AUTOMATED PERITONEAL DIALYSIS PRESCRIPTIONS FOR ENHANCING SODIUM AND FLUID REMOVAL: A PREDICTIVE ANALYSIS OF OPTIMIZED, PATIENT-SPECIFIC DWELL TIMES FOR THE DAY PERIOD

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◆ **Background:** Remaining edema-free is a challenge for many automated peritoneal dialysis (APD) patients, especially those with fast (“high”) transport characteristics. Although increased use of peritoneal dialysis (PD) solutions with high glucose concentrations may improve volume control, frequent use of such solutions is undesirable.

◆ **Methods:** We used the 3-pore kinetic model to evaluate 4 alternative therapy prescriptions for the APD day exchange in anuric patients with high, high-average, and low-average transport characteristics. Four prescriptions were modeled:

Therapy 1: Optimal, individualized dwell times with a dry period

Therapy 2: Use of a midday exchange

Therapy 3: Use of an icodextrin-containing dialysate during a 14-hour dwell

Therapy 4: Use of optimal, individualized dwell times, followed by an icodextrin dwell to complete the daytime period

The alternative therapies were compared with a reference standard therapy using glucose solution during a 14-hour dwell. The nighttime prescription was identical in all cases (10 L over 10 hours), and all glucose solutions contained 2.27% glucose. Net ultrafiltration (UF), sodium removal (NaR), total carbohydrate (CHO) absorption, and weekly urea Kt/V for a 24-hour period were computed and compared.

◆ **Results:** The UF and NaR were substantially higher with therapy 1 than with standard therapy (1034 mL vs 621 mL and 96 mmol vs 51 mmol respectively), without significant changes in CHO absorption or urea Kt/V. However, therapy 1 resulted in reduced β 2-microglobulin clearance (0.74 mL/min vs 0.89 mL/min with standard therapy). Compared with therapy 1, therapy 2 improved UF and NaR (1062 mL vs 1034 mL and 99 mmol vs 96 mmol); however, that improvement is likely not clinically significant. Therapy 2 also resulted in a higher Kt/V (2.07 vs 1.72), but at the

expense of higher glucose absorption (difference: 42 g). The UF and NaR were highest with a long icodextrin-containing daytime dwell either preceded by a short optimized dwell (1426 mL and 155 mmol) or without such a dwell (1327 mL and 148 mmol).

◆ **Conclusions:** The 3-pore model predictions revealed that patient-specific optimal dwell times and regimens with a longer day dwell might provide improved UF and NaR options in APD patients with a variety of peritoneal membrane transport characteristics. In patients without access to icodextrin, therapy 1 might enhance UF and NaR and provide a short-term option to increase fluid removal. Although that approach may offer clinicians a therapeutic option for the overhydrated patient who requires increased UF in the short term, APD prescriptions including icodextrin provide a means to augment sodium and fluid removal. Data from clinical trials are needed to confirm the predictions from this study.

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KEY WORDS: Therapy optimization; individualized dwell time; ultrafiltration; ultrafiltration efficiency; sodium removal; dry period.

Achieving adequate fluid and sodium removal (NaR) is an ongoing challenge for many peritoneal dialysis (PD) patients (1,2). Recent guidelines have emphasized the importance of maintaining euvolemia in that patient population, given the high prevalence of cardiovascular disease (3). The challenge is greatest for patients with fast (“high”) membrane transport characteristics (4–6), which increase the risk of overhydration, hypertension, and cardiovascular complications (7).

Although much of that challenge has been associated with fast-transport patients on continuous ambulatory PD (CAPD) (6,8–10), the increased use of cyclers and Extraneal (Baxter Healthcare Corporation, Deerfield, IL, USA), a 7.5% icodextrin long-dwell PD solution, has enabled patients to achieve better fluid balance, even

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when residual renal function is lost (11). Still, the need for improved fluid removal persists for patients who do not have access to Extraneal, for those who are anuric and require strict fluid restriction (12), and for those who require higher dialysate glucose concentrations because of deteriorating ultrafiltration (UF) capacity. Notably, UF failure rates in long-term PD patients have been reported to range from 15% to 30% (13,14).

Previous attempts to improve UF and NaR have involved novel bimodal PD solutions combining glucose and icodextrin (15–17) or modifications to the number of nighttime dwells and fill volumes (18–21). Although improvements were demonstrated, those improvements either required large quantities of additional glucose (15,16) or were of marginal clinical significance (21). In children, optimization of the PD prescription was suggested on the basis either of the time at which the dialysate glucose and urea curves crossed [that is, the apex (accelerated peritoneal equilibration examination) time, to optimize UF] or of the time at which the phosphate concentration in dialysate reached 60% of that in blood [a dialysate-to-plasma ratio (D/P) of 0.6, to optimize solute removal] (22). Similarly, the maximal effective dialysate flow was recommended for a range of peritoneal equilibration test groups to optimize creatinine clearances (23). Other notable attempts focused on the use of 2 daytime icodextrin exchanges (24–26).

In the present work, we compared alternative prescriptions for the day exchange of automated PD (APD) therapies for patients with high (H), high-average (HA), and low-average (LA) transport. Specifically, as a short-term option to enhance UF when icodextrin is not available, we evaluated a short-dwell exchange followed by a dry period, in which the dwell time was optimized to the patient based on peritoneal transport rate. Also, when icodextrin was available, an additional regimen combining icodextrin with an optimized short glucose exchange was modeled to profile enhanced UF and NaR.

METHODS

The effect of patient-specific short daytime dwells followed by a dry period was evaluated using average values for peritoneal transport parameters derived from a large number of patients. A modified 3-pore model based on PD Adequest (Baxter Healthcare) was used to perform the simulations.

PATIENT DATA

The patient parameters used in the study were obtained from the TARGET [Treatment Adequacy Review

for Gaining Enhanced Therapy (Baxter Healthcare)] dataset, which was constructed in 1999 in collaboration with dialysis centers in Canada and the United States. The centers collected data from patients at the end of a long overnight exchange and 4-hour peritoneal equilibration test. Those data were voluntarily sent to the Renal Division at Baxter Healthcare Corporation for analysis. Data from approximately 1200 patients were available (27). To obtain average kinetic parameters, the data were first grouped into 4 peritoneal equilibration test categories (high to low) according to 4-hour D/P creatinine measurements (28). Relevant kinetic transport parameters, such as solute mass transfer area coefficient (in milliliters per minute), UF coefficient (hydraulic permeability area in milliliters per minute per millimeter Hg), and peritoneal transport surface area (A0/dX in centimeters), were then estimated for each patient using PD Adequest 2.0 (29,30). As a last step, 4 typical patients were created as representatives of each category. That procedure was repeated for 3 body surface area categories (<1.71 m², 1.71 m² – 2.0 m², and >2.0 m²). The patient parameters analyzed in our study represent anuric fast- and average-transport patients (H, HA, LA) in the medium body surface area category. Table 1 summarizes relevant patient parameters.

TABLE 1
Characteristics and Relevant Kinetic Parameters
for High (H), High-Average (HA), and
Low-Average (LA) Transport Patients

Variable	Patient transport type		
	H	HA	LA
Body surface area (m ²)	1.85	1.86	1.87
Total body water (L) ^a	40.6	41.3	42.3
4-Hour D/P creatinine	0.86	0.71	0.59
4-Hour D/D ₀ glucose	0.25	0.34	0.44
MTAC (mL/min) for			
Urea	27.71	23.14	18.40
Creatinine	19.15	11.92	8.60
Glucose	16.34	11.71	8.35
LPA (mL min ⁻¹ mmHg ⁻¹)	0.0575	0.0560	0.0563
A0/dX (cm)	40 398	29 362	21 942

D/P = dialysate-to-plasma ratio; D/D₀ = end-to-initial dialysate concentration ratio; MTAC = mass transfer area coefficient; LPA = hydraulic permeability area (“ultrafiltration coefficient”); A0/dX = peritoneal transport surface area.

^a By the Watson formula.

COMPUTER MODEL

Unlike PD Adequest 2.0, the kinetic model used in our study allowed for sodium modeling and offered flexibility to vary the dwell time without any predefined constraints. It also differed from PD Adequest 2.0 by using MATLAB (version 7.13.0.564: The MathWorks, Natick, MA, USA) to numerically integrate the 3-pore model equations.

For simulations in which icodextrin was used during the long day dwell, steady-state plasma concentrations of the 5 modeled glucose polymer fractions were incorporated to consider patients who routinely use icodextrin. Moreover, the process of amylase hydrolysis was incorporated to include its corresponding effect on UF and total carbohydrate (CHO) absorption (Akonur A, Holmes CJ, Leyboldt JK. Predicting the peritoneal absorption of icodextrin in rats and humans including the effect of α -amylase activity in dialysate. *Perit Dial Int.* In press). Further descriptions and verifications of the model have been provided elsewhere (17,31, Akonur *et al.* In press).

DETERMINATION OF PATIENT-SPECIFIC DWELL TIMES

The concept of a short dwell followed by a dry period relies on patient-specific dwell times that optimize UF without sacrificing small-solute removal. The fundamental basis of such optimization is to drain the peritoneal fluid at a time when the osmotic pressure exerted by the glucose-based dialysis solution is no longer sufficient to offset reabsorption of dialysate from the peritoneal cavity back to the patient's body (tissues, blood, etc.). That time corresponds to the peak point of the UF-versus-dwell-time curve, as shown in Figure 1. The second half of the UF curve beyond the peak point can be characterized by an almost linear decline of UF attributable to reabsorption of peritoneal fluid. The urea-Kt/V-versus-time curve represents another peak dwell time, different from that of UF, as shown in Figure 2. Table 2 identifies and summarizes the dwell times corresponding to the maximal UF and maximal weekly urea Kt/V for each of the 4 typical patients.

ALTERNATIVE PRESCRIPTIONS FOR THE DAY EXCHANGE

The nighttime prescription was identical in each case (10 L over 10 hours), and all glucose solutions contained 2.27% glucose; tidal mode was not used in any of the prescriptions considered. The standard therapy and 4 alternative therapies were modeled for the long day exchange as shown in Figure 3. In the standard therapy,

Figure 1 — The ultrafiltration curves as a function of time and patient transport type during the long dwell of automated peritoneal dialysis. With 2 L of 2.27% glucose solution, peak dwell times were 2.5, 3.5, and 4 hours for high (H), high-average (HA), and low-average (LA) transporters respectively.

Figure 2 — The weekly urea Kt/V curves as a function of dwell time and patient transport type. Separate simulations were performed at each time point—that is, dwell times of 1 hour, 2 hours, and so on, up to 14 hours. With 2 L of 2.27% glucose solution, peak dwell times were 5, 6, and 7 hours for high (H), high-average (HA), and low-average (LA) transporters respectively.

2 L of 2.27% glucose (or 2.5% glucose monohydrate) solution was infused and left in the peritoneal cavity for the entire 14-hour daytime exchange (reference prescription). Therapy 1 modeled variable dwell times optimal for each patient's transport type. The optimal dwell time (T_{OPT}) was obtained for each patient by averaging the peak times obtained from the UF and urea Kt/V curves (summarized in Table 2) to maximize UF and NaR without compromising small-solute removal. The infused 2 L of 2.27% glucose solution was drained when T_{OPT} was reached, and the peritoneal cavity was kept dry

until the nighttime exchanges were started. Therapy 2 modeled two consecutive 2 L exchanges of 2.27% glucose solution for two 7-hour dwells—in other words, using a midday exchange procedure. Therapy 3 modeled the case in which icodextrin was used for the entire 14-hour daytime period. Finally, therapy 4 modeled the case in which T_{OPT} (therapy 1) was followed by an icodextrin dwell to complete the daytime period.

RESULTS

Results are shown for the average H, HA, and LA transport patients, who were assumed to be anuric, with a peritoneal residual volume of 350 mL and a blood sodium concentration of 137 mmol/L (32,33). The 24-hour

TABLE 2
Peak Dwell Times—That Is, the Maximum Points on the Ultrafiltration (UF) and Urea Kt/V Curves—for Each Patient Transport Type

Transport type	Peak dwell time (hours) according to		Optimal dwell time ^a [T_{OPT} (hours)]
	UF	Urea Kt/V	
H	2.5	5	3.75
HA	3.5	6	4.75
LA	4	7	5.5

^a Calculated as the average of the 2 peak dwell times.

Figure 3 — Schematic describing the modeled control and alternative automated peritoneal dialysis therapies. Prescriptions for the daytime period only are shown. Standard = 14-hour dwell; G = glucose; therapy 1 = optimized short dwell (T_{OPT}), followed by a dry day; therapy 2 = midday exchange; therapy 3 = icodextrin; therapy 4 = optimized short dwell, followed by icodextrin.

results are reported throughout, except in Table 3, where detailed results are shown for the nighttime and daytime periods separately.

24-HOUR UF

Figure 4 shows the predicted 24-hour UF. The reference standard therapy resulted in 621 mL of UF in 24 hours, the lowest among the therapies considered. That low value

TABLE 3
Therapy Results for the Night and Day Periods

Variable	Nighttime values (all therapies)	Std	Daytime values Therapy type			
			1	2	3	4
Ultrafiltration [UF (mL)]	852	-230	183	210	476	574
Na removal (mmol)	78	-26	18	22	71	77
Kt/V	1.37	0.30	0.34	0.70	0.42	0.74
CHO absorption (g)	109	42	33	75	71	90
UF efficiency (mL/g)	7.8	-5.4	5.5	2.8	6.7	6.4
β_2 M clearance (mL/min)	0.56	0.33	0.18	0.47	0.51	0.56

CHO = carbohydrate; β_2 M = β_2 -microglobulin; Std = 14-hour dwell; therapy 1 = optimized short dwell, followed by a dry day; therapy 2 = midday exchange; therapy 3 = icodextrin; therapy 4 = optimized short dwell, followed by icodextrin.

Figure 4 — The average of predicted 24-hour ultrafiltration (UF) for patients with high (H), high-average (HA), and low-average (LA) transport. Standard = 14-hour dwell; therapy 1 = optimized short dwell, followed by a dry day; therapy 2 = midday exchange; therapy 3 = icodextrin; therapy 4 = optimized short dwell, followed by icodextrin.

is attributed to rapid loss of glucose from dialysate to blood, resulting in negative UF during daytime dialysis (nighttime: 852 mL; daytime: -230 mL). Implementation of the patient-specific T_{OPT} in therapy 1 prevented the occurrence of negative UF, resulting in improved overall 24-hour UF (24-hour: 1034 mL; daytime: 183 mL). The addition of a second 2-L exchange during the day in therapy 2 provided a substantial improvement in UF compared with the UF achieved with standard therapy (24-hour: 1062 mL vs 621 mL), but the approach was not any more clinically advantageous than optimizing the dwell times for each patient (24-hour: 1062 mL vs 1034 mL). The largest improvements in 24-hour UF were achieved with prescriptions containing icodextrin (therapy 3: 1327 mL in 24 hours, 476 mL daytime; therapy 4: 1426 mL in 24 hours, 574 mL daytime).

24-HOUR NaR

The trend of the predicted 24-hour NaR shown in Figure 5 is the same as that of the 24-hour UF. Standard therapy removed only 51 mmol (1173 mg) of sodium (daytime: -26 mmol). The slight difference in the predicted 24-hour UF between therapies 1 and 2 also existed for NaR. Compared with standard therapy, therapies 1 and 2 removed approximately twice as much sodium: 96 mmol (2208 mg) and 99 mmol (2277 mg) respectively (daytime: 18 mmol and 22 mmol). Icodextrin solution removed 148 mmol (3404 mg) sodium (daytime: 71 mmol). The largest 24-hour NaR was achieved with the combination of icodextrin and optimized glucose dwells: 155 mmol (3565 mg; daytime: 77 mmol). The 24-hour NaR per liter of UF was 8.3 mmol/dL with the standard therapy, and 9.3 mmol/dL and 9.4 mmol/dL with therapies 1 and 2.

Figure 5 — The average of predicted 24-hour sodium removal (NaR) for patients with high (H), high-average (HA), and low-average (LA) transport. Standard = 14-hour dwell; therapy 1 = optimized short dwell, followed by a dry day; therapy 2 = midday exchange; therapy 3 = icodextrin; therapy 4 = optimized short dwell, followed by icodextrin.

The largest 24-hour NaR per unit of UF was 11.2 mmol/dL with therapy 3 (using icodextrin solution). Interestingly, although increases in total UF and NaR were greater with therapy 4 than with therapy 3, the ratio of NaR to UF was modestly lower (10.9 mmol/dL vs 11.2 mmol/dL).

WEEKLY UREA KT/V

As expected, the largest improvements in weekly urea Kt/V were obtained with the addition of a second daytime dwell (therapy 2, midday exchange; therapy 4, optimized short dwell followed by icodextrin), increasing the total prescribed solution volume per day. Figure 6 shows 24% and 27% improvements with therapies 3 and 4 compared with standard therapy (2.07 and 2.12 vs 1.67).

The concept of optimized dwell times incorporates both UF and urea Kt/V curves so that although the modeled prescriptions maximize UF and NaR, they do not markedly affect urea Kt/V. The result is clearly evident when therapy 1 is compared with the standard therapy (urea Kt/V: 1.72 and 1.67 respectively). Therapy 3 with the icodextrin solution also resulted in a urea Kt/V that was improved by 7% (1.79 vs 1.67), a lesser improvement than that with therapies 2 and 4 because of the lower number of exchanges and total solution volume used (12 L vs 14 L).

THE 24-HOUR CHO ABSORPTION AND UF EFFICIENCY

Figure 7(A) shows the predicted variations in 24-hour CHO absorption relative to the standard therapy, and Figure 7(B) shows the predicted UF efficiency defined as UF volume per gram of CHO absorbed. The standard therapy resulted in the lowest UF efficiency (4.1 mL UF

Figure 6 — The average of predicted weekly urea Kt/V for patients with high (H), high-average (HA), and low-average (LA) transport. Standard = 14-hour dwell; therapy 1 = optimized short dwell, followed by a dry day; therapy 2 = midday exchange; therapy 3 = icodextrin; therapy 4 = optimized short dwell, followed by icodextrin.

Figure 7 — The average of predicted 24-hour (A) carbohydrate (CHO) absorption and (B) ultrafiltration (UF) efficiency (UF in milliliters per gram of CHO) for each alternative therapy relative to standard therapy, for patients with high (H), high-average (HA), and low-average (LA) transport. Standard = 14-hour dwell; therapy 1 = optimized short dwell, followed by a dry day; therapy 2 = midday exchange; therapy 3 = icodextrin; therapy 4 = optimized short dwell, followed by icodextrin.

per gram of CHO), primarily because of poor daytime UF (daytime: -230 mL). Optimized dwell times followed by a dry period resulted in less CHO absorption (9 g less than with the standard therapy) and improved UF efficiency (7.3 mL UF vs 4.1 mL UF per gram of CHO). The use of 2 daytime exchanges and icodextrin (therapies 2, 3, and 4) resulted in increased CHO absorption (33 g, 29 g, and 48 g more compared with the standard therapy). However, the corresponding UF efficiencies were still higher than the efficiency with the standard therapy (5.8 mL, 7.4 mL, and 7.1 mL UF vs 4.1 mL UF per gram of CHO) because of substantially improved daytime UF.

MIDDLE-MOLECULE CLEARANCES

We also calculated the clearance of β_2 -microglobulin (β_2 M) as a surrogate of middle-molecule clearances. As shown in Table 4, shorter dialysis periods based on optimized dwell times followed by a dry period (therapy 1) resulted in lower 24-hour β_2 M clearance (0.74 mL/min vs

TABLE 4
Predicted 24-Hour Clearance of
 β_2 -Microglobulin (β_2 M)

β_2 M	Std	Therapy type			
		1	2	3	4
Clearance (mL/min)	0.89	0.74	1.03	1.07	1.13

Std = 14-hour dwell; therapy 1 = optimized short dwell, followed by a dry day; therapy 2 = midday exchange; therapy 3 = icodextrin; therapy 4 = optimized short dwell, followed by icodextrin.

0.89 mL/min with standard therapy). That difference is attributable to the strong dependence of middle-molecule clearance on the length of the dwell. With the other alternative therapies, in which the patients were dialyzed throughout the day, clearances of β_2 M were improved (1.03 mL/min, 1.07 mL/min, and 1.13 mL/min with therapies 2, 3, and 4 respectively).

DISCUSSION

The results from our modeling study emphasize that, to improve UF and NaR, the use of glucose-based dialysis solutions during the daytime period has to be optimized for each individual APD patient. Optimization is important for patients with fast transport characteristics, especially those who do not have access to icodextrin or those for whom it is especially desirable to limit glucose absorption and exposure of the peritoneal membrane to glucose. Currently, icodextrin is not available in certain countries in Central and South America, China, or other countries in Asia (Baxter Healthcare, data on file). Our predictions demonstrated that therapy 1 can be a reasonable short-term option to enhance UF and NaR in patients without access to icodextrin.

When compared with the standard reference therapy, icodextrin-containing prescriptions provided the greatest improvements in UF and NaR. Including all patients in the H, HA, and LA transport groups, we predict that icodextrin will provide an average increase of 97 mmol of NaR (13.7 mmol/dL) and 706 mL of UF over the course of a single 14-hour dwell period. Those predictions are in reasonable agreement with the results of clinical studies that compared icodextrin and glucose solutions in fast-transport patients. Fourtounas *et al.* (34) reported an average increase of 103 mmol NaR in 8 CAPD patients using icodextrin instead of 2.27% glucose solution. In a randomized controlled trial, Davies *et al.* (35) reported an average increase of 61.7 mmol NaR and 399 mL UF during the long dwell (8–14 hours) in a mix of CAPD and

APD patients using icodextrin instead of 2.27% glucose. In another randomized controlled trial, Finkelstein *et al.* (36) also reported an average increase of 399 mL UF with icodextrin solution during the long dwell in APD, this time compared with 3.86% glucose.

As expected, the addition of an optimized short dwell before the icodextrin dwell during the long day period in our study (therapy 4) further improved most adequacy parameters, especially UF and urea Kt/V. The optimized and midday exchange therapies provide similar improvements over the standard reference prescription except with respect to weekly urea Kt/V. The increased total dialysate volume with the addition of a second 2-L 2.27% glucose exchange resulted in greater urea clearances. However, the increased small-solute clearance with the midday exchange (therapy 2) was achieved at the expense of 33 g in extra glucose absorption compared with the 9 g of avoided glucose absorption with the optimized therapy.

The therapy optimization presented here differs from previous optimization efforts in several ways. First, unlike previous studies, which focused on optimizing the short night exchanges for all APD patients in general (18–21), we focused on the long day dwell and identified patient-specific T_{OPT} values that resulted in optimal UF and NaR without compromising small-solute clearances. Those results were achieved not based on the physical characteristics of the patients (for example, body surface area) or on variations in fill volume and number of exchanges (37–40), but rather on peritoneal transport kinetics (patient transport type—that is, D/P creatinine). Second, unlike most previous studies that aimed at increasing the weekly urea Kt/V and creatinine clearance above recommended values of 2.0 and 70 L/1.73 m², based on the results of the CANUSA trial (41), we focused on UF and NaR, which have been recognized to be of equal or even greater importance, based on the findings of the ADEMEX trial (42).

In a recent randomized controlled trial, Fischbach *et al.* (21) demonstrated increases in peritoneal UF, NaR, and small-solute clearances by modifying the fill volume and length of dwells during the short night exchanges. That effort toward improving adequacy is notable, especially because it does not require any additional glucose absorption or cause extra financial burden (21). However, although the demonstrated improvements were statistically significant, the increases were modest. Hence, the clinical impact is likely minimal: the peritoneal UF and NaR were shown to improve only by 87 mL and 14 mmol (21). In contrast, it is evident from the current predictions that optimizing the time of the long day dwell in APD, as opposed to the short night exchanges, might

be more effective in improving UF and NaR simply by preventing the occurrences of near-zero or negative UF. The approach discussed here might therefore provide a complementary and alternative tool to alleviate problems relating to the excessive fluid overload seen in anuric fast-transport patients who do not use icodextrin.

A potential indirect benefit of using short optimized daytime dwell times is the possibility of restoring deteriorated peritoneal membrane function by having dry periods after the short optimized dwells. Although the positive effects of so-called peritoneal resting periods remain uncertain (43), Selgas *et al.* (44) demonstrated that a 4-week peritoneal resting period reversed peritoneal damage caused by the frequent use of hypertonic glucose solutions, as measured by an increase in peritoneal UF and a decrease in the mass transfer area coefficient of creatinine. A further benefit is the minimization of glucose exposure, again as a result of the shorter time that the instilled dialysate resides within the peritoneal cavity.

Despite the significant improvements in UF and NaR, optimized therapy presents certain disadvantages. Most importantly, continued dependence on dry periods will result in impaired middle-molecule clearances. We predict reductions in β_2M clearances ranging from 17% to 35% when optimized therapy is compared with the standard and icodextrin-containing prescriptions. We therefore believe that the optimized therapy may be best suited for patients with residual renal function and for patients who are intermittently in need of fluid removal as a first priority (that is, not every day). In addition, the optimized therapy requires that patients perform a drain procedure sometime around midday, which may be inconvenient, especially for patients outside the home (for example, at work or school). A separate bag is also required to drain the peritoneal effluent, which is an added cost.

CONCLUSIONS

We present a new approach to provide improved UF and NaR without additional CHO absorption in APD patients with fast and average transport characteristics who lack access to icodextrin. In the new approach, a patient-specific optimized dwell is followed by a dry period during the day, offering clinicians a therapeutic means to manage the overhydrated patient who requires increased UF in the short term. That approach would not be recommended for long-term management unless the patient has substantial residual kidney function, because middle-molecule clearances are reduced. In the long term, APD with icodextrin remains an option to augment both sodium and fluid removal while also enhancing β_2M

clearance. A fundamental limitation of the present study is its reliance on 3-pore model simulations. Similar data from clinical trials representing the diverse APD patient population are needed to confirm the predictions from our study.

DISCLOSURES

The authors are employees of Baxter Healthcare Corporation and have ownership interests.

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