CONCENTRATIONS OF TOXIC EFFECTS TO DIALYSIS PATIENTS

Water Contaminants and their Concentrations for which Toxic Effects have been Reported in Dialysis Patients

Contaminant	Lowest Concentration Associated with Symptoms mg/L	Toxic Effects or Symptoms
Aluminum	6.0×10^{-2} (0.06)	Considerable evidence exists that it causes an encephalopathy, which is usually fatal. It has been implicated as contributing to renal bone disease.
Calcium/Magnesium	88 (Calcium)	Listed together since the "hard water syndrome" has occurred with both present. Hypercalcemia and hypermagnesemia are marked by nausea, vomiting, muscular weakness and a sensation of flushing or warm skin. Hyper - or hypotension may result depending on whether excess of Calcium or magnesium predominates.
Chloramine	2.5×10^{-1} (0.25)	Causes hemolysis, anemia and methemoglobinemia, especially severe in patients with exose monophosphate shunt deficiency.
Copper	4.9×10^{-1} (0.49)	Effects range from nausea, chills and headache to liver damage and fatal hemolysis.
Fluoride	1.0	Osteomalacia, osteoporosis and other bone disorders have been attributed to it; however, the evidence is not conclusive.
Nitrate	21 (as Na)	Methemoglobinemia with cyanosis, hypotension and nausea have been reported.
Sodium	300*	Though normally present in dialysis fluid, excessive levels have caused hypernatremia marked by hypertension and pulmonary edema, confusion, vomiting, headache, tachycardia, and shortness of breath. If sodium concentration is sufficiently high, seizure, coma, and death may occur.
Sulfate	200	Nausea, vomiting and metabolic acidosis have been reported .
Zinc	2.0×10^{-1} (0.2)	Anemia, nausea, vomiting and fever have occurred.

Contaminant	Lowest Concentration Associated with Symptoms mg/L	Toxic Effects or Symptoms
pH	6.7 pH units	Low pH of treated water and resultant dialysate have reportedly caused excessive clotting of dialyzers with subsequent reduced dialyzer performance and increased blood loss likely. Itching, nausea, vomiting, and acidosis may also occur. In combination with copper containing pipes and fittings low pH water has caused liver damage and fatal hemolysis (see copper effects above).
Microbial	**	Excessive levels of microbes in supply water have resulted in pyrexial reactions. The microorganisms multiply significantly during the dialysate preparation and delivery interval, particularly if stagnant or dead spaces exist, such that the colony count per mL may increase several-fold over that found in the supply water.

* Although the lowest concentration cited in the literature had levels of 300 mg/L of sodium, symptoms may obviously occur at much lower levels.

** Levels of microbial contamination are more related to level in dialysate than the water supply.