ALUMINIUM: REMOVAL FROM WATER SUPPLIES


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Aluminium or an aluminium complex accumulates in uraemic man on haemodialysis [1]. Dialysis encephalopathy and osteomalacic dialysis osteodystrophy are associated with raised blood and tissue concentrations of aluminium [1–3]. The geographical distribution of these syndromes in the United Kingdom can be explained by the geographical distribution of aluminium containing water supplies [4,8]. This evidence is strongly suggestive that aluminium is the aetiologic agent in both the development of dialysis encephalopathy and osteomalacic dialysis osteodystrophy. The aluminium in the water supply seems to be the main source of the increased body burden in patients on haemodialysis and therefore the removal of aluminium from the water supply used to prepare dialysate is essential. The chemical behaviour of aluminium in water is complex. The proportion of ionised to non-ionised aluminium varies from supply to supply, from day to day in the same supply and is influenced by pH and the presence of other elements, e.g. fluoride [5].

Four commercially available methods of water treatment for use with single proportionating units were studied for their ability to remove aluminium from two different water supplies. The methods of water treatment studied were (a) a water softener; (b) a twin cartridge deioniser; (c) a reverse osmosis unit of spirally wound construction, and (d) a reverse osmosis unit of hollow fibre construction. The water treatment methods were set up and linked individually to a single proportionating unit and operated as for haemodialysis. Water samples were taken from the raw water fed to each individual water treatment method and again after the water had been treated. In water supply (a) the aluminium was naturally occurring and appears to be mainly in ionic form. In water supply (b) the aluminium was added as part of the water treatment process to remove colour from the water. The ratio of ionic to non-ionic aluminium varied considerably from day to day. Both water supplies were studied for 6 to 12 months. The aluminium concentration was measured by either flame or flameless atomic absorption spectrophotometry.

On water supply (a) the raw water aluminium concentration of 900 – 1200 μg/l was reduced unreliably by a water softener to 700 – 1100 μg/l, by a deioniser to 5 – 36 μg/l, by a hollow fibre reverse osmosis unit (with water soft-
ening as pre-treatment), to 5 - 42 μg/l and a spirally wound reverse osmosis unit reduced the aluminium content to less than 5 μg/l.

On water supply (b) with a raw water aluminium content of 150 - 400 μg/l a deioniser reduced the level unreliably to 50 - 220 μg/l and a spirally wound reverse osmosis unit consistently reduced the level to less than 5 μg/l. (The water softener and hollow fibre reverse osmosis unit were not studied on supply (b). Due to the considerable fluctuation in aluminium concentration seen in these supplies it appears necessary to study each individual water supply for at least a year to establish a mean aluminium concentration.

The spirally wound reverse osmosis units appear to be the most efficient method of removing aluminium from these water supplies. Though it may be possible by differing combinations of ion exchange resins to improve the performance of deionisers.

The minimum ‘standard’ of aluminium concentration for water to use in the preparation of dialysate has not yet been established but even at low concentrations of aluminium, (less than 50 μg/l) aluminium can cross a dialysis membrane against a concentration gradient due to plasma binding [6]. As it also appears necessary to remove aluminium from dialysate from the initiation of dialysis to prevent accumulation and development of osteomalacia and dialysis encephalopathy in uraemic man on haemodialysis [7] it seems likely that the aluminium content of the water should be reduced to less than 20 μg/l.

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References