Peritoneal Dialysis
why to choose in 21st Century

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Grand Round KMC
Objectives

- ESRD statistics and treatment options
- Basic principles of peritoneal dialysis
- Historical perspective of PD
- Advantages and disadvantages of PD
- Pearls for clinicians

*ESRD – end stage renal disease, *PD – peritoneal dialysis
Treatment Options For the Patient with ESRD (Renal Replacement Therapy)

1. In-center (outpatient) hemodialysis 3/week
2. Peritoneal Dialysis
3. Kidney transplant from deceased of living donor
4. Home hemodialysis 4-7/week
5. Not accepting any form of renal replacement therapy
What is Peritoneal dialysis?

Form of renal replacement therapy at home which involves use of PD catheter and specially manufactured solutions (dialysate).

Fluid get infused to peritoneal cavity, dwells, exchange electrolytes, absorbs toxins, get drained

- Manual exchanges
- Automated, use of cycler device
2016: 703,243 ESRD patients at USA

Treatment modality:
Hemodialysis        443,043 (63%)
Transplant          203,940 (29%)
Peritoneal dialysis  49,227 (7%)

USRD 2017 report
vol 2 Figure 1.2 Trends in the annual number of ESRD incident cases, by modality, in the U.S. population, 1980-2015

Data Source: Reference Table D1. Abbreviation: ESRD, end-stage renal disease.
Cost comparison of Peritoneal Dialysis versus Hemodialysis for end-stage renal disease

Prior analyses of Medicare enrollees have consistently reported lower healthcare costs among patients who initiated dialysis with PD rather than HD.

Berger et al analyzed retrospectively cost for first 12 mo of initiation of RRT 463pts

HD cost-$173,507 ($43,510 higher )
PD cost-$129,997

HD was associated with more than a 2-fold increased risk of hospitalization relative to PD (hazard ratio, 2.17; 95% CI, 1.34-3.51; P <.01)

Medicare expenditures were reported to be $11,446 lower for PD patients than for HD patients ($56,807 vs $68,253, P <.001) after 1st year.
### Is survival the same for different forms of RRT?

<table>
<thead>
<tr>
<th></th>
<th>3 months (%)</th>
<th>12 months (%)</th>
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Data Source: Reference Tables I.1_adj-l.36_adj. Adjusted survival probabilities, from day one, in the ESRD population. Reference population: incident ESRD patients, 2011. Adjusted for age, sex, race, Hispanic ethnicity, and primary diagnosis. Abbreviation: ESRD, end-stage renal disease.
Figure i.33 Percent distribution of type of renal replacement therapy modality used by ESRD patients, by country, 2014

Green=PD

Data Source: Special analyses, USRDS ESRD Database. Denominator is calculated as the sum of patients receiving HD, PD, Home HD, or treated with a functioning transplant; does not include patients with other/unknown modality. Data for Spain include 18 of 19 regions. Data for France include 22 regions. Data for Italy include 6 regions. Data for Canada excludes Quebec. Abbreviations: CAPD, continuous ambulatory peritoneal dialysis; APD, automated peritoneal dialysis; IPD, intermittent peritoneal dialysis; ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis; sp., speaking. This graphic is adapted from Figure 13.12.
Lets talk more about Peritoneal Dialysis
What are the absolute contraindications to PD?

1. Patient is blind and has no partner to perform PD
2. Patient is homeless
3. House/ apartment is very small/no storage space
4. Multiple abdominal surgeries in the past
Keys to Success of Peritoneal Dialysis

• Qualifying Patient

• Outpatient PD program with Medical Director

• Team of providers: Nephrologist, PD nurse, Dietitian, Social Worker, Surgeon

• Patient and Family education

• Hospital and Extended care facility interaction

• Assessment of quality goals, monthly Quality Assessment and Performance Improvement Meetings
HOW DOES PD CATH WORKING?
Why Do We Need KUB?

- To evaluate the position of the catheter
Basic Principles. How Does Peritoneal Dialysis Work?

Peritoneum serves as a membrane permeable to fluids and solutes

Dialysate (fluid for dialysis) get infused into the peritoneal cavity through the catheter

Fluid dwells in the cavity for few hours on average

Solute got shifted by concentration gradient (BUN and K diffuse to dialysate)

Excess interstitial volume get pulled by high osmotic gradient of Dextrose (patient drains more fluid than was put in)

Diffusion and convection
Basic Principles. How Does Peritoneal Dialysis Work?

**General features**

- The peritoneum is a thin serous membrane that line the walls of the abdominal and pelvic cavities and cover the organs within these cavities.
- **Parietal peritoneum** - lines the walls of the abdominal and pelvic cavities.
- **Visceral peritoneum** - covers the organs.

Size 1.5-5m², approximates BSA

Semi-permeable, bi-directional

Highly vascular

3 pore model of PD

Vessel wall

Trans-endothelial transport

Transcellular pore (aquaporin)

Small solutes

Small pore equivalent

Large pore equivalent

Glycocalyx

Protein

Interstitium

Capillary Lumen

Transcellular forces

Osmotic pressure dominates

Hydrostatic and osmotic pressures

Hydrostatic pressure dominates
In the late 1940s, Fine and colleagues reported successful peritoneal irrigation in a patient with severe anuria, who survived after 4 days of continuous peritoneal lavage.

This was indeed a landmark in the history of treatment of uremia using the peritoneal cavity.

In the late 1960s, intermittent peritoneal dialysis (PD; provided once or twice a week in hospital) was practiced worldwide, but mainly in three centers: Seattle, Montpelier France and in Toronto.

In all these centers PD was provided mainly to patients who could not be dialyzed with hemodialysis (HD). Patients would come to the hospital one or two days a week and start on PD with a new stylet catheter inserted into their abdomen each time.

As soon as a patient on chronic HD would die, one of those patients, who had survived the longest on PD, would be rewarded by being moved to HD.
History of Peritoneal Dialysis (2 of 2)

1962 Tenckhoff designed indwelling silicone rubber catheter with 2 Dacron cuffs. That made PD long-term therapy.

1978 – University of Toronto replaced glass fluid containers to plastic bags

1979 Baxter to manufacture solution, tubing, anticeptic solutions

1979 – Y system developed in Italy (decreased rate of peritonitis)

1981 – Cycler manufactured (continued automated therapy)

1984 – International Society of PD established
1990 s- better polymer technology in PD cath
1992 – extended PD catheters introduced
1993 - Advanced glycosylation end products recognized
2002 – Extraneal solution (starch based) FDA approved
2008 - Phisioneal solution (starch based) approved, not in USA
2010 – Nutrineal solution (amino acids) approved in Europe, 2012 USA
### Dialysate Solutions Used for Peritoneal Dialysis in USA

<table>
<thead>
<tr>
<th>Solution</th>
<th>Dianeal 1.5%</th>
<th>Dianeal 2.5%</th>
<th>Dianeal 4.25%</th>
<th>Icodextrin 7.5 g/dl</th>
<th>Nutrineal (aminoacids)</th>
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<td>Calcium</td>
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<td>35,40</td>
<td>40</td>
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<td>Osm</td>
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<td>346-485</td>
<td>282-286</td>
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<td>pH</td>
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<td>5.2</td>
<td>5.2</td>
<td>6.5</td>
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</tbody>
</table>
Infectious Complications of Peritoneal Dialysis

1. Exit site infection

2. Tunnel infection

3. Peritonitis
Causes of Peritonitis

1. Touch Contamination/breaking the aseptic technique

2. Catheter related infection (defect, pets bite, contaminated water..)

2. Trans visceral migration due to intra-abdominal pathology

3. Hematogenous

4. Procedure related: GI, GU, dental
Patient Education for Prevention of Infection

While taking care of the PD catheter

- Use mask for all people in the room
- Gloves or clean dry hands
- Doors and window are closed
- Avoid catheter directed air conditioner flow
- No pets in the room while connection is ongoing
- Antibiotic cream around exit cite daily
- Dressing change daily
- Bags, tubing inspection for defects
- Antibiotics prophylaxis before colonoscopy/GU and dental procedures
KEEP IT CLEAN=SAVE PATIENT’S LIFE

Peritonitis is a fear of every patient and team caring for him/her.

Peritonitis can cause death or inability to continue PD.

Health care providers in the hospital/office:

- PD catheter care provided ONLY by patient or PD nurse

ALL OTHERS
- Do not remove dressing
- Do not attempt to drain
- Do not access catheter with a syringe or remove covering cap
- Do not collect fluid for culture
- Call PD nurse
Diagnosing Peritonitis in patient on PD

- Abdominal pain
- Weakness, nausea, loss of appetite
- Change in bowel: new diarrhea or constipation
- Cloudy fluid
- Different than non-PD peritonitis
- Fever, rigors, blood WBC and chills are quite uncommon

PD fluid cell count: WBC>100 with >50% PMN (granulocytes) cells
How do we treat Peritonitis Related to PD?

ISPD (international society of PD) guidelines

Intra-abdominal antibiotics

Empiric coverage to start GP+GN

Intraperitoneal dosing for 2-3 weeks

Removal of PD cath only with Fungal infection
  or resistant to targeted Abx therapy for >5 days
Audience Participation Quiz

What can be the reason for hemoperitoneum in PD patient?

1. 

2. 

3.
Diet for Patient on Peritoneal Dialysis

Diet for the patient on PD is much more liberal than on hemodialysis.

While phosphorus restrictions still imply, potassium restriction most of the time is not necessary.

PD patients are frequently hypokalemic and required potassium supplements.

It is common knowledge that potassium rich food frequently comes from healthy choices like fruits and vegetables, which most of the people enjoy to consume.

Less restrictive diet contributes to the better lifestyle on peritoneal dialysis.

Use of specifically designed renal vitamins supplements they need in nutrition.
Blood Pressure and PD

• Patients do not have drastic changes of BP
• Hypotensive episodes on PD almost unheard of
• Good for patients with autonomic dysfunction
• Easy for preload-dependent patients with valvular disease
• Better opportunity to use ACE-I/ARB/MRB as potassium is low
• Overall much easier on hemodynamics than HD
Travel with Peritoneal Dialysis

Easiness of travel is one of the big advantages

Cycler is portable

Peritoneal dialysis fluid can be delivered to hotel/cruise ship by Baxter

International travel possible (by law no fee for travel with medical equipment)

Preserved flexibility of travel plans

Keep the job which requires travel
Peritoneal Dialysis in Selected Populations
PD for Big Girls and Boys

adequate dialysis has been achieved in clinical studies in patients with BMI up to 46 kg/m².

Pre-Sternal bathtub catheter

https://www.homedialysis.org/life-at-home/articles/the-bathtub-presternal-pd-catheter
Novel Indications for Peritoneal Dialysis

Peritoneal Dialysis for Heart Failure Patients with CKD

Table 2
Selected studies on the role of peritoneal dialysis in heart failure

<table>
<thead>
<tr>
<th>Study design</th>
<th>No. of patients</th>
<th>Mean age (yr)</th>
<th>Gender</th>
<th>NYHA class</th>
<th>EF</th>
<th>Renal function</th>
<th>Main findings</th>
<th>Comment</th>
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<td>Koch et al [11]</td>
<td>Prospective</td>
<td>118</td>
<td>73.2</td>
<td>60.2%</td>
<td>III (49.2%)</td>
<td>IV (10.8%)</td>
<td>Creatinine clearance 19.2 mL/min</td>
<td>Significant improvement in body weight and NYHA class</td>
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<tr>
<td>Nilker et al [11]</td>
<td>Prospective</td>
<td>25</td>
<td>75.1</td>
<td>72%</td>
<td>III or IV (100%)</td>
<td></td>
<td>eGFR 35 mL/min per 1.73 m²</td>
<td>Significant improvement in patients' clinical status and NYHA class</td>
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<td>Bertoli et al [11]</td>
<td>Multicenter</td>
<td>48</td>
<td>74</td>
<td>81%</td>
<td>II (6%)</td>
<td>III (45%)</td>
<td>eGFR 21 mL/min per 1.73 m²</td>
<td>Significant improvement in NYHA class and reduction in the number of days hospitalized</td>
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<tr>
<td>Considine et al [11]</td>
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<td>126</td>
<td>72</td>
<td>69%</td>
<td>N/A</td>
<td>IV (49%)</td>
<td>eGFR 33.5 mL/min per 1.73 m²</td>
<td>Significant reduction in the number of days hospitalized for acute heart failure</td>
</tr>
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</table>

Peritoneal Dialysis in Patients with decompensated cirrhosis

Peritoneal dialysis PD-ideal treatment in cirrhotic patients with ascites

Two datasets including a cohort study of China Medical University Hospital (CMUH) from 2004 to 2013 and the Longitudinal National Health Insurance Database for Catastrophic Illness Patients (LHID-CIP) of Taiwan from 1996 to 2011 were analyzed. The survival of cirrhotic patients on PD and the propensity score matched cirrhotic patients on HD were analyzed using Cox proportional hazards regression.

PD in cirrhotic patients who need dialysis is associated with lower all-cause mortality than HD is.

This association is independent of patients’ comorbidity, severity of liver cirrhosis, and serum albumin levels.
PD for patients with Mental Disabilities

Patients who pull, pick, move, jump – extremely difficult for hemodialysis

PD with a catheter with back exit site is an option

Choosing PD in Natural Disasters

Hurricanes, earthquakes, nuclear accidents studies showed how vulnerable hemodialysis patients are. They are highly dependable on medical equipment, purified water, trained staff.

PD patients trained to do manual exchanges only need bags of PD solutions.

“Our experience shows the reliability of PD in emergency situations and should further encourage using PD as the initial modality of renal replacement therapy.”

Literature on use of urgent PD in combat related kidney failure.
What is New for PD in 21st Century?

- Remote patient management
- Cloud-based platform allowing two-way lifetime communication
- Fast response to alarms on therapy and troubleshooting
- Remote monitoring of labs collected locally
- Access to daily weight, BP, HR data
- Monitoring of compliance
- Overcoming geographic and socioeconomic barriers
Advantages of Peritoneal Dialysis

Peritoneal dialysis offers a variety of benefits over in-center hemodialysis.

Studies show evidence of benefits for PD related to survival, quality of life, transportation costs, increased patient autonomy, and clinical benefits including enhanced blood pressure and phosphorus control.

Furthermore, the cost of delivery of care of home modalities in most countries is less than that of in-center hemodialysis
Resources for PD education for Clinicians
THANK YOU
For CHOOSING PD