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Fairy Tales and Myths in Public Health

The use of orthophosphoric acid is a practice used by the water industry to safeguard customers from ingestion of lead but phosphate is a non-renewable resource that has no current practical alternatives. The current dose of 0.5-2mg/l is proven to provide protection of public health, but there is limited published evidence for the use of these concentrations and there could be scope for optimisation.

Lead exposure can have serious consequences on human health, particularly on the mental development of children, but this is not the only impact. High lead exposure can be responsible for coma, convulsions and death, and even low levels can result in anaemia, hypertension, renal impairment, immunotoxicity and toxicity to the reproductive organs [1].

People are generally aware of lead toxicity, particularly from well publicised sources such as paint and petrol, but do not often associate lead risk from drinking water. In the past, lead was used extensively in industrialised nations because of its durability, malleability and strength, making it a perfect material for the distribution of water from the point of treatment to the consumers of water [2]. Although laying new lead pipes was banned in 1969 in the UK, old lead pipe is still present, especially in houses built before this date. Approximately 40% of UK homes (~17 million people) are still supplied by lead pipes [3]. This is mainly because water utilities own the pipes from the treatment works to the property boundary but the homeowners have responsibility for the pipes from this boundary. Without treatment, lead would be present in tap water because of the corrosive effects of water on household plumbing systems that contain lead pipes, solder or fittings. Although water utilities do not having responsibility for all lead pipes, they work hard to minimise the risk of lead at the tap to ensure water quality is maintained and drinking water is safe to consume.

To ensure lead concentrations are beneath than the strict EU Guideline of 10µg/l, UK water utilities randomly sample customer taps within designated water supply zones, with increased frequency in higher risk areas. They control the lead concentration at the customer tap by dosing phosphate, orthophosphoric acid, which forms an insoluble layer of lead phosphate over the soluble carbonate deposits on the pipe wall, preventing lead leaching. The phosphate dose used is 0.5-2mg/l as it is said that a dose <0.5mg/l has no impact on lead at the customer tap and that a dose >2mg/l does not contribute any additional benefit. The dose used needs to adequately form this barrier while also not delivering too much residual phosphate. This is because phosphate rock is a non-renewable resource with <67,500 million tonnes remaining globally, currently enough for the next 50-100 years, although global phosphate demand is growing at 2.1% every year [4] [5].

Having an optimal dose of phosphate is difficult because of the nature of distribution systems and treatment. Distribution networks are highly complex environments that consist of a wide variety of infrastructure and water characteristics; each individual water source has its own risks and challenges requiring mitigation. Determining the optimised phosphate dose to use within a specific supply zone is difficult, despite intensive local operational testing, as centralised water treatment works dose chemicals for a large area. Therefore if one property within a zone has a risk of lead contamination, phosphate has to be dosed for the entire area to alleviate that risk. Furthermore, risk changes over time as changes occur on a households, network and treatment level, meaning that localised tests should be repeated. If this lead risk presents itself at a consumer tap, phosphate dose will likely increase for a supply zone but it is less apparent when a risk of lead leaching has been reduced and so phosphate dose can be decreased.

Phosphate dose could be further optimised if evidence-based industry best practices were to be shared or if quantities of chemicals dosed were dictated by regulations. An investigation into legislation found that phosphate limits were not mentioned at a worldwide level, an EU level or at a UK level. Thorough examination of literature was completed to find the specific evidence that suggests a phosphate dose of 0.5-2mg/l is the most optimal range to use. Only one source alluded to the 0.5-2mg/l value, The "IWA [6] Best Practise Guide on the Control of Lead in Drinking Water". This report referenced laboratory tests that found a phosphate dose of 0.9-2.0mg/l successfully reduced lead levels when doses above and below this value did not. Relying on laboratory test results for wider industry practice is challenging as the full environment complexity cannot be accounted for. For example, the laboratory trial used a 30 minute contact time and 25°C when the actual network can have a residence time of > 10 days and be 4-14°C [7]. The original referenced source of this information was a conference proceedings, further details of which could not be found [8]. The intensive local operational testing that UK utilities actually do but do not publish using universally accessible channels, means the depth of detailing surrounding the dose used may be lost.

Therefore, in the utility's best intentions to safeguard human health, it could be that phosphate is overdosed. It is difficult to find published evidence on the best dose to use and validation of the 0.5-2mg/l phosphate dose used by the water industry currently has not been possible. This is an opportunity to further improve the sustainability of this practice by better optimising this dose, reducing treatment costs and protecting dwindling phosphate supplies, or by investing future research efforts in alternatives to phosphate dosing. Identifying common practise and conducting a thorough investigation of them is one way in which to drive efficiency in all industries. The case of the 0.5-2mg/l optimal phosphate dose is just one example of this.

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