

## **Assessing health risks of chemical and biological contamination in Portuguese drinking water supplies: an exploratory study of five years of drinking water quality data**

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In order to support the new rules for drinking water and develop a methodology for the assessment of health risks from drinking water, we analysed drinking water quality control data for 1993–1997. We studied the geographical distribution of contamination of drinking water by metals, nitrates and biological contaminants. We found that the contamination from mercury, lead, copper, nickel, arsenic and chromium is more important in drinking water supplies serving fewer than 5000 inhabitants. Aluminium is found in drinking water supplies serving more than 10 000 inhabitants, and is associated with eutrophication of the raw water and the occurrence of cyanobacteria blooms.

The sampling in most of the cases satisfied the frequency established by regulatory requirements, but we found that it was not adequate for the health risk assessment. To assess and manage risks, we recommend prevalence studies linked with epidemiological studies.

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## **The role of groundwater chemistry in the transport of bacteria to water-supply wells**

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Static mini-columns and *in situ* injection and recovery tests were used to assess the effects of modest changes in groundwater chemistry upon the pH-dependence of bacterial attachment, a primary determinant of bacterial mobility in drinking water aquifers. In uncontaminated groundwater (<1 mg l<sup>-1</sup> dissolved organic carbon, DOC), bacterial attachment to aquifer grain surfaces declined steadily from 93 to 20% in response to an increase in pH from 5.8 to 7.8. However, bacterial attachment in modestly-contaminated groundwater (4 mg l<sup>-1</sup> DOC) was relatively insensitive to pH change from pH 3.5 to pH 8, as was bacterial attachment in uncontaminated groundwater amended with only ~3 mg l<sup>-1</sup> of purified humic acid. Destruction by UV-oxidation of the DOC in contaminated groundwater partially restored the pH-dependence of bacterial attachment. Results from static column tests and from a small-scale (3.6 m) natural-gradient injection and recovery study suggest that low concentrations of surfactants can also substantively alter the attraction of groundwater bacteria for grain surfaces and, therefore can alter the transport of bacteria to water-

supply wells. This phenomenon was pH-sensitive and dependent upon the nature of the surfactant. At pH 7.6, 200 mg l<sup>-1</sup> of the non-ionic surfactant, Imbentin, caused a doubling of fractional bacterial attachment in aquifer-sediment columns, but had little effect under slightly acidic conditions (e.g. at pH 5.8). In contrast, 1 mg l<sup>-1</sup> of linear alkylbenzene sulphonate (LAS) surfactant, a common sewage-derived contaminant, decreased the fractional bacterial attachment by more than 30% at pH 5.8, but had little effect at pH 7.3.

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