

Practical Approach to Create and Maintain Successful Peritoneal Dialysis Catheter

SHWETA BANSAL, MD, FASN

CLINICAL PROFESSOR OF MEDICINE

DIRECTOR, HOME DIALYSIS PROGRAM

UNIVERSITY OF TEXAS HEALTH AT SAN ANTONIO

SAN ANTONIO, TX



Disclosures

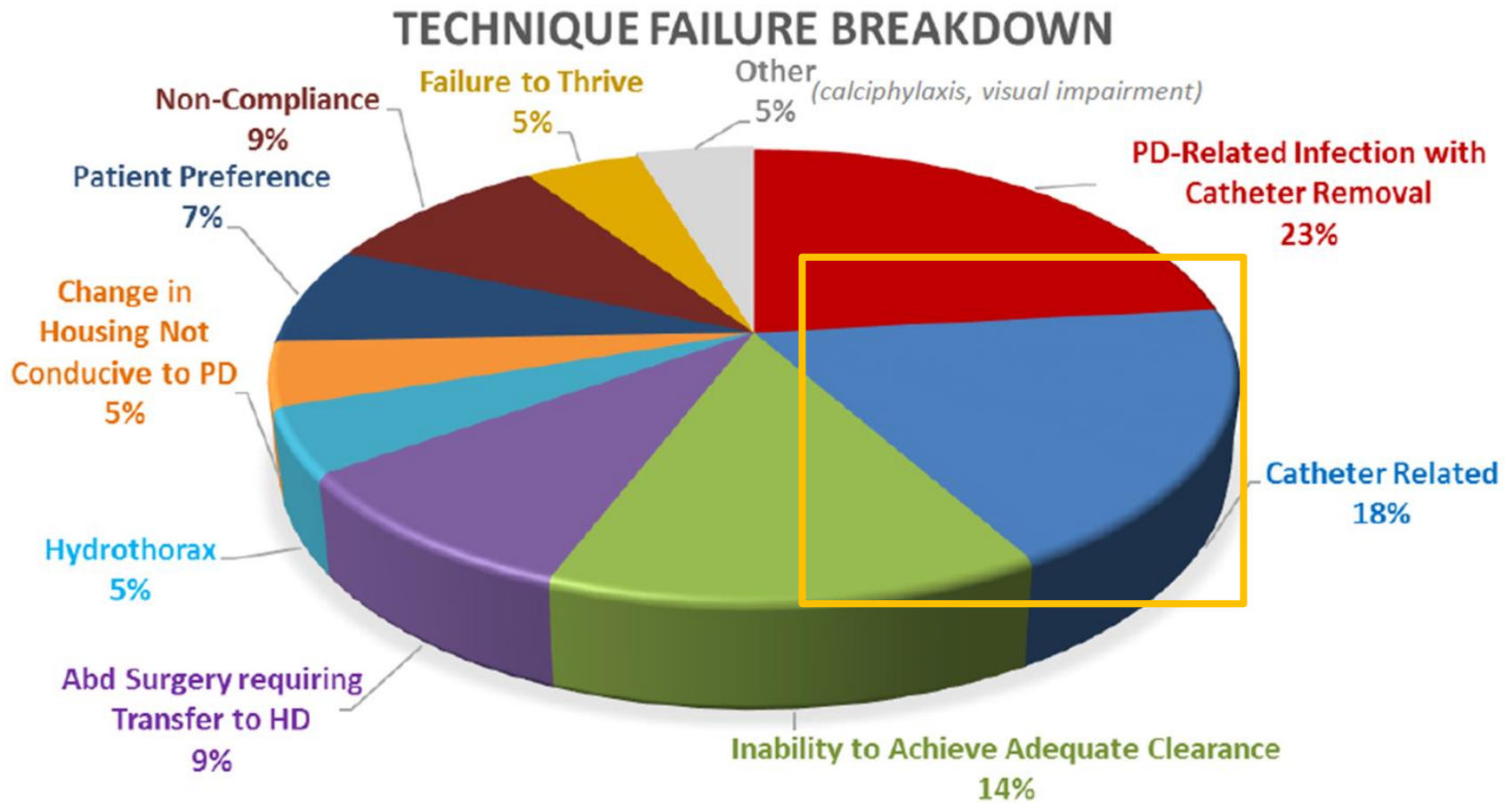
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 - ▶ PD Excellence Academy
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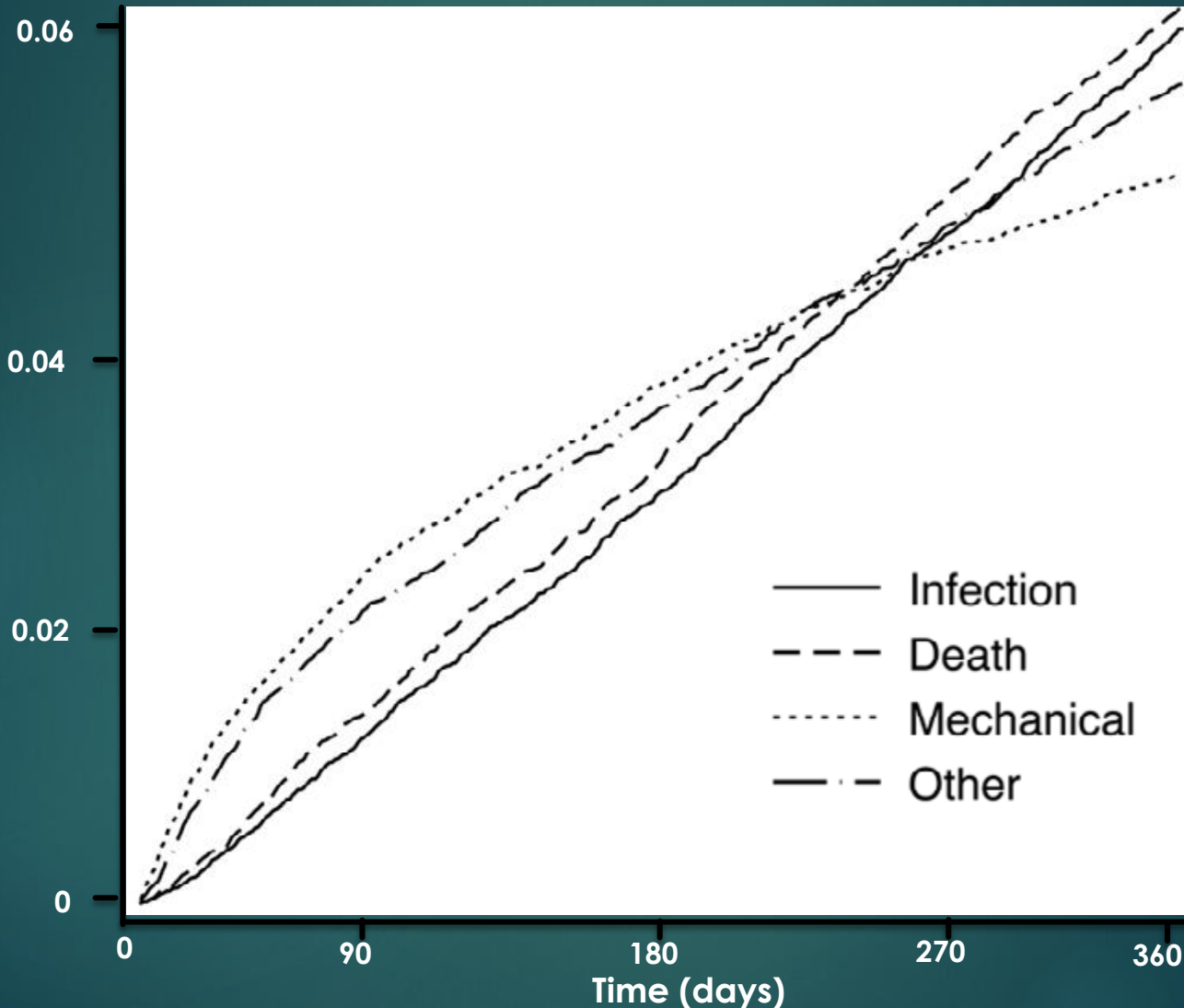
- ▶ **Bansals3@uthscsa.edu**

Causes of Technique Failure on Peritoneal Dialysis



Causes of transfer to HD among an inception cohort of over 40,000 US patients, 2000-2003.

Cause-specific Transfer to HD within First year of Incidental PD Patients.



ISPD GUIDELINES/RECOMMENDATIONS

CREATING AND MAINTAINING OPTIMAL PERITONEAL DIALYSIS ACCESS IN THE ADULT PATIENT: 2019 UPDATE

Talk Outline

- ▶ Catheter Types and selection
- ▶ Placement Considerations
 - ▶ Location
 - ▶ Placement techniques
 - ▶ Peri-operative management
- ▶ Catheter dysfunction
- ▶ Catheter Infection – beyond the scope of this talk
 - ▶ Exit Site Care
 - ▶ Exit Site Infections
 - ▶ Catheter related infections

Goals of All PD Catheters

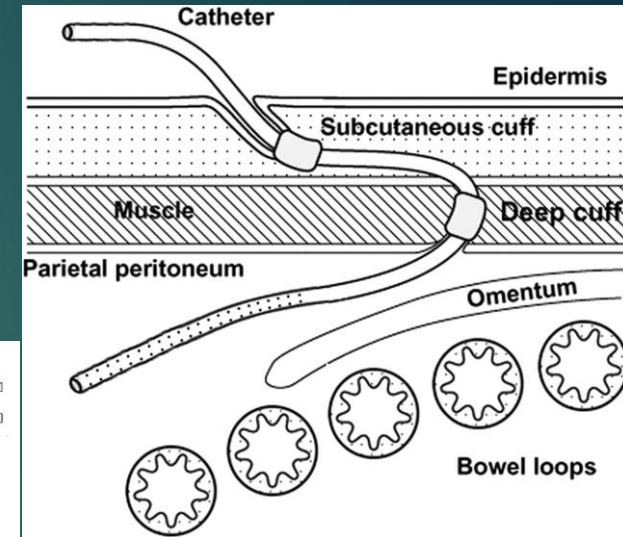
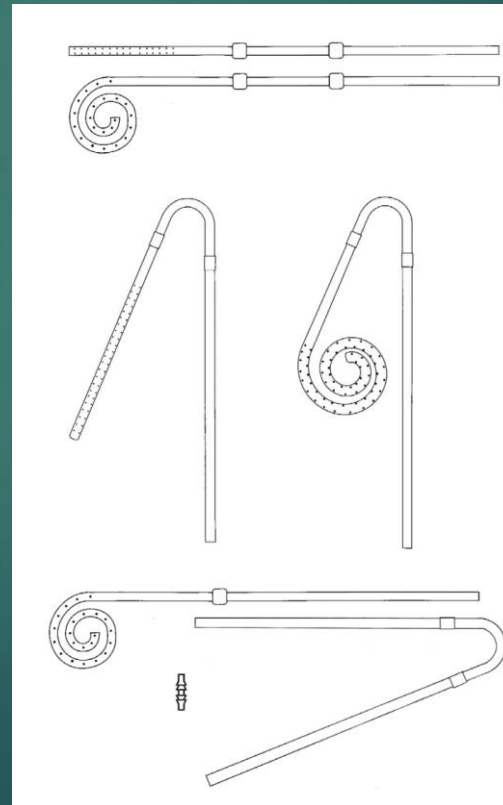


- ▶ Allow unobstructed flow and drain of dialysate
- ▶ Minimize infection risk
- ▶ Prolong catheter survival

Catheter Shapes and Designs

Crabtree et al. Creating and maintaining optimal peritoneal dialysis access in the adult patient: 2019 update. *Peri Dial Int* 2019; 39(5):414–436

- ▶ Intra-peritoneal segment (15-20 cm)
 - ▶ Straight
 - ▶ Coiled
- ▶ Inter-cuff segment (5-7 cm)
 - ▶ Straight
 - ▶ Arc
- ▶ External (20 cm)
- ▶ Single vs. double cuff
- ▶ Extensions



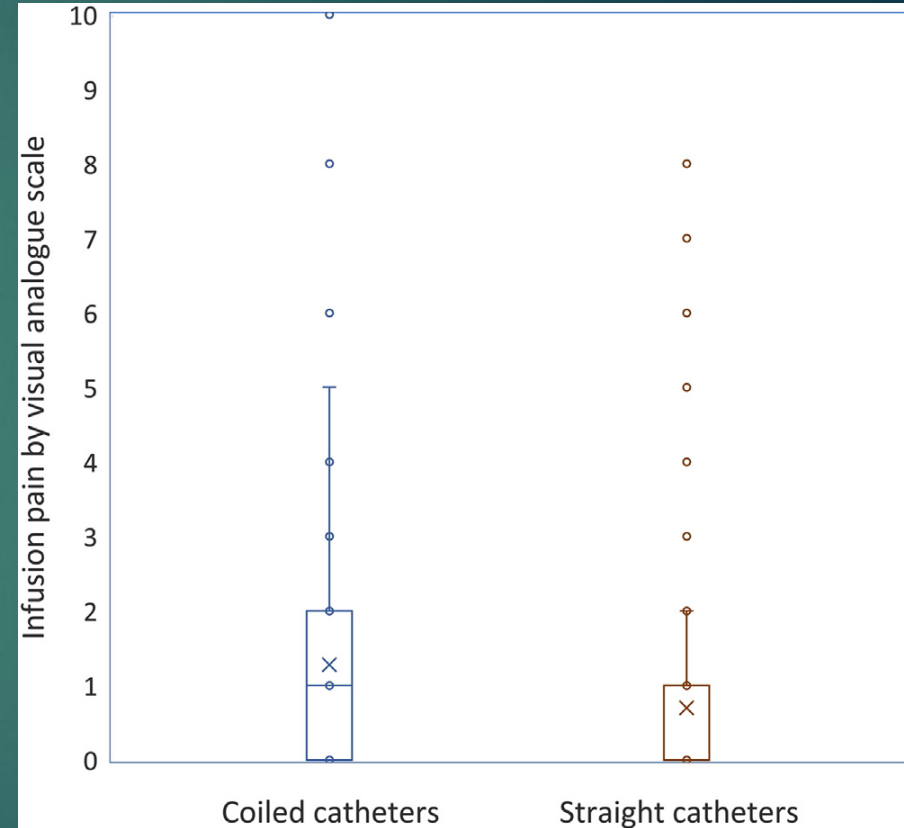
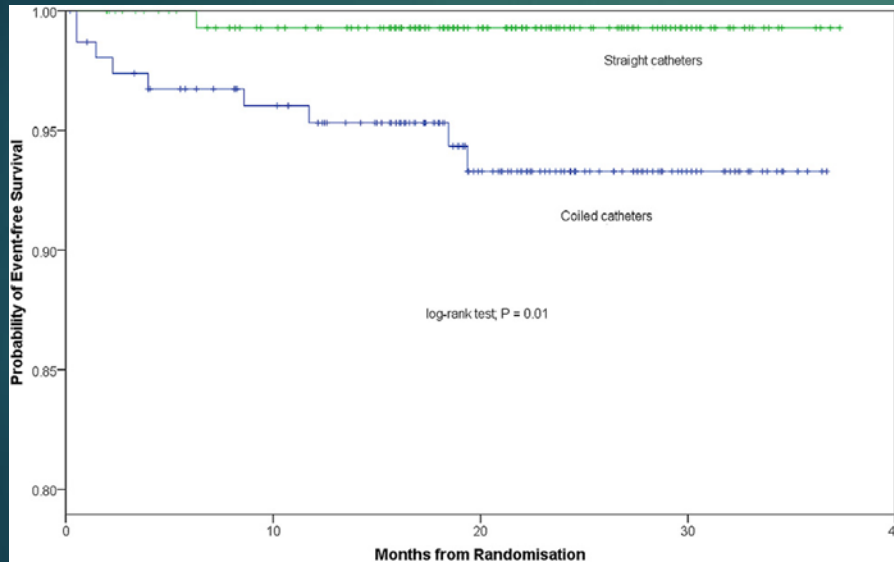
Intraperitoneal Segment: Straight vs. Coiled

Hagen et al. *Kidney International* (2014) 85, 920–932

- ▶ Multiple small RCTs and meta-analysis
 - ▶ No difference
 - ▶ Exit site infection, peritonitis, dysfunction, migration, leakage and removal
 - ▶ Catheter survival
 - ▶ At 1-year: no difference
 - ▶ At 2-year: in favor of straight, HR 2.05; 95% CI 1.10–3.79, P=0.02
- ▶ Heterogeneity
 - ▶ insertion technique, length of FU, peri-procedure care

Intraperitoneal Segment: Straight vs. Coiled - RCT

- 308 CAPD incidental patients
- Outcome: catheter dysfunction requiring surgical intervention over 21 months.



Single vs. Double Cuff

Hagen et al. *Kidney International* (2014) 85, 920–932

Nessim et al. *Nephrol Dial Transplant*. 2010 Jul;25(7):2310-4.

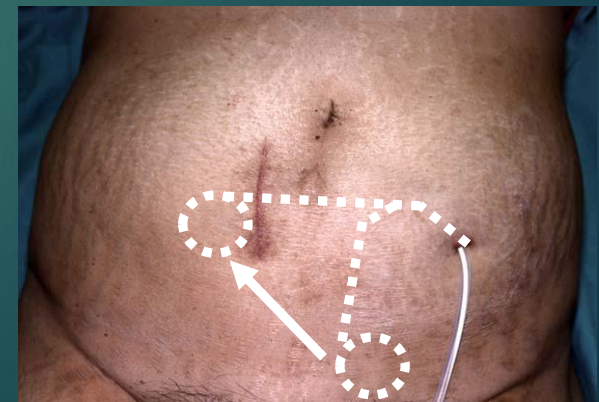
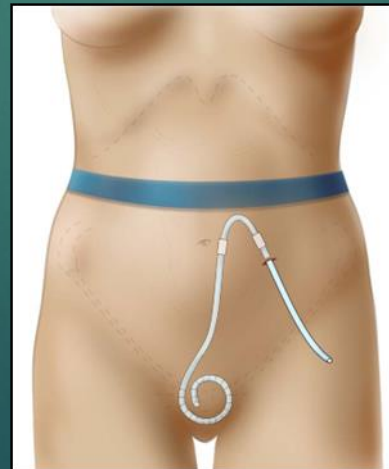
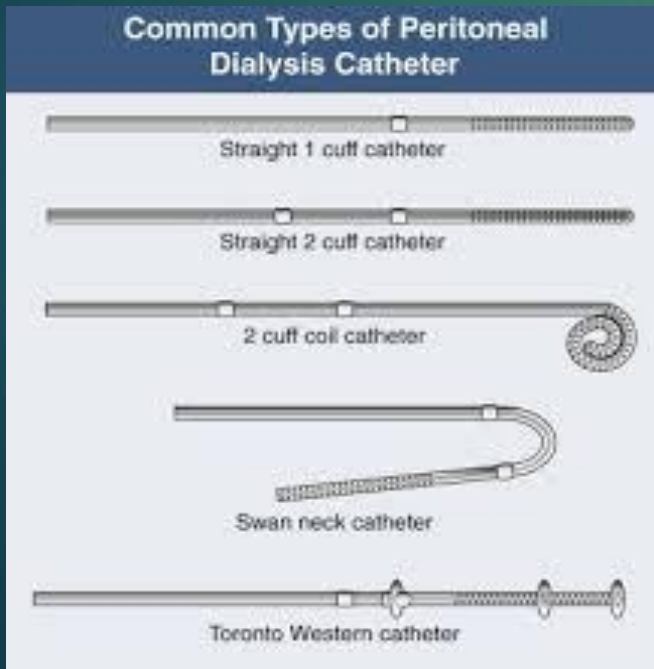
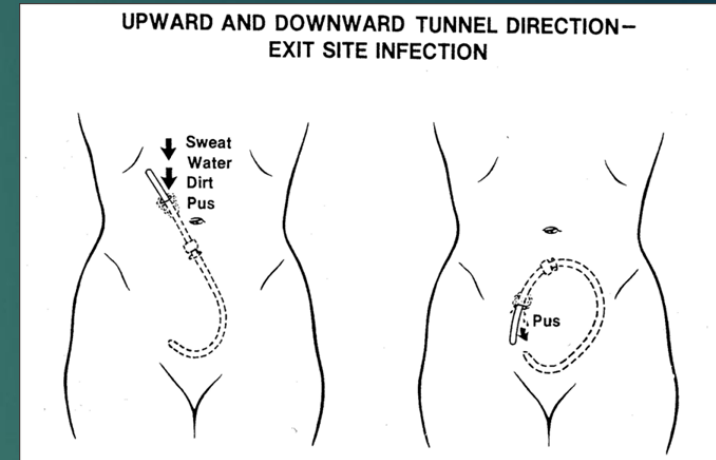
- ▶ Cuff is composed of Dacron polyester fabric that irritates local tissue which then scars down around it
 - ▶ Deep cuff placed in rectus muscle
 - ▶ Superficial cuff in the subcutaneous tissue
- ▶ Single vs. double cuff
 - ▶ No difference in current era
 - ▶ Exit site infection, Migration, Leakage, Peritonitis, Removal
- ▶ Given that compliance with prophylactic ointments is variable, having the added protection of a double-cuff catheter may be advantageous, especially among diabetic and immunosuppressed patients in whom the risk of *S. aureus* catheter infection is higher



Inter-cuff Segment: Straight vs. Swan neck

Gadallah MF et al. Advances in Perit Dial 16: 47, 2000

- ▶ Swan neck preferred
 - ▶ Pre-formed cath with memory more like to maintain downward-directed exit site
 - ▶ Less migration and extrusion

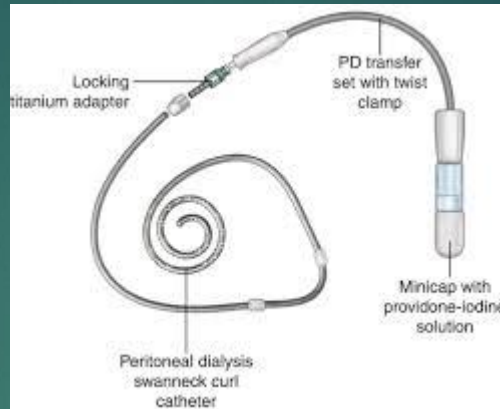
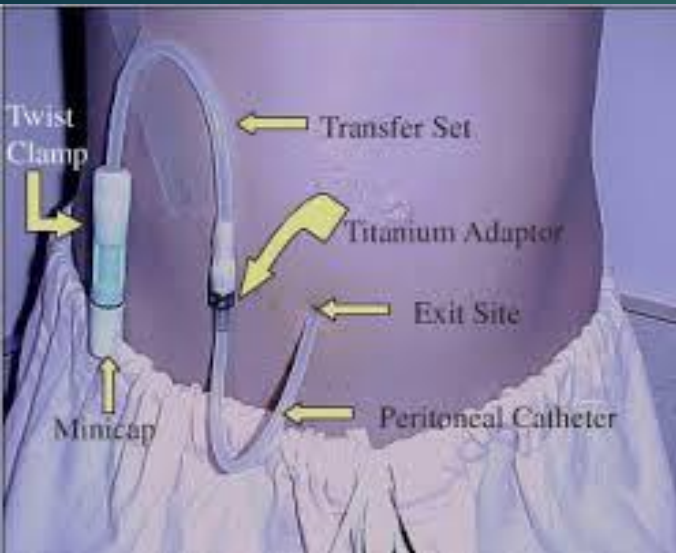


Catheter Internal Diameter

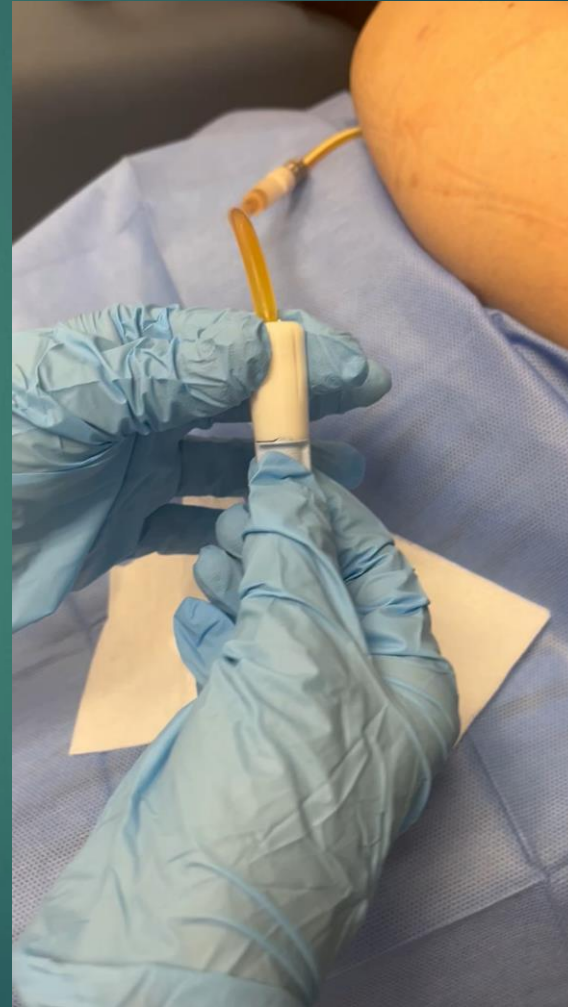


- ▶ Majority of catheters: 2.6-mm internal diameter
- ▶ Merit brand: 3.5-mm, blue radiopaque stripe
 - ▶ 30% higher flow rate
 - ▶ No proven therapeutic advantage
- ▶ Significance of recognizing: avoid accidental interchange of repair kits or replacement adapters resulting in loose fit and separation.

PD Catheter with Transfer Set



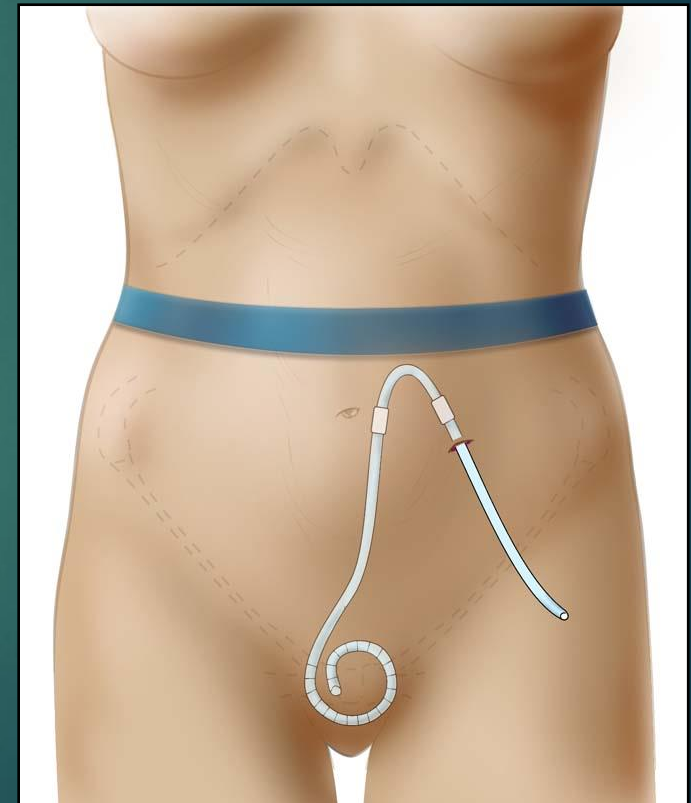
Mechanical Issues with Transfer Set



Placement Considerations

- Points to consider and make a habit

- ▶ Placement technique:
 - ▶ closed, open, laparoscopic
- ▶ Operator:
 - ▶ surgeon, interventionalist (IR or Renal)
- ▶ Position of catheter tip:
 - ▶ iliac fossa vs. deep pelvis
- ▶ Insertion site:
 - ▶ midline vs. lateral
- ▶ Direction of exit-site:
 - ▶ up vs. down or lateral
- ▶ Location of exit-site:
 - ▶ abdomen vs. chest
- ▶ Superficial Segment:
 - ▶ externalized or embedded?



Methods and Techniques for Catheter Placement

Percutaneous Needle-Guidewire Technique (Seldinger)

- “Blind” or with imaging guidance (US or fluoroscopy)
 - US can help identify epigastric artery and bowel loops.
- Interventional Nephrologists or Radiologists
- Allows earlier use without leak with tighter seal
- Can be done at bedside

Open Surgical Dissection (mini-laparotomy)

- Local, regional or general anesthesia

Methods and Techniques for Catheter Placement

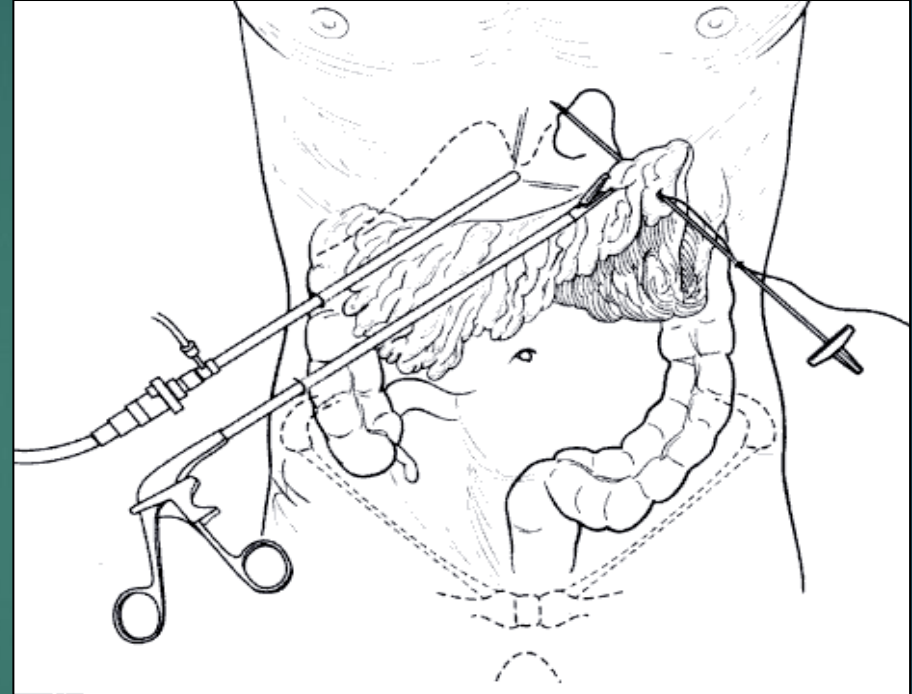
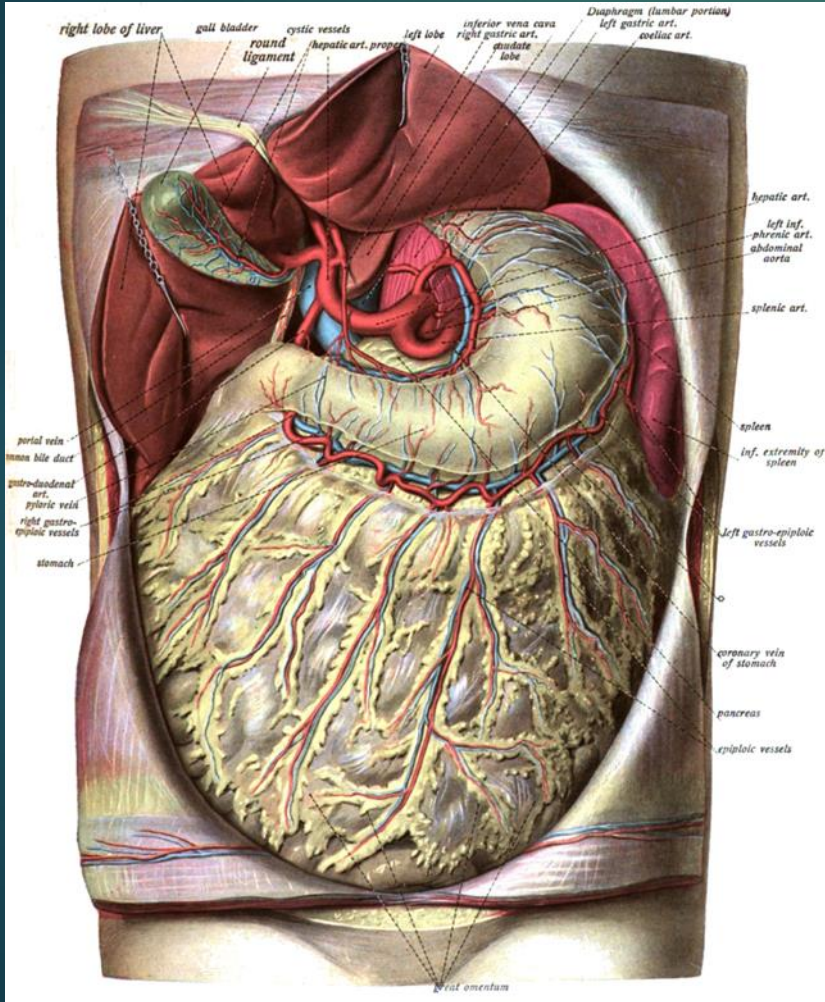
Surgical Laparoscopic method

- Less invasive than open dissection
- Allows direct visualization of peritoneal space
- Allows additional maneuvers to aid in catheter success

Peritoneoscopic approach (Y-TEC)

- Single incision and use of trocar
- Insufflation and direct visualization but in steps.

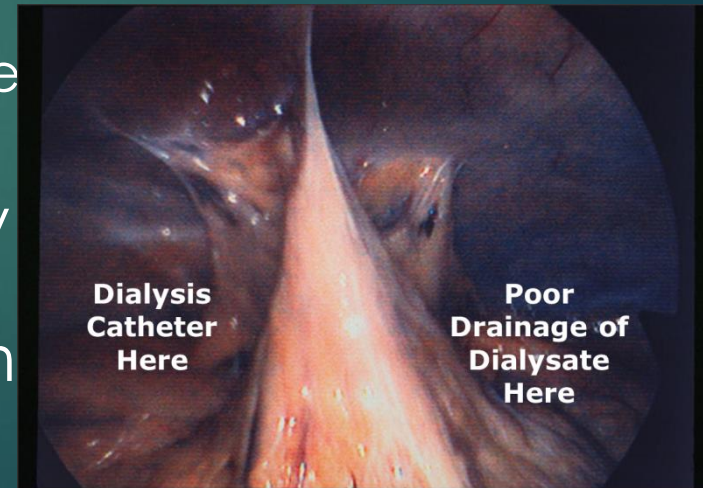
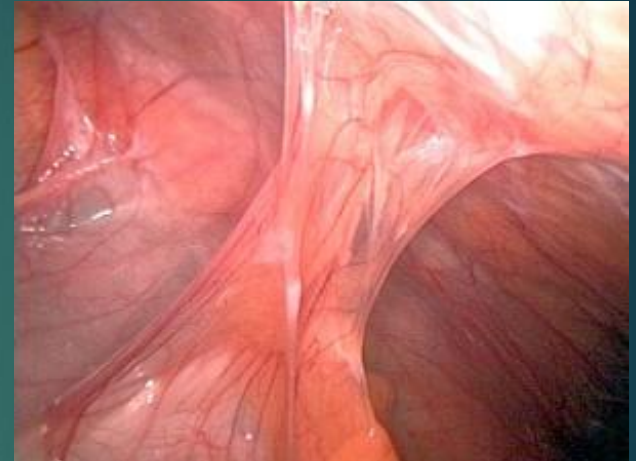
Advanced and Adjunctive procedures (Laparoscopic techniques): OMENTOPEXY



Omentum is displaced into upper abdomen and tacked to abdominal wall. 19

Lysis of adhesions

- ▶ Adhesions can form compartments or loculations that preclude free flow of PD fluid
- ▶ Individuals with previous
 - ▶ Multiple surgeries
 - ▶ Trauma
 - ▶ Refractory peritonitis requiring catheter removal
 - ▶ Rare with routine or minimally invasive laparoscopic procedure history
- ▶ Surgical approach is the only way to know for sure if adhesions or scarring will preclude patient from getting PD



Which Methods is the Best for Insertion

- ▶ Multiple studies and meta-analyses comparing
 - ▶ Surgical vs. Percutaneous
- ▶ Decision should be based on
 - ▶ History of previous abdominal surgeries
 - ▶ Hernia
 - ▶ Local expertise and availability
 - ▶ Morbid obesity
 - ▶ Patient ability to
 - ▶ lay flat or
 - ▶ tolerate anesthesia
 - ▶ **Pre-ESRD care – first time in ER, uremic**

Best Practices in Patient Preparation and Catheter Implantation

TABLE 1
Best Practices in Patient Preparation and
Peritoneal Catheter Implantation

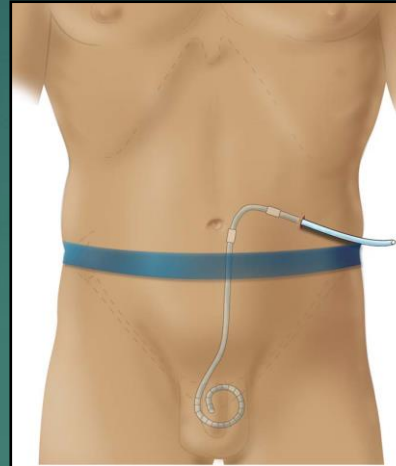
- Preoperative assessment performed by a multidisciplinary peritoneal dialysis access team to select the most appropriate catheter type, implantation technique, insertion site, and exit-site location (17)
- Implement bowel program to prevent perioperative constipation (31,32)
- Shower on the day of procedure with chlorhexidine soap wash of the planned surgical site (33)
- If hair removal is necessary, use electric clippers (33)
- Empty the bladder before procedure; otherwise, Foley catheter should be inserted (34)
- Single preoperative dose of prophylactic antibiotic to provide antistaphylococcal coverage (35)
- Operative personnel are attired in cap, mask, sterile gown, and gloves (33)
- Surgical site is prepped with chlorhexidine-gluconate scrub, povidone-iodine (gel or scrub), or other suitable antiseptic agent and sterile drapes applied around the surgical field (33)
- Peritoneal catheter is rinsed and flushed with saline and air squeezed out of the Dacron cuffs by rolling the submerged cuffs between fingers (36)
- Paramedian insertion of the catheter through the body of the rectus muscle with deep catheter cuff within or below rectus muscle (37–39)
- Pelvic location of the catheter tip (20)
- Placement of purse-string suture(s) around the catheter at the level of the peritoneum and posterior rectus sheath and/or the anterior rectus sheath (40–47)
- Subcutaneous tunnelling instrument should not exceed the diameter of the catheter (48)
- Catheter flow test performed to confirm acceptable function
- Exit site located ≥ 2 cm beyond superficial cuff (49)
- Skin exit site directed lateral or downward (23,36)
- Exit site should be smallest skin hole possible that allows passage of the catheter (48)
- No catheter anchoring sutures at the exit site (use medical liquid adhesive and sterile adhesive strips to secure the catheter)
- Attach dialysis unit's requested catheter adapter and transfer set at time of procedure
- Exit site protected and catheter immobilized by non-occlusive dressing (50)

Location of Catheter Tip, Cuffs and Exit-site

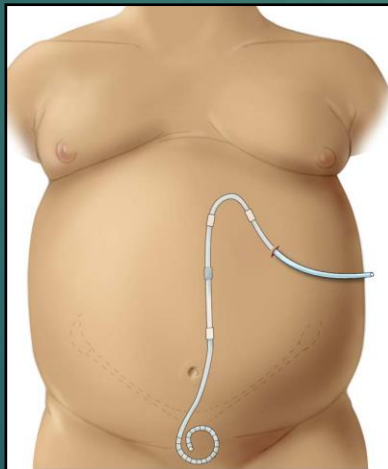
Lower Abdominal for High Belt Line



Mid-Abdominal for Low Belt Line or Low Skin Fold



Upper Abdominal for Obesity or Floppy Skin Folds



Presternal for Morbid Obesity, Incontinence, Desire To Bathe, Or Stomas



- Should be away from belt-lines, skin folds
- Clearly visible to perform daily exit site care
- Determine exit site both in upright and supine position

Badly Chosen Exit Sites

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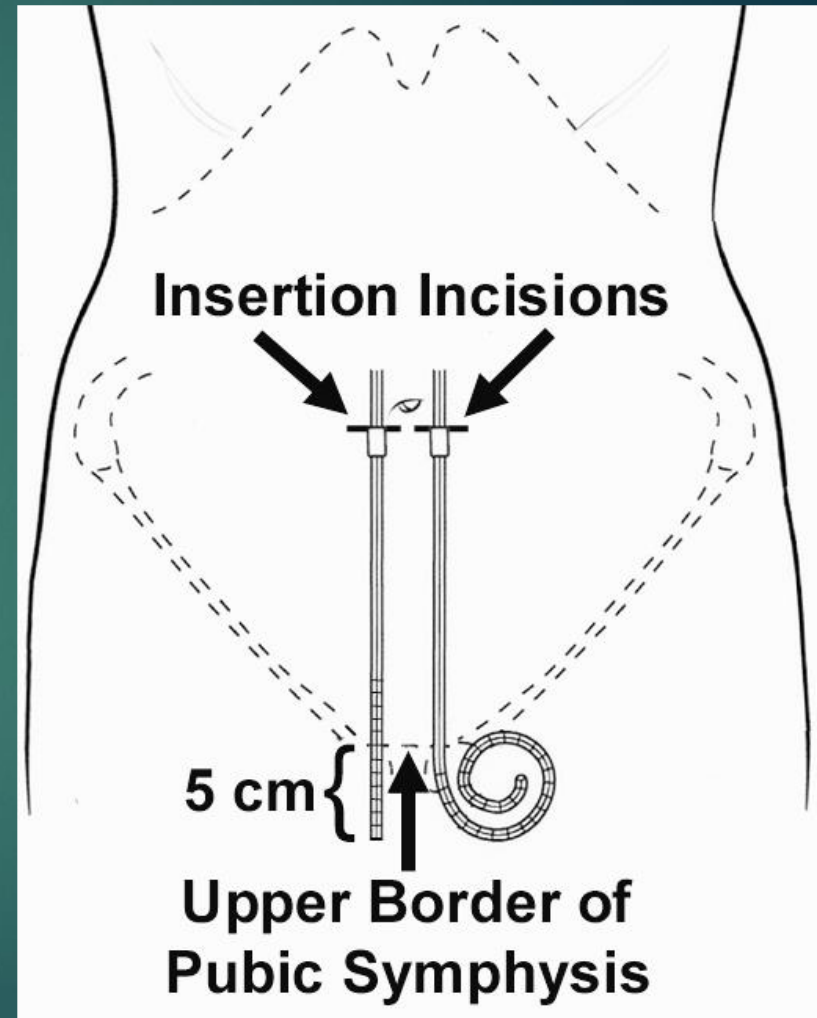


**Preventable by preoperative selection
of proper insertion site**

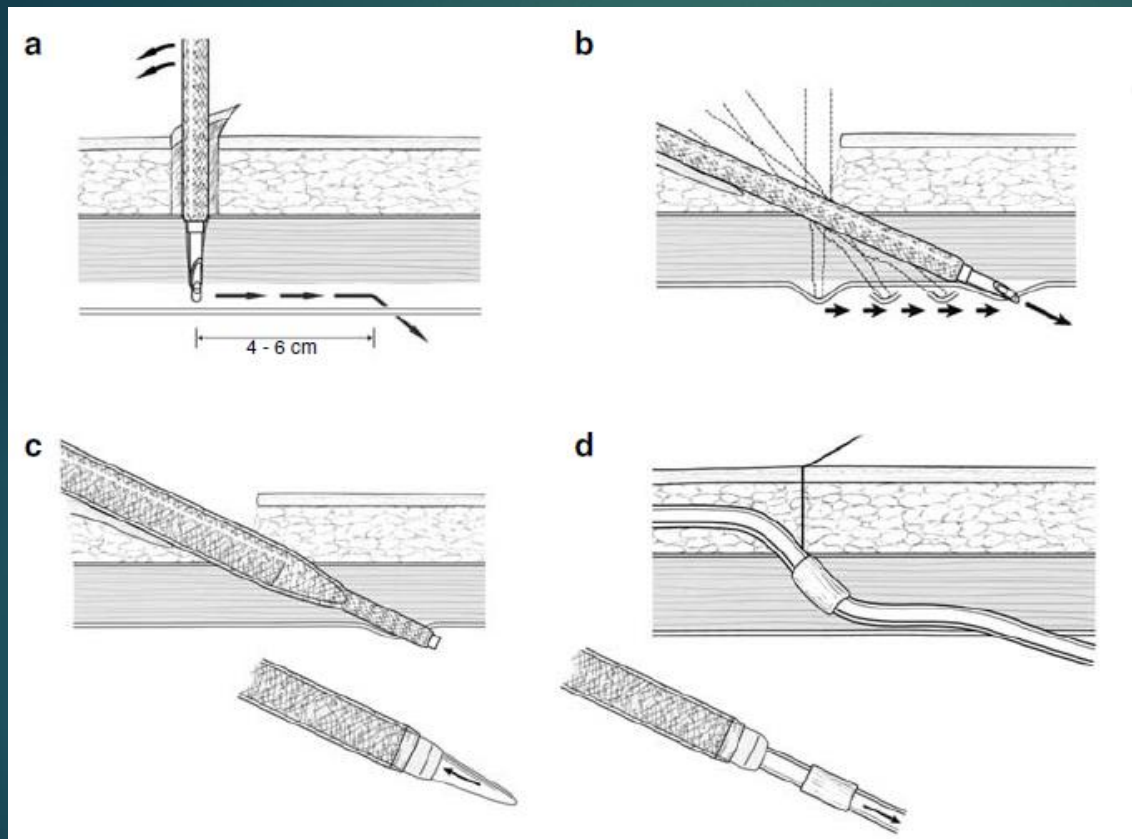
Slide courtesy of Dr. J. Crabtree

Location of Catheter Tip

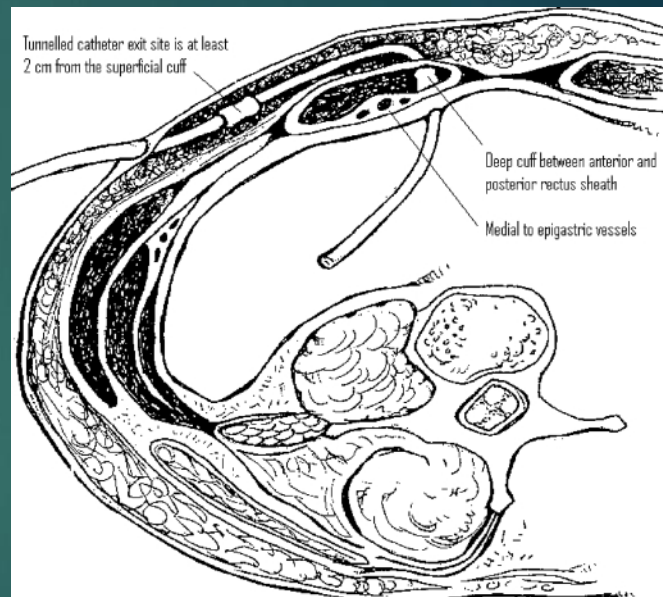
- ▶ In supine position, 30-55% dialysate rests in the pelvis.
- ▶ Minimize omental entrapment
- ▶ Not too deep either to prevent wedging between rectum, bladder and uterus
- ▶ 5 cm of end below upper border of symphysis



Rectal Sheath Tunneling and Cuffs Placement



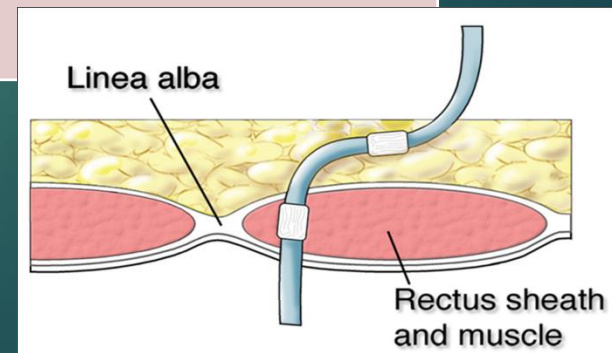
← ↓ Cath tip migration
↓ Pericatheter leak



a) Veress needle–expandable sleeve assembly is inserted through skin incision and anterior rectus sheath. (b) The needle–sleeve assembly is angled toward the pelvis, advanced down the rectus sheath and pushed through into the peritoneal cavity at the indicated site. (c) The needle is removed and the expandable sleeve serves as a conduit for insertion of the dilator–cannula. (d) The dialysis catheter over a stylet is advanced into the peritoneal cavity until the deep cuff is visible. The cannula and stylet are withdrawn and the catheter is retracted until the deep cuff is just below the anterior rectus sheath.

Paramedian Superior to Midline Incision in PD Catheter Placement

	Outcome	Comments
Hwang, 1995 -Eur J Surg	<u>Incisional hernias:</u> 8% midline 0% paramedian	N=49 midline N=131 paramedian
Stegmayr, 1993 -PDI 13:S126,	<u>50 consecutive paramedian catheters:</u> 0 late leaks 1 early leak	PD started within 1d of surgery (supine)
Spence, 1985 -Surg, Gyn and Ob	<u>Leaks:</u> 27% midline v. 13% paramedian <u>Hernias:</u> 3.3% midline, 0% paramedian	N=323



Intra-operative Procedures & Considerations

▶ Peri-operative antibiotics

- ▶ Evidence of reduced catheter exit-site colonization, wound infection, and exit-site infections following perioperative antibiotics

- ▶ 1st or 2nd generation cephalosporin

4RCT's

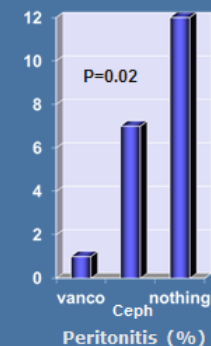
- ▶ *Adv Perit Dial* 1988; 4:147–50.
- ▶ *Nephrol Dial Transplant* 1997; 12:157–60
- ▶ *Am J Kidney Dis* 2000; 36:1014–19.

Pre-operative Antibiotics

Randomized prospective trial

- Vanco 1 gm iv 12 hour before (n=86)
- Cefazolin 1 gm iv 3 hour before (n=85)
- Nothing (n=83)

No difference in age, sex, race, etiology, BMI

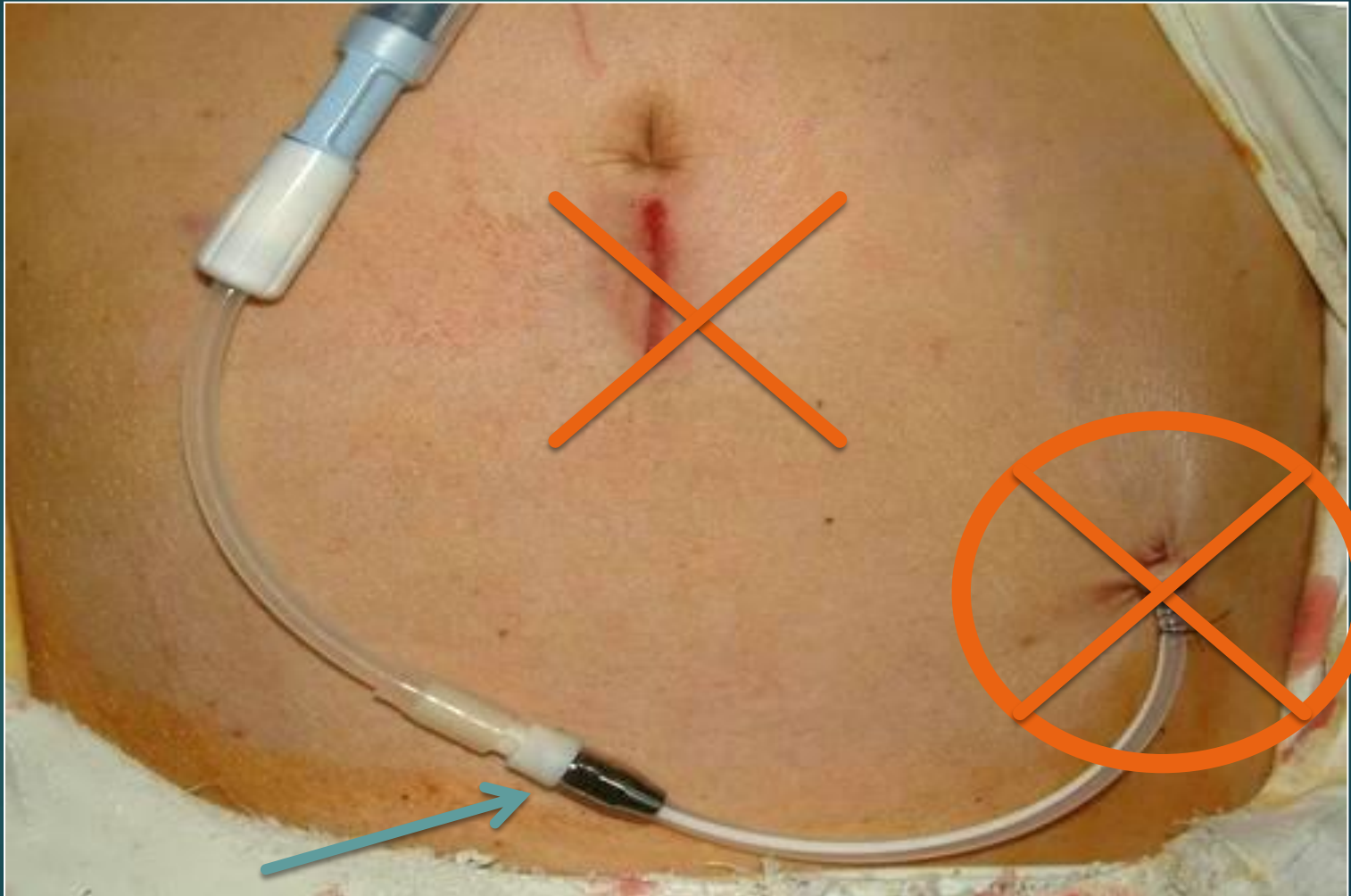


Gadallah et al. AJKD Vol 36, No 5, 2000: 1014-1019

- ▶ If hair removal is necessary, use electric clippers

- ▶ Flush the catheter with 1 l over 5 minutes and take out after 5 min dwell before calling the procedure off.

Do Not Place an Anchoring Suture at the Exit-Site



Postoperative Management



- ▶ DO NOT TOUCH
Semi-occlusive gauze/plastic dressing
- ▶ Don't Change till 5-10 days and only by dialysis staff until routine exit site care protocol initiated.
- ▶ WEAR MASK!
- ▶ NO SHOWER

Post-operative Care

- ▶ Patient sent home from procedure with pain medications, laxatives, and stool softeners.
- ▶ No shower or direct water contact x 2 weeks
- ▶ Catheter flushed in supine position with 1L of 1.5% dextrose in 3-5 days. Repeat weekly until ready for use.
 - ▶ Flush more frequently if bloody effluent
- ▶ Catheter Break-In
 - ▶ At least 2 weeks before elective start
 - ▶ May wait 3-4 weeks if hernia repairs or complicated case
- ▶ For urgent dialysis, catheter may be used immediately
 - ▶ Low volume supine PD
 - ▶ Deep Cuff Purse string suture

Other Peri-operative Procedures to Maximize Catheter Success

- ▶ Bowel clearing
 - ▶ Use a laxative pre-op
 - ▶ Even if denies constipation

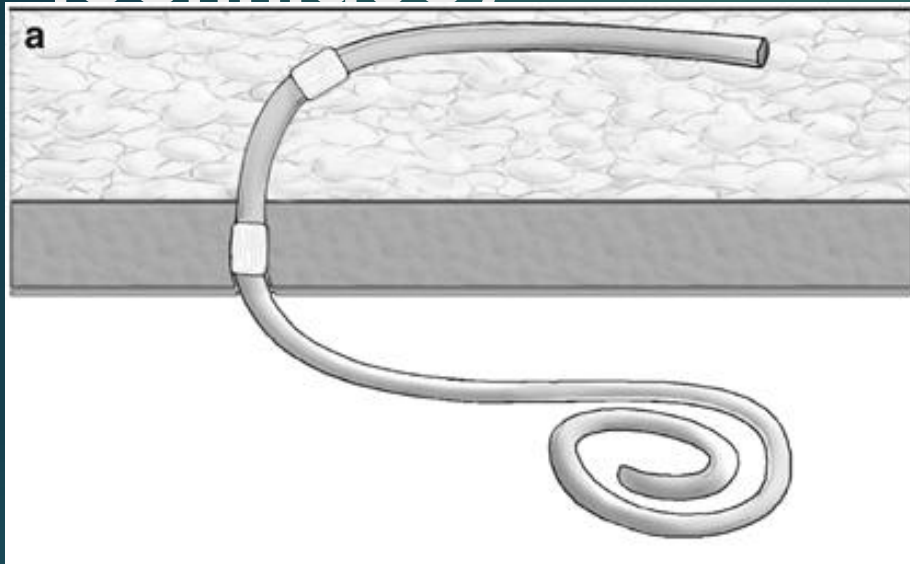
 - ▶ Post-op high risk of constipation
 - ▶ Pain meds, poor PO intake, immobility

 - ▶ Reduces post-op complications

- ▶ Shower on the day of procedure with chlorhexidine soap wash of the planned surgical site

- ▶ Empty the bladder before procedure; otherwise, Foley catheter should be inserted

Buried Catheters (Moncrief-Popovich technique)



- ▶ May be better from infectious risk standpoint (not proven)
- ▶ Overcomes need to “guess” about timing of placement and need for dialysis
- ▶ May make sense in rural or remote settings or where limited access to procedural services



Crabtree JH. Selected best demonstrated practices in peritoneal dialysis access. *Kidney Int Suppl.* 2006 Nov;(103):S27-37.

McCormick BB, et al. Use of the embedded peritoneal dialysis catheter: experience and results from a North American Center. *Kidney Int Suppl.* 2006 Nov;(103):S38-43.

Buried Catheter Outcomes

Author, yr	N	Mean/ Media n (wks)	Range (wks)	%Futile	%Drain problem	%Not functional
Prischl, 1997	26	11.4	4- 96	19%	29%	0%
Danielsson, 2002	30	7.1	1-170	0%	3%	0%
McCormick, 2006	266	13.1	5-42	11%	15%	7%
Junejo, 2008	20	15.7	5-127	10%	5%	-
Elhassan, 2011	122	5.8	0.3-113	NA	10.7%	0.8%
Crabtree, 2015	107	37.6	2-274	13.1%	14.3%	0%

See next slide for references

Securing the Catheter



- ▶ Catheter should be secured and not under tension. Tension can cause irritation at the exit site.

Exit site care

- ▶ Wash exit site in shower with soap and water.
 - ▶ Ok to allow water to run over exit site in shower.
 - ▶ Submersion of the catheter in water is generally not recommended (no bath, swimming, hot tub).
- ▶ Dry with clean towels
- ▶ Clean with sodium hypochlorite 0.1%. Chau et al. *Clin. J. Am. Soc. Nephrol.* 4, 1939–1943 (2009)
- ▶ Place antibiotic cream at exit site daily.
- ▶ Secure catheter tubing.
- ▶ Dressing over top is optional (opinion).
- ▶ Watch for signs of allergy or irritation secondary to tape, gauze or topical antibiotics

- ▶ 54yo male on CCPD for 9 months
- ▶ Presents to PD clinic with progressive
 - ▶ weight gain
 - ▶ increased abdominal girth for 5 days.
- ▶ On exam: hypertensive and edematous
- ▶ Review the Script and **Flowsheets**
 - ▶ Urine output is same to may be little higher
 - ▶ All 2.5% dextrose exchanges
 - ▶ Had poor UF with intermittently prolonged drain times for last few weeks.
 - ▶ Clear effluent
 - ▶ Fill time: <10 min for 2 lt
 - ▶ Drain times: <20 min for 2 lt
- ▶ Quick in- and out-
 - ▶ Dialysate infuses easily, but very slow outflow
 - ▶ First 500 mls takes about 30 minutes

What Would You Do Now?

- a) Turn her on one side and then the other to see if outflow resumes
- b) Flush the catheter vigorously with heparin
- c) Change her to permanent hemo – PD has obviously failed
- d) Inquire about bowel movements and patterns - Laxatives.
- e) Obtain a flat plate x-ray of the abdomen

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Constipation is one of the most common causes of impaired draining in PD

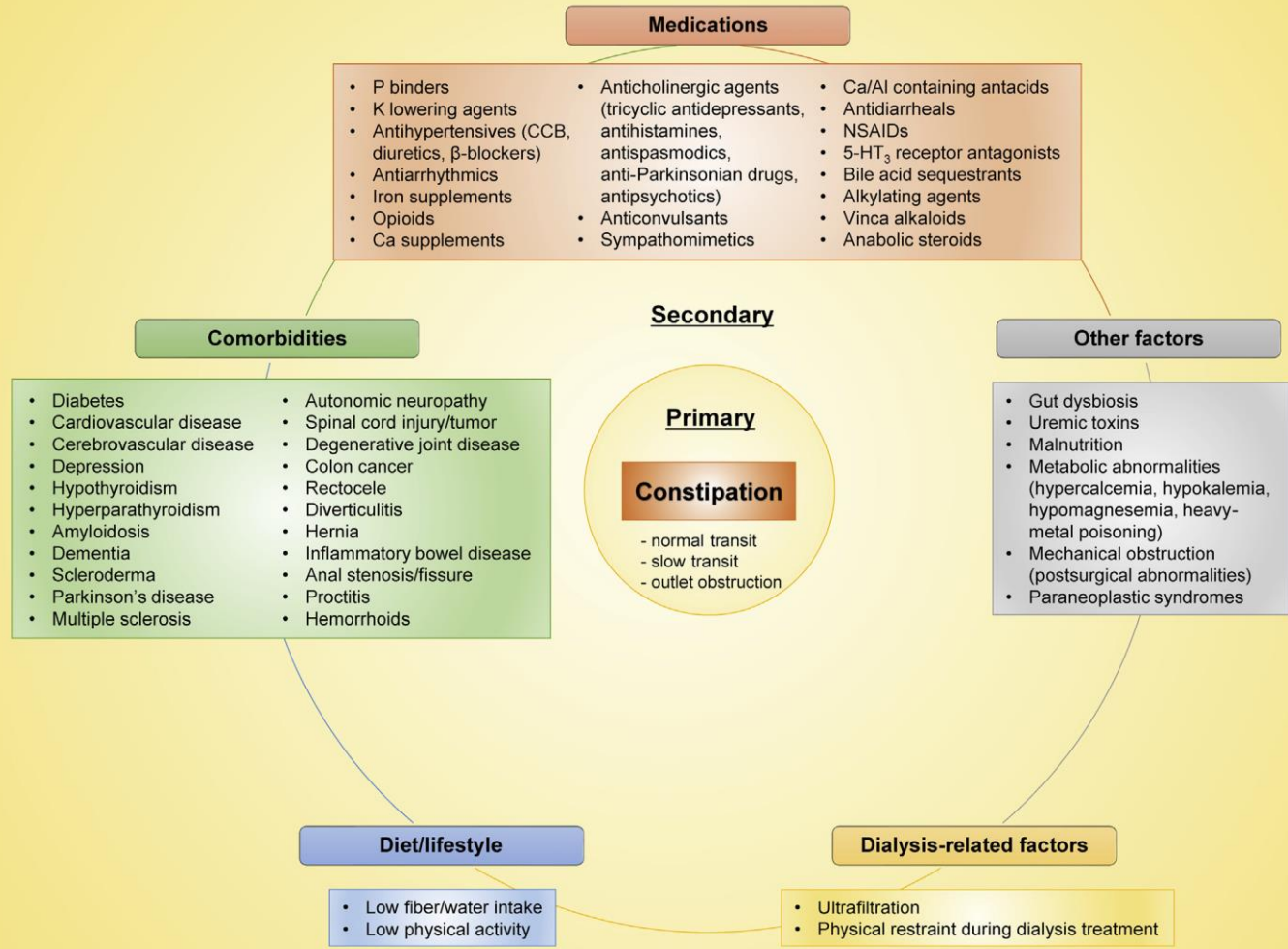
Constipation in CKD



Keiichi Sumida¹, Kunihiro Yamagata² and Csaba P. Kovcsy^{1,3}

¹Division of Nephrology, Department of Medicine, University of Tennessee Health Science Center, Memphis, Tennessee, USA;

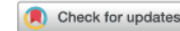
²Department of Nephrology, University of Tsukuba, Ibaraki, Japan; and ³Nephrology Section, Memphis VA Medical Center, Memphis, Tennessee, USA



Constipation and Poor Draining

- ▶ Common cause of PD catheter dysfunction
 - ▶ Generally an outflow problem
 - ▶ Coiled portion of catheter thought to be lying over distended colon, acting as one-way valve.
 - ▶ Patients cannot judge well the amount of stools in colon
 - ▶ Try laxatives/cathartics before embarking on other measures. (lactulose, soap suds/tap water enema)

Constipation in CKD



Keiichi Sumida¹, Kunihiro Yamagata² and Csaba P. Kovcsy^{1,3}

¹Division of Nephrology, Department of Medicine, University of Tennessee Health Science Center, Memphis, Tennessee, USA;

²Department of Nephrology, University of Tsukuba, Ibaraki, Japan; and ³Nephrology Section, Memphis VA Medical Center, Memphis, Tennessee, USA

Table 4. Pharmacological treatment options for constipation

Types	Agents	Mechanisms of action and effects	Common side effects
Commonly used laxatives			
Bulk-forming laxatives	Psyllium, methylcellulose, polycarbophil	Increase water-absorbing properties of stool and decrease stool consistency	Bloating, flatulence
Osmotic laxatives	Sodium phosphate, polyethylene glycol, sorbitol, lactulose, magnesium hydroxide, magnesium citrate, magnesium sulfate	Osmotically increase intraluminal fluids by nonabsorbable ions and molecules and decrease stool consistency	Bloating, flatulence, abdominal cramps, electrolyte disturbance
Stimulants	Diphenylmethane derivatives (bisacodyl, sodium picosulfate), anthraquinones (sennoside, aloe, cascara)	Stimulate mucosa or myenteric plexus to trigger peristaltic contractions and inhibit absorption of water and electrolytes	Abdominal discomfort, pain, and cramps, nausea, incontinence
Stool softeners	Docusate sodium, docusate calcium	Enhance interaction of stool and water	Abdominal cramps, diarrhea
Lubricants	Mineral oil	Lubricate stool and ease passage	Lipid pneumonia, malabsorption of fat-soluble vitamins, incontinence
Newer agents			
Chloride channel activators	Lubiprostone	Selectively activate enterocyte type 2 chloride channels (Cl ₂), resulting in chloride secretion into intestinal lumen followed by passive diffusion of sodium and water	Diarrhea, nausea
Guanylate cyclase C receptor agonists	Linaclotide, plecanatide	Stimulate intestinal epithelial cell guanylate cyclase C receptors, resulting in secretion of chloride, bicarbonate, and water into intestinal lumen and acceleration of stool transit	Diarrhea, nausea
Selective serotonin 5-HT ₄ receptor agonists	Prucalopride, cisapride, tegaserod	Stimulate intestinal fluid secretion and motility through activation of 5-HT ₄ receptors of myenteric plexus	Diarrhea, nausea, headache
Ileal bile acid transporters inhibitors	Elobixibat	Reduce ileal reabsorption of bile acids and enhance colonic secretion and motility	Abdominal cramps, diarrhea

What If You Found This?



Catheter migration

- ▶ Easily diagnosed with KUB
- ▶ **If catheter has flipped out of pelvis:**
 - ▶ Consider radiologic trochar guidance back into pelvis
 - ▶ This may be challenging with swan-neck catheters and rectus sheath tunneling
 - ▶ Consider laparoscopic repositioning

C.D.

- ▶ 54yo male on CCPD for 3 years
- ▶ Presents to PD clinic with progressive
 - ▶ weight gain
 - ▶ increased abdominal girth for 5 days.
- ▶ On exam: hypertensive and edematous
- ▶ Review the Script and **Flowsheets**
 - ▶ Urine out put is same to may be little higher
 - ▶ All 2.5% dextrose exchanges
 - ▶ had poor UF with prolonged drain times this week.
- ▶ Quick in- and out-
 - ▶ Dialysate infuses little slow and difficult to aspirate

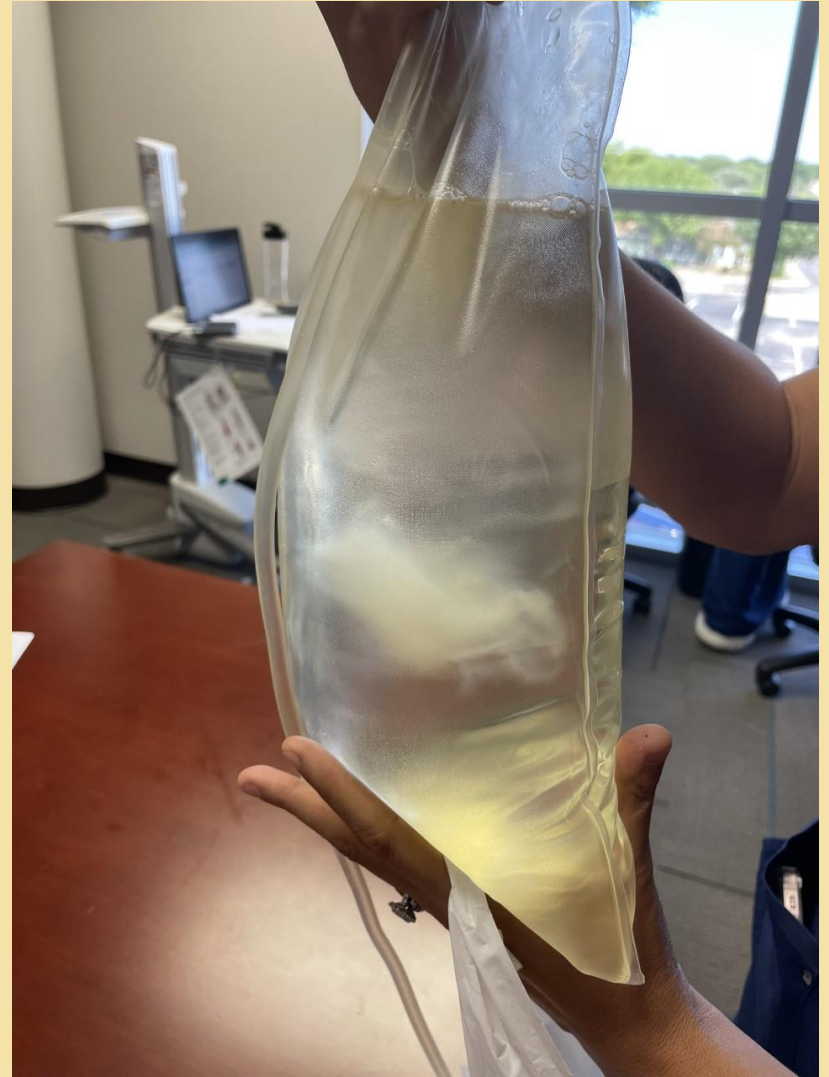
What Would You Do Next?

- a) Give more bowel cathartics
- b) Vigorous flush with heparinized saline**
- c) Infuse 1 or 2 L of dialysate
- d) Inject intra-peritoneal tPA**
- e) Change to hemodialysis

Fibrin Plug



Courtesy Dr. J. Bargman



Summary So far - Impaired Draining / Filling of PD Fluid

▶ Key activities:

1. Rule out constipation

▶ KUB

2. Evaluate for catheter migration or kink

▶ KUB

3. Evaluate for fibrin

▶ Inability to flush and drain

▶ Flush or aspirate catheter, consider tPA

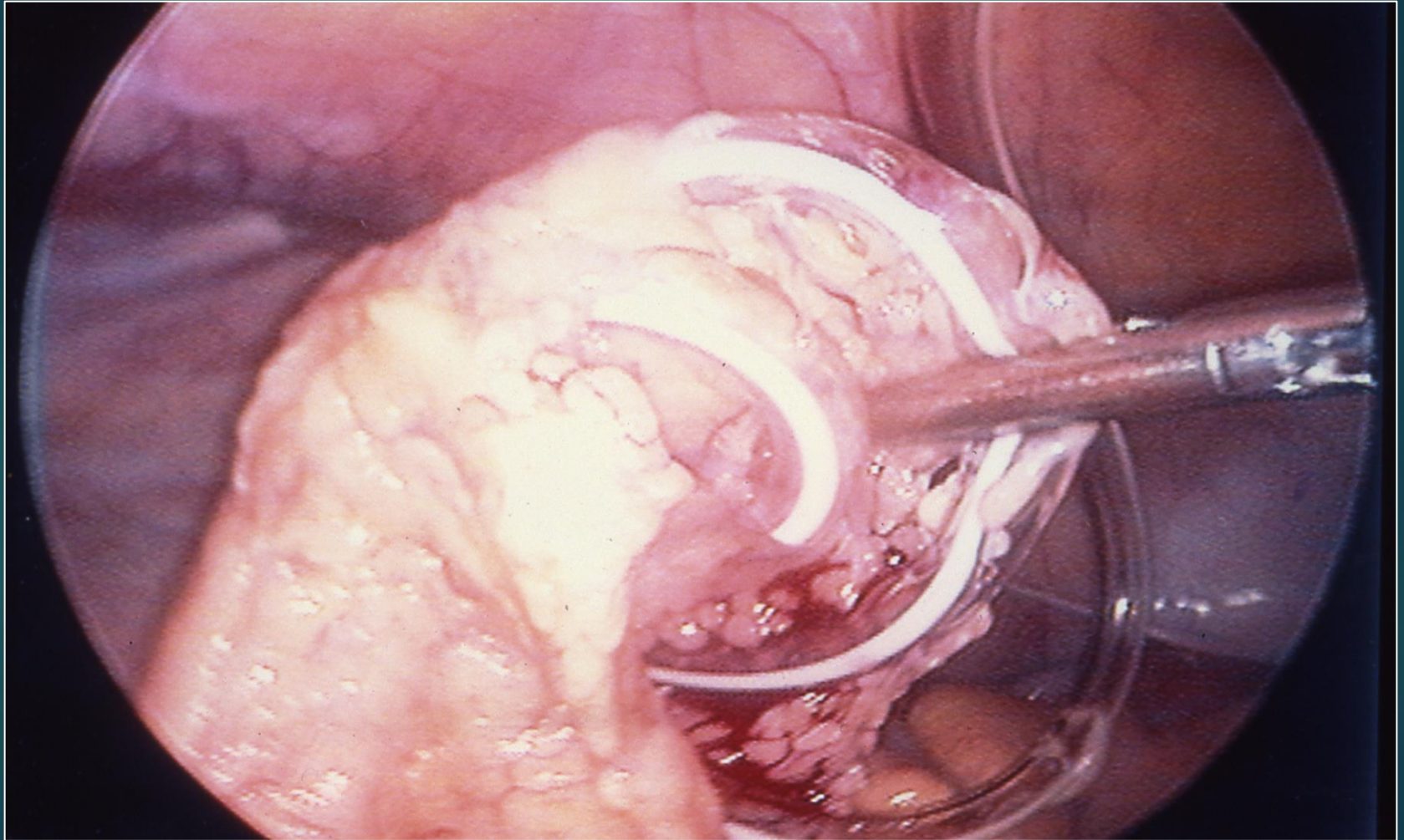
▶ Heparin dwell 500 unit/L till fibrin clears from the effluent

- ▶ Back again to the patient: inflow without problem, outflow is SLOW clear effluent.
 - ▶ KUB = no constipation, catheter has not migrated upwards
 - ▶ Catheter flushes well, but difficult to aspirate
 - ▶ However, no obvious fibrin plug.
 - ▶ Now what?



Courtesy of Dr. R. Mehrotra

Omental Wrap



Courtesy of PDU faculty

Omental Wrap and Outflow Obstruction

- ▶ More likely to occur in:
 - ▶ Children
 - ▶ If the tip of the catheter is outside the true pelvis
- ▶ Generally good inflow but poor outflow
- ▶ Could be prevented by prophylactic omentopexy in children and others with redundant omentum.
- ▶ Requires surgical intervention:
 - ▶ Omentectomy with/without replacement of PD catheter

Differential Diagnosis of Poor Outflow

- ▶ Constipation
- ▶ Constipation
- ▶ Constipation

- ▶ Catheter tip migration

- ▶ Adhesions

- ▶ Omental wrap

- ▶ Fibrin, clots, *external obstructions (frangible, transfer set)*

Subcutaneous Cuff Extrusion 59



Exposed cuff leads to irritation of exit site, risk for infection

Ideally cuff should be at least 2 cm from exit site

With 2 cuff catheters external cuff can be shaved off to salvage catheter and exit site





Summary – PD catheter

- ▶ Lifeline of peritoneal dialysis
- ▶ Know your catheters and nuances needs attention to detail.
- ▶ Good relationship and communication with surgeons and interventionalist
- ▶ Proactive about constipation
- ▶ Methodical approach to solve the problem

THANK YOU!!