential sources of lead ingestion, though significant lead-contamination of domestic water supplies is rare.

What signs and symptoms should be considered in the diagnosis of lead poisoning in a child?

The diagnosis of lead poisoning requires a high index of suspicion since there may be no symptoms or overt clinical signs in those with mild disease. Children with pica (compulsive ingestion of non-food items, which may co-occur with autism and other neurodevelopmental disorders), or who are crawling, or pre-school age, accounted for most cases notified during a UK public health surveillance study. Migrant/refugee status is also an established risk factor. Additional important risk factors for raised BLC (from a review of mainly US data) include degraded or recently renovated older housing, residence near to lead environmental hazards, and iron, zinc and calcium deficiency. Acute severe lead poisoning is rare but should be considered in all children with new onset, otherwise unexplained presentations consistent with Table 1, particularly in the presence of constipation and anaemia.

Table 1 Health effects of severe lead exposure[2]

Haematological	Anaemia at BLC >1.45µmol/L (>30µg/dL) * **Decreased haem synthesis and/or decreased measures of red blood cell haemoglobin have also been reported at BLC<1.45 µmol/L (<30 µg/dL), but in our experience clinically significant anaemia is rarely observed at such low BLCs*
Gastroenterological	Colic, nausea, vomiting, diarrhoea, constipation at BLC>1.45 µmol/L (>30 µg/dL)
Central Neurological	Headache, altered alertness and activity levels, ataxia at BLC>1.45 µmol/L (>30 µg/dL) Cerebral oedema, encephalopathy, seizures more likely at BLC>4.83 µmol/L (>100 µg/dL)
Peripheral neurological	Motor and sensory neuropathy at BLC>1.45 µmol/L (>30 µg/dL)

At what blood lead concentrations do clinical effects occur?

Although the symptoms and signs described above are often not evident until blood lead concentrations are above 1.45 µmol/L (30 µg/dL), there is increasing evidence that lead has deleterious health effects at blood lead concentrations considerably lower than this. The developing nervous system is particularly susceptible with evidence that BLCs even below

[2] Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological profile for Lead. (Draft for Public Comment). Chapter 2. Health Effects. Atlanta, GA: U.S. : Department of Health and Human Services, Public Health Service. ; 2019 [Available from: https://www.atsdr.cdc.gov/ToxProfiles/tp13-c2.pdf.

0.48 µmol/L (10 µg/dL) may have deleterious effects on cognitive function and adverse behavioural effects in children. Therefore, there is essentially no BLC in children that is considered safe.

What should clinicians do?

Taking a clinical history by asking your patient appropriate questions is an essential part of making a diagnosis. This is particularly important when diagnosing lead exposure: your index of suspicion may be raised by the answers you receive. Clinicians should specifically ask if a child is showing any pica behaviour and should have a particularly low threshold for screening for lead poisoning in children with learning disabilities or behavioural disorders as pica may be harder to identify in these cases. Parents/carers should be directly questioned about risk factors and potential sources of lead exposure noted above.

Clinicians should be aware that they may be contacted by PHE Health Protection Teams (HPTs), when they have patients with BLCs that exceed the new public health intervention concentrations. HPTs can also provide public health advice to clinicians and to families. Contact details for HPTs can be found on the gov.uk website: https://www.gov.uk/health-protection-team

Where can I obtain expert advice on diagnosis and management?

The National Poisons Information Service (NPIS) computerised database, TOXBASE® is available free of charge at www.toxbase.org to registered NHS users and contains detailed monographs on the diagnosis and management of lead poisoning.

The NPIS 24-hour telephone helpline (Tel: 0344 892 0111) is available to health professionals for discussion of more complex cases. Where appropriate, senior medical staff can discuss their cases directly with an NPIS consultant clinical toxicologist.

What is the most appropriate investigation to confirm a diagnosis of lead poisoning?

A whole blood lead concentration should be undertaken in all cases of suspected lead poisoning.

What is a ‘normal’ blood lead concentration?

While there is no defined UK threshold for the harmful effects of lead in children, a BLC of ≥0.1 µmol/L (≥2 µg/dL) to <0.24 µmol/L (<5 µg/dL) is now widely accepted as the *clinical threshold* above which investigation should occur and a source should be identified (see Table 2). At ≥0.24 µmol/L (≥5 µg/dL) PHE should be informed and *clinical* and *environmental* monitoring should be initiated with systematic identification of potential sources, identification of other vulnerable individuals and further monitoring.

Are blood lead concentration measurements widely available within the NHS?

Many District General Hospitals will not carry out blood lead analyses themselves, but they will have an arrangement with a hospital that does have a laboratory that is fully accredited by

the Clinical Pathology Accreditation (CPA) scheme or equivalent body. It should be possible for a BLC requested from any NHS hospital to be available within one week.
If parents provide a BLC undertaken by an external laboratory, it is important to ensure that the laboratory is appropriately accredited.

Other clinical investigations that may be appropriate:

- Full blood count
- Iron status (iron stores are normal or increased in lead poisoning) if anaemia is present
- Blood or serum calcium concentration
- Abdominal X-ray if accidental non-food item containing lead is suspected

NB: testing of hair, teeth or fingernails for lead, sodium calcium edetate lead- mobilization tests or neurophysiological function tests are **NOT** recommended.
Radiographic imaging or X-ray fluorescence of long bones are **NOT** part of the routine clinical work-up for suspected lead poisoning in a child.

What are the options for treatment of lead poisoning in children?

The most important aspect of treatment is removal from exposure. Identification of the source of exposure may prove a challenge and requires a detailed history and often a degree of investigative imagination and persistence, acknowledging the principal sources of exposure outlined above. Remember that the source may be at school, a relative's or other frequently visited property. Appropriate investigations can be carried out with advice from PHE, who will work with local authorities to investigate and offer remediation advice to homeowners or landlords; contact details for your local unit can be found at https://www.gov.uk/guidance/contacts-phe-regions-and-local-centres

Public Health England has arrangements with specialist laboratories to notify HPTs within PHE of results where the BLC is ≥0.24 µmol/L (≥5 µg/dL) in children under 16 years residing in England. The treating physician may then be contacted by the HPT.

Management of cases where the blood lead concentration is >0.24 µmol/L (>5 µg/dL) but below 2.4µ mol/L (50 µg/dL) normally involves only removal from exposure but chelation therapy may be considered in some cases of chronic poisoning. Expert advice should be sought in these cases (see below).

It is reasonable to offer chelation therapy to children who are symptomatic or have a BLC >2.4 µmol/L (>50 µg/dL), although there is reliable evidence that chelation therapy does not improve cognitive function in children ≤3 years old with BLCs of ≤2.2 µmol/L (≤45 µg/dL).

Where chelation therapy is indicated, two drugs are available; oral DMSA (succimer) 30mg/kg/day (DMSA is not licensed in the UK) or sodium calcium edetate 40mg/kg twice daily (or 75mg/kg/daily) by IV infusion for 5 days. Expert advice should be sought from NPIS consultant clinical toxicologist before institution of either agent.

How often should a blood lead concentration measurement be repeated in a child found to have an increased blood lead concentration?

This will depend on the initial value and the circumstances:

- Where the initial BLC is <2.4 µmol/L (<50 µg/dL), removal from exposure and a repeat measurement of the BLC 4 weeks later is usually all that is required initially. Lead levels do decline slowly in children, and further follow-up will depend on the child's clinical condition (e.g. if pica behaviour is continuing)

- If the initial BLC is >2.4 µmol/L (>50 µg/dL), chelation therapy should be considered, after taking expert advice (see below). In these circumstances BLC should be measured immediately before and after treatment and ideally during the chelation course. There is usually a rebound in the BLC following chelation (as lead moves from the bone to blood) so a repeat BLC measurement should be undertaken one week after the end of each chelation course

There may be cases where BLCs are not decreasing as expected following the implementation of interventions to reduce exposure. This could be because not all sources of lead have been identified or the interventions put in place to reduce exposure have not been effective. Therefore, further investigation to ensure all potential sources have been identified and an assessment of the control measures implemented may be required.

The rate at which the BLC falls will be dependent upon the total lead body burden. There is some evidence that lead accumulated in the bone from historical exposures, may be remobilised from bone to blood following implementation of mitigation measures. Therefore, this may mask the effectiveness of the measures. For clinical advice including when to retest the BLC in complex cases contact the NPIS (see contact details above).

What public health interventions can be instituted?

Public health interventions include interruption of lead exposure pathways by source identification and remediation and/or abatement, and consideration of whether others may be at risk of exposure. The PHE Lead Exposure in Children Surveillance System (LEICSS)[3] supports rapid case reporting to HPTs from participating laboratories in children aged under 16 years with a current BLC of ≥10 µg/dL (≥0.48 µmol/L)[4]. There is no equivalent system in place for adults, who instead may be reported directly to HPTs by Environmental Health or clinical professionals.

Table 2 Clinical and public health management of cases

Blood lead concentration	Clinical management	Public health management
≥0.1µmol/L (≥2µg/dL) to <0.24µmol/L (<5µg/dL)	Identify and remove/abate sources of exposure	Notification not indicated unless concerned about a wider public health risk

[3] https://www.gov.uk/government/publications/lead-exposure-in-children-surveillance-reports

[4] This changes to ≥0.24µmol/L (≥5µg/dL) with the lowering of the blood lead intervention concentration

	Correct calcium and iron deficiency Repeat BLC testing 4 weeks after removal from exposure	e.g. cluster of cases/family associated with same exposure source
≥0.24µmol/L (≥5µg/dL) to <2.4µmol/L (<50µg/dL)	Actions as above, and if symptomatic discuss with NPIS (as rarely may benefit from chelation)	Public Health Intervention Concentration. Voluntary notification to Public Health England recommended for public health response: - Systematic identification of potential exposure sources and pathways by questionnaire and environmental assessment of e.g. home, school, care settings - Advice on lead source removal/abatement to interrupt exposure pathways - Consideration if other vulnerable individuals (children, pregnant women) at risk - Provide advice on further BLC monitoring following removal from exposure - Surveillance to expedite response, and to describe case epidemiology to inform further public health interventions
≥2.4µmol/L (≥50µg/dL) to <3.3µmol/L (<70µg/dL) and non-encephalopathic	Identify and remove/abate sources of exposure Correct calcium and iron deficiency Discuss with NPIS Consider hospital admission Consider chelation Repeat BLC testing 1 week after treatment	
≥3.3µmol/L (≥70µg/dL) or encephalopathic	Discuss with NPIS Identify and remove/abate sources of exposure Correct calcium and iron deficiency Admit to High Dependency Unit if encephalopathic Chelation using dimercaptosuccinic acid (DMSA, succimer), or sodium calcium edetate under expert advice Monitor BLC according to expert advice	

Further information about lead and useful links below:

Lead

Lead is a metal that is widely distributed in the Earth's crust (soil and rocks), air and water. It is largely emitted into the environment as inorganic salts. Lead is ubiquitous in the environment.

Historically lead has been used in paint, petrol, food cans and water pipes; these uses have been phased out in the EU, but many older properties in the UK still have lead water pipes and old lead paintwork. Leaded petrol was banned in the EU in 2000 with possible exceptions until 2005, while the sale of lead paint was banned in the UK from 1992.

Everyone is exposed to some lead as it occurs widely in the soil, air and water. However, exposure to high concentrations of lead may occur in certain situations, for example, during the removal of old lead-containing paint and through use of some traditional medicines and cosmetics such as kohl eyeliners. Lead in drinking water mostly occurs as a result of old lead plumbing (or the illegal use of lead solder) in the home, and rarely from natural sources.

Workplace exposure to lead and inorganic lead compounds may occur in a variety of occupations, including steel welding and spray coating, battery manufacturing or plumbing. Employers are required by law to limit the exposure of their workers to lead; this is achieved by regular monitoring of workers BLC and subsequently acting if these concentrations are too high. Employers must comply with the Control of Lead at Work Regulations 2002, and the accompanying Health & Safety Executive (HSE) Approved Code of Practice. These provide requirements for biological testing. It is important to recognise that occupational work which involves lead can lead to exposure in the home if contaminants, such as for example, dust and paint flakes are brought into the home on dirty work clothing, or if family members have hobbies which involve lead such as stain glass window making that could expose others in the home.

High lead concentrations have also been observed in pregnant women who have eaten painted plaster due to cravings for non-food items. Pregnant women should also avoid the use of traditional medicines and cosmetics, especially where the ingredients are unknown, and/or the products may be unregulated (such as those bought on the internet from an unknown source).

Lead paint

DEFRA Advice on lead paint in older homes
https://www.gov.uk/government/publications/advice-on-lead-paint-in-older-homes
British Coatings Federation – Lead paint removal – guide to public Removing old lead paint (coatings.org.uk)
The Society for the Protection of Ancient Buildings (SPAB) lead paint advice
https://www.spab.org.uk/advice/lead-paint
RoSPA advice on lead in children's playgrounds https://www.rospa.com/Play-Safety/Advice/Lead-Paint

Interventions

Paper on effectiveness of interventions https://www.ncbi.nlm.nih.gov/pubmed/26990846
WHO lead poison prevention campaign docs https://www.who.int/ipcs/lead_campaign/en/
UNICEF report on lead exposure in children The toxic truth | UNICEF

Toxicology

Chemical compendium Lead: Health effects, incident management & toxicology
https://www.gov.uk/government/publications/lead-properties-incident-management-and-toxicology
COT statement on potential risks from lead in the infant diet
https://cot.food.gov.uk/sites/default/files/cot/cotstatlead.pdf
BMJ Case Report: Lead in a case of encephalopathy
https://casereports.bmj.com/content/2018/bcr-2017-222388.full
EFSA Lead dietary exposure in the European Population
https://efsa.onlinelibrary.wiley.com/doi/pdf/10.2903/j.efsa.2012.2831
CDC Low level Lead exposure harms children: A renewed call of primary prevention
https://www.cdc.gov/nceh/lead/acclpp/final_document_030712.pdf and
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3404672/ and
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6320665/
Toxbase monograph – lead www.toxbase.org

Population

HBM4EU (Human Biomonitoring for Europe) Prioritisation of lead Scoping report
https://www.hbm4eu.eu/wp-content/uploads/2019/03/HBM4EU_Scoping-Document_Lead_v1.0.pdf including HBM4EU summary of EU blood lead surveys on page 9
WHO Ten chemicals of major public health concern
https://www.who.int/ipcs/assessment/public_health/chemicals_phc/en/
WHO lead (including exposure to lead, batteries, paint and BL testing)
https://www.who.int/ipcs/assessment/public_health/lead/en/
UKTIS Lead in pregnancy monograph
https://www.medicinesinpregnancy.org/bumps/monographs/EXPOSURE-TO-LEAD-IN-PREGNANCY/
BUMPS leaflets for pregnant women on lead
https://www.medicinesinpregnancy.org/Medicine--pregnancy/Lead/
LEICSS Annual report 2017 & SLIC report https://www.gov.uk/government/publications/lead-exposure-in-children-surveillance-reports
Unusual cases of lead poisoning in the UK CHaP report No 26
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/522065/CHaP_Report_26_V2.pdf
US Preventive Services Task force (USPTF) Screening for elevated BLL in children
https://www.uspreventiveservicestaskforce.org/Page/Document/RecommendationStatementFinal/elevated-blood-lead-levels-in-childhood-and-pregnancy-screening for full evidence review
https://www.uspreventiveservicestaskforce.org/Page/Document/UpdateSummaryFinal/elevated-blood-lead-levels-in-childhood-and-pregnancy-screening

UK MHCLG Housing Health & Safety Rating System
https://www.gov.uk/government/collections/housing-health-and-safety-rating-system-hhsrs-guidance

Lead in water

DWI Long-term strategies to reduce Lead exposure from drinking water Long-term Strategies to Reduce Lead Exposure from Drinking Water - Drinking Water Inspectorate (dwi.gov.uk)
DWI Advice on finding a plumber watersafe.pdf (dwi.gov.uk)
DEFRA/DWI/Cranfield Review of the latest evidence on lead and estimation of intake via drinking water Review of the latest evidence on lead and estimation of intake via drinking water - Drinking Water Inspectorate (dwi.gov.uk)
DWI Annual Report page Annual Report - Drinking Water Inspectorate (dwi.gov.uk)
Water Safe – finding approved plumbers https://www.watersafe.org.uk/
WHP Lead solder
http://www.waterhealthpartnership.wales/sitesplus/documents/1189/Lead%20solder%20poster%20%28WE%29.pdf
Severn Trent facts about lead in drinking water
https://www.stwater.co.uk/content/dam/stw/tier2_helpandcontacts/Facts-lead-in-water-Jan-14.pdf
United Utilities – Reducing lead: top tips https://www.unitedutilities.com/help-and-support/your-water-supply/lead-pipes/reducing-lead-risk-top-tips/
WHO Drinking water guidelines 4th Ed
https://www.who.int/water_sanitation_health/publications/2011/dwq_guidelines/en/

Occupational Exposure to Lead

The Control of Lead at Work Regulations 2002
http://www.legislation.gov.uk/uksi/2002/2676/contents/made
HSE Control of Lead at work Approved Code of Practice L132
http://www.hse.gov.uk/pubns/books/l132.htm
HSE lead main page http://www.hse.gov.uk/lead/index.htm
HSE Lead and you INDG305 rev 2 http://www.hse.gov.uk/pubns/indg305.htm