Medication Errors

Dangers of Peritoneal Dialysis Solutions When Knowledge of Physiology Is Poor

Matthew Grissinger, RPh, FASCP

Problem: For several weeks, an anephric infant was undergoing peritoneal dialysis via commercially available dialysis solutions. As needed, pharmacists added supplementary electrolytes to the solution. When the infant’s clinical condition changed, however, the physician wrote an order for a tailor-made dialysis solution, listing the amount of each electrolyte, including 140 mEq of sodium as chloride and bicarbonate.

The pharmacist, who had been accustomed to adjusting electrolytes in dialysis solutions, wrongly assumed that the ordered electrolytes should be added to the commercially available solution instead of sterile water for injection (SWFI) as the base. This solution already contained an electrolyte composition similar to that of plasma, with 140 mEq/L of sodium.

To prepare the ordered solution, the pharmacist mixed an additional 140 mEq/L of sodium into the dialysis solution, equal to a total sodium content of about 280 mEq/L. Although he knew that the solution contained an inherent amount of electrolytes, he believed that he was simply adding more sodium to the solution, similar to the way one would treat electrolyte deficiencies, by increasing the amount of sodium in total parenteral nutrition (TPN). The pharmacist had a limited knowledge of the principles governing peritoneal dialysis and did not realize that the patient’s serum sodium level would increase to equilibrium with the solution’s concentration during each cycle of peritoneal dialysis.

The dialysis nurse did not detect the error, because the pharmacy label, which listed only the additives to the dialysis solution, was inadvertently placed over the manufacturer’s label, covering the type and amount of electrolytes inherent in the solution.

In addition, the pharmacist had not recognized that the bicarbonate he added to the solution would precipitate with calcium in the solution. The neonate’s dialysis line became clogged during the night as a result of the calcium carbonate precipitate.

After re-examining the label, a nurse later recognized the error; by then, however, the neonate’s sodium level exceeded 200 mEq/L (n = 135–147 mEq/L). The infant’s condition deteriorated, and he died a few days later.

Safe Practice Recommendation: Several strategies can be used to prevent errors like this one. For example:

1. In the pharmacy, recipe cards can be used along with preprinted order forms for peritoneal dialysis solutions. The forms should list typical ranges of electrolytes per liter and should prompt prescribers to clearly indicate the base solution (or sterile water for injection) and the total amount of electrolytes needed.

2. The staff should be alerted to the potential incompatibility between calcium-containing solutions and sodium bicarbonate.

3. Pharmacy labels for peritoneal dialysis solutions should clearly indicate the total mEq/L of electrolytes. The labels should be placed on bags in a way that avoids covering the manufacturer’s label if commercially available solutions are used as a base.

4. The dialysis nurse should be required to check the solution’s label against the original order, and another nurse should recheck the solution independently.

Practitioners who treat patients undergoing dialysis, as well as pharmacists who prepare or dispense dialysis solutions, should clearly understand the physiology behind the process. Dialysis is the movement of ions and small molecules, including water, across a dialyzing membrane, such as the semipermeable peritoneal membrane. The direction of particle transfer is guided by osmosis, the movement of water across an osmotic membrane from a more dilute solution into a more concentrated solution. Glucose, the common osmotic agent in dialysis solutions, creates a greater concentration gradient across the membrane to remove excess fluid from the blood.

Simultaneously, ions or other small particles may cross the membrane through diffusion, the movement of solutes from an area of greater to lesser concentration. Typically, urea, creatinine, uric acid, potassium, and phosphate move from the patient’s blood (a higher concentration) to the dialysate (a lower concentration), with the net effect of lowering the concentration in the blood. Using a dialysate with an electrolyte concentration higher than the patient’s plasma, however, causes the patient’s serum levels to become equal to the dialysis solution during each cycle of dialysis by moving water and electrolytes through the semipermeable membrane.

This is what occurred in the unfortunate case cited here.

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