Peritoneal Dialysis
Prescriptions: A Primer for Nurses

Betty Kelman RN-EC MEd CNeph (C)
Toronto General Hospital University Health Network
Toronto, Ontario, Canada
A moment to remember
What is a Primer?
Objectives

a) Discuss the basics of peritoneal dialysis (PD) prescriptions
b) Relate membrane function to PD prescriptions
c) Discuss approaches for adjusting to individual differences in patients
Basics of transport in peritoneal membrane

a) Membrane structure
b) Transport of solutes
c) Transport of water
The Peritoneal Membrane

- **Mesothelial layer with microvilli**
- **Interstitial layer with collagen & fibres**
- **Capillary endothelial layer**
The Peritoneal Membrane: Effective Dialyzing Surface

- # of perfused capillaries
- functional area for exchange between blood & dialysate
Diffusion
Solute: High to Low
Diffusion
Eventually reach equilibrium
Osmosis
movement of solvent from low solute to high solute concentration

X = glucose
But Two Way Flow

2 Way Flow between blood & peritoneal cavity

X = glucose
If glucose is absorbed into the blood, then less glucose is available for osmotic pressure for water removal in the peritoneal cavity!
Peritoneal Dialysis Simplified

Fill

Dwell

Drain
Basic Elements of Prescription

What is an exchange?

a) Fill
b) Dwell
c) Drain
Basics of dialysis goals

a) Removal of solutes
b) Removal of fluid (ultrafiltration)
c) Patient survival
d) Patient quality of life
3 Pore Model

- **Transcellular**
  - Water

- **Small Pore**
  - Urea, Creatinine, Glucose
  - Water

- **Large Pore**
  - Protein, Macromolecules

- **Capillary (blood)**

- **Peritoneal Cavity**
Ultrafiltration

Strength of Exchange
# Standard PD Solutions

<table>
<thead>
<tr>
<th>Strength of Solution (%)</th>
<th>Osmolarity (mOsm/L)</th>
<th>Effect (60 min dwell time)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>296</td>
<td>Less return</td>
</tr>
<tr>
<td>1.5</td>
<td>346</td>
<td>50 – 150 mL</td>
</tr>
<tr>
<td>2.5</td>
<td>396</td>
<td>100 – 300 mL</td>
</tr>
<tr>
<td>4.25</td>
<td>485</td>
<td>300 – 400 mL</td>
</tr>
</tbody>
</table>

Korbet & Kronfol, 2001 Handbook of Dialysis
Peritoneal Dialysis Solutions

- **Dextrose Solutions**

- **Icodextrin (Extraneal™)**
  - Starch-derived glucose polymer
  - Maintains osmotic gradient with long dwell
    - 282-286 mOsm/L
    - MW 13,000-19,000 Daltons with long dwell
    - 8 – 12 hours
Prescriptions

- Exchange volume
- Type of PD
- Duration of Therapy
- Intraperitoneal medications
- Target weight
  - Bag strengths
  - U/f goals
Volume & Effective Dialyzing Surface

- # of perfused capillaries
- functional area for exchange between blood & dialysate
What is the right volume?

- And the answer is that depends!!
  - Body size
  - Break-in techniques
  - Adjusting for complications
    - Hernias
    - Back pain
    - Post-surgery
    - Peritonitis
Type of PD

- Intermittent Peritoneal Dialysis (IPD)
- Continuous ambulatory PD (CAPD)
- Automated PD (APD)
  - CCPD
  - CCPD – enhanced
  - NIPD
  - TVPD
Solute Clearance & Flow Rate

Since patients could not tolerate a flow rate of 6 litres/hr, we conclude that a flow rate of 4 litres/hr with a 2-litre exchange will give maximum efficiency.

What does 4 L/hour mean?

- 3 L/hr vs 4 L/hr vs 6 L/hr

- 4 litres per hour
  - 2 litre exchange q30 minutes
    - Fill 10 minutes
    - Dwell 10 minutes
    - Drain 10 minutes
Loss of Osmotic Gradient During a Long PD Dwell

(osmotic equilibrium)

 UF Vol

 Time (hours)

 net reabsorption

(courtesy J. Bargman)
Typical Ultrafiltration Curves for Each Strength of Dialysate


(courtesy J. Bargman)
## CAPD vs APD

### CAPD

<table>
<thead>
<tr>
<th>AM</th>
<th>PM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(4 exchanges: 3 day; 1 overnight)

### APD (i.e. CCPD)

<table>
<thead>
<tr>
<th>AM</th>
<th>PM</th>
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</thead>
<tbody>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

(4 exchanges: 3 overnight, 1 day)
Prescription: CAPD

- 2 litres QID
  - Exchanges at 0800, 1200, 1800 and 2200
  - 2 x 4 hour dwell
  - 1 x 6 hour dwell
  - 1 x 10 hour dwell

- Target weight
  - 65 kg (full)
## Assessing response

<table>
<thead>
<tr>
<th>Time</th>
<th>Strength %</th>
<th>Volume infused (mL)</th>
<th>Volume drained (mL)</th>
<th>Balance (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0800</td>
<td>1.5</td>
<td>2000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1200</td>
<td>1.5</td>
<td>2000</td>
<td>2200</td>
<td>-200</td>
</tr>
<tr>
<td>1800</td>
<td>1.5</td>
<td>2000</td>
<td>2100</td>
<td>-100</td>
</tr>
<tr>
<td>2200</td>
<td>1.5</td>
<td>2000</td>
<td>2250</td>
<td>-250</td>
</tr>
<tr>
<td>0800</td>
<td>1.5</td>
<td>2000</td>
<td>1600</td>
<td>+400</td>
</tr>
</tbody>
</table>
### Assessing response

<table>
<thead>
<tr>
<th>Strength</th>
<th>Volume infused (mL)</th>
<th>Volume drained (mL)</th>
<th>Balance (mL)</th>
<th>Cumulative u/f (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.25%</td>
<td>2000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5%</td>
<td>2000</td>
<td>2700</td>
<td>-700</td>
<td>-700</td>
</tr>
<tr>
<td>4.25%</td>
<td>2000</td>
<td>2300</td>
<td>-300</td>
<td>-1000</td>
</tr>
<tr>
<td>2.5%</td>
<td>2000</td>
<td>2650</td>
<td>-650</td>
<td>-1650</td>
</tr>
<tr>
<td>4.25%</td>
<td>2000</td>
<td>2350</td>
<td>-350</td>
<td>-2000</td>
</tr>
</tbody>
</table>
### Diminishing returns

<table>
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<tr>
<th>Strength %</th>
<th>Volume infused (mL)</th>
<th>Volume drained (mL)</th>
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</thead>
<tbody>
<tr>
<td>2.5</td>
<td>2000</td>
<td></td>
</tr>
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<td>2000</td>
<td>1600</td>
</tr>
<tr>
<td>4.25</td>
<td>2000</td>
<td>1200</td>
</tr>
<tr>
<td>2.5</td>
<td>2000</td>
<td>1400</td>
</tr>
</tbody>
</table>
Prescription: CCPD

- **Total Volume 8 litres**
  - 3 exchanges of 2 litre overnight for 10 hours
  - Last fill of 2 litres

- **Target weight**
  - 65 kg (full)
CCPD (2 litre) x 10 hours
What does this mean?

- **If do 3 exchanges 10 hours overnight**
  - 10 hours x 60 = 600 minutes
  - 600 ÷ 3 = 200 minutes

- **For each 2 litre exchange**
  - Fill = 10 minutes
  - Dwell = 170 minutes
  - Drain = 20 minutes

- **Last exchange (day dwell)**
  - 14 hours

<table>
<thead>
<tr>
<th>Inflow rate</th>
<th>200 mL/min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outflow rate</td>
<td>Variable</td>
</tr>
<tr>
<td></td>
<td>Best 200 mL/min</td>
</tr>
</tbody>
</table>
CCPD – change to 8 hours

- If do 3 exchanges 8 hours overnight
  - 8 hours x 60 = 480 minutes
  - 480 ÷ 3 = 160 minutes

- For each 2 litre exchange
  - Fill = 10 minutes
  - Dwell = 130 minutes
  - Drain = 20 minutes

- Last Fill (day dwell)
  - 16 hours

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If absorbs with long dwell

- May do CCPD – enhanced
- Use of additional exchange during day to reduce absorption

APD (i.e. CCPD enhanced)
AM PM

_________________________________________________
Dry Pain

Empty
- Pulling pain
- Worsens with peritonitis

Leave residual pool of fluid
- Float catheter
TVPD Prescription

• Total Volume  6800 litres
• Tidal Volume  80%
• 2000 x 80% = 1600
• First exchange – 2000 mL
  • Remaining exchanges – 1600 mL
Exchange Volume (TVPD)

- First exchange = 2000 mL
- Second exchange = 1600 mL
- Third exchange = 1600 mL
- Fourth exchange = 1600 mL

Total Volume = 6800 mL
Additional Orders for TVPD

- Manual drains as indicated
  - Drains completely as set
  - If small number of overnight exchanges, may not be effective in reducing dry pain
- Ultrafiltration volume
  - Estimated on first run
  - Avoid overfilling
Not everyone is the same.
Peritoneal Equilibration Test

Drain Volume

- Low
- L Ave
- H Ave
- Rapid

Creatinine

D/P

(ml)

D/P vs Creatinine

(courtesy J. Bargman)
<table>
<thead>
<tr>
<th>Classification</th>
<th>D/P Creatinine</th>
<th>Drain Volume (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid</td>
<td>0.82 - 1.03</td>
<td>1580 - 2084</td>
</tr>
<tr>
<td>Rapid average</td>
<td>0.66 - 0.81</td>
<td>2085 - 2367</td>
</tr>
<tr>
<td>Mean</td>
<td>0.65</td>
<td>2368</td>
</tr>
<tr>
<td>Low</td>
<td>0.50 - 0.64</td>
<td>2369 - 2650</td>
</tr>
<tr>
<td>Low average</td>
<td>0.34 - 0.49</td>
<td>2651 - 3362</td>
</tr>
</tbody>
</table>
## Peritoneal Membrane Classification

<table>
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<tr>
<th>Low</th>
<th>Low Average</th>
<th>High Average</th>
<th>Rapid</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) absorbs dextrose slowly</td>
<td></td>
<td></td>
<td>a) absorbs dextrose rapidly</td>
</tr>
<tr>
<td>b) maintains concentration gradient</td>
<td></td>
<td></td>
<td>b) loss of concentration gradient</td>
</tr>
<tr>
<td>c) ↑fluid removal</td>
<td></td>
<td></td>
<td>c) ↓fluid removal</td>
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<th>Rapid</th>
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</thead>
<tbody>
<tr>
<td>↑dwell time</td>
<td>• enhance solute removal</td>
<td>↓dwell time</td>
<td>• Maintain gradient for water removal</td>
</tr>
<tr>
<td>CAPD</td>
<td></td>
<td></td>
<td>CCPD/NIPD</td>
</tr>
<tr>
<td>Drain volume</td>
<td>• 2651-3326 mL</td>
<td></td>
<td>Drain volume</td>
</tr>
</tbody>
</table>
Applying the Results to the Individual
Mr. L.A.: on APD for lifestyle

- 2 years later, experiencing weight loss/nausea
- Reflux disease
- PET results show low average transport (0.49)

Transport characteristics
Low average 0.34 - 0.49 2651 – 3362 mL

What change do you feel should be made for Mr. L.A.?
Low Transporter

Long dwell periods

- allow for solute clearance to occur over time
- enhanced middle molecule removal

CAPD with or without night exchange
Mr. L.A.: on APD for lifestyle

CHANGE TO CAPD

a) Allow for longer dwell
b) Enhance clearances
Mr. H.A.: on CAPD

- Poor fluid returns from exchanges
- Weight gain
- Short of breath
- PET results show rapid transport (0.91)

What change do you feel should be made for Mr. H.A.?

Transport characteristics
Rapid 0.82 - 1.03 1580 – 2084 mL
Rapid Transporter

Frequent shorter dwell periods
- decrease glucose absorption
- enhance ultrafiltration

a) APD with dry day exchanges
b) APD with added day exchanges
c) CAPD with night exchanges
Mr. H.A.: on CAPD

CHANGE TO CCPD

a) shorter dwell times
b) decreased glucose absorption
c) improved fluid removal
Mr. D.P.

- Radiological insertion of peritoneal catheter
- Flushes well
- IPD for break-in
  - First and second – pain on outflow
  - Third – decreased pain, tolerable
  - Fourth – pain on outflow, lower abdomen, radiating to penis
Mr. D.P.

- Assess
  - No pain when not dialyzing
  - Bowel movements – 2/day
- Adjust for tidal volume
- Bypass initial drain
- Bowel routine
- Consider changing to CAPD for initial training period
Primer on PD Prescriptions: A Beginning

- Membrane
- Dialysis Goals
- Patient Goals

- Adjust
- Balance
- Custom Fit
“The art is that of nursing the sick, please mark, not nursing sickness. This is why nursing proper can only be taught at the patient’s bedside and in the sickroom or wards. Lectures and books are but valuable accessories.”

Florence Nightingale