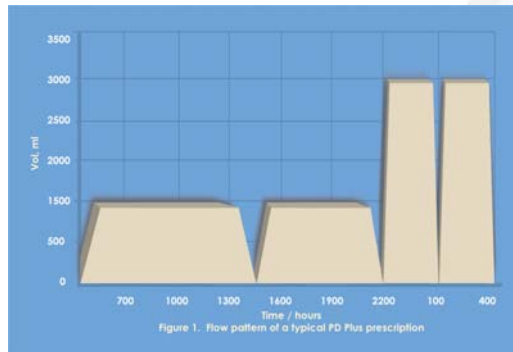



PD Plus™ Therapy: Optimizing Peritoneal Dialysis





Disclosure


- This presentation is not intended to replace the judgment or experience of the attending physician or other medical professional
- The PD treatment prescription is the sole responsibility of the attending physician
- Please refer to clinic policies and procedures for further information

PD Plus Optimizing PD

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PD Plus concept

- First described in 1996 by Diaz-Buxo¹
- Maximize solute clearance and ultrafiltration
- Keep cost of therapy affordable².
- A hybrid between CAPD and CCPD
 - Uses several high volume cyclor exchanges (2.5 to 3.0 L) in the supine position
 - Plus: Add two day-time exchanges
 - The “last automated exchange” in the morning
 - A manual CAPD exchange, or a “pause exchange” provided by the cyclor


1 - Diaz-Buxo JA. *Am J Kidney Dis* 27:92-98, 1996
 2 - Diaz-Buxo JA. *Perit Dial Int* 20:S93-S97, 2000

PD Plus Optimizing PD

The PD Plus™ concept was first described in 1996 by Diaz-Buxo¹, with the intention of maximizing solute clearance and ultrafiltration, while keeping the cost of therapy affordable². PD Plus is a hybrid between CAPD and CCPD through the use of several high volume cyclor exchanges (2.5 to 3.0 L) in the supine position - which maximizes the peritoneal surface area and thereby helps to improve clearance. In addition to the cyclor exchanges, PD Plus adds two day-time exchanges, the first being the “last automated exchange” in the morning and the second is either a manual CAPD exchange, or a “pause exchange” provided by the cyclor.

1 - Diaz-Buxo JA. Enhancement of peritoneal dialysis: The PD Plus concept. *Am J Kidney Dis* 27:92-98, 1996

2 - Diaz-Buxo JA. Continuous cycling peritoneal dialysis, PD plus and high-flow automated peritoneal dialysis: A spectrum of therapies. *Perit Dial Int* 20:S93-S97, 2000



PD Plus concept

- Equilibration of small solutes: 3 to 6 hours of dwell
- Dwell times that exceed 6 hours are inefficient in removing small solutes
 - Often require solutions with higher dextrose concentration
 - Polyglucose
 - Additional expense
 - Risk³

3 - Diaz-Buxo JA, et al. *ASAIO Journal* 47:602-607, 2001

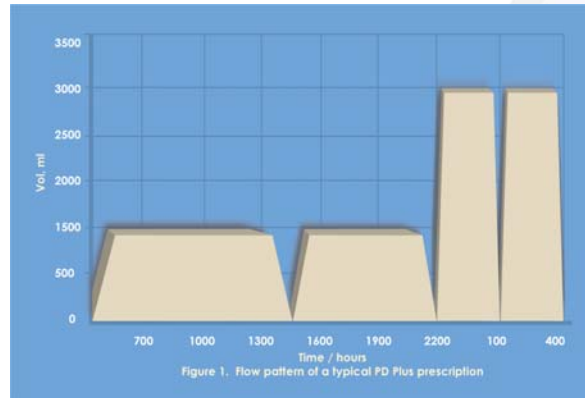
PD Plus Optimizing PD

The equilibration of small solutes between the dialysate and the plasma generally occurs within 3 to 6 hours of dwell. Therefore, dwell times that exceed 6 hours are inefficient in removing small solutes and often require solutions with a higher dextrose concentration or the use of a polyglucose solution, which in the case of the latter, can include additional expense and risk. PD Plus provides a uniform distribution of dwells throughout the schedule and eliminates long dwells.

3 - Diaz-Buxo JA, Passlick-Deetjen J, Gottoib L. Potential hazards of polyglucose. *ASAIO Journal* 47:602-607, 2001

Uniform dwells with PD Plus

- PD Plus provides a uniform distribution of dwells throughout the schedule and eliminates long dwells





Higher solute clearances, even for larger patients

- PD Plus can provide higher solute clearances than other traditional prescriptions, even for larger patients
- A model was developed to predict the proportion of anuric CAPD and APD patients that could obtain weekly adequacy targets with the use of various PD prescriptions⁴
 - Only 24.8% of anuric dialysis patients could be adequately dialyzed using standard CAPD (8 L)
 - Up to 93.2% could achieve the goals if they were prescribed PD Plus (15 L)

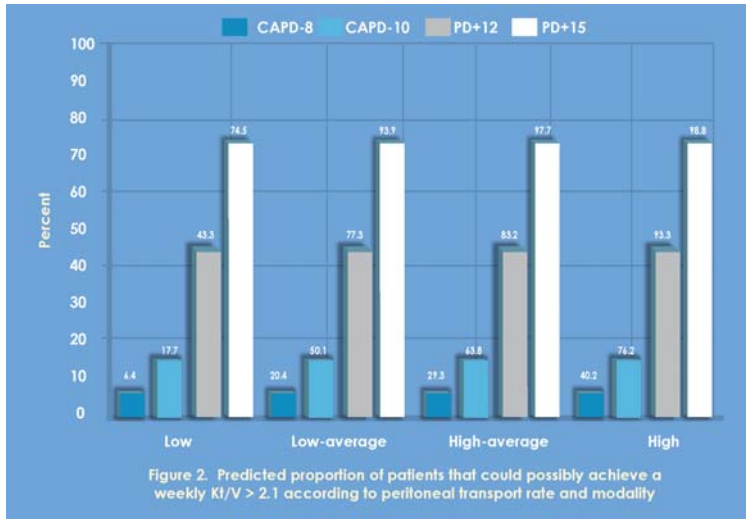
Diaz-Buxo JA, et al. *Kidney Int* 55:2493-2501, 1999

PD Plus Optimizing PD

Theoretical models show that when properly prescribed, a PD Plus prescription can provide higher solute clearances than other traditional prescriptions, even for larger patients. A model was developed to predict the proportion of anuric CAPD and APD patients that could obtain the weekly adequacy targets with the use of various PD prescriptions⁴. The model predicted that only 24.8% of anuric dialysis patients could be adequately dialyzed using standard CAPD (8 L), while up to 93.2% could achieve the goals if they were prescribed PD Plus (15 L)!

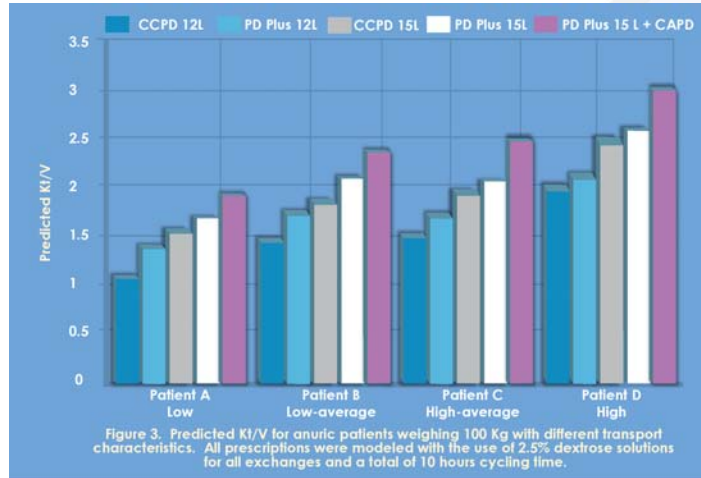
4 - Diaz-Buxo JA, Gotch FA, Folden TI, Rosenblum S, Zazra J, Lew N, et al. A model to assess feasibility with various modalities. *Kidney Int* 55:2493-2501, 1999

Higher solute clearances, even for larger patients




Higher solute clearances, even for larger patients

- Pack PD™ kinetic modelling program predicted favourable small solute clearance for large anuric patients regardless of transport type when compared to other prescriptions



PD Plus Optimizing PD

Additionally, modelling done with the Pack PD™ kinetic modelling program predicted favourable small solute clearance for large anuric patients regardless of transport type when compared to other prescriptions as shown in the figure here.



Not just a theory

- PD Plus is more effective in small solute removal than most other traditional PD prescriptions
- Clinical data also shows its effectiveness⁴⁻⁶
 - Prospective, randomized study comparing the effectiveness of PD Plus with increased volume CAPD⁶
- PD Plus can provide higher ultrafiltration utilizing conventional solutions
 - No need for more expensive, specialty solutions

4 - Diaz-Buxo JA, et al. *Kidney Int* 55:2493-2501, 1999
 5 - Diaz-Buxo JA, et al. *Am J Nephrol* 18:520-524, 1998
 6 - Iles-Smith H, et al. *Perit Dial Int* 22:719-721, 2002

PD Plus Optimizing PD

The theory that a PD Plus prescription is more effective in small solute removal than most other traditional PD prescriptions has also been corroborated with clinical data including a prospective, randomized study comparing the effectiveness of PD Plus with increased volume CAPD⁴⁻⁶. In addition, PD Plus can provide higher ultrafiltration utilizing conventional solutions, thereby decreasing the need to rely on more expensive, specialty solutions.

4 - Diaz-Buxo JA, Gotch FA, Folden TI, Rosenblum S, Zazra J, Lew N, et al. A model to assess feasibility with various modalities. *Kidney Int* 55:2493-2501, 1999

5 - Diaz-Buxo JA, Youngblood BP, Torres AM. Delivered dialysis dose with PD Plus therapy: A multicenter study. *Am J Nephrol* 18:520-524, 1998

6 - Iles-Smith H, Curwell J, Gokal R. PD plus concept leads to significant increases in solute clearances in anuric CAPD patients. *Perit Dial Int* 22:719-721, 2002

Prospective, randomized study: Higher small solute clearance with PD Plus⁶


- Compared PD Plus with an increased fill volume CAPD regimen
 - Improvement of small solute clearance
 - Anuric PD patients
 - Six month study
 - Target dose was a weekly $Kt/V > 1.9$ and/or Ccr of 60 L/1.73m²
 - Randomized anuric patients who:
 - Had been on CAPD for a minimum of three months, and
 - Had been identified as under dialyzed (weekly $Kt/V < 1.7$ and/or Ccr < 50 L/1.73m²)

6 - Iles-Smith H, et al. *Perit Dial Int* 22:719-721, 2002

PD Plus Optimizing PD

This study compared the effectiveness of PD Plus with that of an increased fill volume CAPD regimen in improving small solute clearance among anuric PD patients over a six month period. The target dose was a weekly $Kt/V > 1.9$ and/or Ccr of 60 L/1.73m². The study randomized anuric patients who had been on CAPD for a minimum of three months and had been identified as under dialyzed (weekly $Kt/V < 1.7$ and/or Ccr < 50 L/1.73m²).

6 - Iles-Smith H, Curwell J, Gokal R. PD plus concept leads to significant increases in solute clearances in anuric CAPD patients. *Perit Dial Int* 22:719-721, 2002



Prospective, randomized study: Higher small solute clearance with PD Plus⁶

- Studied at baseline and again after 1 month
- The prescription for the increased volume CAPD group was 4 daily exchanges with 2.5-3 L (total 10-12 L)
- PD Plus prescription has 2 daytime exchanges of 2.5 L and 3 nightly exchanges of 3 L (total 14 L)
- The between group comparison at 1 month showed a significantly greater change in the PD Plus group parameters compared to the CAPD group
 - A mean change in Kt/V of 0.9 versus 0.26 ($p=0.0017$)
 - A significantly greater change in Ccr in the PD Plus group compared to the CAPD group
 - A mean change of 18.8 versus 2.4 L/wk/1.73m² ($p=0.0031$)
- Although number of patients was limited, these results demonstrate that anuric CAPD patients not achieving adequacy targets can be successfully treated with PD Plus

6 - Iles-Smith H, et al. *Perit Dial Int* 22:719-721, 2002

PD Plus Optimizing PD

Patients were studied at baseline and again after 1 month. The prescription for the increased volume CAPD group was 4 daily exchanges with 2.5-3 L (total 10-12 L), while for the PD Plus prescription has 2 daytime exchanges of 2.5 L and 3 nightly exchanges of 3 L (total 14 L). The between group comparison at 1 month showed a significantly greater change in the PD Plus group parameters compared to the CAPD group, with a mean change in Kt/V of 0.9 versus 0.26 ($p=0.0017$). Similarly, a significantly greater change in Ccr in the PD Plus group compared to the CAPD group was observed, with a mean change of 18.8 versus 2.4 L/wk/1.73m² ($p=0.0031$). Although there were a limited number of patients, these results demonstrate that anuric CAPD patients not achieving adequacy targets can be successfully treated with PD Plus.

6 - Iles-Smith H, Curwell J, Gokal R. PD plus concept leads to significant increases in solute clearances in anuric CAPD patients. *Perit Dial Int* 22:719-721, 2002



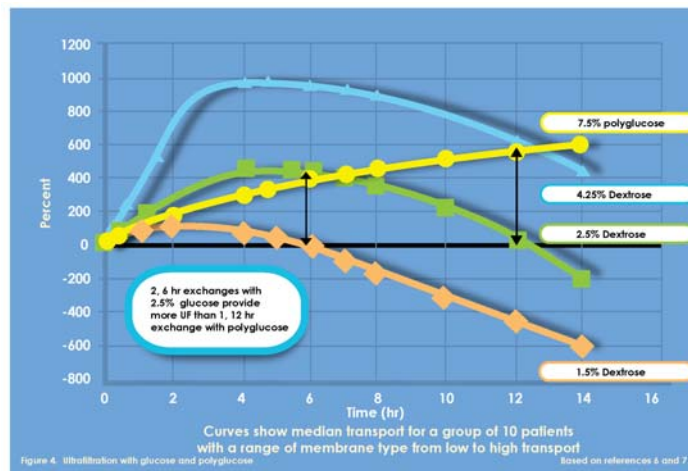
PD Plus can improve net ultrafiltration

- A single long dwell is often associated with poor net ultrafiltration
 - Absorption of glucose
 - Loss of the osmotic gradient, especially among patients with high peritoneal transport
- To remedy this:
 - Use a solution with a higher glucose concentration
 - Avoid exchanges with long dwells
 - Utilize polyglucose

PD Plus Optimizing PD

A single long dwell is often associated with poor net ultrafiltration due to the absorption of glucose and loss of the osmotic gradient, especially among patients with high peritoneal transport. To remedy this, one can use a solution with a higher glucose concentration, avoid exchanges with long dwells, or utilize polyglucose.

Two 6-hour dwells provide better UF than one long dwell with polyglucose



- PD Plus therapy can significantly reduce the need to use hypertonic solutions and eliminate the risks associated with polyglucose, while providing adequate net ultrafiltration


PD Plus Optimizing PD

This figure is a computer simulation showing the net ultrafiltration obtained with the use of various dextrose concentration PD solutions and with polyglucose 7.5% over a 14-hour period. Based on this information, a single 6-hour dwell with 2.5% dextrose provides around 400 mL of UF. Therefore, two 6-hour dwells results in approximately 800 mL of UF compared to a single 12-hour polyglucose dwell that provides only 600 mL of UF. Additionally, the use of 4.25% glucose can further increase net ultrafiltration among the extreme high transporters, but is not necessary in most instances.

Performing PD Plus therapy can significantly reduce the need to use hypertonic solutions and eliminate the risks associated with polyglucose, while providing adequate net ultrafiltration.

7 - Ho-dac-Pannekeet MM, Schouten N, Langendijk MJ, Hiralall JK, de Waart DR, Struijk DG, Krediet RT. Peritoneal transport characteristics with glucose polymer based dialysate. *Kidney Int* 50:979-86, 1996

8 - Douma CE, Hiralall JK, de Waart DR, Struijk DG, Krediet RT. Icodextrin with nitroprusside increases ultrafiltration and peritoneal transport during long CAPD dwells. *Kidney Int* 53:1014-21, 1998



Conclusions

- Theoretical models and extensive clinical experience have shown that PD Plus can effectively increase solute clearance over other PD modalities
- The evidence supports the use of PD Plus to increase ultrafiltration without the added expense and risk associated with polyglucose when CAPD and conventional APD fail to provide adequate fluid removal

PD Plus Optimizing PD

In summary, both theoretical models and extensive clinical experience including a prospective, randomized study have shown that PD Plus can effectively increase solute clearance over other PD modalities. The evidence also supports the use of PD Plus to increase ultrafiltration without the added expense and risk associated with polyglucose when CAPD and conventional APD fail to provide adequate fluid removal.



Fresenius Medical Care

Fresenius Medical Care North America
920 Winter Street,
Waltham, MA 02451
(800) 662-1237
www.fmcna.com

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