Management of PD related Complications
- Infectious & Noninfectious -

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I have no relevant financial relationship to disclose any COI for this research presentation within the period of 36 months.
Peritoneal Dialysis

• Wastes and excess water move from the blood, across the peritoneum (a natural semipermeable membrane) and into dialysate, in the abdominal cavity.

• It offers patients independence and flexibility. The near continuous removal of fluid and uremic metabolites results in “steady state” physiology and biochemistry, allowing even elderly patients and those with cardiovascular disease to tolerate dialysis treatment with few side effects.
As a home-based dialysis therapy, PD can improve patient survival, retain residual kidney function, lower infection risk, and increase patient satisfaction while reducing financial stress to governments by addressing the burden of managing the growing number of patients with end-stage renal disease.
Trends in the prevalence of patients on PD in Asia-Pacific between 1999 and 2013

Complications of Peritoneal Dialysis

**Infectious**
- PD-associated peritonitis
  - Catheter-related infection
    - Exit-site infection
    - Catheter-tunnel infection

**Non-infectious**
- Catheter-related
  - Leak
  - Obstruction
  - Malposition
  - Entrapment
- Metabolic complications
  - Problems with solute/water clearance (UF failure)
  - EPS
Case    Female/68

- Chief complaint: Turbid dialysate x 1day
- ESRD, CGN (r/o IgAN)
- CAPD for 5 years (4 cycles, 1.5% x3, 2.5% x1)
- Vital signs: BP 140/90  PR85  BT 36.5 °C
- Dialysate cell count: WBC 820 (polys 92%)
Peritonitis

• Common and serious complication of PD

• Leads to structural and functional alterations of the peritoneal membrane

• Major cause of PD technique failure

• Although less than 4% of peritonitis episodes result in death, peritonitis is a “contributing factor” to death in 16% of deaths in patients on PD therapy
Diagnosis

Clinical features consistent with peritonitis (symptoms & signs of peritoneal inflammation)

- Abdominal pain
- Nausea/vomiting
- Fever/chill
- Constipation/diarrhea
- (Rebound) Tenderness
- Cloudy fluid

Peritoneal Fluid Exam

- Dialysate
  - WBC >100/µl
  - with >50% polys

Microbiology

- Smear (+) or Culture(+)

at least 2 of 3 are present (1C)

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Differential Diagnosis of Cloudy Effluent

- Culture-positive infectious peritonitis
- Infectious peritonitis with sterile cultures
- Chemical peritonitis
- Calcium channel blockers
- Eosinophilia of the effluent
- Hemoperitoneum
- Malignancy (rare)
- Chylous effluent (rare)
- Specimen taken from “dry” abdomen
Further evaluation

- A break in exchange technique
- Recent antibiotics administration
- Recent episode of peritonitis
- **Endoscopic, gynecologic, dental procedure**
- Constipation/diarrhea
- Exit and tunnel infection
- Localized abdominal pain & tenderness
Initial management of peritonitis

Start intraperitoneal (IP) antibiotics as soon as possible
Allow to dwell for at least 6 hours
Empirical gram-positive and gram negative coverage, based on patient history and center sensitivity patterns

Gram-positive coverage:
- first generation cephalosporin or vancomycin

Gram-negative coverage:
- third-generation cephalosporin or aminoglycoside

Consider Adjuvant Treatment
- Rapid PD exchanges 1-2 times; Analgesics for pain control; IP heparin; anti-fungal prophylaxis
- Education and assess IP injection technique
- Ensure follow-up arrangements

Clinical evaluation.
Examine exit site and catheter tunnel.
Collect PD fluid for cell count, differential count, Gram stain and bacterial culture.
Dosing of Antibiotics

- We recommend that **IP antibiotics** be the preferred route of administration unless the patient has features of systemic sepsis (1B).
- We suggest that **IP aminoglycoside** be administered as *daily intermittent* dosing (2B).
- We recommend that prolonged courses of IP aminoglycoside be avoided (1C).
- We suggest that IP vancomycin be administered intermittently and the serum vancomycin level be kept above 15μg/mL (2C).
- We suggest that IP cephalosporin be administered either continuously (in each exchange) or on a daily intermittent basis (2C).
# Intraperitoneal Antibiotic Dosing Recommendations for Treatment of Peritonitis

**ISPD guideline 2016**

<table>
<thead>
<tr>
<th>Aminoglycosides</th>
<th>Intermittent (1 exchange daily)</th>
<th>Continuous (all exchanges)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Amikacin</strong></td>
<td>2 mg/kg daily (252)</td>
<td>LD 25 mg/L, MD 12 mg/L (253)</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>0.6 mg/kg daily (254)</td>
<td>LD 8 mg/L, MD 4 mg/L (255,256)</td>
</tr>
<tr>
<td>Netilinixin</td>
<td>0.6 mg/kg daily (233)</td>
<td>MD 10 mg/L (257)</td>
</tr>
<tr>
<td>Tobramycin</td>
<td>0.6 mg/kg daily (253)</td>
<td>LD 3 mg/kg, MD 0.3 mg/kg (258,259)</td>
</tr>
<tr>
<td><strong>Cephalosporins</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cefazolin</td>
<td>15–20 mg/kg daily (260,261)</td>
<td>LD 500 mg/L, MD 125 mg/L (254)</td>
</tr>
<tr>
<td>Cefepime</td>
<td>1,000 mg daily (262,263)</td>
<td>LD 250–500 mg/L, MD 100–125 mg/L (262,263)</td>
</tr>
<tr>
<td>Cefoperazone</td>
<td>no data</td>
<td>LD 500 mg/L, MD 62.5–125 mg/L (264,265)</td>
</tr>
<tr>
<td>Cefotaxime</td>
<td>500–1,000 mg daily (266)</td>
<td>no data</td>
</tr>
<tr>
<td>Ceftazidime</td>
<td>1,000–1,500 mg daily (267,268)</td>
<td>LD 500 mg/L, MD 125 mg/L (236)</td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td>1,000 mg daily (269)</td>
<td>no data</td>
</tr>
<tr>
<td><strong>Penicillins</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penicillin G</td>
<td>no data</td>
<td>LD 50,000 unit/L, MD 25,000 unit/L (270)</td>
</tr>
<tr>
<td>Amoxicillin</td>
<td>no data</td>
<td>MD 150 mg/L (271)</td>
</tr>
<tr>
<td>Ampicillin</td>
<td>no data</td>
<td>MD 125 mg/L (272,273)</td>
</tr>
<tr>
<td>Ampicillin/Sulbactam</td>
<td>2 gm/1 gm every 12 hours (274)</td>
<td>LD 750–100 mg/L, MD 100 mg/L (253)</td>
</tr>
<tr>
<td>Piperacillin/Tazobactam</td>
<td>no data</td>
<td>LD 4 gm/0.5 gm, MD 1 gm/0.125 gm (275)</td>
</tr>
<tr>
<td><strong>Others</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aztreonam</td>
<td>2 gm daily (242)</td>
<td>LD 1,000 mg/L, MD 250 mg/L (243,244)</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>no data</td>
<td>MD 50 mg/L (276)</td>
</tr>
<tr>
<td>Clarithromycin</td>
<td>no data</td>
<td>MD 600 mg/bag (277)</td>
</tr>
<tr>
<td>Daptomycin</td>
<td>no data</td>
<td>LD 100 mg/L, MD 20 mg/L (278)</td>
</tr>
<tr>
<td>Imipenem/Cilastatin</td>
<td>500 mg in alternate exchange (244)</td>
<td>LD 250 mg/L, MD 50 mg/L (236)</td>
</tr>
<tr>
<td>Ofloxacin</td>
<td>no data</td>
<td>LD 200 mg, MD 25 mg/L (279)</td>
</tr>
<tr>
<td>Polymyxin B</td>
<td>no data</td>
<td>MD 300,000 unit (30 mg)/bag (280)</td>
</tr>
<tr>
<td>Quinupristin/Dalfopristin</td>
<td>25 mg/L in alternate exchangea (281)</td>
<td>no data</td>
</tr>
<tr>
<td>Meropenem</td>
<td>1 gm daily (282)</td>
<td>no data</td>
</tr>
<tr>
<td>Teicoplanin</td>
<td>15 mg/kg every 5 days (283)</td>
<td>LD 400 mg/bag, MD 20 mg/bag (229)</td>
</tr>
<tr>
<td>Vancomycin</td>
<td>15–30 mg/kg every 5–7 daysb (284)</td>
<td>LD 30 mg/kg, MD 1.5 mg/kg/bag (285)</td>
</tr>
<tr>
<td><strong>Antifungals</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluconazole</td>
<td>IP 200 mg every 24 to 48 hours (286)</td>
<td>no data</td>
</tr>
<tr>
<td>Voriconazole</td>
<td>IP 2.5 mg/kg daily (287)</td>
<td>no data</td>
</tr>
</tbody>
</table>

**Notes:**

- LD = loading dose in mg; MD = maintenance dose in mg; IP = intraperitoneal; APD = automated peritoneal dialysis.
- a Given in conjunction with 500 mg intravenous twice daily (281).
- b Supplemental doses may be needed for APD patients.
We recommend that IP antibiotics be the preferred route of administration unless the patient has features of systemic sepsis (1B).

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dosing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anti-bacterials</strong></td>
<td></td>
</tr>
<tr>
<td>Ciprofloxacin (237)</td>
<td>oral 250 mg BD^a</td>
</tr>
<tr>
<td>Colistin (288)</td>
<td>IV 300 mg loading, then 150–200 mg daily^b</td>
</tr>
<tr>
<td>Ertapenem (289)</td>
<td>IV 500 mg daily</td>
</tr>
<tr>
<td>Levofloxacin (239)</td>
<td>oral 250 mg daily</td>
</tr>
<tr>
<td>Linezolid (290–292)</td>
<td>IV or oral 600 mg BD</td>
</tr>
<tr>
<td>Moxifloxacin (293)</td>
<td>oral 400 mg daily</td>
</tr>
<tr>
<td>Rifampicin (294,295)</td>
<td>450 mg daily for BW &lt;50 kg: 600 mg daily for BW ≥50 kg</td>
</tr>
<tr>
<td><strong>Trimethoprim/ Sulfamethoxazole (252)</strong></td>
<td>oral 160 mg / 800 mg BD</td>
</tr>
<tr>
<td><strong>Anti-fungals</strong></td>
<td></td>
</tr>
<tr>
<td>Amphotericin (296)</td>
<td>IV test dose 1 mg; starting dose 0.1 mg/kg/day over 6 hours; increased to target dose 0.75–1.0 mg/kg/day over 4 days</td>
</tr>
<tr>
<td>Caspofungin (297,298)</td>
<td>IV 70 mg loading, then 50 mg daily</td>
</tr>
<tr>
<td>Fluconazole (299)</td>
<td>oral 200 mg loading, then 50–100 mg daily</td>
</tr>
<tr>
<td>Flucytosine (296)</td>
<td>oral 1 gm/day</td>
</tr>
<tr>
<td>Posaconazole (300)</td>
<td>IV 400 mg every 12 hours</td>
</tr>
<tr>
<td>Voriconazole (301–303)</td>
<td>oral 200 mg every 12 hours</td>
</tr>
</tbody>
</table>

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Management algorithm for G(+) cocci identified in dialysis effluent

- Gram-positive cocci on culture
  - Continue gram-positive coverage based on sensitivities.
    - If enterococci, adjust coverage to vancomycin or other appropriate agents.
    - If methicillin resistant, adjust coverage to vancomycin or other appropriate agents.
  - Assess clinical improvement, repeat dialysis effluent cell count and culture at days 3-5

- Clinical improvement: continue antibiotics; re-evaluate for occult exit-site or tunnel infection
- No clinical improvement: re-culture and evaluate
  - No clinical improvement by 5 days on appropriate antibiotics: remove catheter

- coagulase-negative staphylococci
  - treat for 14 days

- S. aureus
  - screen for S. aureus carrier; treat for 21 days

- Enterococci
  - treat for 21 days

- other streptococci
  - treat for 14 days

Peritonitis resolves but persistent exit-site or tunnel infection
  - consider simultaneous catheter removal and re-insertion

ISPD guideline 2016
Management algorithm for G(-) bacilli or mixed bacterial growth identified in dialysis effluent

1. **Gram-negative bacilli or mixed bacterial growth on culture**
   - Continue gram-negative coverage based on sensitivities. Consider switching to 3rd or 4th generation cephalosporine.
   - Assess clinical improvement, repeat dialysis effluent cell count and culture at days 3-5

2. **Clinical improvement:**
   - Continue antibiotics
   - *Pseudomonas* or *Stenotrophomonas* species
     - **Give 2 effective antibiotics based on sensitivity; re-evaluate exit site and tunnel**
     - **Treat for 21-28 days**

3. **No clinical improvement:**
   - **No clinical improvement by 5 days on appropriate antibiotics: remove catheter**
   - **Re-culture and evaluate**
     - **Other gram-negative bacilli**
       - **Treat for 21 days**
     - **Mixed gram-negative or gram-negative + gram-positive organisms**
       - **Consider surgical problem; in addition to gram-negative coverage, consider metronidazole and ampicillin/vancomycin**
       - **Treat for 21 days**

4. **Peritonitis resolves but persistent exit-site or tunnel infection**
   - **Consider simultaneous catheter removal and re-insertion**

*ISPD guideline 2016*
ISPD Guideline for Culture (-) Peritonitis

- We suggest that (-) effluent cultures on day 3 warrant a repeat dialysis effluent WBC count with differential (2D).

- If the culture (-) peritonitis is resolving at day 3, we suggest discontinuing aminoglycoside therapy and continuing treatment with gram (+) coverage (e.g. 1st-generation cephalosporin or vancomycin) for 2 weeks (2C).

- If the culture (-) peritonitis is not resolving at day 3, we suggest special culture techniques be considered for isolation of unusual organisms (2C). (e.g. mycobacteria, nocardia, legionella, filamentous fungus, and other fastidious bacteria).

- If there is suboptimal response after 5 days of empirical antibiotics, catheter removal should be strongly considered.
Case Male/48

- Chief complaint: Turbid dialysate & abdominal pain x 2days
- ESRD, IgAN
- CAPD for 2 years (4 cycles, 1.5% x 4)
- Previous PD associated peritonitis history
  - Dialysate cell count: WBC 1230/uL (polys 92%)
  - Pseudomonas luteola (+)
  - Tx: Ceftazidime + Cefazolin ➔ Ceftazidime 3 wk + PO Cipro

- ER dialysate effluent cell count: WBC 2820 (polys 90%)
- Empiric antibiotics regimen choice?
  - Ceftazidime + Cefazolin or Vancomycin + Ceftazidime
  - Subsequent culture E.coli (+)
Relapsing Peritonitis

Peritonitis that is treated with appropriate antibiotic therapy, appears to resolve, and yet returns with the same organism or as sterile peritonitis within 4 weeks

⇒ Antimicrobial resistance may develop during the treatment, resulting in early relapse with an identical species, but with a different susceptibility pattern, after completion of treatment.

⇒ Alternatively, the source of the relapse may be the catheter through either biofilm or tunnel infection.

⇒ Catheter removal may be needed if susceptibility pattern of the organism has unchanged.
Recurrent Peritonitis

Peritonitis that occurs *within 4 weeks* of a prior episode, but with a *different* organism:

- the patient’s immunity may be impaired by the first episode, leading in some cases to an episode of peritonitis from a completely different organism, implying a different cause.

- Theoretically, these episodes can be treated successfully without catheter removal.
Recurrent and Relapsing Peritonitis: Causative Organisms and Response to Treatment

Cheuk-Chun Szeto, MD, FRCP, Bonnie Ching-Ha Kwan, MBBS, MCP(UK), Kai-Ming Chow, MBChB, MRCP(UK), Man-Ching Law, BN, RN, Wing-Fai Pang, MBChB, MRCP(UK), Kwok-Yi Chung, MBChB, MRCP(UK), Chi-Bon Leung, MBChB, FRCP(Edin), and Philip Kam-Tao Li, MD, FRCP

Background: The clinical behavior and optimal treatment of relapsing and recurrent peritonitis episodes in patients undergoing long-term peritoneal dialysis are poorly understood.

Study Design: Retrospective study over 14 years.

Setting & Participants: University dialysis unit; 157 relapsing episodes (same organism or culture-negative episode occurring within 4 weeks of completion of therapy for a prior episode), 125 recurrent episodes (different organism, occurs within 4 weeks of completion of therapy for a prior episode), and 764 control episodes (first peritonitis episode without relapse or recurrence).

Predictors: Exit-site infection, empirical antibiotics.

Outcome Measures: Primary response (resolution of abdominal pain, clearing of dialysate, and peritoneal dialysis effluent neutrophil count < 100 cells/mL after 10 days of antibiotic therapy), complete cure (resolution by using antibiotics without relapse/recurrence), catheter removal (for any cause while on antibiotic therapy), and mortality.
Recurrent and Relapsing Peritonitis: Causative Organisms & Response to Treatment

Relapsing peritonitis show a trend to a greater percentage of peritonitis episodes that were caused by *Pseudomonas* species and that were culture negative.

Recurrent peritonitis often is caused by *Enterococcus* species, non-*Pseudomonas* Gram (-) organisms, and mixed bacterial growth. The underlying bowel pathological state may be important.

**Table 3. Microbiological Cause of the Second Episode of Peritonitis**

<table>
<thead>
<tr>
<th>Organisms Identified</th>
<th>Relapsing Group</th>
<th>Recurrent Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gram-positive</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>12 (7.6)</td>
<td>6 (4.8)</td>
<td>104 (13.6)</td>
</tr>
<tr>
<td>Coagulase-negative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Staphylococcus</em></td>
<td>20 (12.7)</td>
<td>12 (9.6)</td>
<td>92 (12.0)</td>
</tr>
<tr>
<td><em>Enterococcus</em></td>
<td>1 (0.6)</td>
<td>4 (3.2)</td>
<td>9 (1.2)</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Streptococcus</em></td>
<td>2 (1.3)</td>
<td>4 (3.2)</td>
<td>81 (10.6)</td>
</tr>
<tr>
<td>Others</td>
<td>6 (3.8)</td>
<td>7 (5.6)</td>
<td>15 (2.0)</td>
</tr>
<tr>
<td><strong>Gram-negative</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Pseudomonas</em> species</td>
<td>26 (16.6)</td>
<td>14 (11.2)</td>
<td>72 (9.4)</td>
</tr>
<tr>
<td><em>Escherichia coli</em></td>
<td>12 (7.6)</td>
<td>10 (8.0)</td>
<td>52 (6.8)</td>
</tr>
<tr>
<td>Others</td>
<td>20 (12.7)</td>
<td>34 (27.2)</td>
<td>85 (11.1)</td>
</tr>
<tr>
<td><em>Fungi</em></td>
<td>1 (0.6)</td>
<td>10 (8.0)</td>
<td>17 (2.2)</td>
</tr>
<tr>
<td><em>Mycobacterium</em></td>
<td>0 (0)</td>
<td>2 (1.6)</td>
<td>15 (2.0)</td>
</tr>
<tr>
<td>Polymicrobial growth</td>
<td>10 (6.4)</td>
<td>22 (17.6)</td>
<td>97 (12.7)</td>
</tr>
<tr>
<td>Culture negative</td>
<td>47 (29.9)</td>
<td>0 (0)</td>
<td>125 (16.4)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>157</td>
<td>125</td>
<td>764</td>
</tr>
</tbody>
</table>

*Am J Kidney Dis, 2009: 54: 702-710*
Recurrent and Relapsing Peritonitis: Causative Organisms & Response to Treatment

- Recurrent peritonitis episodes had a lower primary response rate, more catheter removal, and greater mortality than relapsing and control episodes.

- For patients who present with relapsing or recurrent peritonitis, vancomycin and ceftazidime as the empirical treatment are associated with a better outcome than cefazolin and an aminoglycoside, respectively.

Am J Kidney Dis 2009: 54: 702-710
We recommend that timely catheter removal be considered for relapsing, recurrent, or repeat peritonitis episodes (1C).

There is no reliable way of distinguishing between relapsing and recurrent peritonitis at presentation, but a generic treatment approach with empirical broad-spectrum antibiotics ultimately results in similar outcomes.

*Effluent white cell count* and leukocyte strip test at the time of stopping antibiotics may predict relapse. *J Ren Care 2010; 36:90–95*

*Bacterial DNA fragment* levels in PD effluent are significantly higher 5 days before and on the date of completion of antibiotics amongst patients who subsequently develop relapsing or recurrent peritonitis. *Clin J Am Soc Nephrol 2013; 8:1935–41*
• We suggest that it is appropriate to **consider return to PD** for many patients who have had their catheter removed for refractory, relapsing, or fungal peritonitis (2C).

• We suggest that if re-insertion of a new catheter is attempted after a PD catheter is removed for refractory, relapsing, or fungal peritonitis, it be performed **at least 2 weeks after catheter removal and complete resolution of peritoneal symptoms** (2D).
Case Male/74

Chief complaint: Turbid dialysate
Hypertension, gout
2015.03 PD catheter insertion (NIPD 2L x 4 → CCPD)

2016.07 PD peritonitis treated with Cefazolin + AMK
Acinetobacter baumanii (+) → 3 weeks of AMK treatment

2016.11 PD peritonitis treated with Cefazolin + AMK
Acinetobacter baumanii (+) → 3 weeks of AMK treatment

2017.04 PD peritonitis treated with empiric regimen without improvement for 3 days, changed to Vancomycin + ceftazidime IP
Still no signs of improvement
Dialysate culture result: Sphingomonas (Pseudomonas) paucimobilis (+) → meropenem IP for 3 weeks

2017.05 PD peritonitis – meropenem IP started → enterobacter sakazakii (+) meropenem IP for 3 weeks

Exit site infection (-) Tunnel infection (-) → abdominopelvis CT imaging
Abdominal-Pelvis CT

- Cecum~ Ascending Colon Multiple Diverticuli (+)

Courtesy of Prof. Sun-Hee Park
Diverticular Disease in Peritoneal Dialysis

- Increases **with age**
- Distribution: sigmoid colon in western countries vs. *Rt. sided* colon in Asian population
- Should not preclude PD unless very severe and frequently symptomatic
- *Increased the risk of developing enteric peritonitis*, including \( \geq 10 \) diverticulae or the presence of diverticulae \( \geq 10 \text{ mm} \) and involving the ascending and transverse colon - Tranaeus A, NDT, 1990
- Presence of diverticulosis (hazard ratio [HR] 5) and diverticulitis (HR 7) involving the ascending colon was an *independent risk factor for peritonitis* - Yip T, PDI, 2000
Case Female/63

Chief complaint: abdominal pain
Hypertension, ESRD on CAPD since 2014.12
Past CAPD associated peritonitis history:
  2016.1. (Cx; No growth) Tx. Ceftazidime + Cefazolin
  2016.7. (Cx; Streptococcus agalactiae)
    Tx. Ceftazidime + Cefazolin ➔ Cefazolin
  2016.10. (Cx; Streptococcus viridans)
    Tx. Ceftazidime+ Cefazolin ➔ Vancomycin
  2017.8. (Cx; Pseudomonas luteola)
    Tx. Ceftazidime + Cefazolin ➔ Ceftazidime 3 weeks + PO Cipro
### Organism #1: Enterococcus faecium (VRE)

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ampicillin</td>
<td>R &gt; 8</td>
</tr>
<tr>
<td>Amoxicillin/CA</td>
<td>16/8</td>
</tr>
<tr>
<td>Azithromycin</td>
<td>N/R</td>
</tr>
<tr>
<td>Clindamycin</td>
<td>&gt; 2</td>
</tr>
<tr>
<td>Cefoxithin Screen</td>
<td>N/R</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>R &gt; 2</td>
</tr>
<tr>
<td>Cefepime</td>
<td>&gt; 16</td>
</tr>
<tr>
<td>Cefuroxime</td>
<td>&gt; 16</td>
</tr>
<tr>
<td>Daptomycin</td>
<td>S 4</td>
</tr>
<tr>
<td>Erythromycin</td>
<td>R &gt; 4</td>
</tr>
<tr>
<td>Ertapenem</td>
<td>&gt; 4</td>
</tr>
<tr>
<td>Nitrofurantoin</td>
<td>&lt; =32</td>
</tr>
<tr>
<td>Fusidic acid</td>
<td>&lt; =2</td>
</tr>
<tr>
<td>Fosfomycin</td>
<td>&lt; =32</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>&lt; =4</td>
</tr>
<tr>
<td>Gentamicin Synergie</td>
<td>S &lt; =500</td>
</tr>
<tr>
<td>Imipenem</td>
<td>N/R</td>
</tr>
<tr>
<td>Levofloxacin</td>
<td>R &gt; 4</td>
</tr>
<tr>
<td>Linezolid</td>
<td>S &lt; =1</td>
</tr>
<tr>
<td>Meropenem</td>
<td>&gt; 8</td>
</tr>
<tr>
<td>Moxifloxacin</td>
<td>&gt; 1</td>
</tr>
<tr>
<td>Mupirocin</td>
<td>&lt; =4</td>
</tr>
<tr>
<td>Tobramycin</td>
<td>&gt; 8</td>
</tr>
<tr>
<td>Oxacillin</td>
<td>&gt; 2</td>
</tr>
<tr>
<td>Penicillin</td>
<td>R &gt; 8</td>
</tr>
<tr>
<td>Rifampin</td>
<td>I 2</td>
</tr>
<tr>
<td>Streptomycin Synergie</td>
<td>S &lt; =1000</td>
</tr>
<tr>
<td>Trimethoprim/Sulfa</td>
<td>&gt; 4/76</td>
</tr>
<tr>
<td>Synercid</td>
<td>S &lt; =1</td>
</tr>
<tr>
<td>Tetracycline</td>
<td>R &gt; 8</td>
</tr>
<tr>
<td>Teicoplanin</td>
<td>S &lt; =1</td>
</tr>
<tr>
<td>Vancomycin</td>
<td>R &gt; 16</td>
</tr>
</tbody>
</table>

### Organism #2: Klebsiella pneumoniae

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ampicillin</td>
<td>R &gt; =32</td>
</tr>
<tr>
<td>Ampicillin/Sulbactam</td>
<td>R &gt; =32</td>
</tr>
<tr>
<td>Amikacin</td>
<td>S 16</td>
</tr>
<tr>
<td>Aztreonam</td>
<td>R 16</td>
</tr>
<tr>
<td>Ceftazidime</td>
<td>R &gt; =64</td>
</tr>
<tr>
<td>Cefotaxime</td>
<td>R 8</td>
</tr>
<tr>
<td>Cefazolin</td>
<td>R &gt; =64</td>
</tr>
<tr>
<td>Ertapenem</td>
<td>S &lt; =0.5</td>
</tr>
<tr>
<td>Cefepime</td>
<td>S &lt; =1</td>
</tr>
<tr>
<td>Cefoxitin</td>
<td>R &gt; =64</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>S &lt; =1</td>
</tr>
<tr>
<td>Levofloxacin</td>
<td>R &gt; =8</td>
</tr>
<tr>
<td>Meropenem</td>
<td>S &lt; =0.25</td>
</tr>
<tr>
<td>Trimethoprim/Sulfa</td>
<td>R &gt; =320</td>
</tr>
<tr>
<td>Tigecycline</td>
<td>S 2</td>
</tr>
<tr>
<td>Piperacillin/Tazobac</td>
<td>R &gt; =128</td>
</tr>
</tbody>
</table>

2018.01 CAPD peritonitis

2018.1. (Cx; Enterococcus faecium VRE, Klebsiella pneumoniae)

Tx. IV Linezolid 600mg q12hr + IV Ertapenem #21
IV Linezolid 600mg q12hr + IV Ertapenem #21

Re-admission
2018.01 CAPD peritonitis

Abdominal CT

Courtesy of Prof. Jwa-Kyung Kim
2nd admission

IV linezolid + IV ertapenem
### Organism #1: Acinetobacter baumannii (CRAB)

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Susceptibility</th>
<th>MIC (μg/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ampicillin/Sulbactam</td>
<td>S</td>
<td>4</td>
</tr>
<tr>
<td>Aztreonam</td>
<td>I</td>
<td>16</td>
</tr>
<tr>
<td>Ceftazidime</td>
<td>S</td>
<td>4</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>R</td>
<td>≥4</td>
</tr>
<tr>
<td>Colistin</td>
<td>S</td>
<td>≤0.5</td>
</tr>
<tr>
<td>Cefotaxime</td>
<td>S</td>
<td>8</td>
</tr>
<tr>
<td>Cefepime</td>
<td>R</td>
<td>≥64</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>S</td>
<td>≤1</td>
</tr>
<tr>
<td>Imipenem</td>
<td>R</td>
<td>≥16</td>
</tr>
<tr>
<td>Meropenem</td>
<td>R</td>
<td>≥16</td>
</tr>
<tr>
<td>Minocycline</td>
<td>S</td>
<td>≤1</td>
</tr>
<tr>
<td>Piperacillin</td>
<td>R</td>
<td>≥128</td>
</tr>
<tr>
<td>Trimethoprim/Sulfadiazine</td>
<td>S</td>
<td>≤20</td>
</tr>
<tr>
<td>Tigecycline</td>
<td>S</td>
<td>≤0.5</td>
</tr>
<tr>
<td>Piperacillin/Tazobactam</td>
<td>R</td>
<td>≥128</td>
</tr>
</tbody>
</table>

**CAPD catheter removal**

**+ IV Colistin**
‘ESKAPE’ Pathogens

In 2009, the *Infectious Diseases Society of America* highlighted the impact of the ‘ESKAPE’ pathogens, as a group of particularly troublesome bacteria that can ‘escape’ the effects of conventional antimicrobial therapy

- Enterococcus faecium,
- *S. aureus*,
- Klebsiella pneumoniae,
- Acinetobacter baumannii,
- Pseudomonas aeruginosa
- Enterobacter

Newer antibiotics for the treatment of peritoneal dialysis-related peritonitis

Antibiotic resistance in Gram(+) & Gram(-) organisms isolated from PD fluids of peritonitis patients in North India

- Among the Gram (+) organisms isolated from PD fluid, 15.4% were vancomycin-resistant enterococci (VRE) and 28.6% were methicillin-resistant S. aureus (MRSA).
- Of the 71 episodes of peritonitis caused by coagulase-negative Staphylococcus spp (CONS), 15 (21.1%) were by methicillin-resistant strains.
- Also, 54.3% of the Enterobacteriaceae isolates were resistant to 3rd-generation cephalosporins and all of them were ESBL-producers.
- Carbapenem resistance in Acinetobacter species and P. aeruginosa was 23.5% and 11.5% respectively and all of them were MBL-producers.
- Amikacin resistance in Acinetobacter species and P. aeruginosa was also very high, 47% and 34.5% respectively.

Methicillin resistance (%) in coagulase-negative Staphylococci in various countries combined with the year of the last reported data

Large differences exist between the various countries throughout the world.

Impact of resistance of microorganisms differs between the various publications.

Some studies reported no effects on outcome, while in others it negatively influenced treatment duration, hospitalization rate, catheter removal rate and death.

Semin Nephrol. 2017 Jan;37(1):66-76
## Selected newer antibiotics approved by the FDA since 1999

<table>
<thead>
<tr>
<th>Year of approval</th>
<th>Antibiotic</th>
<th>Route</th>
<th>Drug class</th>
<th>Indications</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>Ceftazidime/avibactam</td>
<td>IV</td>
<td>Cephalosporin/β-lactamase inhibitor</td>
<td>Complicated intra-abdominal and urinary tract infections</td>
</tr>
<tr>
<td>2014</td>
<td>Dalbavancin</td>
<td>IV</td>
<td>Lipoglycopeptide</td>
<td>Acute bacterial skin and skin structure infections</td>
</tr>
<tr>
<td></td>
<td>Oritavancin</td>
<td>IV</td>
<td>Lipoglycopeptide</td>
<td>Acute bacterial skin and skin structure infections</td>
</tr>
<tr>
<td></td>
<td>Tedizolid</td>
<td>IV/PO</td>
<td>Oxazolidone</td>
<td>Acute bacterial skin and skin structure infections</td>
</tr>
<tr>
<td></td>
<td>Ceftolozane/tazobactam</td>
<td>IV</td>
<td>Cephalosporin/β-lactamase inhibitor</td>
<td>Complicated intra-abdominal and urinary tract infections</td>
</tr>
<tr>
<td>2013</td>
<td>Telavancin</td>
<td>IV</td>
<td>Lipoglycopeptide</td>
<td>Hospital-acquired and ventilator-associated bacterial pneumonia</td>
</tr>
<tr>
<td>2010</td>
<td>Ceftaroline</td>
<td>IV</td>
<td>Cephalosporin</td>
<td>Acute bacterial skin and skin structure infections, bacterial pneumonia</td>
</tr>
<tr>
<td>2009</td>
<td>Telavancin</td>
<td>IV</td>
<td>Lipoglycopeptide</td>
<td>Complicated skin and skin structure infections</td>
</tr>
<tr>
<td>2007</td>
<td>Doripenem</td>
<td>IV</td>
<td>Carbapenem</td>
<td>Complicated intra-abdominal infection, complicated urinary tract infection</td>
</tr>
<tr>
<td>2005</td>
<td>Tigecycline</td>
<td>IV</td>
<td>Glycyclycline</td>
<td>Complicated skin and skin structure infections, complicated intra-abdominal infections</td>
</tr>
<tr>
<td>2003</td>
<td>Daptomycin</td>
<td>IV</td>
<td>Lipopeptide</td>
<td>Complicated skin and skin structure infections, S. aureus bloodstream infections, including those with right-sided infective endocarditis</td>
</tr>
<tr>
<td>2001</td>
<td>Ertapenem</td>
<td>IV</td>
<td>Carbapenem</td>
<td>Community-acquired pneumonia, intra-abdominal, skin, urinary tract, kidney and post-surgical gynecological infections</td>
</tr>
<tr>
<td>2000</td>
<td>Linezolid</td>
<td>IV/PO</td>
<td>Oxazolidinone</td>
<td>Uncomplicated and complicated skin and skin structure infections, community-acquired pneumonia, nosocomial pneumonia and VRE infections including concurrent bacteremia</td>
</tr>
<tr>
<td>1999</td>
<td>Moxifloxacin</td>
<td>IV/PO</td>
<td>Fluoroquinolone</td>
<td>Sinusitis, bronchitis, pneumonia, skin structure infections</td>
</tr>
<tr>
<td>1999</td>
<td>Quinupristin/dalfopristin</td>
<td>IV</td>
<td>Streptogramin</td>
<td>Complicated skin and skin structure infections, vancomycin-resistant Enterococcus faecium infection (including bacteremia)</td>
</tr>
</tbody>
</table>

IV, intravenous; PO, per oral.
## Use of newer antibiotics in the treatment of drug-resistant Gram-positive bacterial peritonitis

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Organisms</th>
<th>Route</th>
<th>Dose</th>
<th>Adverse effects</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Linezolid</strong></td>
<td>MRSE, MRSA, VISA, VRSA, VRE</td>
<td>PO/IV</td>
<td>600 mg twice daily</td>
<td>Myelosuppression, neuropathy (optic and peripheral)</td>
<td>Consider therapeutic drug monitoring in elderly patients and/or prolonged therapy required (&gt;2 weeks) Closely monitor hematological parameters and reduce to 300 mg twice daily if myelosuppression IP dosage unknown</td>
</tr>
<tr>
<td><strong>Daptomycin</strong></td>
<td>MRSE, MRSA, VRE, VISA, VRSA</td>
<td>IV</td>
<td>4–6 mg/kg Q48h</td>
<td>Myopathy, rhabdomyolysis, eosinophilic pneumonia, peripheral neuropathy</td>
<td>Monitor CPK levels and follow muscle pain or weakness Consider systemic steroid if eosinophilic pneumonia Limit the dwell time to 6 h and do not mix with icodextrin</td>
</tr>
<tr>
<td><strong>Tigecycline</strong></td>
<td>MRSE, MRSA, VRE</td>
<td>IV</td>
<td>100 mg loading, then 20 mg/L maintenance</td>
<td>Liver dysfunction, pancreatitis</td>
<td>IP dosage unknown</td>
</tr>
<tr>
<td><strong>Moxifloxacin</strong></td>
<td>MRSE, MRSE</td>
<td>PO/IV</td>
<td>400 mg Q24h</td>
<td>Prolonged QT interval, CNS side effects including seizure, peripheral neuropathy, spontaneous tendon rupture</td>
<td>Little anti-pseudomonal activity IP dosage unknown</td>
</tr>
<tr>
<td><strong>Quinupristin/ dalfopristin</strong></td>
<td>MRSE, MRSA, VRSA, VRE (E. faecium only)</td>
<td>IV + IP</td>
<td>IP 25 mg/L in alternate exchange given in conjunction with IV 500 mg Q12h</td>
<td>Infusion site pain, edema, inflammation, thrombophlebitis</td>
<td>Ineffective against E. faecalis</td>
</tr>
</tbody>
</table>

IV, intravenous; IP, intraperitoneal; PO, per oral; MRSA, methicillin-resistant *Staphylococcus aureus*; MRSE, methicillin-resistant *Staphylococcus epidermidis*; VISA, vancomycin-intermediate *Staphylococcus aureus*; VRE, vancomycin-resistant enterococcus; VRSA, vancomycin-resistant *Staphylococcus aureus*; CNS, central nervous system; CPK, creatine phosphokinase.
A lipoglycopeptide antibiotic has a lipophilic side chain that is linked to a glycopeptide.

Similar to vancomycin, lipoglycopeptides exert *bactericidal activity by inhibition of cell wall synthesis*.

Lipoglycopeptides are more potent than vancomycin against Gram(+) bacteria, including MRSA, VISA and VRE.

Currently three FDA-approved lipoglycopeptides
- telavancin,
- dalbavancin
- oritavancin

Lipoglycopeptide

- Pharmacokinetics of oritavancin have not been evaluated in patients with CrCl <30 mL/min.

- Dalbavancin can be used in patients with CrCl <30 mL/min with dosage adjustment, as well as HD patients without dosage adjustment.

- However, currently no data are available for oritavancin & dalbavancin use in PD patients.

- Previous in vitro study showed that telavancin exhibited significantly better bactericidal effects against MRSA than vancomycin in PDF.

- Further clinical studies are required to assess the efficacy and safety of lipoglycopeptides in treating peritonitis.
VRE Peritonitis

• **Enterococcus Species**
  - Normal flora of GI tract
  - Always resistant to cephalosporins
  - Resistance to penicillins and carbapenems is frequently observed in E. faecium (than in E. faecalis)

• **Vancomycin-Resistant Enterococcus (VRE) peritonitis**
  - **14.4%** of patients treated with dialysis have been colonized by VRE  
    (Am J Kidney Dis 2004)
  - Nosocomial infection
  - Spreading from patient to patient in health care settings
  - Various host factors
  - Linezolid IV
  - Catheter must be removed as part of treatment is unclear
We suggest that enterococcal peritonitis be treated for 3 weeks with IP vancomycin (2C).

We suggest adding IP aminoglycoside for severe enterococcal peritonitis (2D).

For peritonitis due to VRE, we suggest treatment for 3 weeks with IP ampicillin if the organism is susceptible or with alternative antibiotics (linezolid, quinupristin/dalfopristin, daptomycin or teicoplanin, based on antimicrobial susceptibilities) if the organism is ampicillin-resistant (2D).

Bone marrow suppression usually occurs after 10 to 14 days of linezolid therapy, and prolonged therapy may also result in neurotoxicity.
In most cases... PD catheter was removed.
Among 7 cases, two involved MDR A. baumannii, and one involved a carbapenem-resistant strain.

All the MDR bacterial infections failed treatment.

Perhaps PDR A. baumannii will be the next threat to PD patients.

Predisposing factors
- malnutrition,
- anemia,
- hypokalemia
- poor hygiene during exchange procedure
CRE Peritonitis

- CRE is defined as Enterobacteriaceae which is resistant to imipenem, meropenem, doripenem, or ertapenem or possesses a carbapenemase.

- Different types of carbapenemases confer diverse spectrums of antibiotic resistance.

- Class B metallo-β-lactamases (MBLs) are characterized by their ability to hydrolyze carbapenems and by their resistance to the commercially available β-lactamase inhibitors but susceptibility to inhibition by metal ion chelators.

- Treatment is limited and combination therapy may be beneficial for severely ill patients.

- Experience suggests that CRE peritonitis may require early catheter removal.
Case  Female/69

- Chief complaint: Exit site pain for 3 days
- CRF due to CGN
- CAPD since 2015 (1.5\%x3 + 7.5\%)
- V/S  BP 110/60  HR 84  RR 20  BT 36.5°C, BW 52.8kg  UO 800 mL

- Dialysis effluent study: negative
Catheter-related infections

- Major predisposing factors to PD-related peritonitis
- **Exit-site infection (ESI)**
  - Diagnosed by ISPD as *purulent drainage* with or without erythema of the skin at the catheter–epidermal interface (not graded)
- **Tunnel infection**
  - A presence of clinical inflammation or US evidence of collection along the catheter tunnel (not graded)
  - More common in association with ESI

ISPD guideline 2017
Management of catheter-related infections

• Exit-site care
  – Cleansed at least daily during ESI (1C)
• Empiric oral antibiotic treatment with appropriate S. aureus cover such as a penicillinase-resistant penicillin or first-generation cephalosporin unless the patient has had a prior history of infection/colonization with MRSA or Pseudomonas species (1C)
• Duration of treatment
  – ESI, except episodes caused by Pseudomonas species, be treated with at least 2 weeks of effective antibiotics (1C)
  – ESI caused by Pseudomonas species and any tunnel infection be treated with at least 3 weeks of effective antibiotics (1C)
## Oral Antibiotics Used in Catheter-Related Infections

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Dose Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amoxicillin</td>
<td>250–500 mg BD (182)</td>
</tr>
<tr>
<td>Amoxicillin/clavulanate</td>
<td>875 mg/125 mg BD (183)</td>
</tr>
<tr>
<td>Cephalaxin</td>
<td>500 mg BD to TID (86)</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>250 mg BD (164) or 500 mg daily (184)</td>
</tr>
<tr>
<td>Clarithromycin</td>
<td>500 mg loading, then 250 mg BD (165)</td>
</tr>
<tr>
<td>Clindamycin</td>
<td>300–450 mg TID (185)</td>
</tr>
<tr>
<td>Cloxacillin/flucloxacillin</td>
<td>500 mg QID (186)</td>
</tr>
<tr>
<td>Erythromycin</td>
<td>250 mg QID (187)</td>
</tr>
<tr>
<td>Fluconazole</td>
<td>oral 200 mg loading, then 50–100 mg daily (188)</td>
</tr>
<tr>
<td>Levofloxacin</td>
<td>300 mg daily (189)</td>
</tr>
<tr>
<td>Linezolid</td>
<td>300–450 mg BD (190–192)</td>
</tr>
<tr>
<td>Metronidazole</td>
<td>400 mg TID (193)</td>
</tr>
<tr>
<td>Moxifloxacin</td>
<td>400 mg daily (194)</td>
</tr>
<tr>
<td>Rifampicin</td>
<td>450 mg daily for BW &lt;50 kg; 600 mg daily for BW ≥50 kg (144,145)</td>
</tr>
<tr>
<td>Trimethoprim/sulfamethoxazole</td>
<td>80 mg/400 mg daily (8) to 160 mg/800 mg BD (195)</td>
</tr>
</tbody>
</table>
Possible Indications for Ultrasonographic Examination of Catheter Tunnel

- Initial evaluation of suspected tunnel infection, e.g. tunnel swelling without erythema and tenderness
- Initial evaluation of ESI without clinical features of tunnel involvement (especially if caused by S. aureus)
- Follow-up of exit-site and tunnel infection after antibiotic treatment
- Relapsing peritonitis episodes
Resistant ESI & Tunnel Infections

- **Recommend simultaneous removal & reinsertion** of the dialysis catheter with a new exit site under antibiotic coverage in refractory infections defined as *failure to respond after prolonged therapy* (e.g., >3 weeks) with effective antibiotics (1C).

- **Suggest catheter removal** if ESI that progress to, or occur simultaneously with, peritonitis (2C).

- **Suggest** that, any reinsertion of a PD catheter be performed at least 2 weeks after catheter removal and complete resolution of peritoneal symptoms (2D).
Complications of Peritoneal Dialysis

Infectious
- PD-associated peritonitis
  - Catheter-related infection
    - Exit-site infection
    - Catheter-tunnel infection

Non-infectious
- Catheter-related
  - Leak
  - Obstruction
  - Malposition
  - Entrapment
- Metabolic complications
  - Problems with solute/water clearance (UF failure)
  - EPS
Case  Female/45

- Chief complaint: poor drainage for 1 week
- CRF due to DKD
- CAPD since 2017 (1.5% x 3 + 7.5%)
Outflow failure (+), Inflow failure (-)

Immediate after OP

Day of OPD visit

Courtesy of Prof. Sun-Hee Park
Outflow failure and inflow failure (+)

**Treatment**
- Ambulation
- Laxatives
- Enema

What is the next step?
- Aspiration and flushing with Heparinized fluid
- Brushing with semiflexible wire

*Courtesy of Prof. Sun-Hee Park*
Catheter tip malposition

- Repositioning of malpositioned catheter
- Blind manipulation with stiffening stylet
- Fluoroscopically guided manipulation with semiflexible wire
- Laparoscopic or peritoneoscopy
- Surgical

Bronchoscopic forceps
Omental Wrapping

Laparoscopic PD catheter reposition, anchoring on Douglas’ pouch, partial omentectomy

Courtesy of Prof. Sun-Hee Park
After laparoscopic reposition of PD catheter

Courtesy of Prof. Sun-Hee Park
Causes of Outflow Failure

- Constipation
- Catheter tip malposition
- Omental wrapping or adhesion
- Kinking
- Intraluminal occlusion (fibrin, hematoma..)
Intraluminal Occlusion

- Manual compression of the dialysate container
- Simple aspiration and/or flushing with heparinized solution
- Heparin (1:1000) dwell for a few hours before repeating aspiration and flushing.
- Thrombolytic agents instillation
  - Tissue plasminogen activator: alteplase (1 mg/ml, 1 hr)
  - Streptokinase (750,000 IU / NS 30-100 mL, 2hrs, X2)
  - Urokinase (5000 μ / NS 40 mL)

Courtesy of Prof. Sun-Hee Park
Outflow failure patient …

- Complaints of decreased PD drainage
- Infusion volume 800mL with drainage of 300 mL

- Diffuse abdominal wall swelling (+)

Residual Intraabdominal volume?
Peritoneal membrane function – High transport Leak?
Gross appearance (reference case)
Subcutaneous leakage of contrast via trochar insertion site
PD rest for 2 weeks & restart PD
Case  Male/51

- Chief complaint: Scrotal swelling, Lt
- T2DM (+) for 17 years
- 2016. 11. 02 HD start via temporary catheter
- 2016.11.09 PD catheter insertion
- Icodextrin (6AM) + 1.5% physioneal (10PM)
- 2017.05.04 CCPD 10hrs, TV 11.5L, 2L X 5cycle, LF 1.5L (2.5% #2 + ico, prn 4.25%+2.5%)
- Started heavy weight exercise at gym
- 2 weeks later developed Lt scrotal swelling and wt gain 3kg
- At outpatient clinic, he reports a new “lump” in his left groin.
Peritoneal leak to scrotum by increased IAP

- Temporary PD stop
- Try to reduce IAP (low volumes, supine posture, etc)
- Surgical correction

Courtesy of Prof. Sun-Hee Park
Increased intra-abdominal pressure (IAP)

- Instillation of dialysate into the peritoneal cavity leads to increased IAP

- Magnitude of the increase depends upon:
  - volume of dialysate instilled
  - position of the patient (sitting>standing>supine)
  - age, body mass index
  - coughing, lifting, straining at stool
Case Male/47

- Chief complaint: DOE for 1 week
- Occupation: Bus driver
- 2016.02 ESRD on CAPD (1.5% x 3 + 7.5% x ON)
- 2017.10 Worsening Orthopnea x 2days
Admission Chest X-ray
Drainage of Effusion

Pigtail catheter insertion for drainage of right pleural effusion
Thoracoscopic diaphragm covering and pleurodesis, Rt.
**Hydrothorax**

**Definition:** Presence of peritoneal dialysate in the pleural cavity

**Pathogenesis:** Movement of dialysate, under increased IAP, from peritoneal to pleural cavity through congenital or acquired defects in the diaphragm

**Presentation:**
- May be asymptomatic
- Shortness of breath
- No improvement with hypertonic dialysate
- Diminished effluent return
- Right-sided pleural effusion on chest X-ray
Hydrothorax

**Diagnosis:**
- Thoracentesis for relief of symptoms and/or diagnosis
- Pleural fluid analysis: transudate, high glucose concentration

**Treatment**
- Temporary HD with subsequent return to PD
- Temporary HD with return to PD with lower IAP
- Obliteration of the pleural space (pleurodesis)
- Operative repair (patch repair of diaphragmatic defects)
Take Home Messages

• Guidelines and protocols on prevention and treatment of PD related infections should be implemented to improve the overall peritonitis rate and outcomes.

• Noninfectious complications of PD, catheter-related (leakage, obstruction) or related to increased intra-abdominal pressure (hernia, hydrothorax), are also important causes of technique failure and need to be reviewed to improve patient care and outcomes.
Thank You for Your Attention!