Effects of Different Mixing Methods on the Concentration of Sodium in “Fresh” Dialysate

Sodium sieving or dipping is an important parameter in peritoneal membrane functional assessment and follow-up (1,2), and so measurements of the Na concentration in fresh dialysate (FD) have to be accurate. However, for reasons that have not yet been well clarified, it has been observed that if Physioneal dialysate (Baxter Healthcare SA, Castlebar, Ireland) is used for a peritoneal equilibration test (PET), the concentration of Na in FD is significantly lower at time 0 in the PET than

that declared by the manufacturer (3). Physioneal bags have two compartments separated by an “interchamber frangible pin.” The top compartment [small chamber A (ChA)] holds the solution containing the glucose; the Na-containing solution is in the bottom compartment [large chamber B (ChB)]. When the frangible pin is broken, the solutions mix to produce the FD. The producer recommends “breaking the frangible seal between the two chambers immediately before use. After mixing, the intraperitoneal solution must be administered within 24 hours.” Although that guideline is sufficient for clinical use of the solution, it is clearly insufficient for performance of a PET (3).

In the present study, we sought to demonstrate our hypothesis that the lower concentration of sodium in Physioneal bags of FD is simply a result of insufficient mixing of the chambered solutions, and if so proved, to develop a standardized mixing method that will prevent the problem.

OBJECTIVES

We evaluated the concentration of Na in 3.86% Physioneal bags of FD mixed by gravity as suggested by the manufacturer, and we compared the results with those obtained after subjective manual mixing and a standardized mixing method.

METHODS

These methods were used to mix the FD:

- Mix A: After breaking the frangible pin, no action was taken while the solution in ChA drained into ChB (Figure 1). This method is suggested by the manufacturer for clinical use of the solution. To visually evaluate the remixing of the dialysate after it had passed from ChA to ChB with Mix A, the solution in ChA was colored with 10 mL rifamycin (500 mg/10 mL).
- Mix B: After breaking the frangible pin, a constant rhythmic pressure was applied with both hands on ChB while the solution in ChA drained into ChB (Figure 1).
- Mix C (standardized): No action was taken after the frangible pin was broken. When all the contents of ChA had drained into ChB, the bag was turned upside down so that the dialysate flowed back from ChB into ChA. After approximately 10 minutes, 1300 mL of dialysate had passed from ChB into ChA and the flow had stopped. At that point, the bag was turned upside down again so that all the dialysate returned into ChB (Figure 2).

Figure 1 — Mix A and Mix B methods.

Figure 2 — Mix C method. When the entire content of chamber A has drained into chamber B (step 2), the bag is turned upside down so that the dialysate flows back from chamber B into chamber A (steps 3 and 4). When the flow stops, the bag is turned upside down again so that all the dialysate returns to chamber B (steps 5 and 6).

At the end of each mixing method, the drain line from which the FD is collected was cut at its midpoint. The collection of FD (10 mL) was preceded by flushes of 30 mL (FLvol₃₀), 50 mL (FLvol₅₀), 100 mL (FLvol₁₀₀), 150 mL (FLvol₁₅₀), and 500 mL (FLvol₅₀₀). Each flush was transferred into a container into which all the contents of the bag were drained at the end of the test. At the end of the test, a sample was taken from this container to determine the Na concentration (benchmark) in the solution overall (ALLvol). Each mixing method was performed on eight 2000 mL 3.86% Physioneal bags. Mix B was performed by various people.

The Na and glucose were measured for each collection, the latter with appropriate dilution. The concentration of Na was determined using an indirect potentiometer (Dimension EXL: Siemens Healthcare, Erlangen, Germany) (4). Our laboratory's coefficient of variability for Na concentration in dialysate for values less than 150 mEq/L is 1.2%.

RESULTS

Table 1 presents the concentrations of Na and glucose obtained using the various mix methods after the various flush volumes.

In all collections (FLvol₃₀ – FLvol₅₀₀), the concentrations of Na obtained after Mix A were significantly lower ($p < 0.001$) than the concentration obtained for the dialysate overall (ALLvol).

In all collections, the concentrations of Na obtained

after Mix B were lower (FLvol₃₀: nonsignificant; FLvol₅₀, FLvol₁₀₀, FLvol₁₅₀: $p < 0.005$; FLvol₅₀₀: $p < 0.05$) than the concentration obtained for the dialysate overall.

In all collections, the concentrations of Na obtained after Mix C were nonsignificantly different from the concentration of Na in the dialysate overall.

The concentrations of glucose corresponded inversely with the Na concentrations: that is, they were higher after Mix A than after Mix B or Mix C (Table 1).

Finally, visualization of Mix A (Figure 3) showed that remixing of the solution was not complete at the end of the passage of the colored solution from ChA to ChB.

DISCUSSION AND CONCLUSIONS

Our study shows how PET results can be influenced by the type of solution used. In particular, it shows that the smaller concentration of Na in a Physioneal bag of FD (3) depends on the way in which the chamber contents are mixed. The manufacturer's recommendation not to administer the dialysate without first breaking the frangible pin between the chambers is necessary for clinical practice, but it is not sufficient for correct measurement of the Na concentration in FD during a PET. This problem can be obviated by using a standardized method (Mix C) to mix the solutions. Finally, for a drainage line cut in half, a 50 mL flush seems to be adequate because, with Mix C, the Na concentration at FLvol₅₀ is superimposable with the overall concentration.

TABLE 1
Concentrations of Sodium and Glucose^a Obtained in Physioneal 3.86% Dialysate^b Using Various Mix Methods After Different Flush Volumes

Mix type ^c	30 mL	50 mL	100 mL	150 mL	500 mL	Dialysate overall
Sodium (mEq/L)						
Mix A	121.9±4.9	119.5±2.3	120.1±2.0	120.8±2.0	122.5±1.7	134.0±2.5
Mix B	132.8±2.7	131.6±1.9	131.5±1.8	131.9±1.6	133.1±1.0	134.4±0.9
Mix C	136.0±4.5	133.4±1.2	133.1±1.5	133.3±1.2	133.4±1.8	133.8±1.3
Glucose (mg/dL)						
Mix A	4438±360	4521±195	4385±300	4476±107	4440±101	3788±159
Mix B	4001±229	3923±106	4005±98	3960±106	3953±89	3863±111
Mix C	3790±269	3864±168	3875±154	3909±136	3900±140	3875±160

^a Mean ± standard deviation of 8 experiments.

^b Baxter Healthcare SA, Castlebar, Ireland.

^c See the Methods section for details of the mix types.

Figure 3 — Mix A. A vial of rifamycin (250 mg in 10 mL) is injected into chamber A. Even at the end, mixing is not complete.

DISCLOSURES

The authors declare that no financial conflict of interest exists.

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REFERENCES

1. Mujais S, Nolph K, Gokal R, Blake P, Burkart J, Coles G, *et al.* Evaluation and management of ultrafiltration problems in peritoneal dialysis. International Society for Peritoneal Dialysis Ad Hoc Committee on Ultrafiltration Management in Peritoneal Dialysis. *Perit Dial Int* 2000;

20(Suppl 4):S5–21.

2. La Milia V, Pozzoni P, Virga G, Crepaldi M, Del Vecchio L, Andrulli S, *et al.* Peritoneal transport assessment by peritoneal equilibration test with 3.86% glucose: a long-term prospective evaluation. *Kidney Int* 2006; 69:927–33.
3. La Milia V, Limardo M, Crepaldi M, Locatelli F. Effects of ionized sodium concentrations on ultrafiltration rate in peritoneal dialysis using lactate and lactate/bicarbonate solutions. *Perit Dial Int* 2009; 29:158–62.
4. La Milia V, Di Filippo S, Crepaldi M, Andrulli S, Del Vecchio L, Scaravilli P, *et al.* Sodium removal and sodium concentration during peritoneal dialysis: effects of three methods of sodium measurement. *Nephrol Dial Transplant* 2004; 19:1849–55.

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