Dialysate Concentrate: A Potential Source for Lethal Complications

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Dear Sir,

Hemodialysis has become easier to deliver, but the equipment and modalities of therapy have become more complex and diversified. We report one problem that occurred in 2 patients undergoing hemodialysis therapy at our center, and which could possibly result in an undetected cause of mortality and could account for unnecessary morbidity in this patient population.

Two patients normally dialyzed on a Gambro AK-10 machine with normal heparinization on a Gambro-5-N dialyzer experienced difficulties after dialysis. The first patient was noted to be sick and hypertensive and not feeling well toward the end of dialysis. It was questioned whether he was receiving adequate hemodialysis, was septic or had experienced an acute pulmonary event or possible air embolus. Blood chemistries indicated that he had received adequate hemodialysis and the CBC had a normal white count. The surprising finding was a severe metabolic acidosis on arterial blood gas analysis, atypical for a patient having just completed 4 h on dialysis. It was discovered that the patient's acetate bath was really an acid concentrate jug used in bicarbonate dialysis into which potassium had been added. The patient was redialyzed with the proper potassium content and bath without incident.

The second patient had dialyzed and left the unit when it was discovered that he, too, had used the acid concentrate instead of the acetate as dialysate bath. He was contacted at home and told to return to the unit where he underwent dialysis with the proper bath. His only symptoms were mild nausea and fatigue, and he felt that they were not extraordinarily different from the symptoms experienced after dialysis on other days. Table I lists the laboratory values at the end of dialysis for the 2 patients undergoing dialysis with an acid concentrate.

We questioned whether it was possible for the dialysate equipment to proportion the dialysate fluid using an acid concentrate as acetate and still obtain the proper conductivity without setting off alarms. We selected seven machines used on these patients. The machines were first used with acetate hemodialysis concentrate (GB-17, Dialysate Products) and then run with acid concentrate (GB-1010, Dialysate Products). Table II lists the results.

Table I. Postdialysis laboratory values

Na ⁺ , mEq/l	142.04 ± 2.34	129.31 ± 4.044
K ⁺ , mEq/l	2.16 ± 0.114	3.21 ± 0.772
pH	7.369 ± 0.04	4.728 ± 0.23a

Conductivity, mmho/cm 14.07 ± 0.22 14.2 ± 0.16

Most significant variation.

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Table III. Results after dialysis with acid in place of acetate (A) and after dialysis with wrong acid and bicarbonate concentrate (B)

Data for acetate dialysate are in agreement with product specifications indicating what concentrations should be delivered to the dialyzer. The acid concentrate is however capable of replacing the acetate without alarms and with matching conductivity. The largest difference and potential problem is the low pH.

Acetate and acid concentrate are both colorless fluids containing electrolytes and dextrose; perhaps the only characteristic that distinguishes the two is the taste and smell of acetic acid in the acid concentrate or differences on the package label. As demonstrated above, if acid concentrate is used in place of acetate concentrate, the proportioning equipment will be able to dilute it to the proper conductivity. This is true in both volumetric and dynamic proportioning systems. Our study dealt with the Gambro machine, but if the Century Rx machine or others are used, they, too, will achieve a conductivity that is appropriate despite a low pH (table III) [1] with the use of the acid concentrate in the acetate mode. In fact, serious error is also possible with bicarbonate dialysis if the wrong acid and bicarbonate concentrates are used on the wrong manufacturer's equipment (table III) [1].

Potential errors with concentrate are numerous, depending upon how solutions are mixed, stored and dis-

pensed, and depending upon the variety of solutions available at the dialysis center [2,3]. Some manufacturers safeguard against some of the potential errors by color-coding the concentrate container, the delivery line and connector as well as by keying the connector on the line to the connector on the concentrate container. However, these safeguards are obviously not fool-proof, and when multiple equipment from a list of manufacturers is utilized it is possible to override these safety features. Our recommendations are that the placement of dialysate concentrate be regarded as an important medical task with concomitant care and liability for the responsible individuals that set up the machines, maintain concentrate levels during dialysis as well as medical personnel performing hemodialysis. Being aware of the problem and knowing that it exists is probably the best safeguard. Physicians should also keep in mind that clinical deterioration instead of improvement with dialysis can be due to concentrate errors as well as a host of physical and medical factors surrounding the dialysis patient. Color coding, keying of connectors and increasing the volume of concentrate containers so that mid-run changes are not necessary would all be helpful to prevent or minimize this risk.

References

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