2018 Vascular Access for Hemodialysis Symposium

May 10-12, 2018
New Orleans, LA

PD Catheter 101

The Good Catheter!

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with thanks to Dr. Jack Work

Vascular Catheters are Bad!

- Primary failure rate between 52-91% per year.
- High infection rate 2.5-5.5 cases per 1000 patient-days
  or 0.9-2.0 episodes per patient-year.
- Relative risk of **death** increased 1.4-3.4 times compared to fistula.
- Catheters associated with greater hospitalization rates because of sepsis and greater rates of all-cause hospitalization.

Multiple studies!

Vascular Catheters are Bad!

- Catheters have the worse associated mortality risk.
- Changing from a catheter to either a fistula or a graft is associated with a significantly improved survival.
- Risk of mortality with a graft approached that of a fistula.
- Converting from a graft or fistula to a catheter increased risk of mortality two fold.

Lacson et al examined the affect of vascular access change on mortality.

Lacson AJKD 2009

Vascular Catheters are Bad!

Scope of the problem

- CPM 2005 Report - 74% of patients initiated HD therapy using a CVC.
- 52% continued to use a CVC 90 days later.
- Recent USRDS data - 82% of patients initiated HD therapy using a CVC.

The Good Catheter

Advantages of PD as the first dialysis modality

- Survival advantage over HD in first few years.
- Associated with better Quality of Life
- Patient remains in workforce while dialyzing at night
- More freedom to travel
- Maintains residual renal function
- Less delayed function after renal transplant
- Better long-term allograft function
- Continuous dialysis
- Less expensive to Society
- No needle punctures
- Used as bridge to HD

Davidson el al J.Vascular Access 2007

The Good Catheter

Long term patency of PD catheters

- PD catheter outcomes in 315 patients over 9 years.
  - DM primary etiology of ESRD in 43%
  - 58% had previous abdominal surgery
  - Overall PD catheter survival 92.9%, 91.9%, 91.1% at 12, 24, 36 months

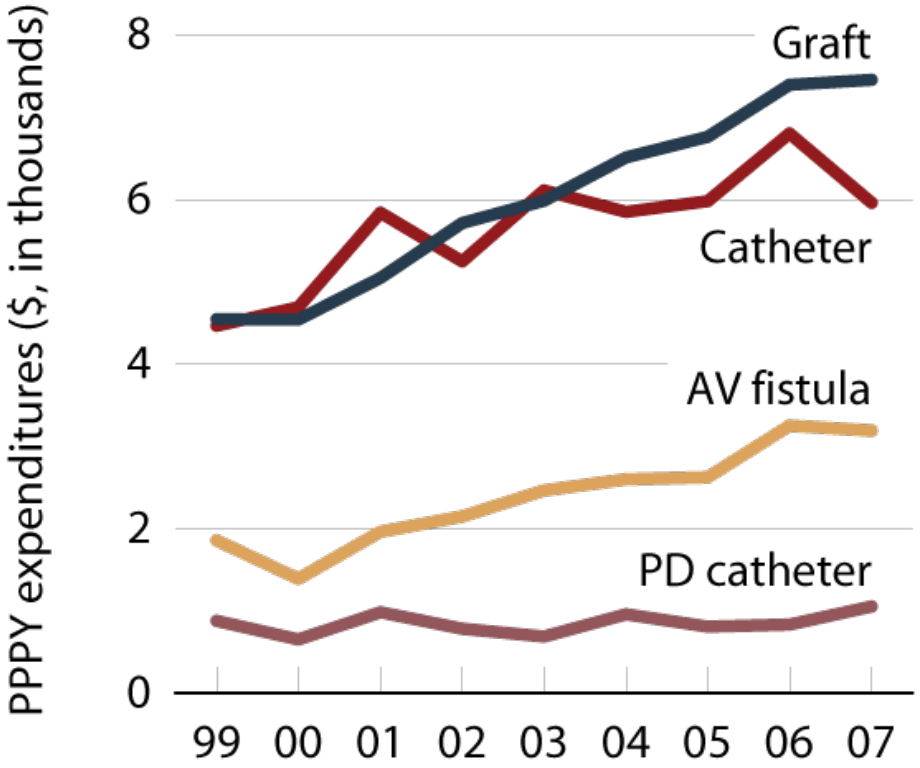
TABLE II - PERITONEAL DIALYSIS COMPLICATIONS

	Number of patients (%)
Infectious complications	
Number of peritonitis	
0	190 (60.3)
1	66 (21.0)
>1	59 (18.7)
Number of exit site & tunnel infections	
0	243 (77.1)
1	54 (17.1)
>1	18 (5.8)
Number of non-infectious complications	
0	239 (75.9)
1	66 (20.9)
>1	10 (3.2)

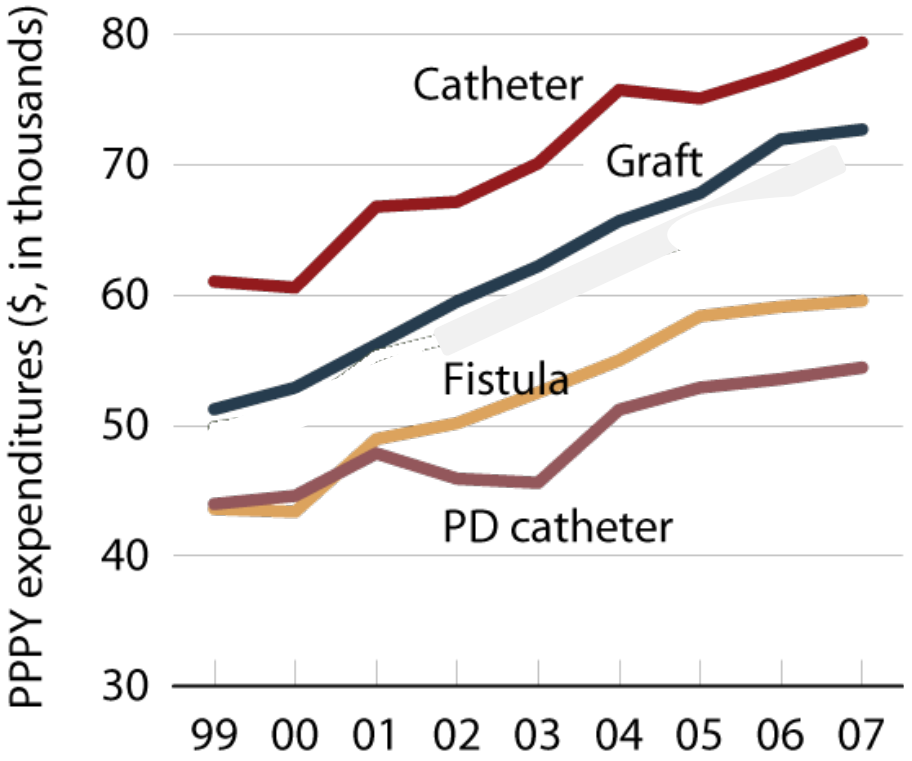
Singh J Vasc Access 2010

The Good Catheter

Costs comparison



Per person per year access event costs, by access type:



Per person per year total expenditures, by access type

USRDS 2009 ADR

Goals of peritoneal access

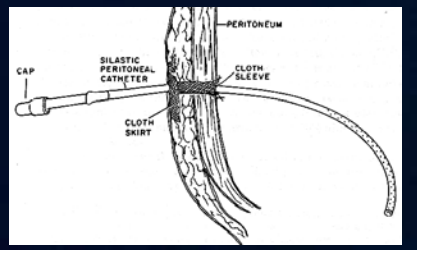
- Optimal and consistent hydraulic function
- Stable interface between catheter and body
- Minimal interference with abdominal function and clothing
- Maintenance free
- Infection free

The making of the Tenckhoff catheter

Gutch defined size of side holes and used straight silastic design 1964

Palmer and Quinton laid the foundations for the basic catheter design and used a long subcutaneous tunnel 1964

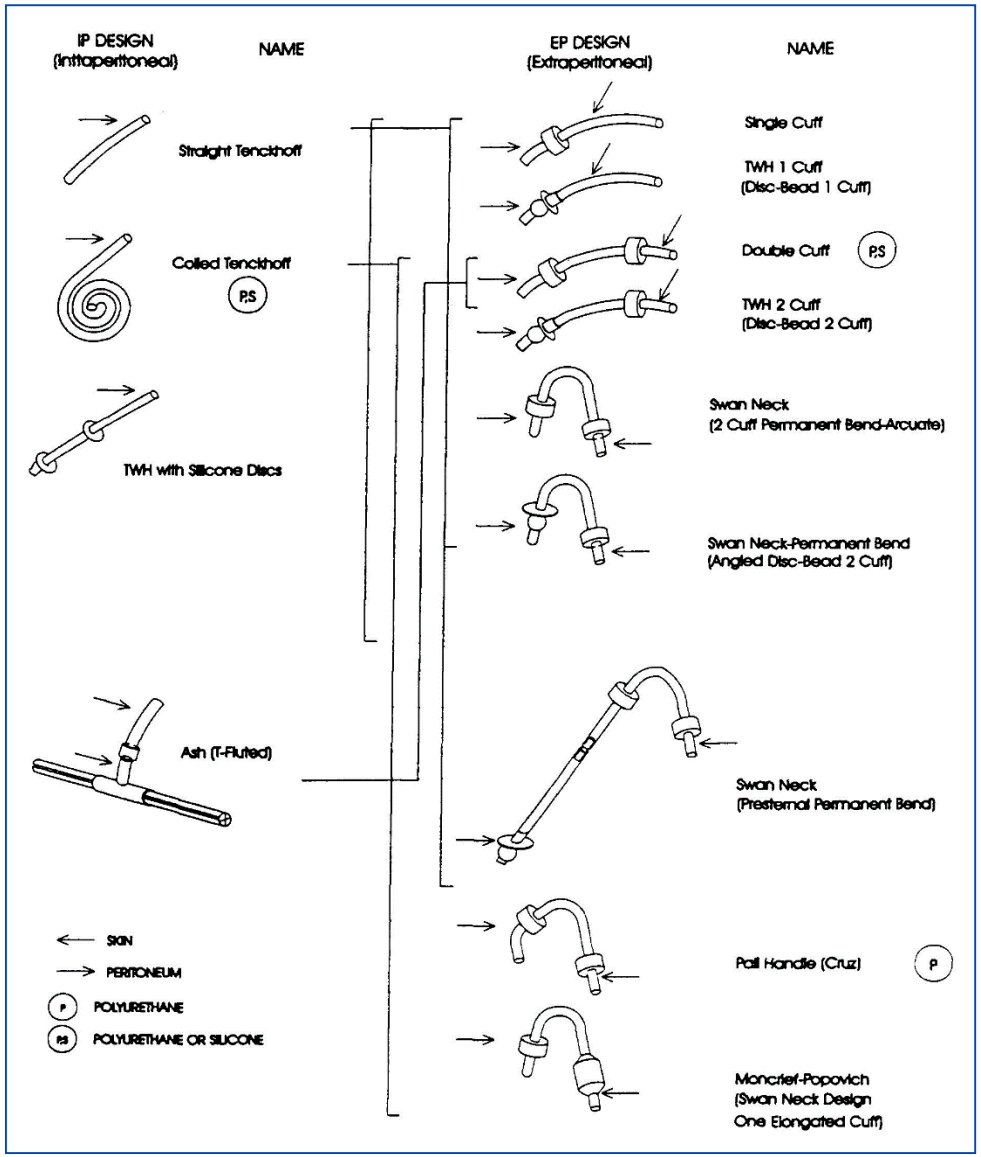
McDonald also introduced a Dacron sleeve to his straingt silastic catheter in 1968



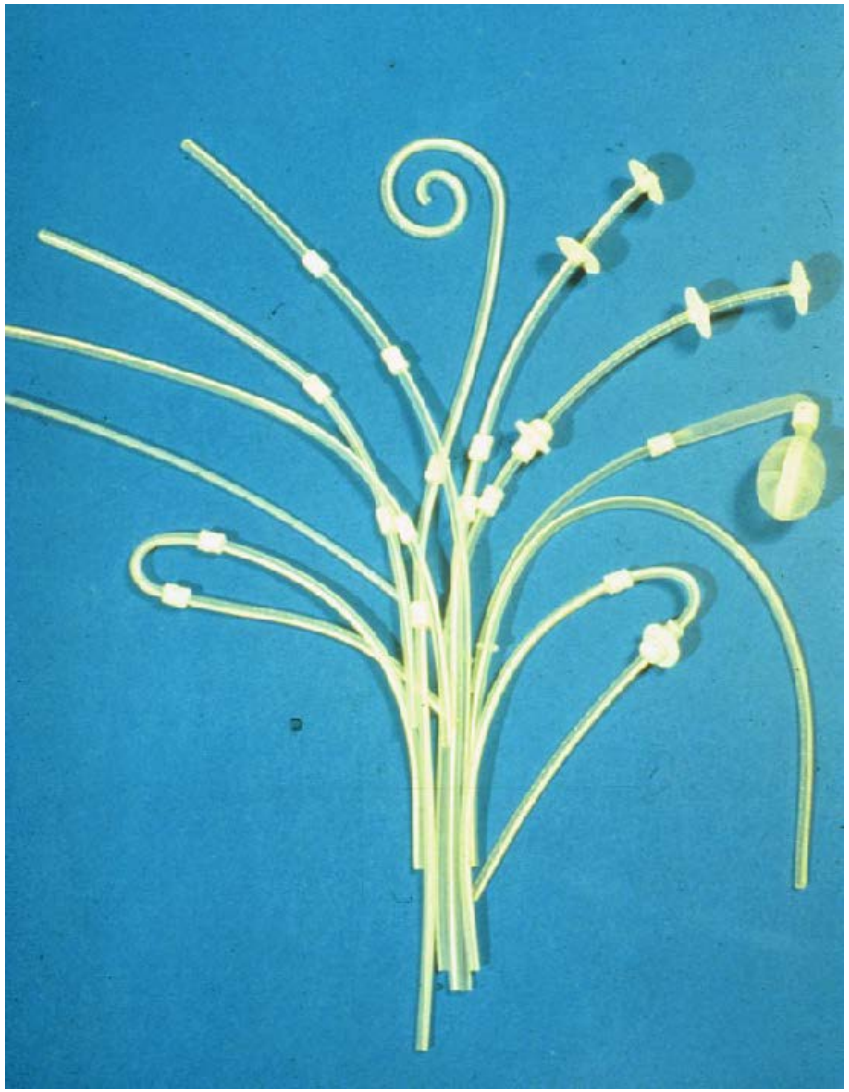
Catheter design

Options

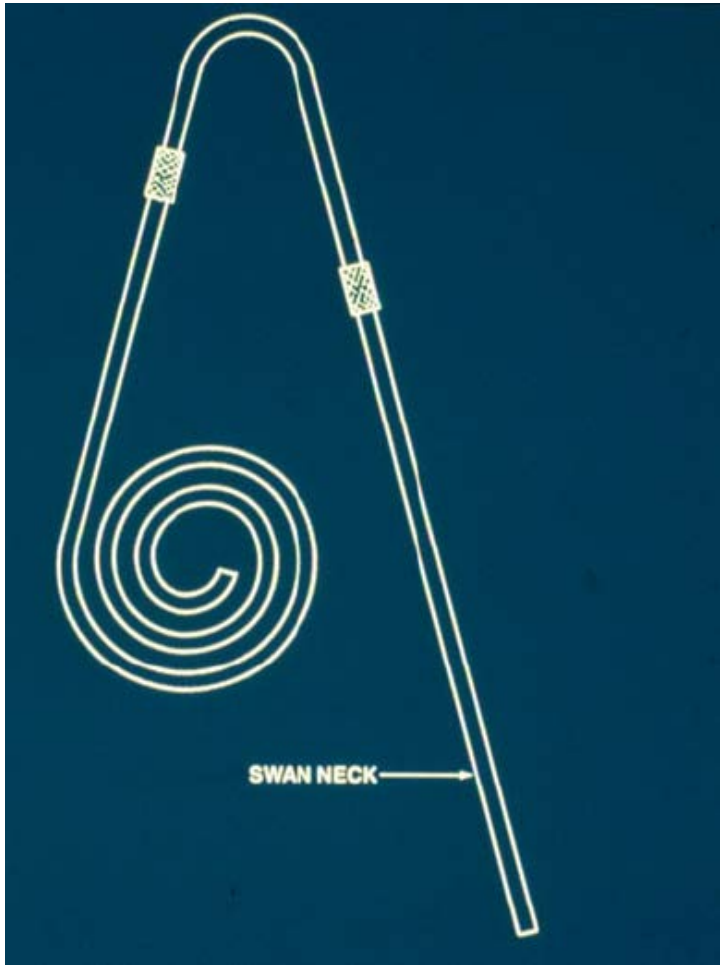
- Curled vs. straight
- Column disc
- T-fluted
- Number of cuffs
- Cuff location
- Tunnel configuration
- Distal discs/balloons
- Materials



Catheter design



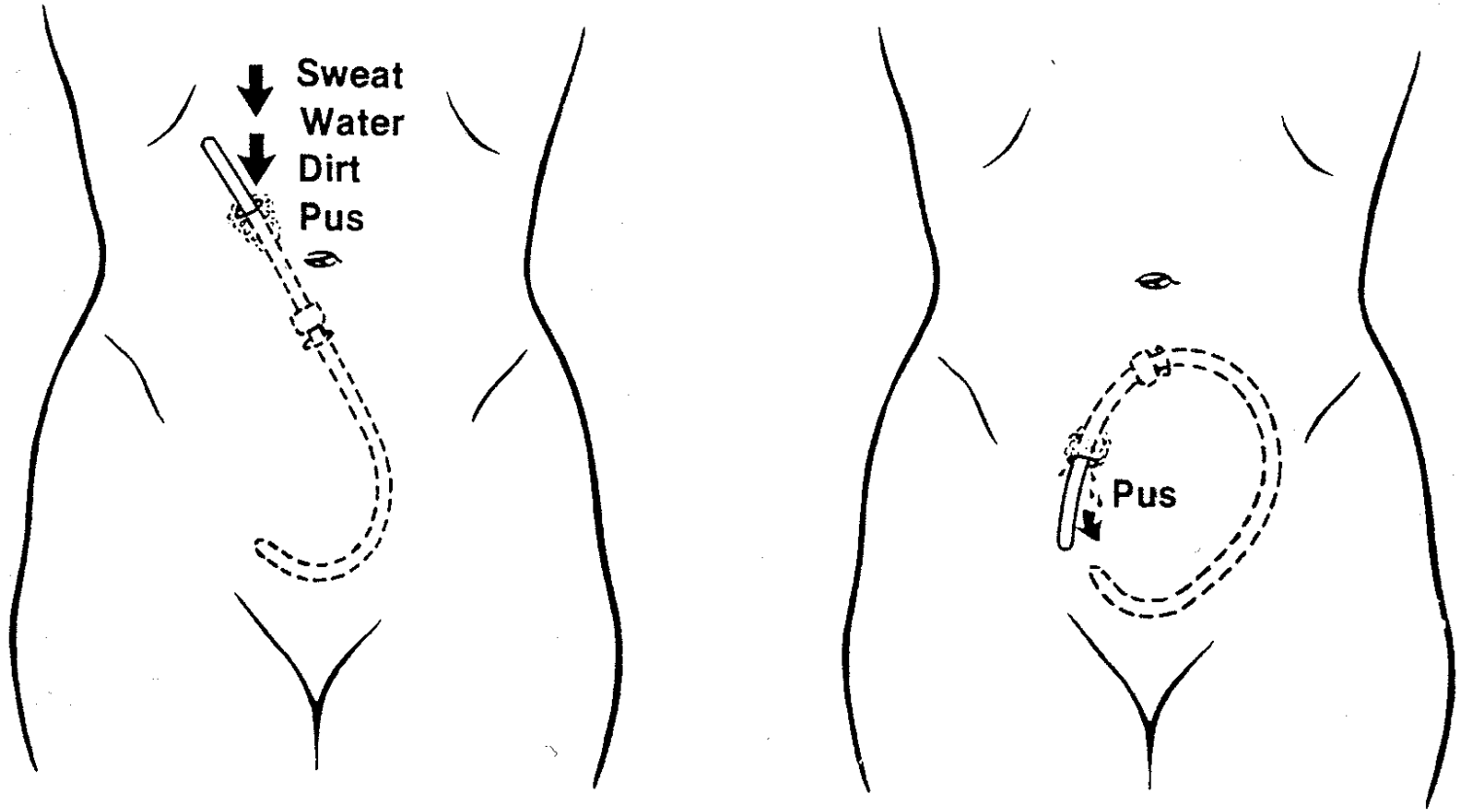
Catheter design



Advantages and disadvantages of silicone and polyurethane

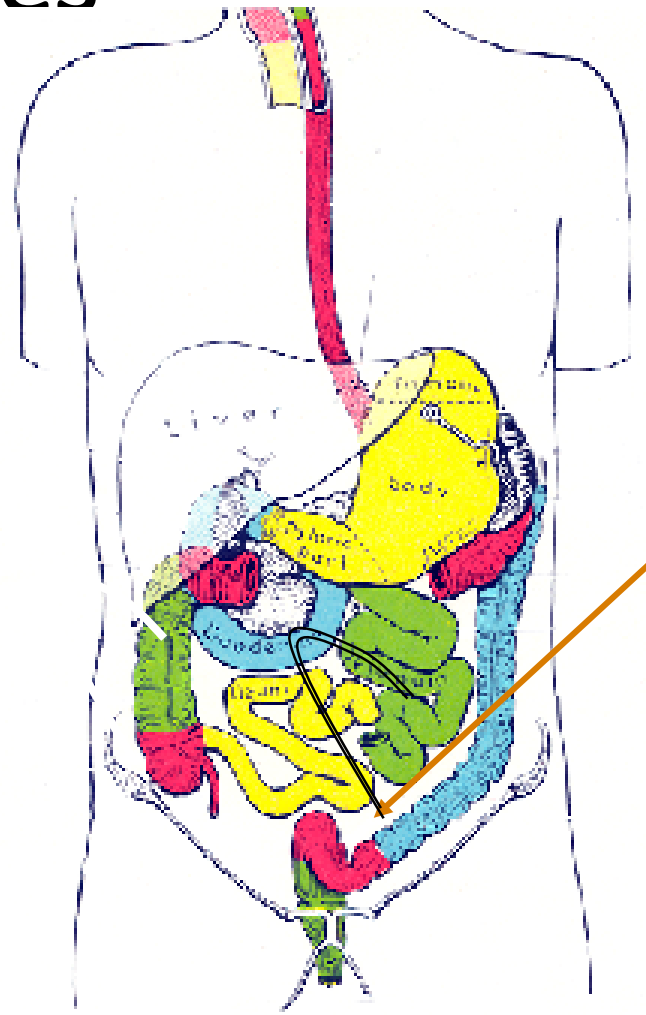
Silicone	Polyurethane
Thicker wall - smaller lumen	Thinner wall - larger lumen
Low resistance to tear propagation	High resistance to tear propagation
Flex life limited	Flex increases due to water absorption
Thermoset (has memory)	Thermoplastic (changes configuration)
Resistant to alcohol	Alcohol/ethylene glycol soluble

Exit site placement

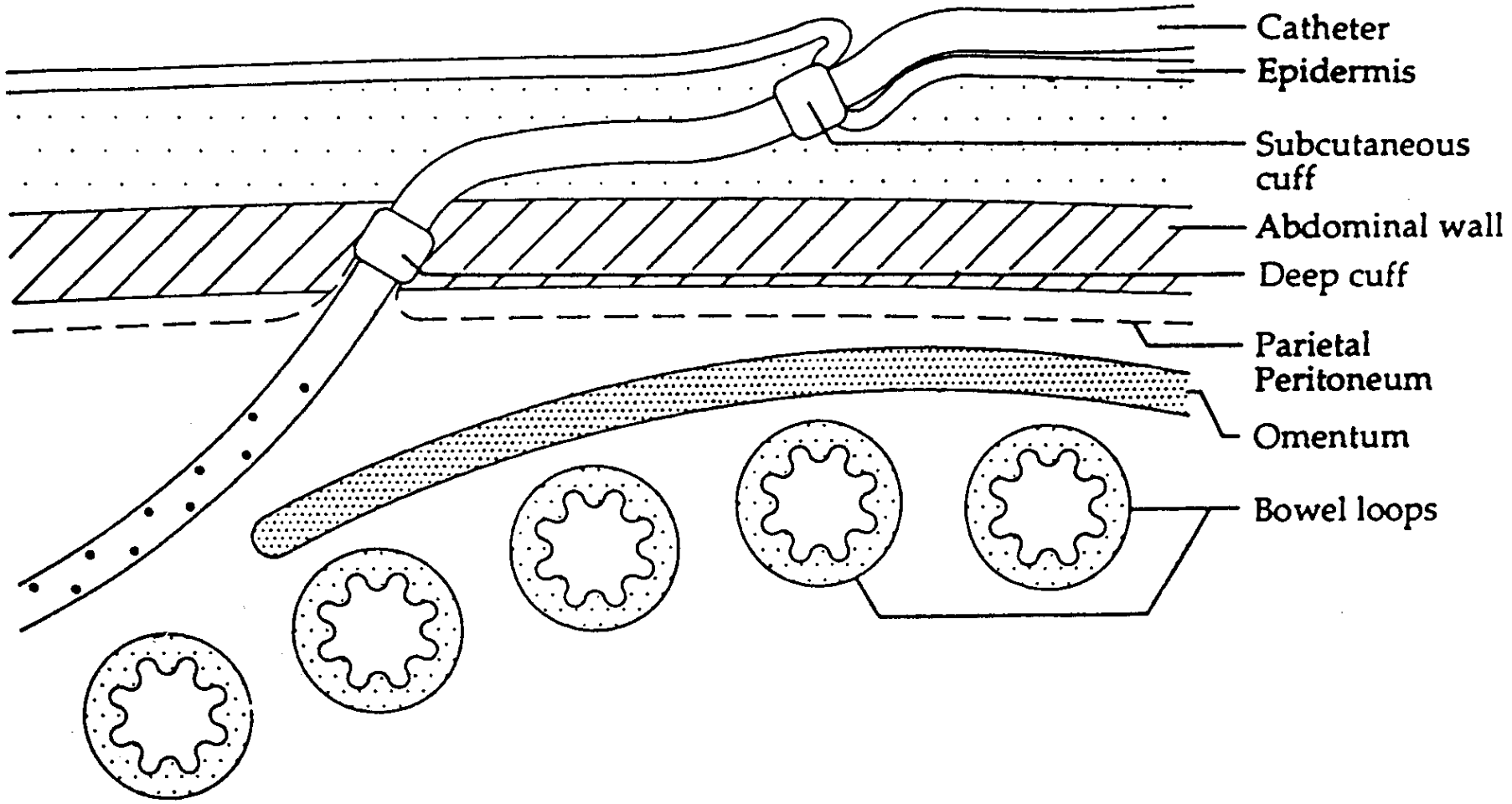


UPWARD AND DOWNWARD TUNNEL DIRECTION–
EXIT SITE INFECTION

Primary placement sites



Optimal PD catheter placement



Catheter outcomes

- Catheter outcome is possibly affected by:
  - Operator's experience and abilities
  - Catheter care
  - Catheter design
  - Catheter material (?)
- Average survival of >80% at 1 yr and >70% at 2 yrs
- No catheter appears to be superior to the double cuff Tenckhoff catheter in terms of survival

Areas of agreement on catheter implantation

- Double cuffed catheters are better for chronic use
- Paramedian implantation is recommended
- Deep cuff should be placed in abdominal wall muscle
- Subcutaneous cuff - 1 to 2 cm from skin
- Exit site to fit catheter diameter
- Exit should face downwards or laterally
- Intra-abdominal portion of catheter between visceral and parietal peritoneum (pouch of Douglas)
- Stable interface between catheter, skin and muscle

Preoperative management

- Evaluate for hernias, diastasis
- Assess patient for dexterity, vision, handedness, strength, motor skills
- Determine exit site position with patient sitting
- Avoid scars, beltline, skin folds, pressure points
- Prophylactic antibiotics

Methods of implantation

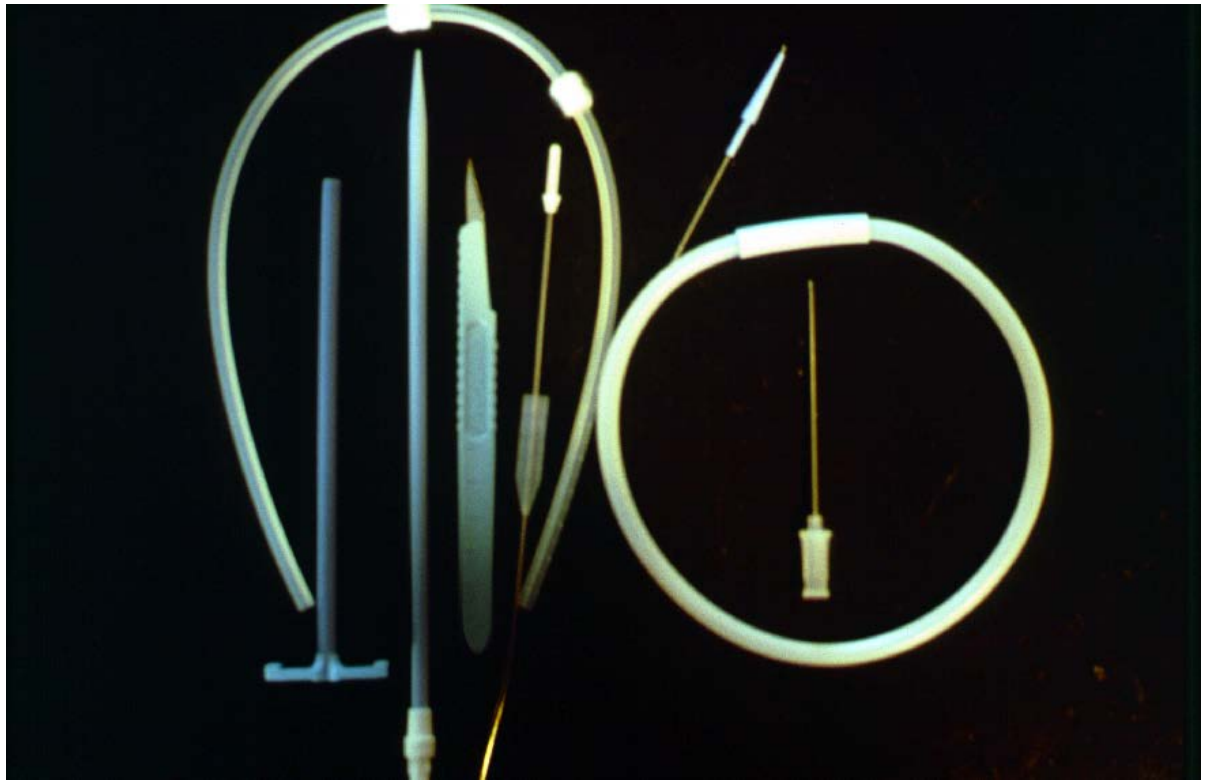
- Surgical
- Percutaneous
  - Seldinger technique
    - Blind
    - With imaging assistance
  - Laparoscopic (sighted)
- Combinations

Surgical implantation

- Most common method
- Light general or local anesthesia
- Lateral or paramedian approach
- Allows visualization of peritoneal cavity, precise placement of catheter tip and optional fixation, lysis of adhesions if present and omentectomy if required
- Higher incidence of leaks

Percutaneous implantation using the Seldinger technique

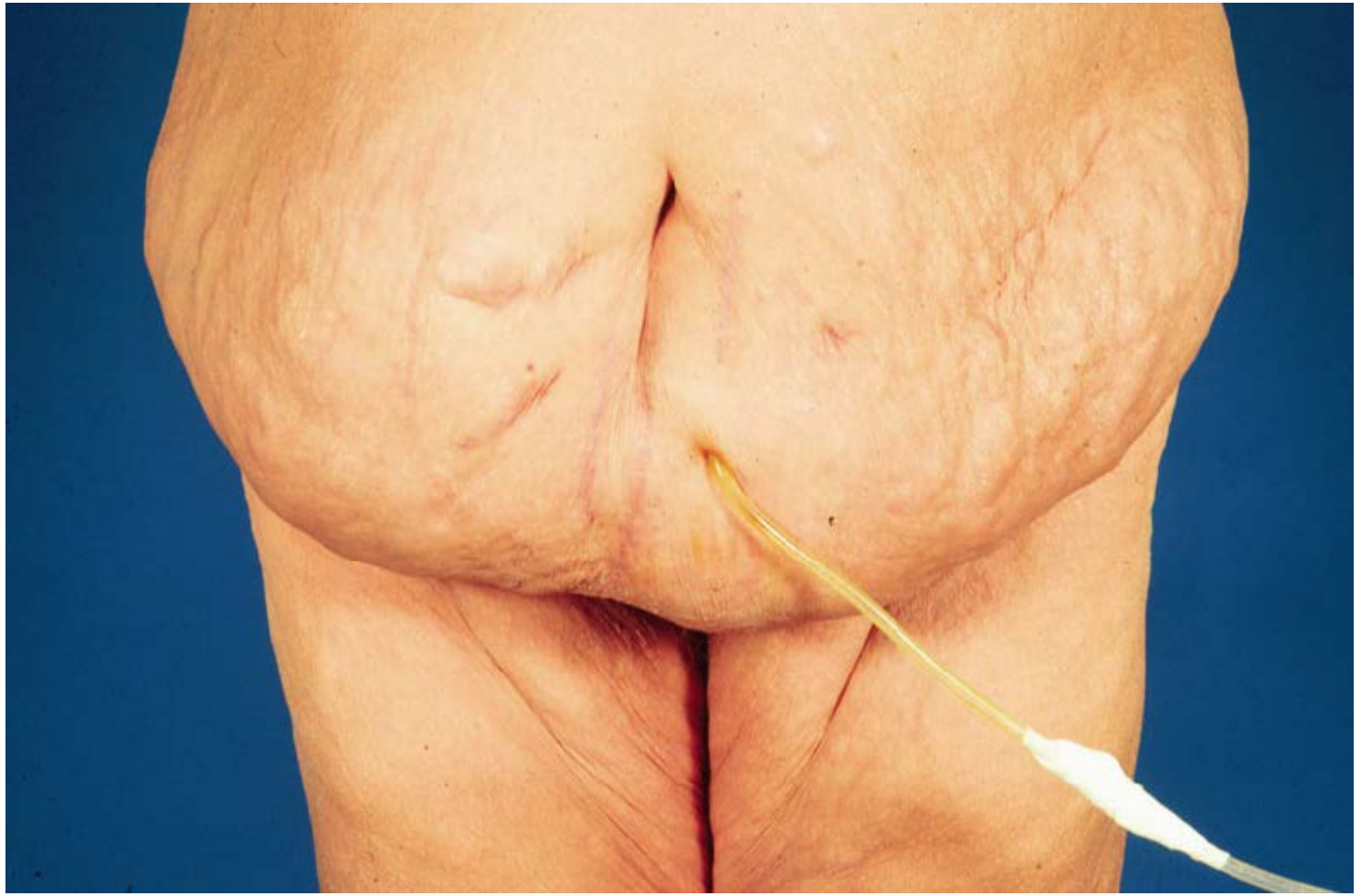
- Blind implantation
- Simplest technique
- Low risk of perforation



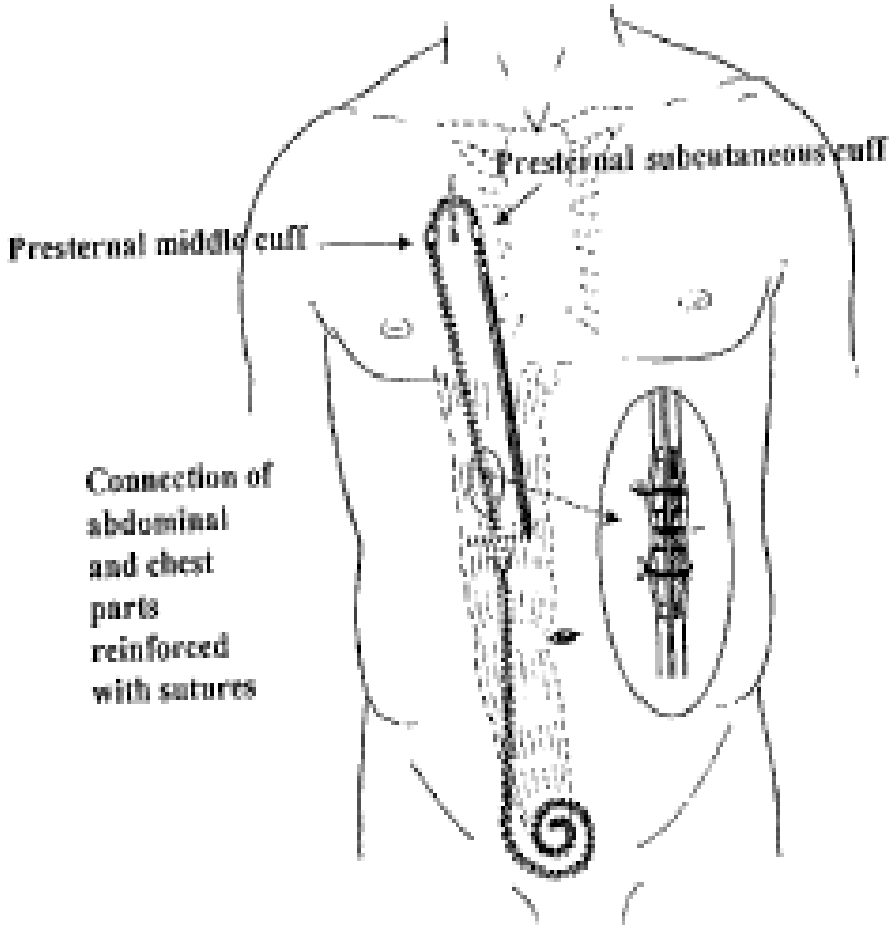
Laparoscopic implantation

- Increasingly popular
- Good visualization of peritoneal structures
- Allows early diagnosis of impediments to good function and of complications

PD catheter in obese patient



Presternal Swan Neck Catheter



Indications for a Swan-neck Presternal Catheter

- Medical
  - Extreme obesity (BMI > 35)
  - Abdominal ostomy(ies)
  - Multiple prior ESIs
  - Multiple abdominal scars
  - Other
- Psychosocial/ Patient Preference
  - Strong desire to bathe in tub, ski
  - Body image
  - Improve exit site care
  - Other

Potential Advantages of Presternal Catheters

- Better wound healing
- Better immobilization
- Decreased pressure by garments
- Increased distance from ostomy sites, diapers
- Easier exit-site care
- Improved body image (for most)

Overall, therefore, one would expect a lower frequency of ESI and peritonitis.

Presternal Catheter Outcomes

- Non-randomized study of presternal vs.abdominal catheters placed at a single tertiary care referral center over 6.25 years.
- Presternal catheters are useful (preferred ?) in obese patients.
- They may provide patients with superior lifestyle choices.
- Surgical implantation is slightly more difficult.
- Outcomes are probably superior to those of traditional abdominal catheters.

The Moncrief-Popovich catheter and technique

- Subcutaneous burial of the external segment of the catheter to prevent colonization of the catheter by skin bacteria and promote attachment of the cuff to the tissue prior to exteriorization
- No evidence of reduced risk of contracting peritonitis or exit-site infection in controlled randomized study
- Reports of seromas, subcutaneous hematomas and fibrin thrombi postoperatively

Postoperative care

- Securely capped
- Cover with sterile gauze and tape not bio-occlusive dressing
- Hide catheter/keep it dry
- Do not disturb for at least 2 weeks
- Notify Home Training Unit from Recovery Room

Post insertion management

- Immediate use
- Small volumes (≤ 1L)
- Dry days
- Heparin optional
- Break-in period without use for at least 2 weeks

Complications

- Inadequate placement/obstruction
- Pain
- Bleeding
- Perforations
- Leaks
- Hernia
- Infectious
  - Exit site infection/erosion
  - Tunnel infection
  - Peritonitis

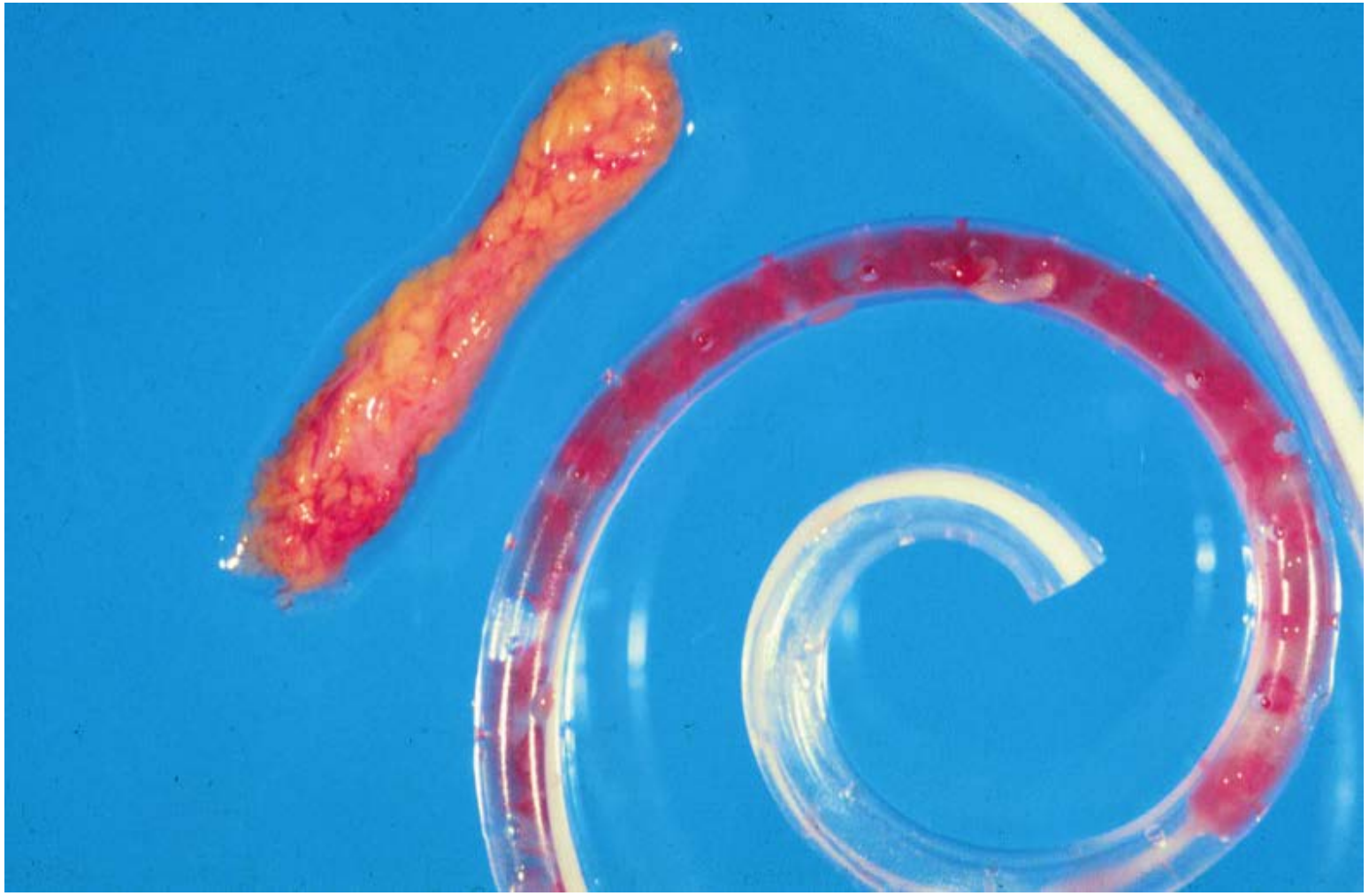
Peritoneal catheter malfunction

- Is a frequent source of morbidity and hospitalization
- Significantly reduces delivery of PD therapy
- Is a source of frustration to the patient and medical team
- Contributes to the cost of therapy

Peritoneal catheter malfunction

- Migration is not necessarily associated with malfunction
- Most common types are:
  - One-way obstruction
    - Omental wrapping
    - Malposition
    - Accordion clot (reversed one-way obstruction)
  - Total obstruction
    - Kinking of the catheter
    - Internal obstruction from clots (blood, fibrin, cryoglobulin, others)

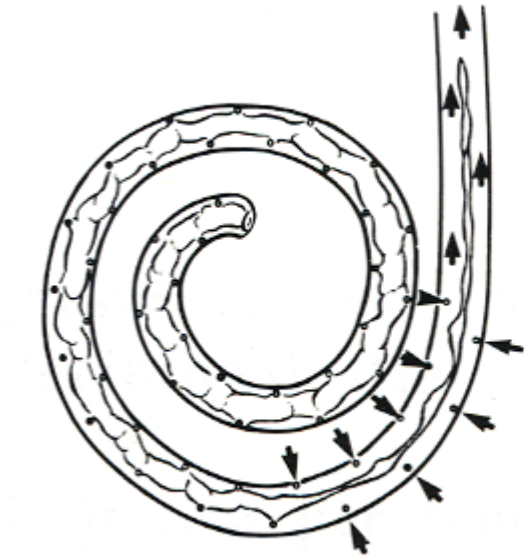
Total obstruction from clots

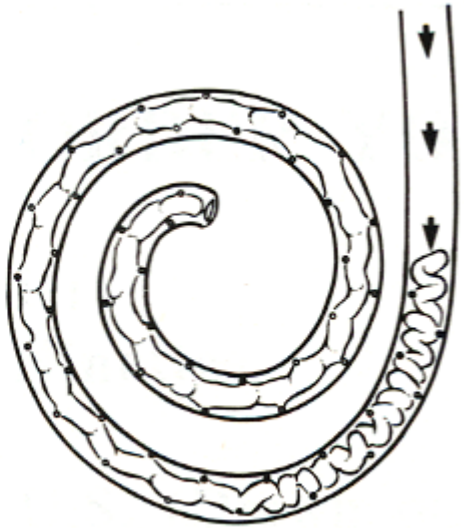


Reversed one-way obstruction from accordion clot

Clot stretched and narrowed during drainage allowing fluid to flow

Clot buckles and widens during infusion completely occluding the catheter



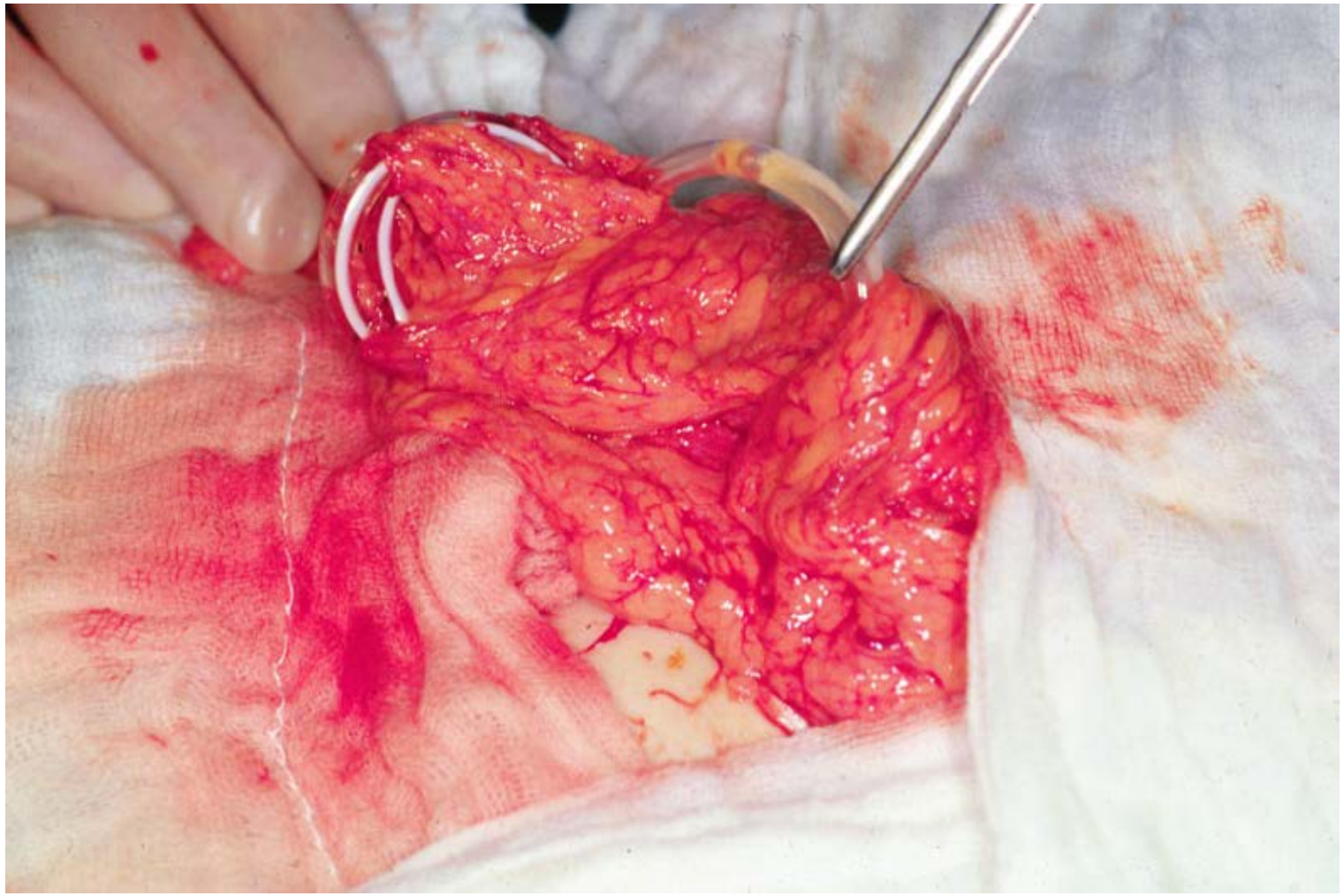


Twardowski et al., *Perit Dial Int* 14:296-297, 1994

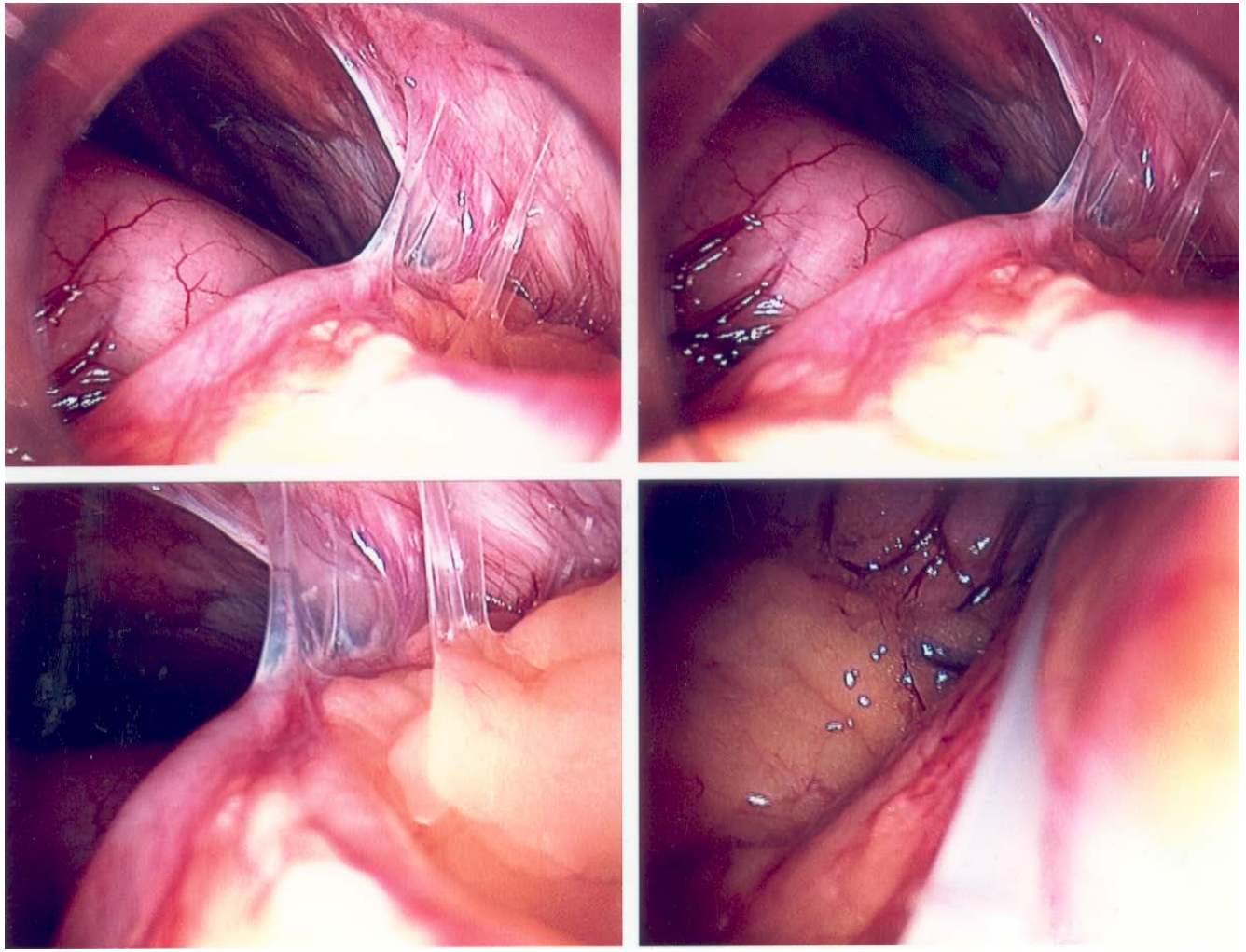
Peritoneal catheter malfunction-Therapy

- Observation
- Exercise
- Heparin infusion
- Enemas
- Urokinase/streptokinase, TPA irrigation
- Wire manipulation
  - Under fluoroscopy
  - Blindly
- Laparoscopy
- Surgical manipulation
- Replacement

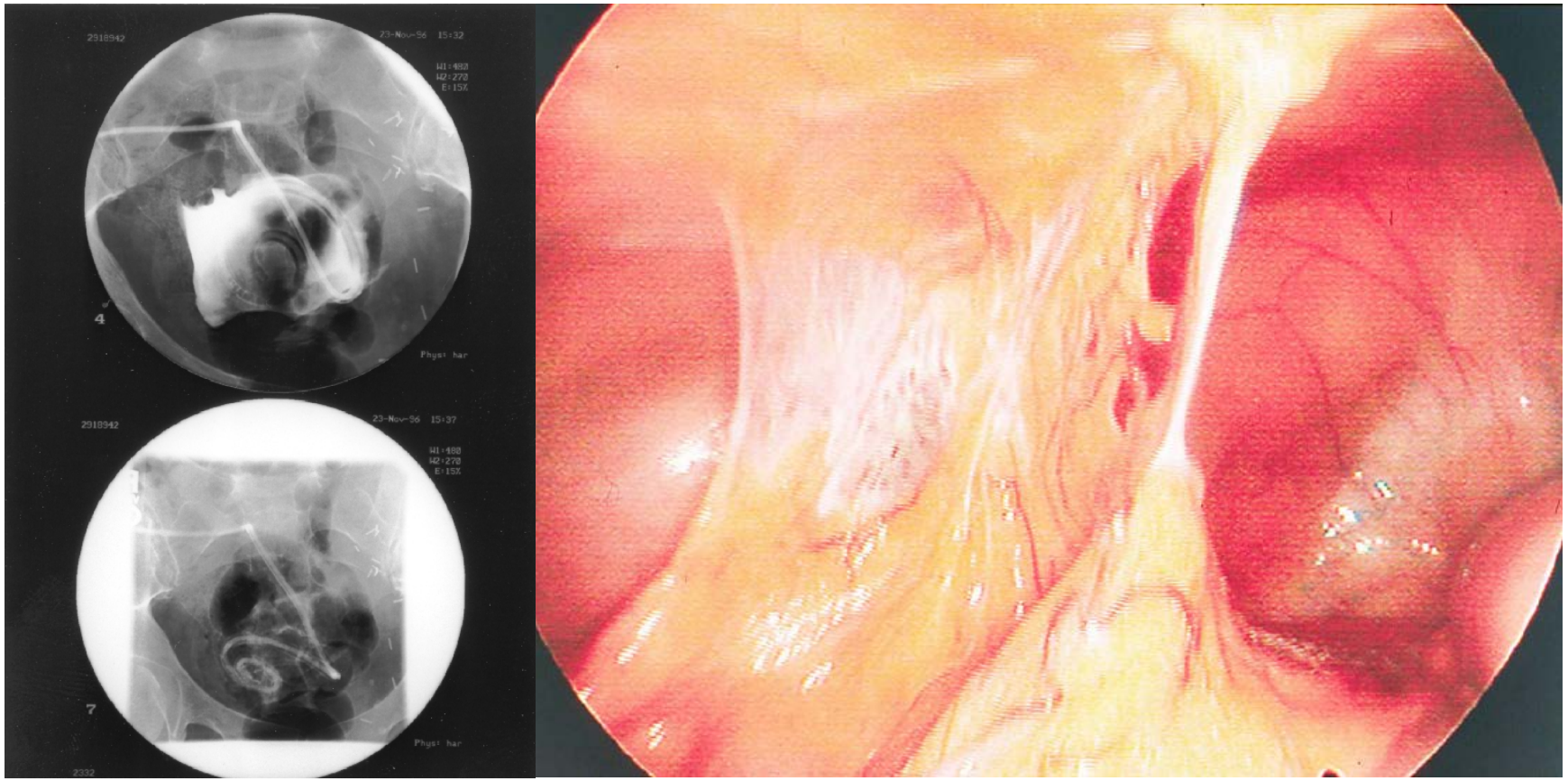
Obstruction from omental wrapping



Adhesions



Compartmentalization



Diaz-Buxo JA. *Perit Dial Int* 17:209-210, 1997 Photomicrograph courtesy of JH Crabtree

Pain

- Often present immediately post catheter insertion (mild and self limiting). This is sometimes due to subdiaphragmatic air.
- Diffuse and associated with cloudy outflow usually signifies peritonitis
- Diffuse pain relieved by drainage is often due to increased IAP
- Localized pain may be due to pressure from catheter tip

Bleeding

- Hemoperitoneum may occur immediately post implantation or long after the procedure
- Possible etiologies
  - Perforation of intraperitoneal vascular structures
  - Pre-peritoneal bleeding
  - Trauma to catheter anchoring
  - Retrograde menstruation

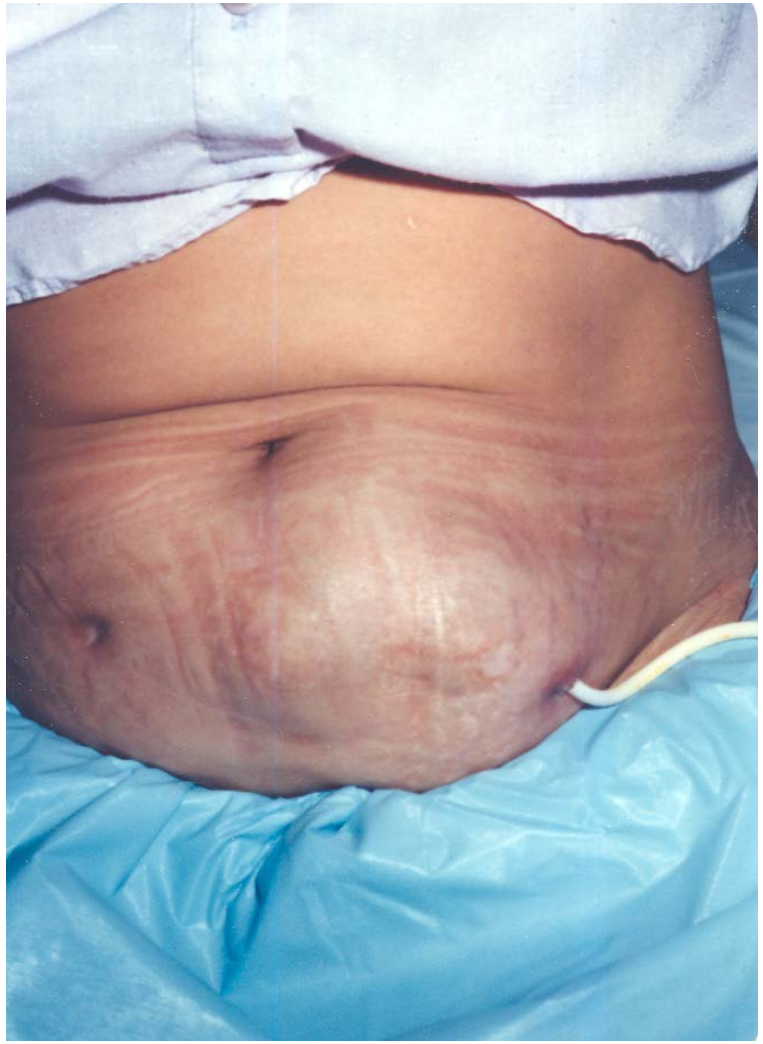
Leaks

- External
- Internal
  - Pre-peritoneal
  - Pleuroperitoneal (hydrothorax)
    - Traumatic
    - Congenital
  - Scrotal/vaginal (patent processus vaginalis)

Leaks

- Can be minimized or eliminated by:
  - Meticulous catheter implantation technique
    - Precise size of exit site
    - Good placement of cuffs
    - Secure ligation of internal cuff
    - Layered wound closure
  - Avoid elevated intraabdominal pressure
- More frequent among diabetics, immunosuppresed and malnourished patients

Pericatheter leak (pseudohernia)



PD catheter related hernia

- Common complication of PD (9-24%)[1]
  - Umbilical 4.0%
  - Inguinal 0.3%
  - Incisional 0.6%
  - Femoral <0.01%
- Predisposing factors:
  - Increased intrabdominal pressure
  - Multiparity
  - Weak anterior abdominal wall
  - Congenital defects

PD catheter related herniae

Diagnosis of exit site and tunnel infections and erosions

- Visual inspection for purulence, drainage and discoloration, erosions, extrusion of cuff
- Palpate cuff and tunnel for presence of warmness, tenderness, mass and fluctuance (abscess)
- Confirm presence of subcutaneous abscess with ultrasound

Diagnosis of exit site infection

Purulent or bloody drainage
Erythema
Edema
Tenderness
Epithelial regression
Pain

Treatment of exit site and tunnel infections

- Immediate Gram stain, culture and sensitivities on peri-exit smear
- Initiate empiric antibiotics
- Adjust antibiotics based on sensitivities
- Continue therapy until completely healed or a minimum of 2 weeks
- Cauterize or remove exuberant granulation tissue

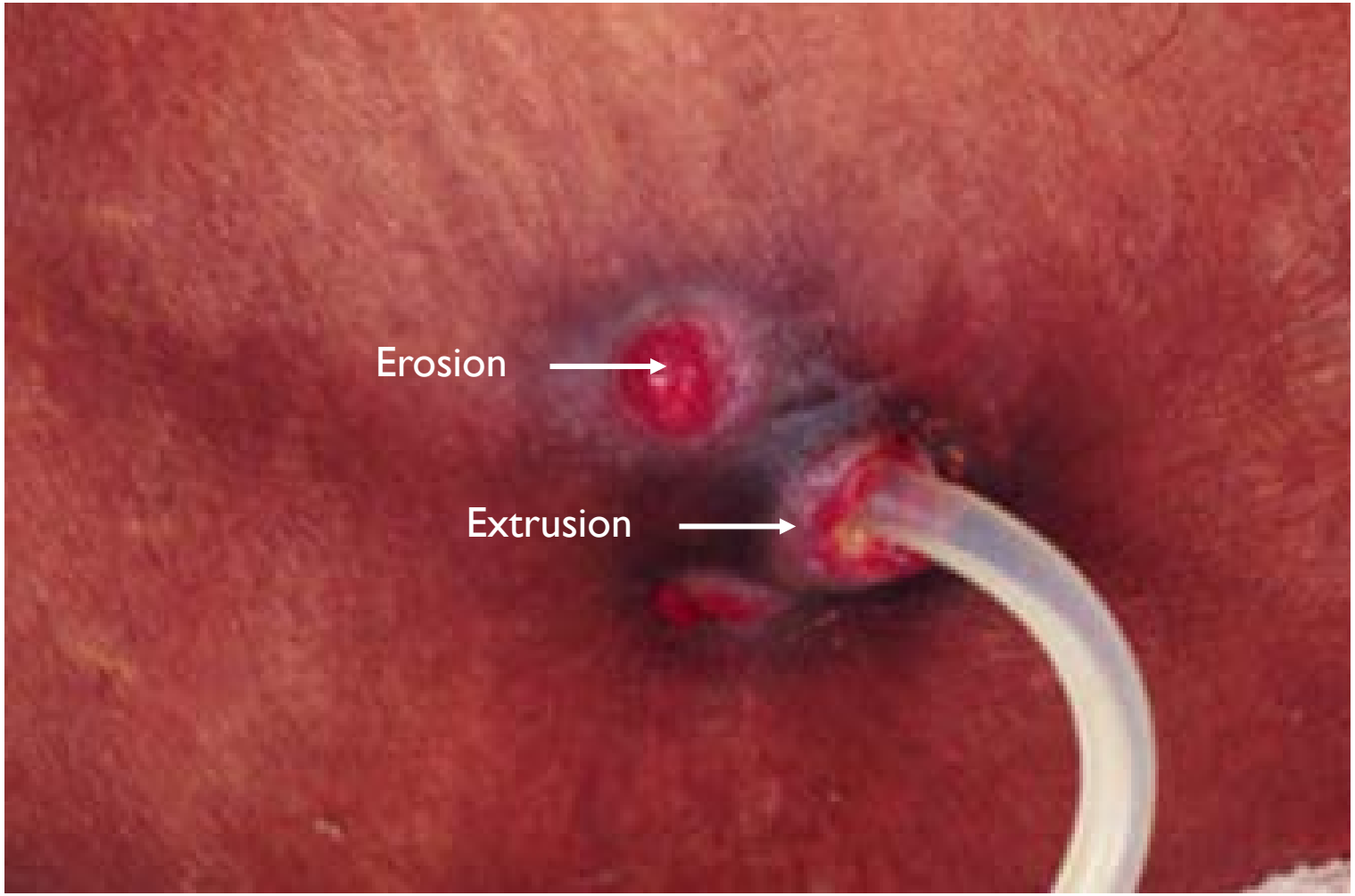
Treatment of exit site and tunnel infections

- Cuff shaving
  - Complete removal of the superficial cuff when antibiotics do not resolve an infection
  - Peritonitis with the same organism occurs in 50% of patients who undergo cuff shaving for S. aureus; may result in eventual removal of the catheter
- Topical Treatment
  - May be used as an adjunct to systemic antibiotics in treatment of exit infections or initial therapy for low grade infection (equivocal).
  - Topical antibiotic therapy only not appropriate for acute and chronic exit infections

Treatment of exit site and tunnel infections

- Care of the infected site:
  - Daily or BID exit site care
  - Crusts or scabs should not be forcibly removed, but gradually softened with hydrogen peroxide, saline, soap and water, or exit soaks
  - Sterile dressings to absorb drainage, reduce exposure to micro-organisms and protect from trauma
  - Curettage of persistent lesions
- Catheter replacement:
  - When the inner cuff is infected due to high risk of peritonitis
  - Refractory or recurrent peritonitis with exit or tunnel infections or extensive cellulitis unresponsive to antibiotics

Catheter erosions and cuff extrusions



Peritonitis

- Early appearance suggests intraoperative contamination
- ESI is a frequent cause
- Polymicrobial peritonitis with Gram negative organisms and yeasts suggests bowel perforation

Conclusion

- PD catheters are the least costly best method of dialysis for those who can be properly trained.
- Curl cath dual cuff is most common choice
- Exit site is based on body habitus
- Many different ways to implant PD catheters
- Catheter malfunction can almost always be corrected
- Infection is the leading cause of catheter removal