



Interventional Nephrology Primer: Part 2

Peritoneal Dialysis Catheter

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Ammar Almekhmi, MD, MPH

University of Alabama at Birmingham

Editor: Anil Agarwal, MD

Editorial and Design Assistance: Serene Almekhmi

Peritoneal Dialysis (PD) Catheter

Most people with kidney failure can be treated by peritoneal dialysis with few exceptions:

1. People who have had major abdominal operations. Scarring of the peritoneal membrane might cause it to be ineffective for dialysis.
2. People who are unable to care for themselves, or patients who need assistance.

Good things about PD (The Good Catheter)

- PD catheters have lower infection rate than permcath.
- Better quality of life and autonomy.
- PD catheter can be used acutely within 12 hours of insertion if needed (urgent start PD).
- Easy to transition to other dialysis modalities.
- Preserves the vascular real estate.
- Can be performed at home setting, avoiding exposure to crowded setting and infections.

Care for advanced CKD and ESRD patients is an integrated dynamic process with several transition points between peritoneal and hemodialysis.

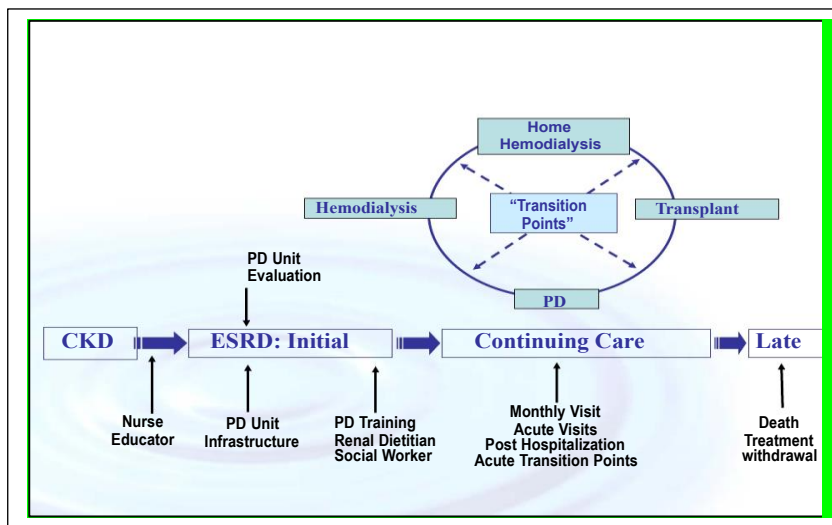
Transfer from PD to HD

- 1- Recurrent infection
- 2- Catheter malfunction
- 3- Ultra-filtration failure
- 4- Adequacy (solute) failure
- 5- Psychological burnout
- 6- Failure in daily activities
- 7- Uncontrolled diabetes
- 8- Significant weight gain

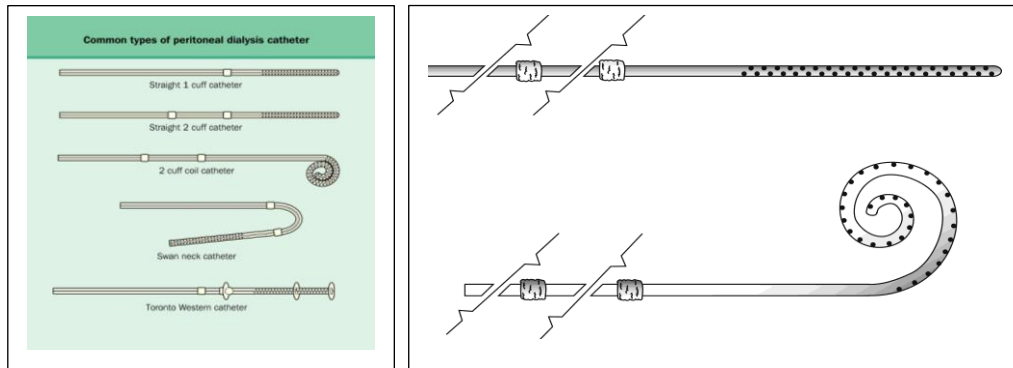
Transfer from HD to PD

- 1- Recurrent CHF
- 2- Hemodialysis access failure
- 3- Hypercoagulability
- 4- Malnutrition
- 5- Nursing home care
- 6- Social factors (work, travel)
- 7- Intra-dialysis hypotension

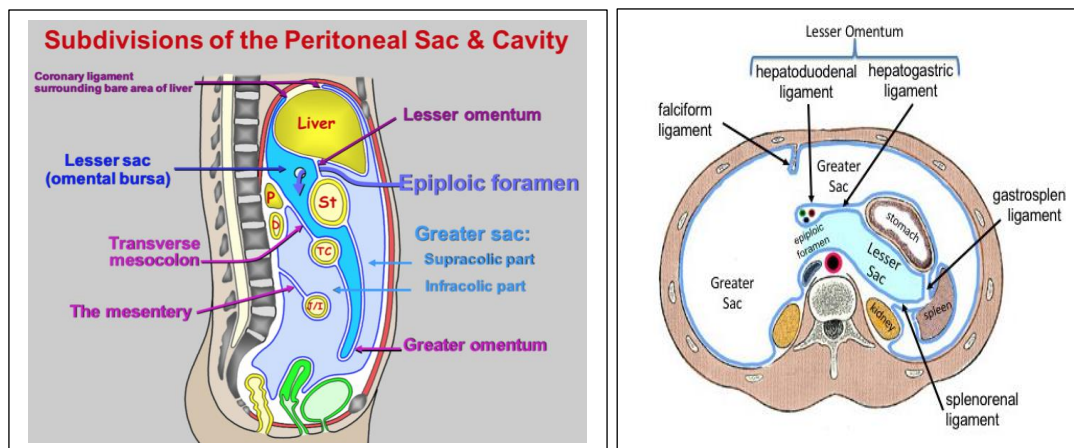
Integrated care for advanced CKD patient



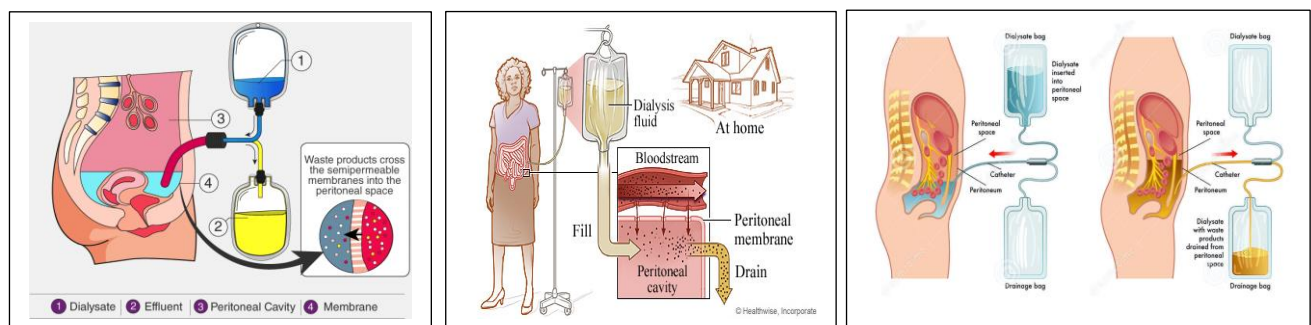
Types of PD catheters:



Anatomy of the Peritoneum



Principle of PD



Methods of PD catheter insertion

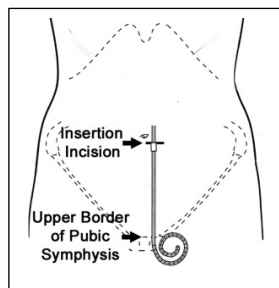
Open Surgical.
Laparoscopic.
Peritoneoscopic.
Fluoroscopic with ultrasound guidance.

Pre-op preparation protocol:

- NPO after MN the night prior to procedure.
- Check CBC, BMP, PT/INR.
- Hold blood thinners (5-7 days; see anticoagulation protocol).
- Assess for previous abdominal surgeries.
- BMI to determine the best insertion method.
- The procedure is signed off by a nephrologist.
- Bowel preparation the day before the procedure: 2 L of polyethylene glycol solution, enema, or stimulant suppository.
- Shower on the day of the procedure with chlorhexidine soap wash.
- Removal of body hair preferably with electric clippers.
- Empty the bladder before procedure (if needed, insert Foley catheter).
- Pre-operative antibiotic prophylaxis: (cefazolin, vancomycin, or clindamycin).

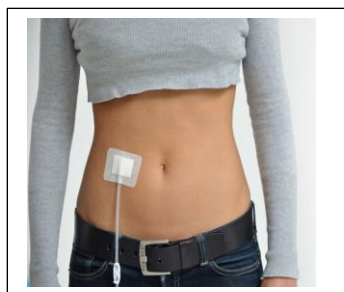
Key technical issues in PD implantation

1. Location of the catheter tip within the pelvis (shown): due to hydraulic function of the catheter and to prevent the omental entrapment.



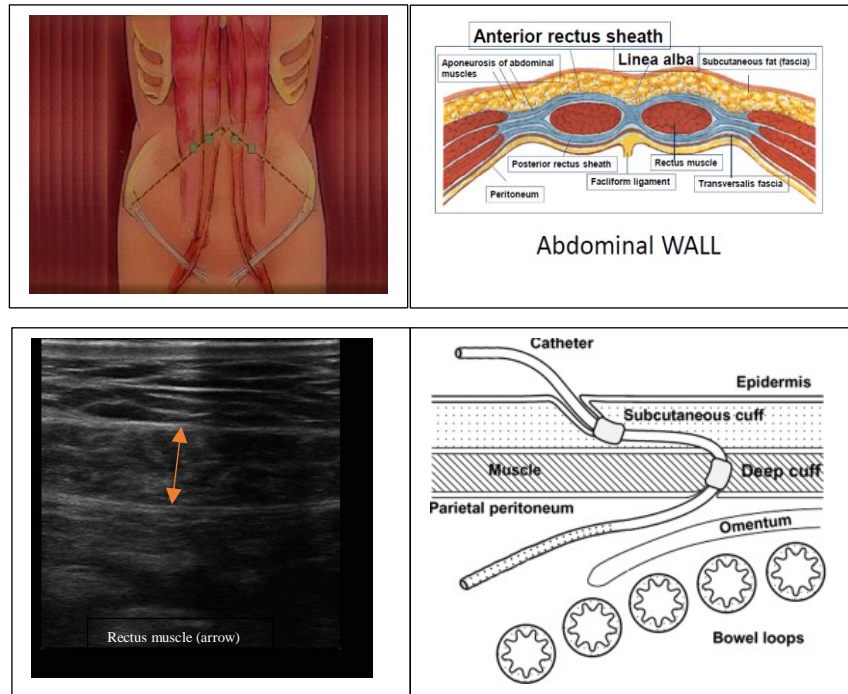
2. Location of the exit site:

- Should be away from beltlines, skin creases, and folds.
- Should be **clearly visible** to the patient to perform daily exit site care.
- The direction of the exit is downward or lateral.



3. PD catheter cuffs:

- Two-cuff catheters with coiled intra-peritoneal segment are commonly used.
- The superficial cuff should be 1 inch away to exit site.
- The deep cuff is buried within the rectus muscle of abdominal wall.
- Two cuff catheters may lower the risk of *Staph aureus* peritonitis.

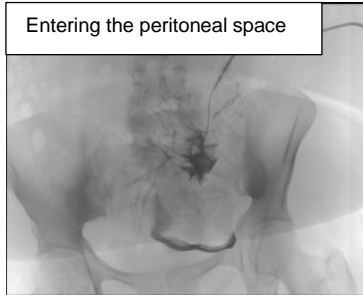


PD Catheter Fluoroscopic Insertion Procedure

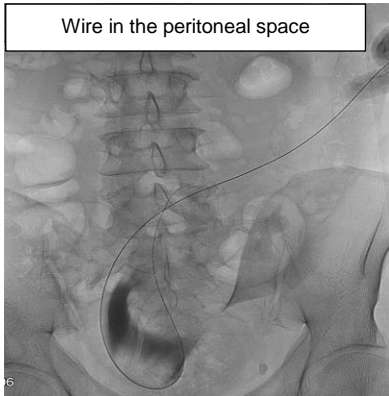
Prepping the patient



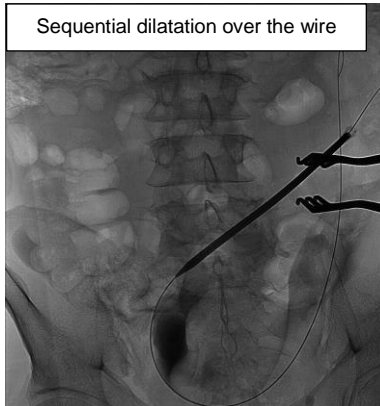
Entering the peritoneal space



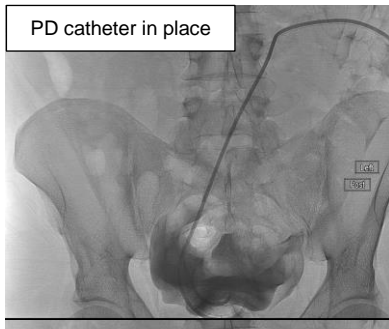
Wire in the peritoneal space



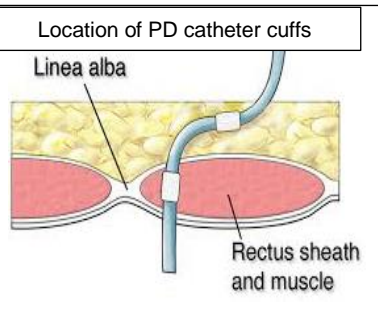
Sequential dilatation over the wire



PD catheter in place



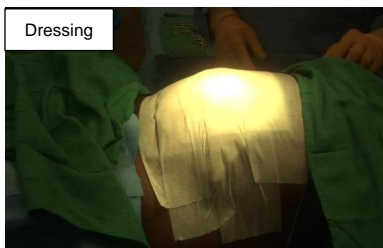
Location of PD catheter cuffs



2 Layers suturing



Dressing



Complications of PD

I. Mechanical Complications of Peritoneal Dialysis Catheter

Catheter Flow Dysfunction

Peritoneal leakage issues

Flow dysfunction

1. Extrinsic compression of catheter tip.
2. Internal luminal obstruction.
3. Poor positioning and migration.
4. Tissue attachment and entrapment.

Peritoneal leakage issues

- Pericatheter leaks.
- Abdominal wall hernias.
- Pleuroperitoneal connection (fistula).

Catheter Flow Dysfunction

1. *Extrinsic compression of catheter tip*

Key causes: constipation and bladder distention.

Mechanism: obstruction of the catheter side holes by distended bladder or colon.

Check KUB and post-void residual urine volume.

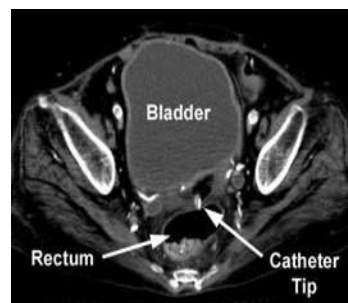
Treat the cause.



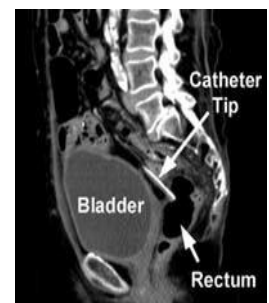
Constipation



Relief of constipation



Neurogenic bladder



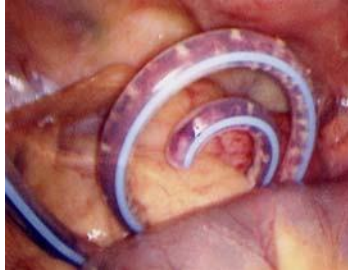
PD catheter is between bladder and rectum

2. Luminal obstruction

Key issues: tube kink or fibrin/blood clot.

Mechanism: two-way luminal obstruction.

Treatment: irrigate using syringe of saline; instill tPA to dissolve the fibrin clot; or use the wires under fluoroscopic guidance. Sometimes, PD catheter requires exchange.



Intra-luminal fibrin and blood clot



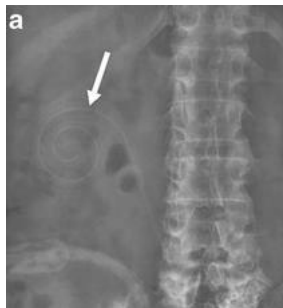
PD catheter Kink

3. Poor positioning and migration

Key problem: unusual position of the PD tip causing poor flow.

Mechanism: catheter resiliency memory forces and other factors.

Treatment: fluoroscopic repositioning or exchange.



4. Tissue attachment and entrapment

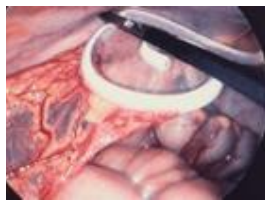
Key issue: one-way or two-ways poor flow.

Mechanism: entrapment due to omentum or adhesions.

Treatment: laparoscopic intervention.



Omentum



Omental entrapping



Omental entrapment

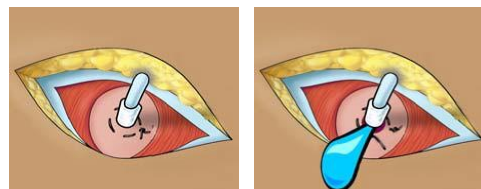


Adhesion entrapment

Peritoneal leakage issues

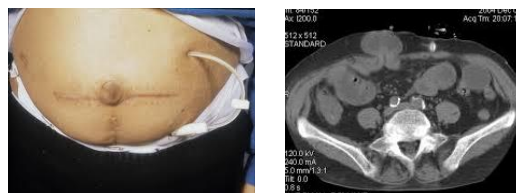
i. Pericatheter leaks

Mostly seen in urgent start of PD catheter.
Supine small volume dialysate exchanges.
Decrease physical activities.
May require switching to hemodialysis.



ii. Abdominal wall hernia

Due to increased intra-abdominal pressure.
Obesity and steroid use are risk factors.
May require surgical repair.



iii. Hydrothorax (Pleuroperitoneal connection).

Pathogenesis: The movement of the dialysate from the peritoneal to pleural space through defects present in the diaphragm.
Treatment: low volume dialysate, pleurodesis, or pleuroscopic repair.



II. Infectious Complications of PD

Infectious complications are the most common cause for the loss of the peritoneal dialysis catheter and switching to hemodialysis.

1. Exit-site infections



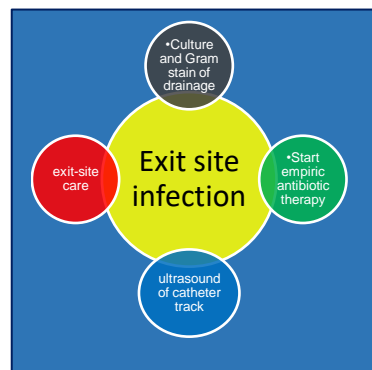
Healthy exit site

Natural skin color.
No scab, crust, or granulation tissue.
No visible drainage.
Epithelium covers whole visible sinus.
Epithelium is snug around the catheter.



Acute exit site infection

Usually related to poor exit site care



2. Tunnel infections



Treatment:

1. Culture and Gram stain of drainage
2. Initiate empiric antibiotics (that includes *Staphylococcus aureus* coverage).
3. Refer to a surgeon to determine next step/intervention.

3. Superficial cuff extrusion



Treatment:

1. Exit site care.
2. Removal of the extruding cuff (shaving) allows the exit site to heal.

4. Peritonitis

Peritonitis: 2 of 3 criteria

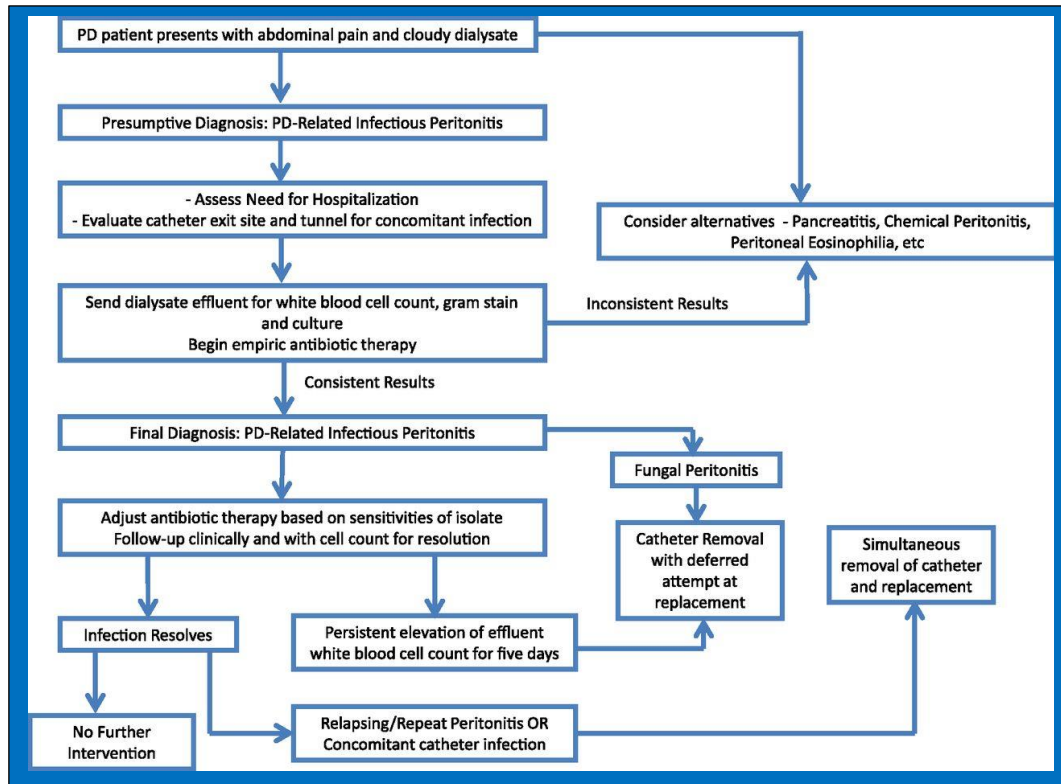
1. Signs and symptoms (Abdominal pain, fever).
2. Cloudy fluids (>100 WBC/ml; 50% Neutrophils).
3. Identification of an organism.

Source of Peritonitis:

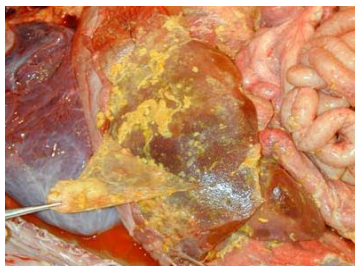
- a. Contamination 41%
- b. Catheter related 23%
- c. Enteric injury 11%
- d. UTI 4%
- e. Others 22%



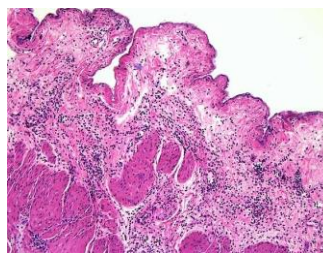
Flow Chart for Peritonitis Assessment



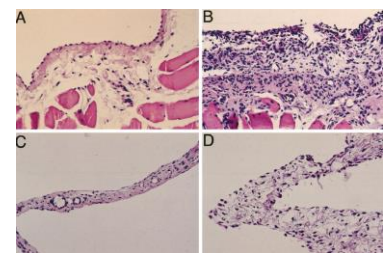
Peritonitis: gross and microscopic appearance



Acute peritonitis



Histopathology of peritonitis



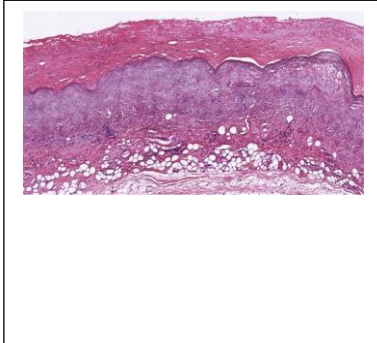
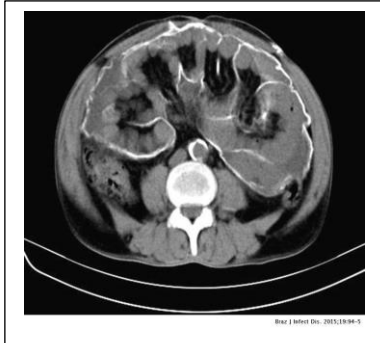
A&C: normal parietal and visceral peritoneal membrane. B&D: acute peritonitis.

Indications for PD Catheter Removal due to Infections

- Refractory peritonitis.
- Relapsing peritonitis.
- Fungal peritonitis.
- Refractory exit site and tunnel infections.
- Consider removing the PD catheter if not responding to therapy:
 - Multiple enteric organisms
 - Mycobacterial peritonitis

Encapsulating peritoneal sclerosis (EPS):

EBS is characterized by a fibrocollagenous membrane encasing the small intestine, resulting in recurrent small bowel obstructions. EPS is most commonly associated with long-term peritoneal dialysis. The mortality rate for EPS is high, primarily due to complications related to bowel obstruction.



Color of Peritoneal Dialysis Effluent as a Diagnostic Tool



Bloody effluent

- Menstruation
- Ovulation.
- Ovarian cyst rupture.
- Anticoagulation.



Cloudy Effluent

- Infections.
- Reactive.
- Idiopathic.
- Neoplastic.



Yellow green effluent

- Cholecystitis



Milky effluent

- Lymphoma.
- Trauma
- Medications.



Black brown effluent

- Rhabdomyolysis



Normal effluent

References:

1. Crabtree JH, Chow KM. Peritoneal Dialysis Catheter Insertion. *Semin Nephrol.* 2017;37(1):17-29.
2. Crabtree JH, Shrestha BM, Chow KM, et al. Creating and Maintaining Optimal Peritoneal Dialysis Access in the Adult Patient: 2019 Update. *Perit Dial Int.* 2019;39(5):414-436.
3. Crabtree JH. Selected best demonstrated practices in peritoneal dialysis access. *Kidney Int Suppl.* 2006;(103):S27-S37.
4. Li PK-T, Szeto CC, Piraino B, Arteaga J de, Fan S, Figueiredo AE, Fish DN, Goffin E, Kim Y-L, Salzer W, Struijk DG, Teitelbaum I, Johnson DW: ISPD Peritonitis Recommendations: 2016 Update on Prevention and Treatment. *Perit. Dial. Int.* 36: 481–508, 2016
5. Mujais S: Microbiology and outcomes of peritonitis in North America. *Kidney Int. Suppl.* S55-62, 2006
6. Nessim SJ: Prevention of peritoneal dialysis-related infections. *Semin. Nephrol.* 31: 199–212, 2011
7. Dossin T, Goffin E. When the color of peritoneal dialysis effluent can be used as a diagnostic tool. *Semin Dial.* 2019;32(1):72-79.
8. Twardowski ZJ, Prowant B. "Classification of normal and diseased exit sites." *Perit Dial Int* 16. Suppl 3 (1996): S32-S50.
9. Crabtree, JH. "Peritoneal dialysis catheter implantation: avoiding problems and optimizing outcomes." *Semin Dial* 28.1 (2015): 12-15.
10. Szeto CC, Li P, Johnson DW, et al. "ISPD catheter-related infection recommendations: 2017 update." *Perit Dial Int* 37 (2017): 141-154.
11. Debowski JA, Waerp C, Kjellefold SA, Abedini S. "Cuff extrusion in peritoneal dialysis:single-centre experience with the cuff-shaving procedure in five patients over a 4-year period." *Clin Kidney J* 10.1 (2017): 131-134.
12. Szeto CC, Li PK. Peritoneal Dialysis-Associated Peritonitis. *Clin J Am Soc Nephrol.* 2019;14(7):1100-1105.
13. Twardowski ZJ, Prowant BF, Nichols WK, Nolph KD, Khanna R. Six-year experience with Swan neck presternal peritoneal dialysis catheter. *Perit Dial Int.* 1998;18(6):598-602.
14. Jagirdar RM, Bozikas A, Zarogiannis SG, Bartosova M, Schmitt CP, Liakopoulos V. Encapsulating Peritoneal Sclerosis: Pathophysiology and Current Treatment Options. *Int J Mol Sci.* 2019;20(22):5765.