From corrosion to contamination: Using indirect parameters and machine learning to predict lead (Pb) levels in drinking water

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various materials are used in our internal water supply systems (IWSS). Predominant among the metallic materials are galvanized steel, brass, copper, and stainless steel, with some parts still made of lead. Lead and the corrosion of brass can release lead (Pb) ions into the water, which can then enter the human body. Lead (Pb) is among the most toxic chemical contaminants. Although the current EU limit in drinking water is set at 10 µg/L and will be reduced to 5 µg/L by 2036, there is no truly safe concentration of lead (Pb) in water. While lead (Pb) in drinking water typically does not act acutely (unlike Legionella, for example), its short-term effects are less noticeable, but long-term exposure can lead to severe health issues. Despite the significance of this problem, Slovenia does not have a systematic data collection on the presence of lead in drinking water, even in defined priority premises (hospitals, schools, restaurants, etc.). Additionally, there is no data on the proportion of different materials used in IWSS in Slovenia. Individual indicators which might be available do not capture the entire complexity of material degradation processes in IWSS and their consequences. However, measurable material properties and basic water parameters can aid in developing IWSS condition assessment techniques through machine learning. The goal of this investigation was to prepare a database of available and experimental data and develop a machine learning algorithm to indirectly predict lead (Pb) concentrations in drinking water. For this purpose, two types of brass fittings were laboratory-exposed to two different types of drinking water characteristic of Slovenia. These waters were also supplemented with chloride disinfectants and softening agents. After a 3-month exposure, visual inspections of the exposed metals' surfaces were conducted to determine the extent and type of corrosion damage. In parallel, physical parameters of water and metal ions leached into the water were systematically analyzed before, during, and after the 3-month exposure using ICP-MS. Visual observations of corrosion damages and analyzed water parameters served as input data for developing a simple machine learning algorithm. The threshold values of the analyzed parameters (according to WHO standards) will be further used to train the algorithm to predict health risks.