

## PUBLIC HEALTH

## Lead in drinking water

**T**he presence of lead in drinking water is not a new problem. Lead was historically used to produce pipes to carry water and later to solder iron and copper pipes. It is a ubiquitous heavy metal that has been used for centuries as a constituent in various products such as face powder, ceramic glazing, gasoline, plumbing, radiation shielding, children's toys and paint. Its long history of use and distribution means lead exposure and its health effects are global.

By following the risk assessment process first established by the US National Research Council,<sup>1</sup> this article provides practitioners with information to respond to their patients' concerns regarding lead in drinking water.

Many countries have succeeded in reducing lead exposure through regulation of products. However, according to the World Health Organization, a number of developing countries still allow lead in gasoline. About one-fifth of the burden of disease from lead exposure occurs in Southeast Asia, and another one-fifth occurs in the western Pacific region.<sup>2</sup> The burden is also felt in poorer sections of Europe: the World Health Organization estimates that nearly 157 000 days of healthy life are lost among children under 4 years old because of mild retardation from lead poisoning.<sup>3</sup> In Central and South America, 33%–34% of children have blood lead levels above 10 µg/dL (0.48 µmol/L), compared with 7% in North America.<sup>4</sup>

Lead exposure in Canada has decreased significantly over the past several decades, thanks to the introduction of regulations to remove lead from common sources such as paint and gasoline. However, as we control these sources, others, including drinking water, become relatively more important. Homes built before the 1950s were often built with lead plumbing, and those built as recently as 1990 may contain lead solder.<sup>3</sup> Many communities in

## Key points

- Lead is found in many sources, including drinking water.
- Municipal drinking-water systems are routinely monitored for lead levels.
- Older homes may have lead pipes and solder that leach into drinking water.
- Owners of houses built before 1990 should have their drinking water tested.
- If lead is detected, a risk assessment should be conducted to guide appropriate mitigation steps, such as removal of lead plumbing or flushing of pipes by running water for 5 minutes or more each morning.

Canada have older sections of their drinking-water distribution systems that have lead pipes or soldering.

The risk assessment process described in this article starts with an exposure and hazard assessment, which in turn informs risk management decisions.

## Exposure assessment

Lead is a natural and ubiquitous element found in several sources, including many foods, the air we breathe, our backyard soils and our homes (e.g., blinds, paints and toys).<sup>1,5</sup> All of these sources must be considered in addition to the possibility of lead in drinking water when determining a person's total lead exposure and risk.

In most developed countries, municipal drinking-water systems are tested for lead at least annually and action taken when acceptable levels are exceeded. Residents can find out what the lead content is in their community's water supply from the municipal operator. Alternatively, companies are available that can conduct lead sampling at a person's residence.

If there is good reason to believe that a person may have a significant source or combination of sources of lead exposure, biomonitoring may be prudent. Typically, whole blood lead levels are measured; however, bone lead measurement is becoming a more robust method to assess prolonged exposure. Lead has a short residence time of about 30 days in blood, whereas its residence time in bone is 10 years. There is a dearth of Canadian data on blood lead levels in children, but Amer-

ican data show, as a potential reference point, a geometric mean blood lead level of 1.9 (95% confidence interval [CI] 1.7–2.3) µg/dL (0.09 [95% CI 0.08–0.11] µmol/L).<sup>5</sup> Sanborn and colleagues<sup>6</sup> and Brodtkin and colleagues<sup>7</sup> have provided information on assessing a patient's exposure history and interpreting biomonitoring results.

## Hazard assessment

Lead has many toxic effects on human health. In children, the most vulnerable population, neurodevelopmental health effects are of greatest concern. Lead exposure is consistently associated with intellectual and other neurologic deficits.<sup>3,8,9</sup> Lanphear and colleagues,<sup>10</sup> in a large meta-analysis, found an intelligence quotient point decrement of 3.9 (95% CI 2.4–5.3) associated with an increase in blood lead levels from 2.4 to 10 µg/dL (0.12 to 0.48 µmol/L). Braun and colleagues<sup>11</sup> reported that children with a blood lead level greater than 2 µg/dL (0.10 µmol/L) were at a 4.1-fold increased risk of attention-deficit hyperactivity disorder.

Many health professionals misinterpreted the action level of 10 µg/dL (0.48 µmol/L) set by the US Centers for Disease Control and Prevention (CDC) in 1991<sup>12</sup> as indicative of a threshold or safe blood lead level. Not so. Evidence has been accumulating for more than 15 years that blood lead levels below 10 µg/dL are associated with various neurodevelopmental problems,<sup>6,7,13,14</sup> which suggests that there is no threshold.<sup>7</sup> The CDC's current position is that a blood lead level of 10 µg/dL does not

define a threshold for the harmful effects of lead and that children's physical and mental development can be affected at lower lead levels.<sup>1,3</sup>

### Risk characterization

What would the average lead intake be for children drinking water at the 10 µg/dL standard? According to Health Canada's risk assessment numbers,<sup>15</sup> a toddler drinking reconstituted formula would ingest 0.6 L of water a day, or 6 µg of lead. On average, this would work out to 0.36 µg/kg daily. Yet this intake level would be only 20% of the safe level of 1.85 µg/kg daily advocated by the Ontario Ministry of the Environment, which is one of the most protective safe levels in Canada.<sup>16</sup> As discussed earlier, recent research has questioned the threshold paradigm for lead, which makes risk characterization from test results difficult. Clinicians are encouraged to consider all sources of lead exposure, water test results and their individual patient to determine the level of risk.

### Risk management

Because a threshold for lead has not been established, reducing exposure to all sources of lead would be reasonable. To reduce exposure to lead in drinking water, public health agencies have spent considerable effort attempting to educate the public living in homes built before 1990 to test their water for lead or check their plumbing materials.

If lead is detected, the risk assessment should guide the appropriate steps to be taken to reduce exposure. Homeowners can reduce exposure by replacing lead pipes or lead solder or by adjusting the chemistry of the water so that it is less corrosive. Replacing the pipes is an expensive albeit permanent solution. Corrosion control often is cheaper and has other ancillary benefits, but it does not address the source of the

problem. Flushing of the pipes by running water for 5 minutes or more every morning is often an effective temporary solution. Flushing greatly reduces the amount of lead coming out of the tap, because it purges the contaminated water and draws water that has had less contact time with the plumbing in the house. If the source of lead is the municipal plumbing system, the homeowner should inform the municipality of their concerns and institute a regimen of flushing their pipes until the problem is remediated. Many municipalities have remediation programs in place.

Other ways to reduce childhood exposure to lead that physicians can recommend include discouraging hand-to-mouth actions by children, having them wash their hands more frequently, removing lead toys, blinds, paint or jewellery from the house, increasing their calcium and iron intake, vacuuming more often and filtering indoor air.

The most effective way to reduce lead exposure further can be determined on an individual basis. Physicians can contact their local public health unit or Health Canada for help in identifying possible sources of lead in their community. Continued vigilance and cooperation among agencies and physicians are important to protect children against lead exposure.

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