Mechanisms of hemolysis in patients undergoing hemodialysis			
Etiology	**Mechanism of hemolysis**	**Location of defect**	**Indicators of contaminant**
Sodium hypochlorite (bleach)	Oxidant red blood cell (RBC) injury	Inadequate rinsing during dialyzer reprocessing	Hemolytic anemia Heinz bodies Methemoglobinemia
Chloramine	Oxidant RBC injury	Activated charcoal filter (minimally removed by deionizers, but NOT by RO)	Hemolytic anemia Heinz bodies Methemoglobinemia
Copper	Oxidant RBC injury	Deionizer	Greenish hue to serum or plasma
Nitrate (common in contaminated well water)	Oxidant RBC injury	Water source	Black venous blood
Formaldehyde (seen with reuse dialyzers)	Inhibition of RBC glycolysis	Use of formaldehyde during sterilization of dialyzers	Anti–N-like cold agglutinins
Dialysate temperature >42°C	Thermal RBC injury	Temperature-sensing monitors	
Dialysate osmolarity	Osmolar trauma	Mixing error	
Tubing	Mechanical trauma	Kinked tubing	Schistocytes

The process of water purification in hemodialysis involves multiple steps in series to create a water product that is free of contaminants.

1. Carbon filtration removes chlorine, chloramines, and other dissolved organic contaminants. This step is essential and generally includes two carbon beds to ensure complete removal of chloramine.
2. Water softeners exchange calcium and magnesium for sodium. Although these ions are also removed by reverse osmosis, water softeners in regions with “hard water” reduce accumulation of calcium and magnesium salts, thereby prolonging the life of the reverse osmosis (RO) membrane.
3. Reverse osmosis is the mainstay of dialysis water purification. Hydrostatic pressure drives water across a semipermeable membrane and excludes >90% of the contaminants. This strategy removes ionic contaminants, bacteria, and endotoxin.
4. Deionization (DI) removes ionic contaminants by exchanging cations for H^+ and anions for OH^-. DI is usually used for water purification when the RO membrane fails. Water processing through DI requires bacterial control filters after DI purification because DI systems promote bacterial growth. Finally, the DI membrane is saturable and requires continuous monitoring of conductivity with mechanisms for diverting RO water when conductivity exceeds 1 μS/cm to avoid breakthrough of fatal contaminants such as fluoride.
5. Depth filters remove particulate matter from municipal water.
6. Bacteria- and endotoxin-retentive filters bind and remove bacteria and endotoxin.