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Water treatment for hemodialysis.

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Full Text

Water treatment for preparation of dialysate is probably the most neglected area of renal replacement□with dialysis. According to a report from the CDC of United States of America based on survey of Dialysis associated hepatitis and other disease, it was reported that 1 % centres used no water tredtment, 50% used reverse osmosis, 13% used deionization, 33 % combination of reverse osmosis and deionization and 2% used other combination. The frequency of pyrogen reactions were reported between 10□13%, it was believed that this figure was an under estimate.

Quality of water contributes very significantly in morbidity and life threatening reactions in dialysis patients in both; an acute sense, as well as in long-term prognosis. Several reports have appeared in literature describing the toxic effects of various contaminants. These are summarised in [Table:1].

Survival of haemodialysis patient is steadily improving which has led to increasing problems due to contaminants of dialysis water. Haemodialysis patients are exposed to 25 to 30 times of water compared to normal individuals drinking water needs. Contaminants enter the blood compartment of dialysers and accumulate in the body due to inability of these patients to excrete them via their kidneys.

Association for the Advancement of Medical Instrumentation (AAMI) have defined water quality standards for haemodialysis for substances with known toxicity during haemodialysis. These are shown in [Table:2].

In our country as yet there is no prescribed standards for water quality for haemodialysis. The goal should be to prepare sterile, pyrogen□free and chemically pure water.

The attaining of this goal has become necessary urgently because: 1) prolonged survival on dialysis has become common; (2) dialysis patients are exposed to 25 to 30 times more water; compared to the gut of normal individuals, across a non□selective membrane.; (3) dialysers are re□used; (4) water contamination by bacteria and endotoxins is common.; (5) water dis-infection in municipal water by chlorine and chloramines is toxic to dialysis patients; (6) use of bicarbonate dialysis is increasing due to recognition of complications of acetate dialysis both immediate as well as long term. In Japan almost □100% and in Europe 40% patients are on bicarbonate dialysis. The bicarbonate concentrate has been documented to have increased susceptibility to microbial contamination. (7) High flux membranes are available and are being used with increasing frequency. The issue of back transport during dialysis has therefore assumed great importance; of particular interest is transfer of endotoxins from dialysate to blood compartment, these can cause minor febrile resactions to severe shock as acute toxicity and may be responsible for chronic effects such as amyloidosis, carple tunnel syndrome by continuolus stimulation of cytokines formation (8) Quality of water varies from place to place and from time to time in the same place.

Several technologies are available for purification of water. Each haemodialysis unit should decide to use a combination of these to, achieve above mentioned goal of nontoxic, sterile and pyrogen free water. The factors influencing the selection of a combination are: (1) Composition of feed water. (2) Amount of treated water required. 3) Availability of space. (4) Cost of the system and its running expenditure (5) Type of dialysate and membrane used. (6) Major load of patients for acute versus maintenance dialysis.

Following options are available for water treatment.

1. Filtration:

a. Sediment filtration is used to remove suspended solids, which are more than 1.0 micron particle size. Water is allowed to percolate through a porus material eg. sand, closely packed fibres etc. This process is necessary to protect dialysis or water treatment equipment from clogging by particulate material and hence loosing their efficiency. The efficiency of a sediment filter is monitored by pressure drop across the filter. The problems associated with these filters are microbial proliferation and sloughing of filter media in effluent water.

b. Ultraffitration and microfiltration: These are membrane, filters capable of removing dissolved and undissolved particulate matter in submicron range typically smaller than 0.1 microns. These membranes are therefore used to remove bacteria, viruses, pyrogen and dissolved high molecular weight organic contaminants. The efficiency of these filters is also monitored by pressure drop across the filter. These are incapable of removing ions. These are best used just prior to haemodialysis machines to check bacterial contamination that might have occured in other water treatment devices.

2. Water treatment based on ion exchange resins

(a) Water Softeners: Use cation exchange resins that exchange sodium ion for calcium, magnesium and other polyvalent cations present in feed water. As more and more exchanges take place the resin gets exhausted and has to be regenerated by concentrated salt solution.

These are useful to prevent hard water syndrome and to protect reverse osmosis membrane from scaling. The monitoring of effluent for hardness should be periodically done. Problem of resins is that, they promote bacterial growth.

(b) Deionisers as the name suggests remove all ions from feed water. These employ columns of cations resins and anion resins, the former exchange hydrogen ions for cations and the latter hydroxyl ions for anions Some times mixed bed resins containing both resins are added.

These are used after the two column deionisers. The efficiency of deionisers are constantly monitored by measuring resistivity of effluent water. It is desirable to obtain a resistivity of at least 1 magohm/ cm. The resitivity monitors should be temperature compensated. The regeneration of resins is done by using strong (hydrochloric) acid for catonic resins and by strong alkalies (sodium hydroxide) for anionic resins. Regular resistivity and pH monitoring is essential.

Acidic effluent from exhausted resins resulting in heparin inactivation and clotting of dialysers has been reported. If water is obtained after the resins are exhausted, they may release large quantities of contaminants they were supposed to remove. Other important problem in deionisers like softeners is of microbial proliferation. Regular disinfection and bacteriological survellance is therefore absolutely essential.

3. Absorption to activated charcoal filters:

These are most useful for removal of chlorine and chloramines and other organic matter by absorption. They have very large surface area due to microporous nature of activated charcoal obtained by heating and exposure to steam the source of carbon is coal, wood, coconut shells bone etc. Unlike resins, activated carbon filters cannot be regenerated. Once exhausted they have to be replaced. Their efficiency is monitored by measuring chlorine and chloramines in the effluent. Other problem with activated carbon is release of small carbon particles in the effluent and microbial proliferation. As deionisers are not capable of removing chlorine and chloramines, which may damage reverse osmosis membranes; the carbon filtration is used as a pre-treatment.

4. Reverse Osmosis Like Ultraffitration: This is also a membrane based process. Commonly used membranes are: Cellulose acetate, or polyamide. The membranes arranged in. tubular spiral wound or hollow fibre configuration. In osmosis the flow of solvent is from less concentrated to more concentrated side of the semi-permeable membrane. Pressure is applied to the concentrated side to reverse this flow and hence, the process is called reverse osmosis. The process is capable of rejecting more than 90% monovalent ions and 95□99% of divalent ions (more than 200 daltons). It is very effective in removing dissolved inorganic and organic contaminants, bacteria, endotoxins and particulate matter. The efficiency of reverse osmosis measured by calculating "percent rejection" calculated from resistivity of feed water to the resistivity of effluent. Reverse osmosis membranes are susceptible damage by pH, chlorine and particulate matter. As they are very expensive and hence, to protect them, water pro□treatment is essential.

Though they are efficient removers of bacteria, their contamination through small leaks in membrane and at joints is possible. Regular bacteriological surveillance and dis-infection is therefore necessary.

5. Distillation of Water: Water is converted to steam and then condensed again by cooling. This is effective method of removing particulate, colloids, bacteria, viruses and pyrogen. It is incapable of removing volatile contaminants. It also requires storage of treated water and is very expensive. It is therefore not used as a treatment for haemodialysis water.

6. Ultraviolet Irradiation: This is used finally just prior to the dialysis machine, to inhibit bacterial growth, after all other water treatment is done. Bacteria may grow resistant to ultraviolet light. If used without pro□ treatment the effectiveness is lost because suspended particulate matter may block light waves.

A summary of various treatment technologies for reducing contaminants is given in [Table:3].

The water treatment system designed in my dialysis unit at Muljibhai Patel Urological Hospital, Nadiad is given in [Figure:1].

1. Water treatment is a generally neglected area of dialysis therapy.

2. Due to increased survival of dialysis patients, in creased use of bicarbonate dialysate and high flux membranes water treatment has become essential.

3. It is worthwhile achieving the goal of sterile, pyrogen tree and chemically pure water for dialysis.

4. The above goal is achievable with a combination of various technologies available.

5. After designing a system based on requirements of individual unit both quality, quantity and cost effectiveness, it

is essential to monitor the effluent water regularly.

6. Guidelines and expert panel needs to be set□up in our country to advise and supervise dialysis water treatment.

References

1 Scrivner RE, Favero M, Calpin JA, Grisim J, Valchek D. Issues in Water Treatment. Dial Transpl 1987; 16(11):593.

2 Cartwright PS. Haemodialysis water treatment: A consultant's perspective. Dial Transpl 1992; 21(3):130□138.

3 Keshaviah PR, Shaldon S. Haemodialysis monitors and monitoring. In: Maher JF, editor. Replacement of Renal Function by dialysis. Dordrecht, Netherlands: Kluwer Academic Publishers; 1989, pp 276.

4 Berland Y, Brunet A, Ragon A. Frenkian G, Crevat A. Dialysate biocompatibility evaluation & expectations. Contrib Nephrol 1993; Vol 103, pp 76□88.

5 Klinkmann H, Ebbighausen H, Uhienbusch I, Vienken J. High flux dialysis, diaiysate Quality & backtransport. Contrib Nephrol 1993; Vol. 103, pp 89□97.

6 Platt MM, Moorhead PJ, Grech P. Dialysis Dementia. Lancet 1973; 2:159

7 Dunea G, Mahurkar SD, Manridani B, Srnith EC. RIP of aluminium in dialysis dementia. Ann Intern Med 1978; 88:502.

8 Ward MK, Ellis HA, Feest G, Parkinson IS, Kerr DNS. Osteomalacic dialysis osteodystrophy: evidence of a water borne etiological agent, probably aluminium. Lancet 1978; 1:841□845.

9 Freeman RM, Lawton RL, Chamberlain MA. Hard water syndrome. N Engl J Med 1967; 276:1113□1118

10 Neilan BA, Ehiers SM, Kolpin CF, Eaton JW. Prevention of chloramine induced haemolysis in dialysed patients. Clin Nephrol 1978; 10:105

11 Manzier AP, Schreiner W. Copper induced acute haemolytic anaemia. Ann Intern Med 1970; 73:409□412

12 Robson M, Oren A, Ravid M. Dialysate sodium concentration. Hypertension and pulmonary edemain haemodialysis patients. Dial Transpl 1978; 7:678□679.

13 Lonnemann G, Bingel M, Flogge J, Xoch KM, Shaldon S, Dinarello CA. Kid int 1988; 33:524-526.

14 Bommer J, Ritz E. Water quality □ a neglected problem in haemodialysis. Nephron 1987; 46:1□6.