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A PRACTICAL GUIDE TO PD ACCESS CARE

INFECTIOUS AND NON-INFECTIOUS COMPLICATIONS MANAGEMENT

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INFECTIOUS AND NON-INFECTIOUS COMPLICATIONS MANAGEMENT

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OPTIMAL LONG-TERM MANAGEMENT OF THE PERITONEAL DIALYSIS (PD) PATIENT hinges on achievement of best demonstrated practices and prevention of complications associated with peritoneal dialysis. Published recommendations enhance our understanding of how to achieve these goals and encourage focus on prevention in an effort to improve patient management.

A Practical Guide to PD Access Care: Infectious and Non-infectious Complications Management was developed based on a review of the current medical literature, the recommendations of the International Society for Peritoneal Dialysis (ISPD) ad hoc advisory committee on PD-related infections, and the authors' clinical experience. Sections include operative planning and processes, chronic catheter care, and infectious and noninfectious complications, with suggested references and additional clinical resources. By its nature, this guide cannot be considered to be exhaustive, and users are encouraged to pursue specific issues that may not be covered herein. **Therefore, this guide should not replace the independent clinical judgment of the healthcare provider.**

This guide was developed as an aid to improve PD catheter management in the adult patient. It is our hope that these guidelines will assist you in improving patient care by optimizing PD catheter outcomes.

Please note:
Certain products discussed in this guide are not available in all geographic locations.

HOW TO USE THIS DIGITAL GUIDE

To assist navigation through this digital book, the **Contents** pages have been hyperlinked. Simply click on the page title to go directly to that page in the book.

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

USE OF THE GUIDE

USE OF THE GUIDE

The format of the guide has been designed to provide the user a consistent approach for optimal peritoneal catheter and complications management. Each section is intended to proactively address the key activities required to achieve desired clinical outcomes, to promote early recognition of complications with appropriate clinical interventions, and to collect clinical data necessary for outcomes assessment.

The information published in this guide is for general and educational purposes only and should not be construed as medical advice or otherwise substitute for the independent clinical judgment of healthcare providers. Additional Clinical Resource (ACR), formerly titled appendix, is available with supplemental clinical information. It is the last section of this guide.

USE OF THE GUIDE

Clinical Process of Care identifies the clinical processes of care that contribute to the overall outcome of improved catheter and complications management. The intent is to supplement good clinical judgment and facilitate coordination of team activities.

KEY ASSESSMENTS

Identifies major clinical findings and potential causes of common problems that should be incorporated into development of the plan of care.

CLINICAL INTERVENTIONS

Identifies major activities of members of the renal team who organize and support achievement of the desired clinical outcome.

PATIENT EDUCATION

Utilizes assessment and diagnostic findings to create an individualized patient/caregiver education program, maximize self-care skills, and promote adaptation to the therapy.

OUTCOMES EVALUATION

Identifies data required for tracking, trending and comparative benchmarking through a clinical monitoring system and for analysis by the continuous quality improvement (CQI) team to improve clinical outcomes.

SECTION 1

CATHETER INSERTION AND CARE

PREOPERATIVE MANAGEMENT

Catheters can be placed by either a surgeon or an interventionalist. Preoperative management is the same regardless of insertion technique. Optimal timing for PD catheter insertion is at least 2 weeks prior to use.[1] This is to ensure good tissue ingrowth, fixation of the deep and superficial cuffs and healing of the exit-site.[2] Urgent start PD utilizes the catheter immediately. (See ACR-Topic E) The Moncrief-Popovich technique of embedding catheters allows placement months ahead of anticipated need.[3]

KEY ASSESSMENTS

- Determine factors that may impair initial wound healing and exit-site management
  - Clinical status (chronic cough, steroids use, edema)
  - Nutritional status (malnutrition impairs healing)
  - Obesity-pannus location[4*]
  - Presence of colostomy, gastrostomy, or urostomy[5*]
  - Presence of incontinence[5*]
- Evaluate for:
  - Abdominal wall for rash and evidence of infection
  - Pre-existing abdominal scars[5]
  - Skin creases or folds[5]
  - Chronic skin conditions[5]
  - Abdominal wall hernias that require repair[6]
  - *S. Aureus* nasal carriage. If positive, treat with intranasal mupirocin[7]

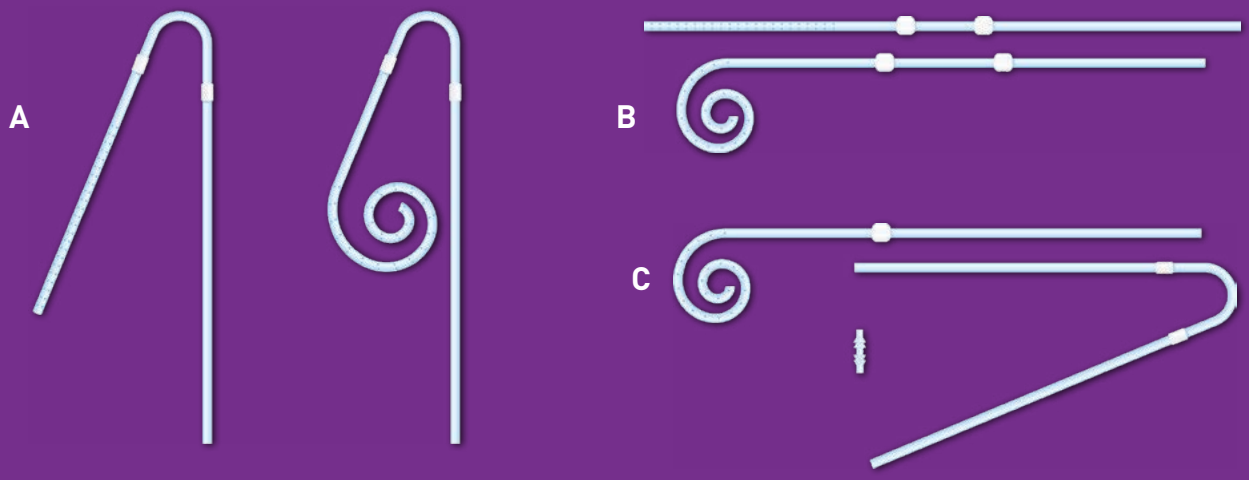


FIG 1. Shown are commonly used peritoneal catheters. (A) Tenckhoff catheters with preformed intercuff arc bend, 2 cuffs, and straight or coiled tips. (B) Tenckhoff catheters with straight intercuff segment, 2 cuffs, and straight or coiled tips. (C) Extended catheter with one-cuff, coiled-tip abdominal catheter, two-cuff extension catheter with preformed intercuff arc bend, and titanium double-barbed connector.

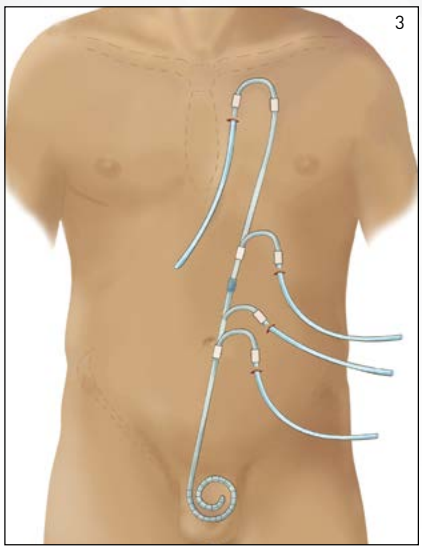
* may indicate need for upper abd or presternal ES

PREOPERATIVE MANAGEMENT

CLINICAL INTERVENTIONS

- Set up appropriate communication plan with surgeon and interventionalist for catheter placement and patient follow-up (See ACR-Topic B)
- Confirm catheter placement date; schedule post-op follow up with PD nurse
- Determine exit-site location that optimizes longevity and patient satisfaction
  - Exit-site must be visible to patient[5]
  - Determine whether lower abdominal, midabdominal, high abdominal, or presternal location is most appropriate for individual patient[5] (see Figure 2)
  - Patient preference should be considered in determining exit-site placement unless there is a strong clinical indication that precludes choice
  - Locate exit-site to maximize self-care skills (vision, handedness, strength, and motor skills).[4,5,8] Patient should be able to look down and easily visualize the proposed exit-site[5]
  - Evaluate patient while dressed and in the sitting position to determine belt line location and other anatomical features that will influence selection of catheter type, insertion site, and exit-site location
  - Avoid scars, belt line, skin creases, floppy skin folds, moist areas due to perspiration, pressure points from clothing or areas that cannot be sufficiently visualized during exit-site care[4]
  - Mark exit-site location with indelible ink using stencils or actual catheter or record measurements of exit-site position in relation to anatomical landmarks that will permit subsequent indication of exit-site location[9] (See ACR-Topic A)
- Choose appropriate catheter configuration and operative methodology
  - Despite innovative attempts to design peritoneal catheters to overcome problems with flow function, none of these devices have been shown to outperform the standard Tenckhoff-style catheters with or without a preformed intercuff bend or a straight- or coiled-tip configuration[4,6]
  - Catheters are made by different manufacturers. There is one catheter with the blue radio-opaque stripe which has a larger internal diameter (3.5mm vs. 2.6mm), and therefore requires its own unique adapter[5]

FIG. 2



Illustrations courtesy of John Crabtree, MD

PREOPERATIVE MANAGEMENT

Patients with belt lines BELOW umbilicus

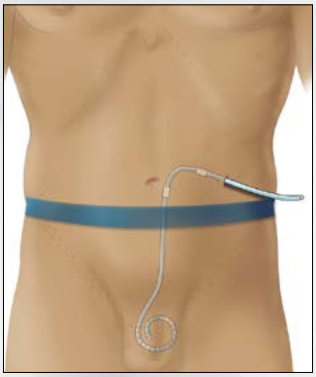


FIG. 3

Patients with belt lines below the umbilicus may require a Tenckhoff- style catheter that produces a laterally directed exit-site above the belt.[5]

Patients with belt lines ABOVE umbilicus

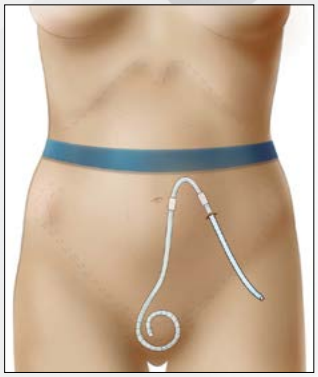


FIG. 4

Patients with belt lines above the level of the umbilicus may require a catheter that is bent or manufactured with a preformed bend that results in a downwardly directed exit-site.[5]

Indications for Presternal/Upper Abdominal Peritoneal Dialysis Catheter[4]

- Morbid obesity
- Multiple loose skin folds, scars, or other abdominal wall deformities
- Chronic abdominal wall intertrigo
- Abdominal stomas (colostomy, ileostomy, urostomy)
- Urinary or fecal incontinence
- Desire to be able to take deep tub bath[4,10]
- Patient preference

Contraindications for Presternal/Upper Abdominal Peritoneal Dialysis Catheter

- Body image issues
- Breast implants (presternal)
- Large pendulous breasts-may obstruct view of upper abdominal exit-site[4]
- Requires surgical expertise

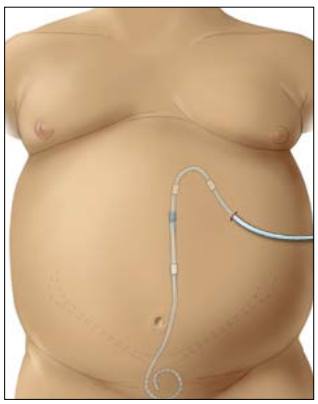


FIG. 5

An extended catheter for upper abdominal exit-site may be useful for patients with obesity or floppy skin folds or per patient preference.[5]

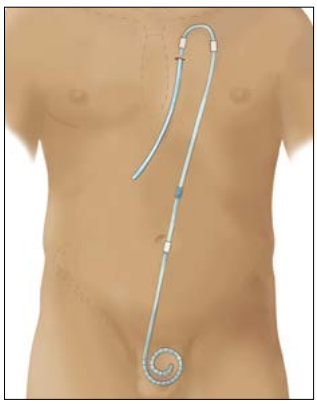


FIG. 6

An extended catheter with an upper chest exit-site can be utilized in patients with morbid obesity, abdominal stomas, or urinary-fecal incontinence or per patient preference.[6]

Illustrations courtesy of John Crabtree, MD

PREOPERATIVE MANAGEMENT

- Choice of catheter type may be impacted by belt line location and body habitus[4]
  - Patients with belt lines below the umbilicus are often best suited for a catheter with a straight intercuff segment that is bent in a gentle arc to produce a laterally directed exit-site above the belt (Figure 3)[4]
  - Patients with belt lines above the level of the umbilicus are often best suited for a catheter with a preformed intercuff bend, a so-called swan neck design, that results in a downwardly directed exit-site below the belt (Figure 4)[4]
  - Patients with obesity, especially with large rotund abdominal contours (exit-site must be visible to patient), or urinary-fecal incontinence may be best suited for an extended catheter with an upper abdominal/presternal exit-site to reduce risk of infection (Figure 5)[6]
  - Patients with morbid obesity, floppy skin folds, abdominal stomas, urinary-fecal incontinence, or those desiring to be able to take a deep tub bath may be suitable candidates for an extended catheter to produce a presternal exit-site (Figure 6)[4]
  - Patients for whom dialysis initiation is not anticipated until at least 3 to 5 weeks after catheter implantation may benefit from having the catheter embedded (Moncrief-Popovich technique) (Figures 7A, 7B)[11]
  - Catheter embedding procedure can be performed with any catheter type, e.g., conventional Tenckhoff abdominal catheters or two-piece extended catheters for upper abdominal or presternal exit-sites[4]

Embedded Peritoneal Dialysis Catheter

Advantages

- Catheter heals in environment without exposure to contamination from exit-site[4]
- Greater patient acceptance for earlier catheter implantation:
  - No catheter maintenance until dialysis starts[12]
  - Avoids urgent temporary hemodialysis
- Start full-dose peritoneal dialysis without break-in period after exteriorization[3]

Disadvantages

- 10-15% of embedded catheters are obstructed by fibrin clots and adhesions when exteriorized[5]
- Small risk of bowel erosion[13]

See ACR-Topic D for information on externalizing embedded catheters

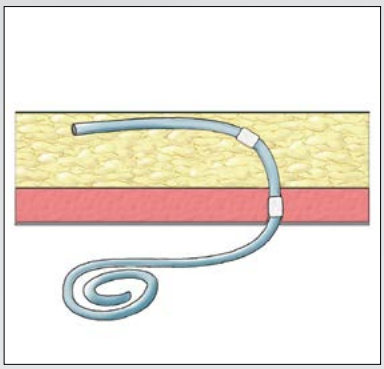


FIG. 7A

The external limb of catheter is buried under the skin, permitting healing and tissue ingrowth of the cuffs in a sterile environment.

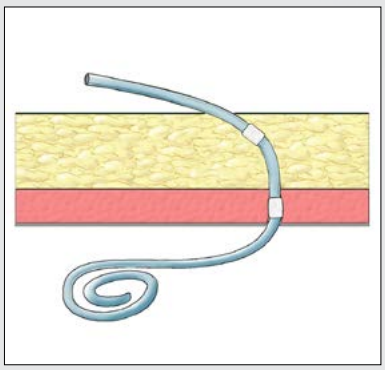


FIG. 7B

External limb of catheter is exteriorized when time to initiate dialysis.

Illustrations courtesy of John Crabtree, MD

PREOPERATIVE MANAGEMENT

PATIENT EDUCATION

Ensure PD education program is underway, including the following topics:

- Home dialysis concept
  - Supply storage/space
  - PD prescription evolves over time as RKF decreases fill volumes may increase
    - -Exchanges may increase resulting in fluid dwelling in peritoneum 24 hours a day, 7 days per week when anuric per KDOQI[14]
  - Lifestyle issues
    - -No tub bath / hot tub or whirlpool[15]
    - -Swimming, requires healed exit-site (follow clinic protocol)[15]
    - -Pets allowed, but not in room where PD connection/disconnections occur[15]
    - -Lifting limitations of 7-10 kg until catheter fully healed[5]
    - -Dressing to exit-site mandatory until exit-site fully healed[2]
  - Keep catheter immobilized at all times[16]
  - Avoid constipation. Report constipation/diarrhea immediately.[5,17] (See ACR-Topic P)
- Basics of PD therapy
- Permanency of catheter
- Self-care concept
- Postoperative catheter care
  - Sterile dressing change 5-10 days post-op by experienced PDRN[5]
    - -Patient to report to PDRN immediately if dressing becomes soiled, wet, or loose
  - Provide postoperative care instructions and, if applicable, supplies including: soap/alcohol-based hand disinfectants, masks, absorbent dressing (e.g., gauze), tape, clamp, transfer set caps, and exit-site cleansing agent/skin disinfectant

Prior to catheter insertion, review written pre and post-op instructions with the patient/caregiver:

Preoperative Patient Education:

- Review catheter placement procedure
- Fast after midnight or at least 8 hours prior to catheter insertion (essential medications are permitted with a sip of water)
- Empty bladder[2,6,8]
- Bowel preparation to evacuate the lower colon in case of previous history of constipation (e.g., polyethylene glycol solution, enema, or a stimulant suppository administered beginning a day or two before the procedure depending on the severity of symptoms)[2,6,8]
  - Avoid using sodium phosphate bowel preps[18]
- Shower or bathe with chlorhexidine soap on the day of surgery[2,6,8]
- Arrange for a follow up appointment post-op with PDRN

PREOPERATIVE MANAGEMENT

Post-operative Patient Education:

- Keep sterile dressing clean, dry, securely taped for 5-10 days unless signs and symptoms of infection or bleeding[5]
- Dressing is only to be changed by PDRN[5]
- Report bleeding, pain, or tenderness immediately
- Report severe cough
- Avoid high intra-abdominal pressure:[5]
  - Heavy lifting[5]
  - Straining and constipation[15]
- No showers until completely healed up to 3-4 weeks (2 days in case of embedded catheters)[4]

OUTCOMES EVALUATION

- Document patient education given and patient understanding
- Assure follow up appointment is established

SURGICAL PLACEMENT

Perioperative and Intraoperative Management

Optimal long-term peritoneal catheter function and exit-site healing are directly related to the skills and competence of the catheter insertion team.[8] Proper catheter insertion technique is one of the most important aspects in preventing catheter exit-site and/or tunnel infections. Attention to detail and commitment to excellence should be foremost in goals for success.[8] Peritoneal catheter insertion procedures should meet the standards of any surgical procedure and inclusive of known best demonstrated practice, whether performed by a surgeon in the operating room, an interventional radiologist in a radiology suite, or an interventional nephrologist at the bedside.[8]

KEY ASSESSMENTS

- Verify completion of preoperative activities:
  - Fasting state maintained
  - Shower on day of surgery with chlorhexidine soap[8]
  - Bladder emptied or Foley catheter as needed[8]
  - Bowel preparation complete[2,5,6]
- Verify exit-site marked appropriately[5,8]
  - Verify that selected catheter which produced the above marked exit-site is available at the facility

CLINICAL INTERVENTIONS

Prepare patient:

- Single preoperative dose of prophylactic antibiotics to provide antistaphylococcal coverage [5,17]
  - First-generation cephalosporin 1000 mg intravenously[17]*

OR

  - Vancomycin 1000 mg intravenously[17]*
  - A prospective randomized trial determined that vancomycin was superior to cephalosporin or no treatment in reducing post-operative peritonitis[19]*
  - If vancomycin is used, weigh potential benefits versus risk of resistant organisms*
- Perform surgical skin prep (use electric clipper to avoid skin nicks)[5]

Prepare catheter:

- Eliminate air from catheter cuffs prior to implantation by soaking and gently squeezing cuffs in saline solution[5,8]

*The epidemiology and resistance patterns contributing to peritonitis should be considered in determining the appropriate preoperative antibiotics[17]

SURGICAL PLACEMENT

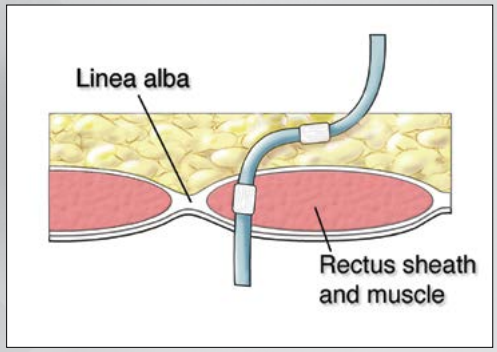
Perioperative and Intraoperative Management

Insert catheter:

Catheter implantation approaches include laparoscopic, open dissection, and percutaneous needle-guidewire with or without image guidance.[5] The following general guidelines should be adhered to irrespective of implantation technique chosen:

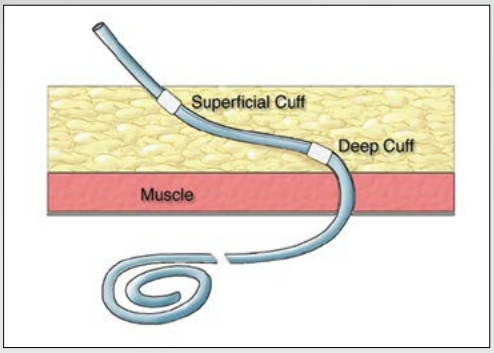
- Preoperative determination of most appropriate catheter type, insertion site, and exit-site location[5]
- Use of double cuff catheter preferred[5,20]
- Paramedian insertion through body of rectus muscle and sheath to provide optimal catheter immobilization and minimize risk of pericatheter leak and hernia (Figure 8)[5,8]

FIG. 8



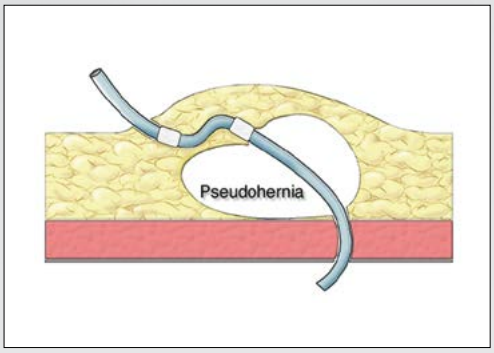
Peritoneal dialysis catheter implanted through paramedian approach with deep cuff resting within the muscle.

FIG. 9A



Deep catheter cuff implanted external to the fascia. The mesothelium from the peritoneal surface reflects along the surface of the catheter to reach the deep cuff.

FIG. 9B



The extension of the peritoneal lining above the muscle layer creates the potential for a pseudohernia and pericatheter leak. If the abdominal wall is weak, the track may dilate and develop a true hernia.

Illustrations courtesy of John Crabtree, MD

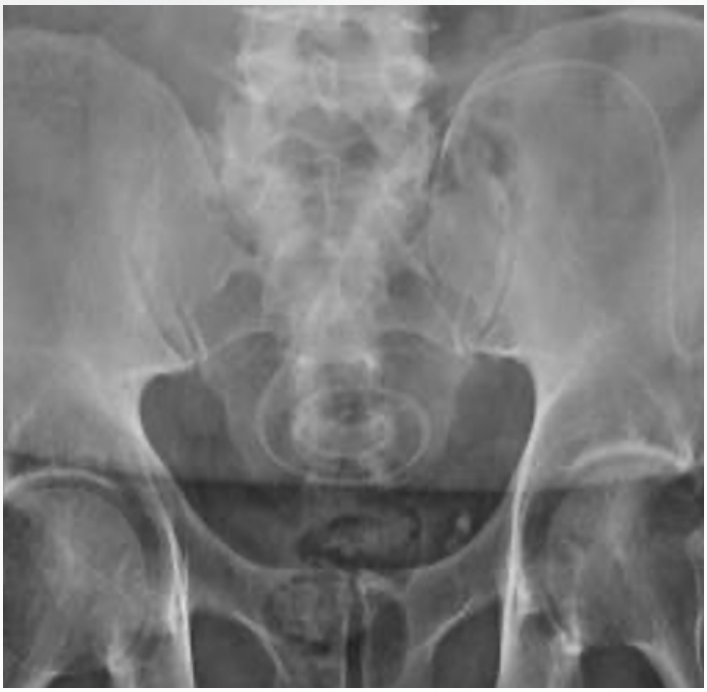
- Position deep cuff within rectus muscle sheath[8]
- Implanting deep cuff superficial to rectus fascia can lead to formation of hernia or pseudohernia and late pericatheter leak (Figure 9A and 9B)[2]

SURGICAL PLACEMENT

Perioperative and Intraoperative Management

- Catheter tip should have pelvic location[8] (see Figure 10)
- Place purse-string absorbable suture at level of peritoneum during open dissection or anterior rectus fascia with laparoscopic or percutaneous insertion to reduce risk of pericatheter leak[8]
- Catheters with straight intercuff segment should not be bent excessively in subcutaneous tissues to avoid creating shape memory resiliency forces that can lead to catheter tip migration and superficial cuff extrusion (Figures 11 and 12)[5]
- Subcutaneous tunneling instruments should not exceed diameter of dialysis catheter[8] and should be capable of being advanced in direction from insertion site toward exit-site
- Create the smallest skin hole possible to provide for catheter exit-site[8]
- Position subcutaneous cuff 2 to 4 cm from exit-site[8]

FIG. 10



X-ray courtesy of John Crabtree, MD

SURGICAL PLACEMENT

Perioperative and Intraoperative Management

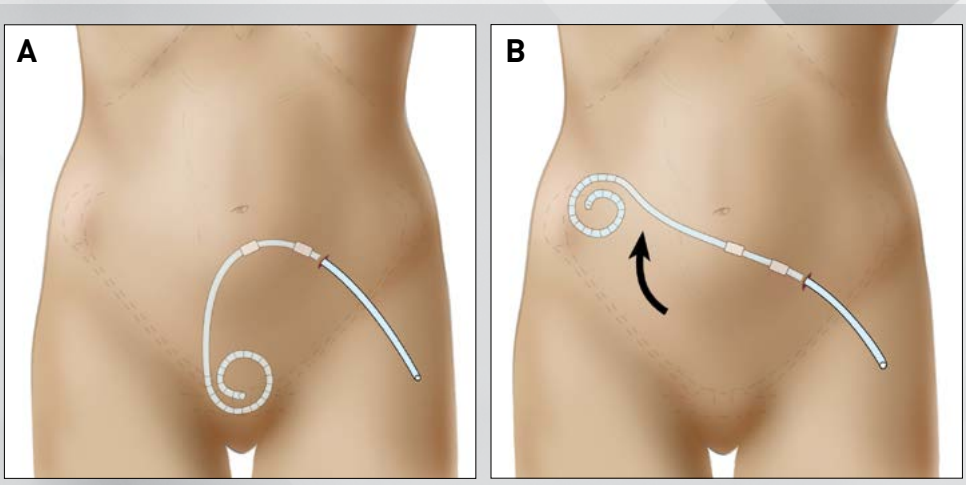


FIG. 11

(A) Straight catheter implanted into arcuate configuration.

(B) Shape memory can cause catheter tip migration out of the pelvis.

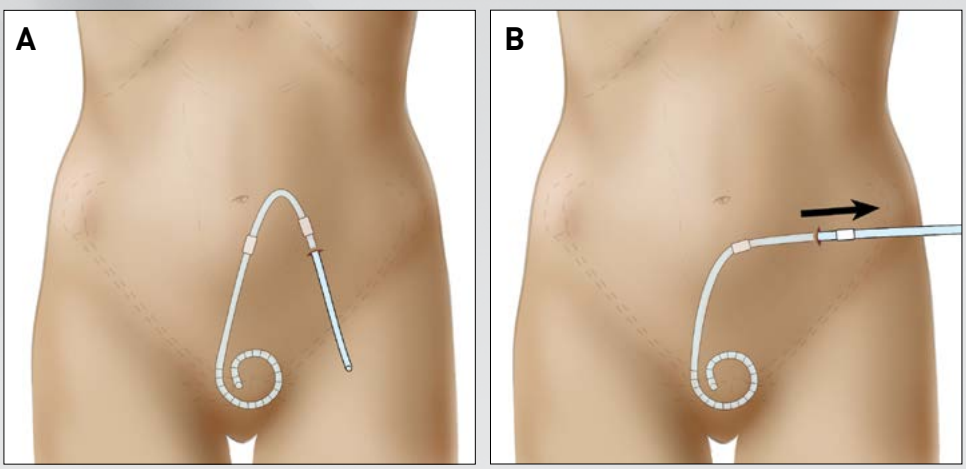


FIG. 12

(A) Straight catheter implanted into arcuate configuration.

(B) Shape memory can cause the superficial catheter cuff to extrude through the exit-site.

Illustrations courtesy of John Crabtree, MD

- Exit-site should face downward or lateral[8]
- Immobilize catheter with sterile adhesive strips[4] and nonocclusive gauze surgical dressing[5]
- Do not utilize catheter anchoring sutures at the exit-site due to risk of infection[5,8]
- Perform adjunctive procedures to catheter implantation such as hernia repair, omentopexy, omentectomy, and adhesiolysis as needed[8]

SURGICAL PLACEMENT

Perioperative and Intraoperative Management

Verify function:

- Catheter patency and flow must be tested during surgical procedure prior to final closure.[5] With the patient in reverse Trendelenburg position, a trial irrigation is performed by infusing a standard 1-liter bag of normal saline or dialysate. Infuse 500-1000 mL of saline or dialysate: observe for unimpeded inflow and out flow. Leave a residual volume of 100-200 mL[5] in the abdomen to reduce the likelihood of intraperitoneal structures being siphoned up to catheter tip and side holes toward the end of the drainage phase[5]
- Catheter position should be revised until satisfactory flow function is achieved[21]
- After demonstrating satisfactory hydraulic function the catheter is tunneled to the exit-site[21]

Final catheter preparation:

- Insert catheter adapter[5]
- Attach catheter cap or transfer set with cap (as per individual center policy)[5]
- Make sure transfer set is in closed position
- Apply sterile gauze or other nonocclusive absorbent dressing and tape securely[5]
- Tape catheter and transfer set securely to abdomen in several places[5]

PATIENT EDUCATION

- Review postoperative instructions prior to patient discharge
- Provide written instructions regarding follow-up care (See ACR-Topic B)
- Review postoperative medications
- Review postoperative pain management
- Schedule return appointment for postoperative evaluation and ideally for weekly dressing changes by experienced staff

OUTCOMES EVALUATION

Review operative report for baseline catheter data:

- Date, surgeon, inpatient/outpatient placement, surgical approach, special procedures
- Catheter type, catheter material, position of cuffs, direction of exit-site
- Catheter function
- PD Unit catheter outcomes should be monitored and reviewed at least annually[5]

INTERVENTIONAL PLACEMENT

Perioperative and Intraoperative Management

Peritoneal dialysis (PD) catheters can be placed by interventional radiologists, interventional nephrologists, or surgeons. The percutaneous interventional approach may offer operational efficiencies in busy medical centers and is a minimally invasive approach to PD catheter placement.[22]

The ability to perform image guidance (ultrasonography, fluoroscopy) during the percutaneous procedure assures greater safety and reliability of catheter insertion. The availability of this technique as an alternative to surgical/laparoscopic placement has had a favorable impact on PD utilization and PD program growth. The percutaneous approach has been particularly beneficial for urgent-start protocols because of shorter response times for requested PD access. Several publications have shown favorable outcomes of this minimally invasive technique compared to catheter placement by open surgical approaches or when laparoscopy was used only to visually verify the catheter position without employing advanced techniques.[23-30]

Percutaneous technique has similar indications to surgical/laparoscopic placement. No general anesthesia is required for percutaneous placement[22] which makes it a suitable choice for patients who may have a contraindication for general anesthesia. However, the percutaneous approach may be inadvisable for patients with pronounced central obesity, previous major or multiply operated abdomens because of the concern for adhesions, prior severe peritonitis, inability to lay flat, or poor tolerance to procedures under local anesthesia, even with conscious sedation.[5] Patients who require hernia repair should consider laparoscopic surgical insertion.[23]

KEY ASSESSMENTS

- Verify completion of preoperative activities:
  - Fasting state maintained
  - Bladder emptied or Foley catheter as needed[5]
  - Bowel preparation complete[2,5,6,22]
- Verify exit-site marked appropriately[5,8,22]

CLINICAL INTERVENTIONS

Prepare patient:

- Single preoperative dose of prophylactic antibiotics to provide anti-staphylococcal coverage[5,17]
  - First-generation cephalosporin 1000 mg intravenously[22]*

    OR
  - Vancomycin 1000 mg intravenously[22]*
  - A prospective randomized trial determined that vancomycin was superior to cephalosporin or no treatment in reducing post-operative peritonitis[19]*
  - If vancomycin is used, weigh potential benefits versus risk of resistant organisms[17]*
- Perform surgical skin prep (use electric clipper to avoid skin nicks)[5]

*The epidemiology and resistance patterns contributing to peritonitis should be considered in determining the appropriate preoperative antibiotics[17]

INTERVENTIONAL PLACEMENT

Perioperative and Intraoperative Management

Prepare catheter:

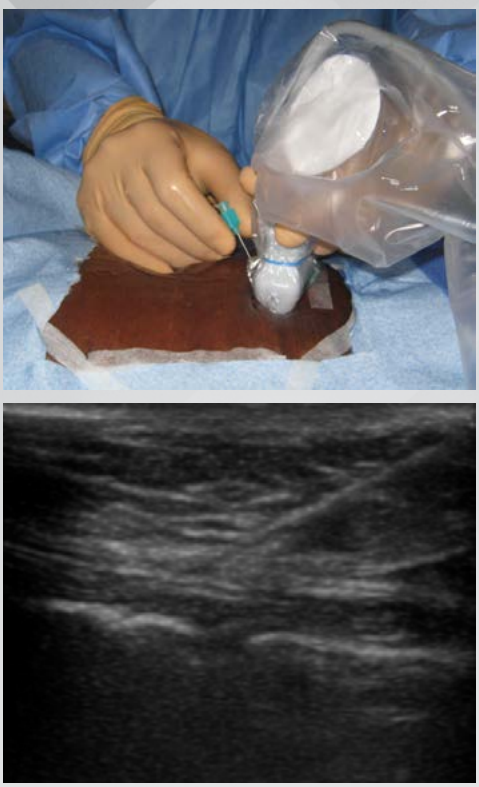
- Eliminate air from catheter cuffs prior to implantation by soaking and gently squeezing cuffs in saline solution[5,8,22]

Insert the catheter:

The following general guidelines should be adhered to:

- Preoperative determination of most appropriate catheter type, insertion site, and exit-site location (as described earlier in preoperative management section)
- Use ultrasound guidance for initial entry into the peritoneum at the insertion site to avoid inadvertent bowel puncture (see Figure 13)[22]
- Needle direction at the insertion site should be 45 degrees caudal with the skin surface.[22,29]
- Advancing the needle for 3-4 cm in the rectus muscle before penetrating the peritoneum allows the catheter to be tunneled in the rectus muscle which provides more stability and less migration outside the pelvis.[22]
- Needle entry into the peritoneum should be verified by injecting contrast under fluoroscopy[22] (see Figure 14).
- Dilatation of the track before catheter insertion facilitates catheter placement and should be performed under fluoroscopic guidance[21] (see Figure 15)
- Use of double cuff catheter preferred[5,20]
- Paramedian insertion through the body of the rectus muscle and sheath to provide optimal catheter immobilization and minimize risk of peri-catheter leak and hernia (see Figure 8)[5,8,22]
- Deep cuff should be inserted within rectus muscle sheath (see Figure 16)[8,22]
- Implanting deep cuff superficial to rectus fascia can lead to formation of hernia or pseudohernia and late peri-catheter leak (see Figure 9A and 9B)[8]
- The deep cuff is typically not sutured into the rectus; however, if urgent-start dialysis is planned, the deep polyester fiber cuff can be sutured to the rectus fascia using absorbable suture[22]
- Catheter tip should have pelvic location, and the catheter curl should preferably be in the direction of the insertion site (see Figure 17)[8,22]

FIG. 13A AND B



Images courtesy of Dr. AK Abdel-Aal

(a) and (b) Ultrasound guidance for initial entry into the peritoneum at the insertion site to avoid inadvertent bowel puncture

FIG. 14

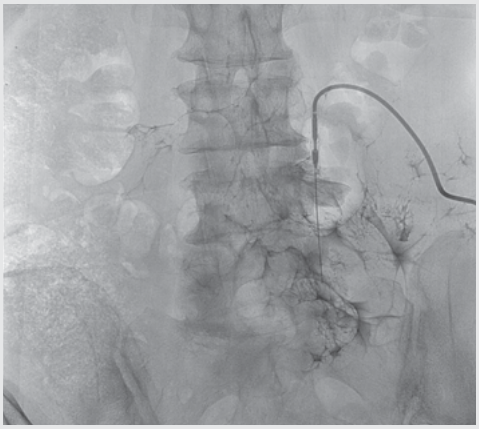


Image courtesy of Dr. AK Abdel-Aal

Needle entry into the peritoneum should be verified by injecting contrast under fluoroscopy

INTERVENTIONAL PLACEMENT

Perioperative and Intraoperative Management

Verify catheter function:

- Catheter patency and flow must be tested during procedure prior to tunneling to prevent unnecessary tunnel track and exit-site trauma in the event that catheter repositioning is required.
  - A trial irrigation is performed by infusing a standard 1-liter bag of normal saline or dialysate. Infuse 500-1000 mL of saline or dialysate observe for unimpeded inflow and out flow. Leave a residual volume of 100-200 mL in the abdomen to reduce the likelihood of intraperitoneal structures being siphoned up to catheter tip and side holes toward the end of the drainage phase[5]
  - Catheter position should be revised until satisfactory flow function is achieved

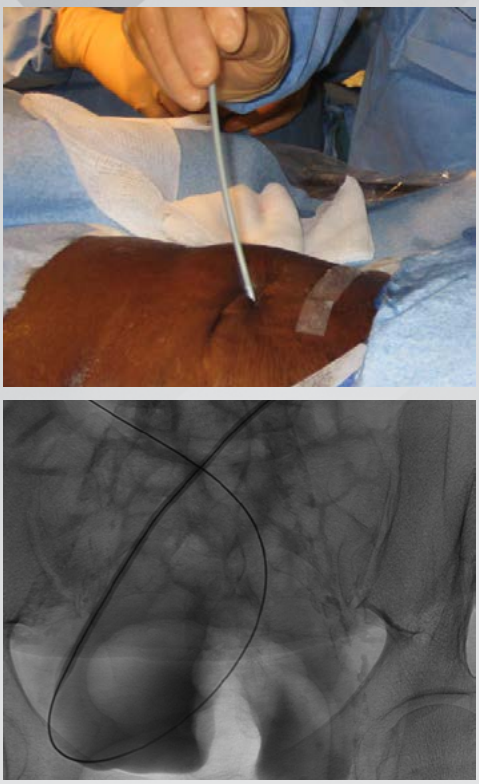
Catheter tunneling:

- Catheters with straight intercuff segment should not be bent excessively in subcutaneous tissues to avoid creating shape memory resiliency forces that can lead to catheter tip migration and superficial cuff extrusion. (see Figures 11 and 12)[6]
- Excessive bending of the straight intercuff segment can also lead to kinking and partial obstruction of the catheter resulting in suboptimal function. Check patency and absence of catheter kinking by injecting contrast in the catheter under fluoroscopy after insertion[22]
- Subcutaneous tunneling instruments should not exceed diameter of dialysis catheter and should be capable of being advanced in direction from insertion site toward exit-site
- Create the smallest skin incision possible to provide for catheter exit-site[8]
- Caution should be exercised during the tunneling process to avoid displacement of the deep cuff from the rectus abdominis muscle[22]
- Position subcutaneous cuff 2 to 4 cm from exit-site to reduce the chance of subsequent extrusion[8,22]
- Exit-site should face downward or lateral to avoid perspiration, bacteria or skin debris from pooling at the exit-site[8,22]
- Do not utilize catheter anchoring sutures at the exit-site due to risk of infection[5,8]

Dressing:

- Immobilize catheter with sterile adhesive strips[4] and non-occlusive gauze surgical dressing[5,22]

FIG. 15A AND B



Images courtesy of Dr. AK Abdel-Aal

(a) and (b) Dilatation of the track before catheter insertion should be performed under fluoroscopic guidance

FIG. 16

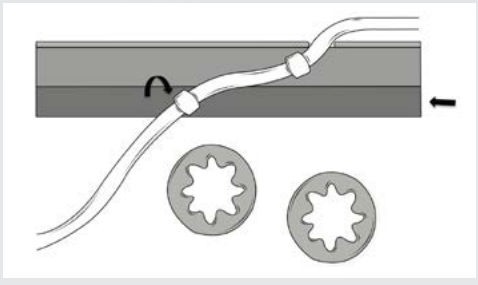


Image courtesy of Dr. AK Abdel-Aal

Deep cuff (curved arrow) should be inserted within rectus muscle sheath (straight arrow)

INTERVENTIONAL PLACEMENT

Perioperative and Intraoperative Management

Final catheter preparation and Dressing:

- Insert catheter adapter[5]
- Attach transfer set to catheter[5]
- Make sure transfer set is in closed position
- Apply sterile gauze or other nonocclusive absorbent dressing and tape securely[5,22]
- Tape catheter and transfer set securely to abdomen in several places[5,22]

FIG. 17

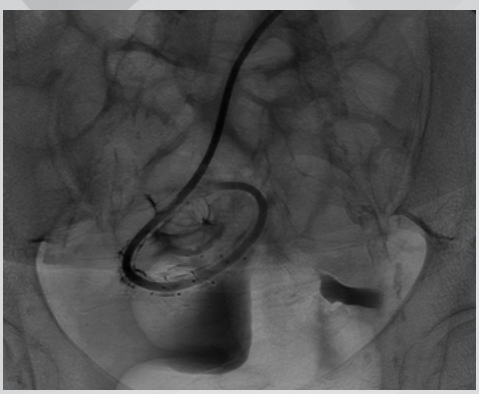


Image courtesy of Dr. AK Abdel-Aal

Catheter tip should have pelvic location, and the catheter curl should preferably be in the direction of the insertion site

PATIENT EDUCATION

- Review postoperative instructions with patient:
  - Maintain clean, dry, securely taped sterile dressing
  - Protect site from gross contamination and wetness
  - Immobilize catheter
  - Meticulous hand hygiene[7]
  - Practice good hygiene
  - No shower or bath until healed[16,20,31]
  - Avoid stair climbing, straining, and constipation[15]
  - Notify PD unit in case of blood or other drainage, pain or tenderness, trauma to abdomen
- Restrict dressing changes following implantation to experienced PDRN[5]

OUTCOMES EVALUATION

Review operative report for baseline catheter data:

- Date, interventionalist, inpatient/outpatient placement
- Catheter type, catheter material, position of cuffs, direction of exit-site
- Catheter function
- PD Unit catheter outcomes should be monitored and reviewed at least annually[5]

SURGICAL OR INTERVENTIONAL PLACEMENT

Postoperative Management

Optimal postoperative care promotes healing of the exit-site wound and the catheter track. Postoperative care includes immobilization of the catheter to prevent trauma to the exit-site and cuffs, minimizing exposure to bacteria and preventing colonization.[16] If possible, implantation should be timed to allow 2 weeks for healing prior to initiation of dialysis except in urgent start patients.[1] If dialysis is required early, small volume exchanges in the supine position may be performed[2] with frequent checks for leakage. (See ACR-Topic E) Postoperative assessment and dressing changes should be performed weekly by experienced staff only using aseptic technique with mask and gloves until healed.[2,31]

KEY ASSESSMENTS

- Assess exit-site and wound healing for:
  - Absence of bleeding, drainage, or leakage
  - Absence of pain or tenderness on palpation
- Follow clinic protocol for catheter flushing to assess patency

CLINICAL INTERVENTIONS

- Surgical dressing should be left in place for 5-10 days.[5] It may be changed earlier in presence of:
  - bleeding[5]
  - infection[5]
  - gross contamination
  - wetness
- Weekly dressing changes by PDRN until exit-site is healed.[2,31]
- Maintain clean, dry, intact dressings[2]
- Utilize sterile technique using mask and gloves[2]
- Exit-site care:
  - Minimize manipulation of catheter
  - Use sterile technique, including masking and wearing sterile gloves for postoperative dressing changes until healed[16,31]
  - Inspect and classify exit-site[2,32] (See ACR-Topic N)
  - Palpate tunnel assessing for fluid loculation, tenderness, or drainage
  - Clean with nonirritating solution (e.g., normal saline, or chlorhexidine)[2]
  - Protect sinus track and wound from povidone iodine and hydrogen peroxide[2]
  - Tape dressing securely[2]
  - Immobilize catheter at all times to minimize tension on cuffs[2]

SURGICAL OR INTERVENTIONAL PLACEMENT

Postoperative Management

CLINICAL INTERVENTIONS

Catheter Irrigation:

Perform catheter irrigation with 500-1000 mL saline or dialysate. Early postoperative irrigation of the PD catheter is advisable to reduce the risk of obstruction from fibrin strands, blood clots, and adhesions. Early irrigation also enables timely identification of catheter dysfunction, creating an opportunity to revise the catheter prior to scheduled training and initiation of therapy.[4,8]

Timing of the first irrigation should be based upon the extent of bleeding observed during catheter placement, the number of other simultaneous interventions performed that may be accompanied with bloody seepage, e.g., adhesiolysis, hernia repair, or omentopexy, or the patient was previously on antiplatelet or anticoagulant therapy. Under these conditions, it is reasonable to perform the first irrigation within 24 hours; otherwise, early irrigation is recommended by 72 hours. Heparin, 1000 units/L, may be added to the irrigant to help prevent blood clots and fibrin plugs.[4,8]

- If the catheter is not used for a time, it is advisable to repeat irrigation periodically, such as during weekly dressing changes, to assure patency and function by the time the patient is ready to start dialysis training.[15]
- Catheters that are exteriorized secondarily (Moncrief technique) can be used immediately for full-volume peritoneal dialysis.[8] Exit-site management for secondarily exteriorized catheters is the same as described for primary exteriorization. (See ACR-Topic D)

PATIENT EDUCATION

- Review postoperative instructions with patient:
  - Maintain clean, dry, securely taped sterile dressing
  - Protect site from gross contamination and wetness
  - Immobilize catheter
  - Meticulous hand hygiene[7]
  - Practice good hygiene
  - No shower or bath until healed[16,20,31]
  - Avoid stair climbing, straining, and constipation[15]
    - Increased intra-peritoneal pressure can cause both early and late leaks[5] and should be avoided
  - Notify PD unit in case of blood or other drainage, pain or tenderness, trauma to abdomen
- Restrict dressing changes following implantation to experienced PDRN[5]

OUTCOMES EVALUATION

- Exit-site assessment (See ACR-Topic N)

CHRONIC CARE OF PERITONEAL DIALYSIS CATHETER

Optimal long-term peritoneal catheter management focuses on maintaining a healthy exit-site and catheter track. Catheter survival of greater than 80% at one year is desired.[2,6] The primary preventative steps are ongoing assessment of the exit-site, institution of antibiotic prophylaxis, early identification and treatment of exit-site problems, prevention of contamination, and immobilization of the catheter to protect from trauma.

KEY ASSESSMENTS

- Inspect exit-site using magnifying glass as needed
- Evaluate exit-site and sinus track (See ACR-Topic N)
- Examine exit-site appearance by checking for:[32]
  - absence of drainage, erythema, crust, scab, granulation tissue, swelling, and pain or tenderness on palpation
- Palpate tunnel for induration, fluctuance, discomfort or drainage from exit-site
- Compare exit-site appearance on each clinic visit
- Assess catheter function by asking CAPD patients about changes in fill and drain times or review cycler data for APD patients. (usually 10 min to fill/ 10-20 min to drain)[33]
- Review chronic catheter care with patient
- Ensure compliance with topical exit-site antibiotic prophylaxis
- Assess for constipation/diarrhea
- Ensure catheter is immobilized at all times. In a manner that respects the natural tubing bend as it emerges from the exit-site to prevent pressure ulceration at the skin exit[15,31]
- Dressing change per clinic policy

CLINICAL INTERVENTIONS

- Document exit-site and tunnel appearance at each clinic visit
- Obtain exit-site culture if drainage or wetness noted
- Perform exit-site care as required
- Review and reinforce exit-site and catheter care plan

ANTIBIOTIC PROPHYLAXIS

ISPD recommends one of the following:[7]

- We recommend daily topical application of antibiotic cream or ointment to the catheter exit-site
- Gentamicin 0.1% cream daily at exit-site effective in reducing both gram-positive and gram-negative infections
- Mupirocin cream or ointment daily at exit-site effective in reduction of gram-positive infections
  - avoid using ointment with polyurethane catheters
- Apply to skin around catheter site only, not catheter[34]

CHRONIC CARE OF PERITONEAL DIALYSIS CATHETER

CHRONIC EXIT-SITE CARE

Cleanse exit site frequently, preferably daily[35]
ISPD recommends cleansing at least 2 x week and after every shower or vigorous exercise[36]

Choose one of the following:

A

- Apply gentamicin cream or ointment to exit-site daily in all patients[36]†
- Apply to skin around catheter exit-site only. Not catheter[36]** (see Figure 18)

B

- Apply mupirocin cream or ointment to exit-site daily in all patients[36]
- Apply to skin around catheter exit-site only. Not catheter[36]** (see Figure 18)

IMPORTANT POINTS

- Alternating mupirocin and gentamicin has been associated with increased risk of fungal peritonitis[36]
- Keep catheter immobilized[36]
- Chronic dressing is optional; keep site dry[36,37]

† Gentamicin may be associated with increased non-TB, enerobacteriacea[7] and fungal exit-site infections[38]

** Excessive application of antibiotic cream directly to catheter, has been reported to cause catheter damage[7,34]

PATIENT EDUCATION

Follow your clinic protocol. Review these recommendations from the literature

- Wash and dry hands thoroughly[2,16]
- Inspect catheter, exit-site, and tunnel before catheter care[2]
  - Report trauma of exit-site or catheter
  - Check catheter & transfer set for holes leaks or cracks
  - Check connection of adapter, transfer set and mini cap to prevent disconnection
- Cleanse exit-site with liquid antibacterial soap or non-cytotoxic antiseptic[20]
  - Do not refill cleansing agent containers to avoid cross-contamination[2,16]
- Soften crusts and scabs with saline or soap and water. Never forcibly remove crusts and scabs[2,16]

CARE FOR PATIENTS WHO SWIM

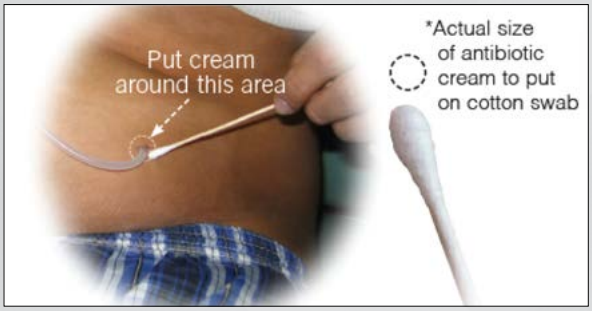
- Swimming may be allowed for patients with fully healed exit-site[39]
- Common practice is to have appropriate protection over exit-site:[5]
  - Ostomy pouch over exit-site[8,40]
- May swim in a chlorinated pool or ocean; avoid hot tubs, rivers, ponds[32]
- Avoid swimming in open water right after storms to limit exposure to waterborne pathogens[40]
- Perform exit-site care immediately following submersion in water[8,40,41]
- Avoid swimming in the presence of exit-site infection[38]

CHRONIC CARE OF PERITONEAL DIALYSIS CATHETER

- Showers recommended; avoid immersion in tub[15]
- Follow clinic protocol for topical antibiotic prophylaxis at exit-site (see Figure 18)
  - Avoid mupirocin ointment with polyurethane catheters[20] (No polyurethane catheters on market in North America)
- Immobilize catheter with tape or immobilization device at all times
  - Allow catheter to lay in natural position without tension
  - Avoid tight clothing over exit-site
  - Avoid use of scissors or other sharp objects around catheter
- Perform exit-site care if exit-site becomes wet or grossly contaminated[16]
- Maintain regular bowel movements; avoid constipation[31] (See ACR-Topic P)

FIG. 18

TOPICAL ANTIBIOTIC PROPHYLAXIS



OUTCOMES EVALUATION

- Assess patient technique on exit-site care
- Exit-site classification/assessment (See ACR-Topic N)
- Culture date, result, and treatment
- Topical antibiotic regimen
- Evaluation of catheter outcomes
  - Peritonitis rate
  - Exit-site/tunnel infection rate (See ACR-Topic I & J)
  - Catheter survival
  - RN to perform a home visit[31] (See ACR-Topic M)

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SECTION 2

NONINFECTIOUS COMPLICATIONS

PERICATHETER AND SUBCUTANEOUS LEAKS

Pericatheter and subcutaneous leaks are often related to poor catheter implantation technique, anatomical abnormalities, early use of the recently placed catheter or trauma.[1] Leakage occurring in the first 30 days following catheter implantation is usually external in nature and is evident at the catheter exit-site or surgical incision. Subcutaneous leaks may resolve with a prolonged rest period or dry day. Subcutaneous leakage involving the genital region or abdominal wall usually indicates a larger leak requiring exploration of the incision site or evaluation for an anatomical defect. Attention to surgical recommendations on insertion location (paramedian approach) and positioning of internal cuff reduce the risk of leakage.[1]

Leaks also occur through the diaphragm into the pleural space. This is referred to as a hydrothorax.[1] Even though a hydrothorax is a leak, it will not be discussed in this section. (see Noninfectious Complications-Hydrothorax, page 54).

Leaks confined to the genital area can occur through a patent processus vaginalis, an extension of the peritoneum that accompanies the testicle as it descends into the scrotum. In females, the extension of the peritoneum accompanies the round ligament of the uterus as it extends into the labia. In many individuals this processus vaginalis structure does not fuse normally and allows for a patent communication between the abdominal cavity and the scrotum or labia.[2] These patients may present with massive scrotal or labial edema during initiation of PD.

Leaks are detected clinically by visualizing clear dialysate at the exit-site, by examination of the subcutaneous tissue that would present with a feeling of induration and fullness, or by obvious genital edema. Leaks at the exit-site can be confirmed with glucose testing of the visible fluid. Subcutaneous leaks and genital leaks can be confirmed by either CT peritoneography, scintigraphy, or MRI.[3, 4, 5]

KEY ASSESSMENTS

Patients at risk:

- Patients with poor tissue healing (diabetics, elderly, malnourished, and those taking corticosteroids)
- Patients with increased intra-abdominal pressure[1] caused by:
  - Early large fill volumes, sneezing, coughing, straining with constipation, lifting with fluid in abdomen

Findings that require evaluation for leaks:[1]

- External fluid at wound or exit-site
- Simultaneous reduced exchange outflow volume and weight gain
- Abdominal swelling and edema/increased girth
- Scrotal, penile, or labial edema
- Peripheral edema
- Unilateral pleural effusion with or without volume overload (see Noninfectious Complications-Hydrothorax)

PERICATHETER AND SUBCUTANEOUS LEAKS

CLINICAL INTERVENTIONS

External leaks:

- Verify that clear fluid at incision or exit-site contains glucose, using glucose test strip[1]
- Document condition of exit-site, subcutaneous cuff, tunnel, and/or wound
- Alter dressing change procedure to accommodate increased fluid drainage
- Reduce leak by use of dry days, supine low volume dialysate exchanges, or temporary suspension of PD[6]
- Leaks increase the risk of peritonitis, and consideration should be given to prophylactic antibiotic administration[7]

Subcutaneous leaks:

- Monitor girth[6]
- Examine flank and back[6] for subcutaneous fluid
- Examine for scrotal, penile, or labial swelling[6]
- Order/review abdominal computerized tomography (CT) with intraperitoneal (IP) contrast, peritoneal scintigraphy, or magnetic resonance imaging (MRI) without gadolinium[3-5] (see ACR-F)
- Increase clinic visits as needed for observation

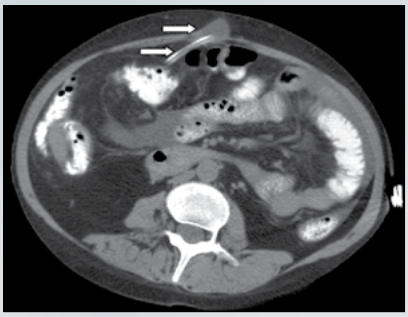
NON-INFECTIOUS COMPLICATIONS LEAKS

TYPICAL PRESENTATION OF EARLY LEAKS vs. LATE LEAKS

	Early leaks < 30 days[1]	Late leaks > 30 days[1]
Etiology	• Related to implantation technique[1] • Timing of PD initiation -(wait 2 weeks before use to minimize risk)[7] • Dialysate volumes utilized[7] -(too much, too soon) • Underlying abdominal wall weakness	• Cuffs separate from surrounding tissues[7] • Physical strain[1] • Abdominal wall weakness[1] • Occult tunnel infections • Steroids[7] • Hernias[1]
Signs and symptoms	• Fluid leaking from exit-site[7] • Glucose test strip-high glucose in fluid[7] • Genital edema	• Abdominal wall edema[1] • Weight gain[1] • Decreased UF or outflow[1] • Genital edema • SOB or cough (rule out hydrothorax, see hydrothorax section)
Interventions	• Hold PD 1-3 weeks[7] • Consider prophylactic antibiotic[7] • Chronic external leak — requires surgical evaluation[7] • Genital edema-surgical repair	• Hold PD 1-3 weeks may resolve leak[7] • CT peritoneography/scintigraphy to diagnose location/cause of leak[7] • Treatment depends on findings; surgery often required • Genital edema — surgical repair

PERICATHETER AND SUBCUTANEOUS LEAKS

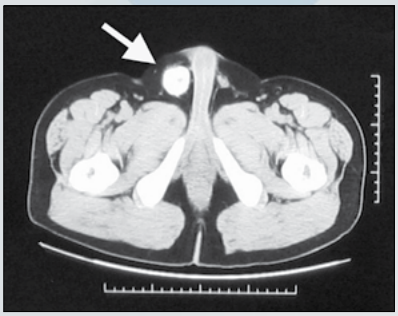
Pericatheter Leak



CT without IP contrast revealing a pericatheter leak in a patient with improper placement of the catheter. White arrows indicate catheter and leak area identified by different contrast to other subcutaneous tissue.

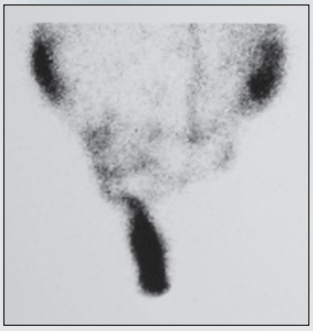
Radiograph courtesy of Ali Abu-Alfa, MD

CT Peritoneography



CT peritoneography with IP contrast showing dye around the cord structures in the upper scrotum on the right side (arrow) at the level of the root of the penis. (see ACR-F)

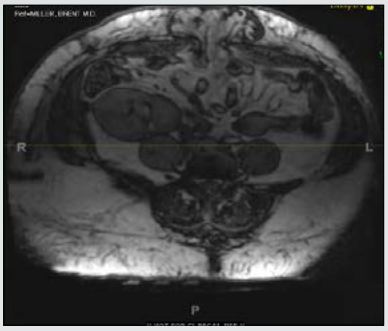
Peritoneal Scintigraphy



Peritoneal scintigraphy postdrain image demonstrating right inguino-scrotal fluid collection. (see ACR-F)

Radiographs courtesy of John Crabtree, MD

MRI (Magnetic Resonance Imaging)



MRI showing anterior abdominal hernia. Dialysate brightly enhances in the subcutaneous tissue demonstrating a leak.

The element, titanium, is essentially non ferromagnetic. [8, 9, 10] The adapter may remain attached to the patient. Inform MRI technologist of presence of titanium adapter.

Radiograph courtesy of Brent Miller, MD

PERICATHETER AND SUBCUTANEOUS LEAKS

MANAGEMENT

Dialysis therapy:

- Initiate PD or APD in supine position, using low volume exchanges (500 to 1500 mL) until leak has resolved. Keep abdomen dry when not in supine position[1]
- If required, use HD backup temporarily[1]

In new patients in whom dialysis is not urgently required:

- Delay use of PD for up to 2 weeks if necessary until leakage subsides[7]
- Cautious reintroduction of PD after rest period with frequent monitoring for recurrence

Invasive steps:

- Persistent leak may require surgical repair[1]
- Provide HD backup if needed during healing in patients with no residual renal function if low volume APD is not feasible or does not adequately control azotemia
- Recurrent pericatheter leaks may require catheter replacement[7]

PATIENT EDUCATION

- Monitor for signs and symptoms of exit-site infection and peritonitis in presence of leaks
- Alter dressing change procedure and frequency to accommodate increased drainage
- Report physical examination changes indicating potential leak
- Alter dialysis regimen if required to minimize intra-abdominal pressure
- Reduce activities that increase intra-abdominal pressure such as coughing[1], straining[1] or lifting (7-10 kg limit)[7]

OUTCOMES EVALUATION

Collect data to include:

- Type of catheter and insertion technique
- Condition of exit-site/surgical incision
- Condition of subcutaneous cuff and tunnel
- Type of leak
- Diagnostic testing and results
- Dialysis prescription alterations

PERICATHETER AND SUBCUTANEOUS LEAKS

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PERITONEAL CATHETER OBSTRUCTION

Inflow and outflow obstruction occurs more commonly as early complications, but can also occur at any time, especially during or following episodes of peritonitis. Ascertaining the cause of obstruction will assist in determining the appropriate intervention.[1]

KEY ASSESSMENTS

Inflow obstruction may be due to:

- Mechanical blockage such as clamps or kinks in the transfer set, kinks in the catheter segment under the dressing or internal kinks[2]
- Post-implantation blood clot or fibrin[2]
- Fibrin, particularly with peritonitis[2,3]
- Omental wrap[4,5]

Outflow obstruction may be due to:

- Constipation (most common cause)[2]
- Mechanical blockage of transfer set or catheter
- Post-implantation blood clot or fibrin[2]
- Fibrin, particularly with peritonitis[2,3]
- Extrinsic bladder compression due to urinary retention[2] (see Fig. 1)
- Catheter tip migration out of pelvis[2,5]
- Catheter entrapment
  - Omental wrap[4,5]
  - Epiploic appendices of colon[5]
  - Fallopian tubes[5]
  - Adhesions[5]

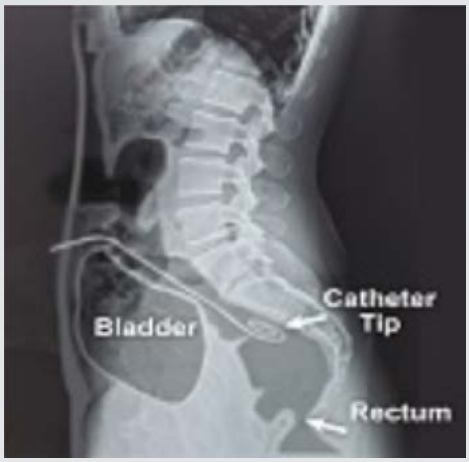

Figure 1. CT showing bladder distention and compression of catheter tip

Baxter Internal

Clinical Presentation of Catheter Obstruction:

- Low or negative ultrafiltration[6]
- APD patients may have
  - Slow drain
  - Increased alarms
  - Lost dwell time

KEY ACTIVITIES

Conservative Noninvasive Steps:[1,7]

- Eliminate kinks or remove clamps on transfer set and catheter. Examine portions hidden by clothing and dressings
- Change body position (have patient get up and move about)
- Dislodge blockage by catheter flush (by experienced PD personnel)
  - Infuse dialysate or normal saline with a 50 mL syringe using moderate pressure ("push and pull" maneuver).[1] Discontinue procedure if patient notes pain or cramping
- Correct constipation (see ACR-P)
  - Laxative may help reposition catheter[1]

PERITONEAL CATHETER OBSTRUCTION

- Obtain a flat plate X-ray of abdomen to visualize catheter position; a lateral view may be necessary to identify a subcutaneous and/or intraperitoneal catheter kink[2]

Thrombolytic Therapy for Obstructed Catheter:

Tissue plasminogen activator (tPA) may be used to restore patency to PD catheters obstructed by fibrin after failure to resolve the flow restriction with push-pull irrigation of the catheter with dialysate or normal saline with heparin.[8,9] Indications for tPA use are documented difficulties in draining and/or filling in the absence of tubing kinks, catheter malposition, closed clamps, constipation, or bladder distention.[2]

Administration of tPA:

- Prepare a solution of tPA (1 mg/mL) per manufacturer's directions that **is equal to 110% of the calculated volume of the PD catheter and transfer set**.[9]

Formula to calculate catheter volume:[9]

Conventional lower abdominal catheters:
Conventional 1-piece catheters with white guide stripe: Catheter length (cm) x 0.053 = volume in cm^3 (mL)**
Conventional 1-piece catheters with blue guide stripe: Catheter length (cm) x 0.096 = volume in cm^3 (mL)***

Pre-sternal or upper abdominal catheters:
Extended 2-piece catheters have variable lengths depending on the amount of tubing trimmed from the abdominal and extension segments at the time of implantation. Request surgeons to measure and document in the operative note the length of tubing between the upper border of the abdominal catheter Dacron cuff and the upper border of the Dacron cuff in the ascending segment of the extension tube of catheters with a white guide stripe (black marker ring in catheters with blue guide stripe). In the absence of this documentation, the length is estimated by measuring the distance (cm) between the lower incision scar used for catheter insertion and the upper incision scar (located in upper abdomen or chest) for the extension segment.
Extended catheter with white guide stripe: (Measured length + 70) x 0.053 = volume in cm^3 (mL)**
Extended catheter with blue guide stripe: (Measured length + 63) x 0.096 = volume in cm^3 (mL)***

Example of tPA volume calculation:

- Patient has a conventional lower abdominal Medtronic swan neck double cuff catheter with a 6-inch Baxter transfer set. Use formula above for conventional lower abdominal catheters.
  - **Step 1: Calculate the volume of the catheter using Table A**
    62.5 x 0.053 = 3.3 mL
  - **Step 2: Add catheter volume + transfer set volume using Table B**
    3.3 + 2 = 5.3 mL
  - **Step 3: Calculate 110% of the total volume (catheter + transfer set)**
    5.3 x 1.1 = 5.8 mL

5.8 mL of tPA would be required for this patient.

PERITONEAL CATHETER OBSTRUCTION

TABLE A: LENGTHS OF COMMONLY USED 1-PIECE CONVENTIONAL ADULT PERITONEAL DIALYSIS CATHETERS IN NORTH AMERICA BY MANUFACTURER[a]

Peritoneal dialysis catheters are available in multiple designs and lengths. The list is not exhaustive. When possible, verify with the operator about catheter type used and tubing length.

Manufacturer	Description	Length (cm)[b]
Medtronic[10]	Curl Cath Catheter, 2 cuffs	57-62
	Swan Neck Curl Cath Catheter, 2 cuffs	62.5
MedComp[11]	I-Series Coiled Catheter, 2 cuffs	57 or 63
	V-Series Coiled Catheter, 2 cuffs (swan neck)	63
Medionics[12]	Coiled Catheter, 2 cuffs	57-72
	Swan Neck Coil Catheter, 2 cuffs	62.5
Merit Medical[13]	Flex-Neck Classic Adult Coiled Catheter, 2 cuffs (small, standard, large)	62
	Flex-Neck Arc Adult Coiled Catheter, 2 cuffs (small, standard, large) (swan neck)	**62**

a. **Medtronic**, **MedComp**, and **Medionics** catheters possess white guide stripes.[10,11,12] **Merit Medical** catheters have a blue guide stripe.[13] Refer to manufacturer's catalog for catheter types not listed.

b. Shown are the range of lengths available for this design. Request the length of the device used by the operator.

TABLE B: LENGTHS OF TRANSFER SETS

Transfer set length	Volume
6-inch	2 mL[14]
4-inch	1.6 mL[15]

Procedure to instill tPA:

1. Estimate total volume of catheter and transfer set
2. Reconstitute tPA at dilution of 1mg/mL[9]
3. Aspirate contents of catheter
4. Connect syringe to transfer set and inject 110% of calculated volume of tPA[9]
5. Allow tPA to remain in catheter for 1-2 hours[8]
6. Aspirate tPA from catheter[9]
7. With 60 mL syringe, briskly irrigate the catheter with saline to determine patency and dislodge any fibrin clots[9]

PERITONEAL CATHETER OBSTRUCTION

8. Repeat procedure if catheter remains obstructed[9]
9. When flow is adequate, perform 1-2 L in-and-out flush to remove any residual tPA
10. Fill patient with dialysis fluid with added heparin (500-2000 units/L) as per PD orders to keep catheter patent[1]

No adverse consequences have been documented for tPA overfill or repeat administration[2]

Factor Calculations:

** 0.053 was derived from the formula for calculation of the volume of a cylinder: volume = $\pi r^2 h$, where π = 3.14, r = radius of the catheter lumen, and h = height (length) of the catheter. The radius of a catheter lumen with a white guide stripe is 0.13 cm; the square of the radius is 0.0169. Therefore, 3.14 x 0.0169 = 0.053. The length (cm) of the catheter x 0.053 = volume in cm^3.[9]

*** 0.096 was derived from the formula for calculation of the volume of a cylinder: volume = $\pi r^2 h$, where π = 3.14, r = radius of the catheter lumen, and h = height (length) of the catheter. The radius of a catheter lumen with a blue guide stripe is 0.175 cm; the square of the radius is 0.0306. Therefore, 3.14 x 0.0306 = 0.096. The length (cm) of the catheter x 0.096 = volume in cm^3 (mL).[9]

Invasive Steps:

- Laparoscopy
- Open surgical repositioning of catheter or replacement
- Partial omentectomy or omentopexy[4]
- Adhesiolysis if indicated
- Fluoroscopically guided stiff wires or stylet manipulation[14]
- Fogarty catheter manipulation[15]

SHORT-TERM PREVENTION FOR RECURRENCE OF CATHETER OBSTRUCTION

In case of fibrin-related obstruction:

Add heparin 500 units/L to each dialysate exchange.[16] May use up to 2000 units/L[1] (heparin is contraindicated in patients with heparin induced throbocytopenia[17])

PATIENT EDUCATION

- Tape catheter and transfer set to avoid kinking
- Position tubing to prevent kinking while asleep if using APD
- Prevent constipation with diet, exercise, and stool softeners
- Patient to report reduced drain volume
- Cycler placement (consult product guide for correct cycler placement)

PERITONEAL CATHETER OBSTRUCTION

OUTCOMES EVALUATION

Collect data to include:

- Type of obstruction (inflow/outflow)
- Etiology
- Results of diagnostic testing
- Findings and responses to interventions
- Record data per unit policy in EMR

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HERNIA

Significant abdominal wall hernias should be surgically repaired prior to the initiation of peritoneal dialysis. The majority of hernias can be repaired at the time of the catheter implantation.[1] Repair of large or complicated hernias may be staged as a separate procedure in advance of catheter placement or accompanied with an embedded catheter approach when an extended healing period is anticipated to minimize risk of recurrence.[1]

Hernias require timely repair to prevent conventional hernia complications and to alleviate discomfort.[2]

The most commonly seen hernias are umbilical, inguinal, incisional, and pericatheter.[3] Pericatheter hernias occur more often when the catheter is placed through the midline instead of the paramedian approach through the rectus muscle.[3]

KEY ASSESSMENTS

- Protrusion at umbilicus, inguinal area, genitalia, previous surgical scars, or catheter insertion site
- Presence of genital or abdominal wall edema
- Drainage from umbilical sinus
- Determine reducibility/pain/size
- Evaluate for tenderness and inflammation
- If pericatheter, review catheter placement procedure

KEY ACTIVITIES

- Inspect and examine suspect sites
- Refer to surgeon to determine intervention
- Umbilical hernias should be repaired due to risk of bowel incarceration and strangulation[3]
- Schedule patient follow-up

THERAPEUTICS

- Significant hernia requires surgical repair
- Hernias should be repaired with prosthetic mesh techniques to minimize the high risk of recurrence in patients on PD.[1,2,4] Until more information is known about resistance to infection of intraperitoneally placed prosthetic materials in the event of PD-related peritonitis, extraperitoneal hernia repair techniques with prosthetic mesh are advised.[1,4]

HERNIA

- Appropriate surgical attention to details in producing a watertight peritoneal closure[1] and the use of supine, low-volume intermittent PD permits immediate resumption of therapy after hernia repair and avoids the need for temporary hemodialysis[3,5]
  - Removal of the PD catheter and interim hemodialysis may be required if bowel was incarcerated or strangulated in the hernia, as bowel wall may be compromised increasing the risk of peritonitis.[6] Surgical judgment required in the decision to retain or remove the catheter in such cases.
- Patients have been continued on PD during the postoperative period after hernia repair; use of lower volume supine exchanges with dry days have allowed for continuation of PD without conversion to temporary HD[2] (see Table 1)

Consider HD backup in patients with no residual renal function in whom small volume frequent exchanges are insufficient to control azotemia[3]

TABLE 1

PROTOCOL FOR POSTOPERATIVE, LOW VOLUME, AUTOMATED, INTERMITTENT PERITONEAL DIALYSIS[2]	
First week	• 1 L, exchanges over 10 hours while supine • Dry abdomen while ambulatory
Second week	• 1.5 L, exchanges over 10 hours while supine • Dry abdomen while ambulatory
Third week	Resume usual dialysis regimen

PATIENT EDUCATION

- Minimize intra-abdominal pressure by avoiding:
  - Straining
  - Coughing
  - Constipation
  - Stair climbing
  - Lifting
- Report increase in size of hernia or pain
- Following surgical repair, instruct patient to maintain separation of exit-site and operative wound dressings to prevent cross-contamination
- Observe for recurrence
- If using an alternative perioperative dialysis regimen instruct the patient on the following:[3,5]
  - Supine position during dialysis therapy
  - Initial low-volume intermittent dialysis
  - Dry abdomen during ambulatory periods during first two weeks
  - Volume graduated incrementally over 2 weeks to usual regimen

HERNIA

OUTCOMES EVALUATION

Collect data to include:

- Type of hernia
- Interventions utilized
- Results
- Dialysis prescription alterations

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ABDOMINAL DISCOMFORT DURING INFUSION AND DRAIN

Pain with infusion and drainage of dialysate usually occurs at the beginning of PD therapy and usually resolves after a few months on therapy.[1] It effects around 13-25% of PD patients.[2] Inflow pain is less common than outflow pain.[3] The etiology of the pain may be different depending upon occurence during inflow or outflow.

KEY ASSESSMENTS

Perform dialysis exchange, inflow and outflow:

- Evaluate patient for the presence, frequency, and degree of discomfort or pain and relation to inflow and outflow
- Monitor dialysis outflow drainage (effluent) for timing, completeness of drain, color, and clarity
- Check dialysis solution temperature
- Rule out peritonitis
- If using APD, consult product guide for appropriate cycler placement, as improper placement may contribute to fill and drain pain

KEY ACTIVITIES

Inflow pain can be due to mechanical causes or to the effects of solution temperature or pH. Inflow pain usually subsides gradually after filling is complete.[1,4] For abdominal discomfort during inflow:

Interventions:

- Change position during infusion[1]
- In CAPD patients, reduce dialysis infusion rate by lowering the IV pole or partially closing the transfer set clamp;[1] in APD patients, adjust fill rate or program cycler to deliver modified tidal (85%–90%)[5]
- Ensure proper warming of dialysis solution[1]
- Treat constipation[1]
- Obtain flat plate of abdomen to investigate catheter migration[6]
  - Lateral view may be necessary to identify a subcutaneous and / or intra-peritoneal catheter kink
- Reposition PD catheter if unresolved as necessary[1]
- May manually add bicarbonate 4-5 meq/L to each dialysate bag for acid-related infusion pain. Lidocaine 1-2% may be added to dialysate (5 mL/L) for infusion pain.[7]

ABDOMINAL DISCOMFORT DURING INFUSION AND DRAIN

Outflow or drain pain may be due to a variety of causes including the following:

- PD catheter implanted too deep in pelvis[2,6]
  - Tip pressing on bladder, rectum or uterus[2,6]
- Visceral structures siphoned up to catheter pressing it against sensitive parietal peritoneum
  - Occurs more frequently with APD vs CAPD[2]
- Omental wrap[1]
- Constipation[3]

Interventions:

- Modified tidal (85-90%)[5]
- Conversion from APD to CAPD (gravity only drainage)[2]
- Catheter removal if unable to resolve drain pain with tidal and gravity drainage: likely due to excessively deep pelvic placement[2]

PATIENT EDUCATION

Teach patient causes and interventions for inflow pain:[1]

- Avoid constipation
- Rapid inflow – reduce infusion rate
- Too rapid a transition to larger dialysis fill volumes – slowly increase fill volumes
- Dialysis solution too warm or too cold – warm to body temperature

Teach patient causes and interventions for outflow pain:

- Leave small amount of dialysate fluid in the peritoneal cavity in patients on CAPD. In APD patients, program cycler to deliver modified tidal PD (85%-90%)[5]
- Elevating the drain bag to reduce the distance between the abdomen and drain bag can reduce the syphoning pressure that may create drain discomfort

OUTCOMES EVALUATION

Collect data to include:

- Duration and degree of discomfort
- Interventions
- Adjustments to dialysis prescription
- Patient tolerance
- Medications prescribed
- Diagnostic tests and results
- Stool records

ABDOMINAL DISCOMFORT DURING INFUSION AND DRAIN

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PNEUMOPERITONEUM

It is not unusual to see free air under the diaphragm in PD patients.[1] Intraperitoneal air may lead to referred pain to the shoulder. Pneumoperitoneum typically occurs due to the inadvertent infusion of air during the instillation of dialysate.[2] Pneumoperitoneum is benign and the air will gradually reabsorb.[1] If, however, a patient presents with abdominal pain and pneumoperitoneum, perforation of the viscus should be ruled out.[1]

KEY ASSESSMENTS

- Rule out perforation of viscus then:
  - Evaluate degree and duration of shoulder pain
  - Interview patient regarding recent infusion of air during exchange procedure

KEY ACTIVITIES

- Send effluent sample for cell count and culture to rule out potential contamination[2]
- Observe patient / caregiver's exchange procedure for appropriate priming of tubing assuring no air in system
- Perform upright abdominal X-ray to identify PD catheter position and identify sub-diaphragmatic free air in the peritoneal cavity[2]
- Intervention:
  - drain abdomen
  - infuse full exchange volume
  - drain in Trendelenburg or knee-chest position to facilitate air removal[3]

PATIENT EDUCATION

- Review proper priming/flushing procedure for PD system
  - For manual systems, always close clamps after infusion of solution
    - CAPD systems – always close clamps after infusion of solution
    - CAPD systems – be sure to flush the fill line[3]
    - APD systems – verify patient line has been properly primed[3]

OUTCOMES EVALUATION

Collect data to include:

- Diagnostic testing and results
- Interventions

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HEMOPERITONEUM

Performing peritoneal dialysis provides a window to the peritoneum. It allows visualization of intraperitoneal bleeding which may be either physiologic or pathologic.[1] Hemoperitoneum presents as red dialysate, this can be quite frightening to the patient. As little as 2 mL of blood can make dialysate look quite bloody.[1]

The most common cause of hemoperitoneum is menstruation or ovulation.[1] When menstruation has been excluded a careful investigation for other causes should be considered.[2] Recurrent hemoperitoneum may be associated with a diseased peritoneal membrane such as peritoneal calcification or encapsulating peritoneal sclerosis.[2] (See table A.)

KEY ASSESSMENTS

- Assess for hemodynamic stability with blood pressure and pulse
  - May check serum hemoglobin
- Assess general appearance to rule out acuity
- Assess for abdominal pain and any localizing symptoms
  - A painful abdomen or localized tenderness with hemoperitoneum should mandate urgent surgical consult.[2]
- Observe dialysis exchange drain fluid for color and clarity
  - Rule out peritonitis[3]
- Obtain patient history, investigate potential causes including:
  - Status post peritoneal catheter placement
  - In menstruating females, assess menstrual cycle to consider retrograde menstruation or mid-cycle ovulation
  - Inquire regarding any recent procedures: colonoscopy, catheter insertion, catheter manipulation[2]
  - Consider retro-peritoneal source ie; hematoma, renal cystic bleeding, ruptured aortic aneurysm, other retro-peritoneal pathology malignancy or cirrhosis-related varix[4]
  - Consider surgical causes such as cholecystitis, rupture of the spleen, or pancreatitis[1]
  - Consider medical causes such as coagulation disorders, polycystic kidney disease, leakage of hematoma outside of peritoneal cavity, post extracorporeal lithotripsy for kidney stones, rupture of ovarian cysts, encapsulating peritoneal sclerosis[1]
  - Patients on anti-platlet or anticoagulant therapy[5]
  - Recent use of anti-platelet or intraperitoneal tPA

KEY ACTIVITIES

CLINICAL APPROACH TO HEMOPERITONEUM:

- Rapid exchanges with room temperature heparinized dialysate (heparin 500-1000units/L)[1]
- Add heparin 500-1000 units/L as long as the effluent has visible signs of blood or fibrin to maintain catheter patency[1]
  - Intraperitoneal instillation of heparin does not affect systemic coagulation parameters and does not increase the risk of bleeding.[1] However, it has been reported that heparin may still reach the systemic circulation potentially via lymphatic absorption or with increased peritoneal membrane

HEMOPERITONEUM

permeability with peritonitis. Therefore, IP heparin is contraindicated in patients with heparin-induced thrombocytopenia (HIT)[6]

- Observe drain fluid color with dialysis exchanges
- Document duration of blood-tinged exchanges and progression (increase/decrease)
- Consider investigating for peritonitis or other acute abdominal issue if prolonged
- Obtain imaging and surgical consultation as required
  - If bleeding is severe, recurrent or associated with abdominal pain or fever prompt medical or surgical management is required including blood tests and abdominal imagining (ultrasound or CT Scan).[2]

Table A

REPORTED CAUSES OF HEMOPERITONEUM		
Gynecological	• Menstruation[1,2] • Ovulation[1,2] • Ovarian cysts[1,2] • Endometriosis[1,2]	
Neoplastic	• Renal cell carcinoma[2] • Adenocarcinoma of colon[1]	
Polycystic Disease	• Polycystic kidney disease[1] • Polycystic liver disease[1]	
Gastrointestinal	• Post colonoscopy[1,2] • Pancreatitis[1,2] • Cholecystitis[2]	• Colon perforation[2] • Hepatoma or hepatic metastasis[1,2] • Splenic rupture[2]
Peritoneal Membrane	• Sclerosing peritonitis[1,2] • Peritoneal calcification[1,2] • Radiation induced peritoneal injury[1,2]	
Traumatic	• Post catheter insertion/manipulation[2] • Catheter-induced splenic injury[1,2] • Catheter-induced mesenteric vessel erosion[2]	
Miscellaneous	• Anticoagulation therapy[1,2] • Idiopathic thrombocytopenic purpura[1] • Leakage from extra peritoneal hematoma[1,2]	• Uremic bleeding[2] • Ruptured abdominal aortic aneurysm[2] • Idiopathic[4]

PATIENT EDUCATION

- Instruct women of reproductive age about the potential for hemoperitoneum
- Observe dialysis exchanges drain fluid for decreasing color and resolution

Teach patient to:

- Avoid heavy lifting/trauma
- Document frequency, duration, and treatment of bloody effluent
- Bleeding, typically minimal to moderate, may resolve spontaneously

HEMOPERITONEUM

OUTCOMES EVALUATION

Collect data to include:

- Interventions including medications
- Response to intervention
- Alterations in dialysis prescription or schedule

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HYDROTHORAX

Hydrothorax typically presents as a right-sided pleural effusion due to a pleuroperitoneal defect which allows dialysate to enter the pleural cavity.[1] Diagnosis is confirmed by aspirating pleural fluid and determining that the pleural fluid glucose concentration is higher than the plasma glucose.[1] Alternatively, the diagnosis of pleuroperitoneal fistula can be established with peritoneal scintigraphy showing radioisotope in the thoracic cavity[2] or with CT peritoneography (including images of the chest) showing contrast in the pleural space. Alternatively MRI may be used to show dialysate in pleural space. Temporary cessation of PD allows for the slow reabsorption of dialysate, but more rapid drainage of the pleural dialysate can be achieved by pleural aspiration procedures such as a thoracentesis.[3]

Hydrothorax may be acquired after heavy exertion or may be congenital due to innate diaphragmatic defects. If acquired, the hydrothorax may resolve after cessation of PD.[4] If congenital, the diaphragmatic defects require repair procedures—most commonly done by video-assisted thoracoscopy.[5]

KEY ASSESSMENTS

Signs and symptoms of pleural effusion:

- Cough or dyspnea[6]
- Chest pain[2]
- Acute respiratory distress[6]
- Weight gain with decreased dialysis drain volumes[7]
- Small pleural effusion may be symptom free[3]
  - dullness or flatness with percussion[6]
  - diminished or absent breath sounds[6]

KEY ACTIVITIES

Diagnostic:

- Assess for decreased lung sounds (pleural collection frequently on right side)
- Observe for shortness of breath or cough especially when supine
- Shortness of breath increasing with hypertonic exchanges, especially if drainage amount is decreased
- Chest X-ray showing unilateral pleural effusion, usually right-sided
- Peritoneal scintigraphy or CT peritoneography[8] to identify pleural-peritoneal communication may be considered
- Pleural fluid aspirated and tested for glucose and compared to plasma glucose. A pleural fluid to blood glucose ratio > 1 confirms hydrothorax from dialysate.[2] Aspirated fluid will have a low protein content consistent with a transudate.
- Conservative management for pleural leakage in the form of peritoneal rest and intermittent low volume dialysis is rarely successful[9]
- Temporary hemodialysis for 2–6 weeks usually required to allow pleuroperitoneal communication to seal, especially following pleurodesis[4]
- Thoracentesis or chest tube drainage with chemical pleurodesis (talc slurry, autologous blood, has been successful)[4]
- Video-assisted thoracoscopic surgery (VATS) may permit visualization of a pleuroperitoneal communication and direct surgical obliteration or directed pleurodesis[10]

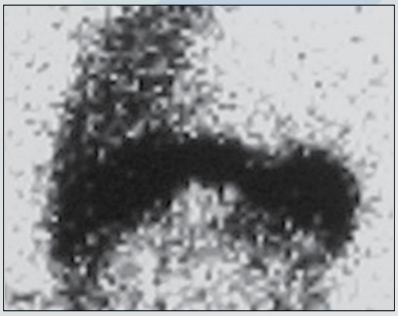
HYDROTHORAX

Hydrothorax

Chest radiograph showing accumulation of dialysate in right hemithorax.

Radiograph courtesy of Steve Guest, MD

Peritoneal Scintigraphy



Pleuroperitoneal fistula confirmed with accumulation of radioisotope in the right thoracic space.

Radiograph courtesy of John Crabtree, MD

- Thoracoscopic pleurodesis with talc poudrage and/or mechanical rub produces 87%–93% success rate in resolving pleural leaks[9]
- Follow-up radiograph to establish closure of pleuroperitoneal communication may be utilized after restarting PD

PATIENT EDUCATION

Intruct patient to:

- Report physical changes indicating potential leak
- Alter dialysis regimen if required
- Schedule more frequent clinic visits for observation

OUTCOMES EVALUATION

Collect data to include:

- Location of hydrothorax – right vs. left side
- Diagnostic testing and results
- Response to interventions

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CATHETER ADAPTER DISCONNECT OR FRACTURE OF PERITONEAL CATHETER

KEY ASSESSMENTS

Signs and symptoms of pleural effusion:

- Observe for dialysis fluid leak from peritoneal catheter or transfer set
- Obtain cell count and culture to rule out peritonitis

KEY ACTIVITIES

Initiate prophylactic antibiotics[1,2,3]

For adapter disconnect or catheter fracture:[3,4]

- Stop dialysis
- Clamp catheter proximal to damage
- If catheter length is adequate, use full sterile technique to:
  - Disinfect catheter proximal (closer to abdomen) to damaged area per unit policy and procedure
  - Trim catheter proximal to expanded area on catheter or fracture
  - Using sterile scissors, trim the catheter above area that is damaged or stretched
  - Fit a sterile, new adapter into the catheter
  - Attach transfer set to adapter

If catheter portion is marginal length:

- Repair with appropriate manufacturer's repair kit or catheter extension
- If catheter portion is too short for long-term stability of the exit site after insertion of adapter and attachment of transfer set or too short for attachment of extension with repair kit, secure with catheter adapter and transfer set and refer to surgeon for intercuff splicing procedure with subcutaneous extension to new exit site.[2] (See section 5 for catheter splicing procedure)

PATIENT EDUCATION

Instruct patient to:

- Stop dialysis
- Clamp catheter proximal to damaged spot
- Cover area with sterile dressing
- Go to clinic or emergency room as soon as possible

Teach patient to prevent catheter damage by:

- Secure catheter and transfer set under clothing, avoiding sharp bends in catheter
- Keep sharp objects and tools away from catheter[3]
  - Avoid using scissors to remove catheter dressing[3]
- Avoid using unsuitable disinfectants and soaps on catheter[3]
- Do not use toothed hemostat on catheter
- Avoid applying antibiotic cream to the catheter
  - Apply cream to skin only during exit-site care

CATHETER ADAPTER DISCONNECT OR FRACTURE OF PERITONEAL CATHETER

OUTCOMES EVALUATION

Collect data to include:

- Type of peritoneal catheter
- Type of perforation
- Intervention
- Response to intervention

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SECTION 3

INFECTIOUS COMPLICATIONS

INITIAL EMPIRIC MANAGEMENT OF PERITONITIS

The following steps including key assessments, key activities, patient education, and outcomes evaluation are applicable to all peritonitis algorithms shown on subsequent pages.

ISPD guidelines suggest a peritonitis rate of no more than 0.4 episodes per year at risk (1 episode per 30 patient months).[1] Rates of 0.18–0.20 (1 episode per 60–66 patient months) per year[2] have been reported in some centers. The center's overall peritonitis rate should be monitored at a minimum on an annual basis.[1]

KEY ASSESSMENTS

The clinical presentation of peritonitis may include any of the following: cloudy effluent, abdominal pain, fever, and acutely declining peritoneal ultrafiltration.

Clinical Diagnosis:[1]

- Peritonitis is diagnosed when at least 2 of the following are present:
  (1) clinical features consistent with peritonitis, i.e. abdominal pain and/or cloudy dialysis effluent;
  (2) dialysis effluent white cell count > 100/μL or > 0.1 x 10^9/L (after a dwell time of at least 2 hours), with > 50% polymorphonuclear leukocytes (PMN);
  (3) positive dialysis effluent culture.
- We recommend that PD patients presenting with cloudy effluent be presumed to have peritonitis and be treated as such until the diagnosis can be confirmed or excluded.
- We recommend that PD effluent be tested for cell count, differential, Gram stain, and culture whenever peritonitis is suspected.
- WBC count depends on length of dwell; therefore, in APD use %PMN vs absolute WBC count to diagnose peritonitis.
- If patient is dry, instill 1 L of dialysate for a 2 hour dwell. Use %PMN for diagnosis.

Differential Diagnosis of Cloudy Effluent:

- Culture-positive infectious peritonitis[3]
- Infectious peritonitis with sterile cultures[3]
  - recent antibiotic usage[3]
  - technical problems with culture technique[3]
  - unusual organisms (filamentous fungus, mycobacteria, legionella, nocardia, and other fastidious bacteria)[3]
- Chemical peritonitis[1]
- Calcium channel blockers[1]
- Eosinophilia of the effluent[1]
- Hemoperitoneum[1]
- Malignancy (rare)[1]
- Triglycerides (milky white)[1]
- Specimen taken from "dry" abdomen[1]
- Noninfectious causes of cloudy effluent[1]
  (See ACR-Topic K)

INITIAL EMPIRIC MANAGEMENT OF PERITONITIS

KEY ACTIVITIES

Initiate the following:

Performed by the PD nurse in the dialysis unit or emergency department:

1. Perform physical exam including abdominal palpation, degree and location of pain, exit-site and tunnel assessment
2. Obtain effluent sample and send sample to laboratory for cell count with differential, Gram stain, and culture. Dwell time should be at least 2 hours.[1]
   - Innoculate 2 (aerobic and anaerobic) blood culture bottles with 5–10 mL of effluent (yield enhanced with rapid blood-culture bottle kits)[1]
3. In presence of cloudy effluent with pain and/or fever:
   - Initiate empiric antibiotic therapy as soon as possible after obtaining effluent for testing[1]
4. Patients with cloudy effluent may benefit from the addition of heparin 500 units/L IP to prevent occlusion of the catheter by fibrin.[1]
5. Initiate adequate pain management intervention. Peritonitis-related pain may require analgesics for adequate control[1]
6. Assess need for hospitalization[1]
7. Each peritonitis episode should be considered as preventable. For each episode a root-cause analysis should be done to determine etiology and how to prevent it from recurring[1]
   Review with patient:
   - Discuss possibility of break in technique, compliance to hand washing, mask use
   - Inquire about recent procedures, constipation, diarrhea, and antibiotic use
8. Review:
   - Peritonitis and exit-site infection history and treatment
   - Review use of exit-site prophylaxis
9. Schedule retraining for technique issues

INITIAL EMPIRIC MANAGEMENT OF PERITONITIS

PATIENT EDUCATION

- Immediately report cloudy effluent, abdominal pain, and/or fever to PD unit
- Save drained cloudy effluent and bring to clinic
- Stress importance of obtaining specimen prior to beginning antibiotics
- Stress importance of completing 100% antibiotic therapy
- May add heparin 500 U/L to each bag until clear[1]

OUTCOMES EVALUATION

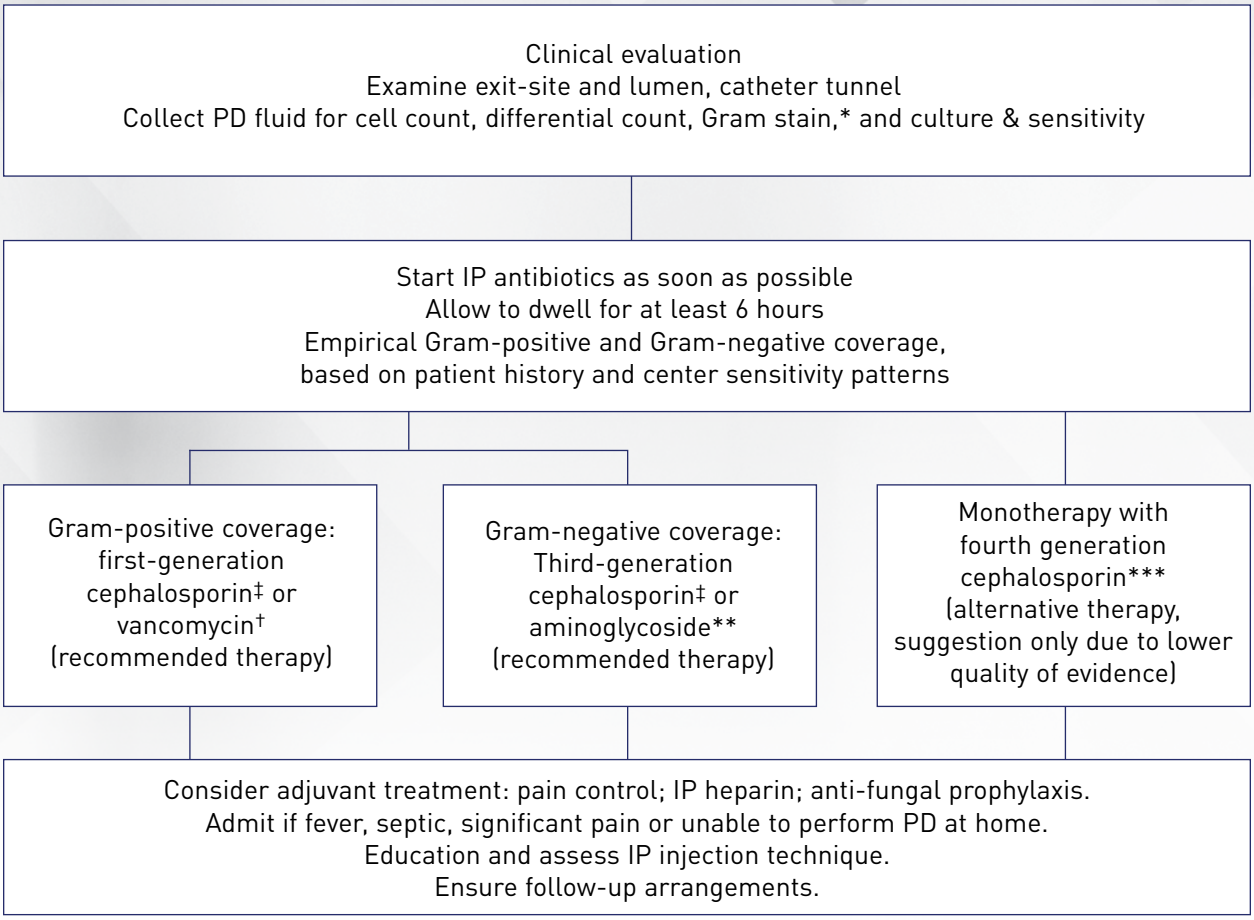
Collect data to include:

- Date of culture, organism identified, drug therapy used
- Date antibiotic course completed
- Determine if this is a relapsing or recurrent episode of peritonitis
  - If it is relapsing or recurrent notify MD
- Documentation of contributing factors
  - Break-in technique, exit-site infections, tunnel infections
- Date of re-education/training

Enter data into infection tracking tool

INITIAL EMPIRIC MANAGEMENT OF PERITONITIS

Initial Management of Peritonitis[1]



IP=intra-peritoneal

* Check results of gram stain, if fungi identified remove PD catheter.[1]

‡ If the patient is cephalosporin allergic, aztreonam is an alternative to ceftazidime[2] or cefepime.

† Vancomycin may be considered if patient has a history of methicillin-resistant Staphylococcus aureus colonization/infection, is seriously unwell, or has a history of severe allergy to penicillins and cephalosporins.[5] If the center has an increased rate of methicillin resistance, vancomycin should be considered.[1]

** Adjunctive oral N-acetylcysteine therapy with aminoglycosides to help mitigate the ototoxicity.[1]

*** Cefepime monotherapy shown to be non-inferior to cefazolin with ceftazidime.[1] Cefepime was studied in CAPD with continuous dosing LD (loading dose) 1g MD (maintenance dose) 250mg in each subsequent exchange. Dose of cefepime was increased by 25% in patients with urine voume>100mL/day[4]

KEY CLINICAL PEARLS TO OPTIMIZE PERITONITIS MANAGEMENT

EMPIRIC TREATMENT PERITONITIS

- Antibiotic choice for empiric therapy should be center specific[1]
- Empiric management of peritonitis requires continued assessment and modification of therapy based on culture and sensitivity results and organisms cultured.[1]
- Exchange containing antibiotics must be a minimum 6-hour dwell.[1] Longer dwell acceptable; drain at 6 hours not required.
- ISPD suggests the use of icodextrin be considered for volume overload which may occur during acute peritonitis[1]

DWELL TIME & VANCOMYCIN DOSING

- Vancomycin is a middle molecule (1486g/mol). Absorption into the plasma is dependent on dwell time, requiring a longer dwell for absorption due to larger molecular size. Lam et al. recommends utilizing a 10-15 h dwell when giving vancomycin IP, to allow adequate time for vancomycin to move into plasma.[6]
- A dwell of 10-15 hours allows achievement of steady-state equilibrium between the dialysate and the systemic circulation.[6] When the longer dwell is not possible the minimum dwell time is 6 hours.[1]
- ISPD 2022 guidelines on vancomycin dosing are: CAPD, every 5-7 days and APD every 4 days with the stipulation supplemental doses may be required. Re-dose vancomycin based on serum trough <15 mg/L.[2,6]

DOSING CEFAZOLIN & CEFTAZIDIME IN AUTOMATED PERITONEAL DIALYSIS (APD)

- Dose cefazolin and ceftazidime at 20mg/kg every day during short dwells on the cycler per the ISPD 2022 guidelines.[1] This dosing regime was studied using five 2 L exchanges over 10 hours on the cycler followed by a dry day. Two 5 L bags of dialysate were placed on the cycler with the whole antibiotic dose put only into the heater bag.[7]

COMPATIBILITY OF ANTIBIOTICS

- Vancomycin and ceftazidime are compatible when mixed in a dialysis solution volume greater than 1 L; however, they are incompatible when mixed in the same syringe or empty dialysis solution bag for reinfusion.[2]
- Aminoglycosides should not be added to the same exchange with penicillins as this results in incompatibility.[1]

IP ANTIBIOTIC STABILITY SUMMARY[1]

	PD Solutions			Storage conditions		Remarks[a]	
Antibiotics	Dextrose-based	Icodextrin-based	Stability	Room temperature	Refrigerated	Tested for	Stable for
Gentamicin	X		14 days	X	X	14 days	
		X	14 days	X	X	14 days	
Cefazolin	X		8 days	X			8 days
	X		14 days		X	14 days	
		X	7 days	X			7 days
		X	14 days		X	14 days	
Ceftazidime	X		4 days	X			4 days
	X		7 days		X		7 days
		X	2 days	X			2 days
		X	14 days		X	14 days	
Cefepime	X		14 days		X	14 days	
Vancomycin	X		28 days	X		N/A	
		X	14 days	X	X	14 days	
Piperacillin/tazobactam + Heparin	X	X	7 days		X	7 days	

PD: peritoneal dialysis.
a 'Stable for X days' indicates that the antibiotic concentration retained at least 90% of its initial concentration up to day X. 'Tested for X days' indicates the antibiotic concentration retained at least 90% of its initial concentration up to the study duration set for X days only. Stability (Stable for X days) is interpreted according to the type of PD solutions and storage conditions specified.

INFECTIOUS COMPLICATIONS: PERITONITIS MANAGEMENT

Staphylococcus aureus[1]

Staphylococcus aureus on culture

Continue gram-positive coverage based on sensitivities
Stop gram-negative coverage

If methicillin resistant (MRSA) change to vancomycin

Assess clinical improvement, repeat dialysis effluent cell count and culture at day 3*

Clinical improvement

Continue antibiotics IP: duration 21 days

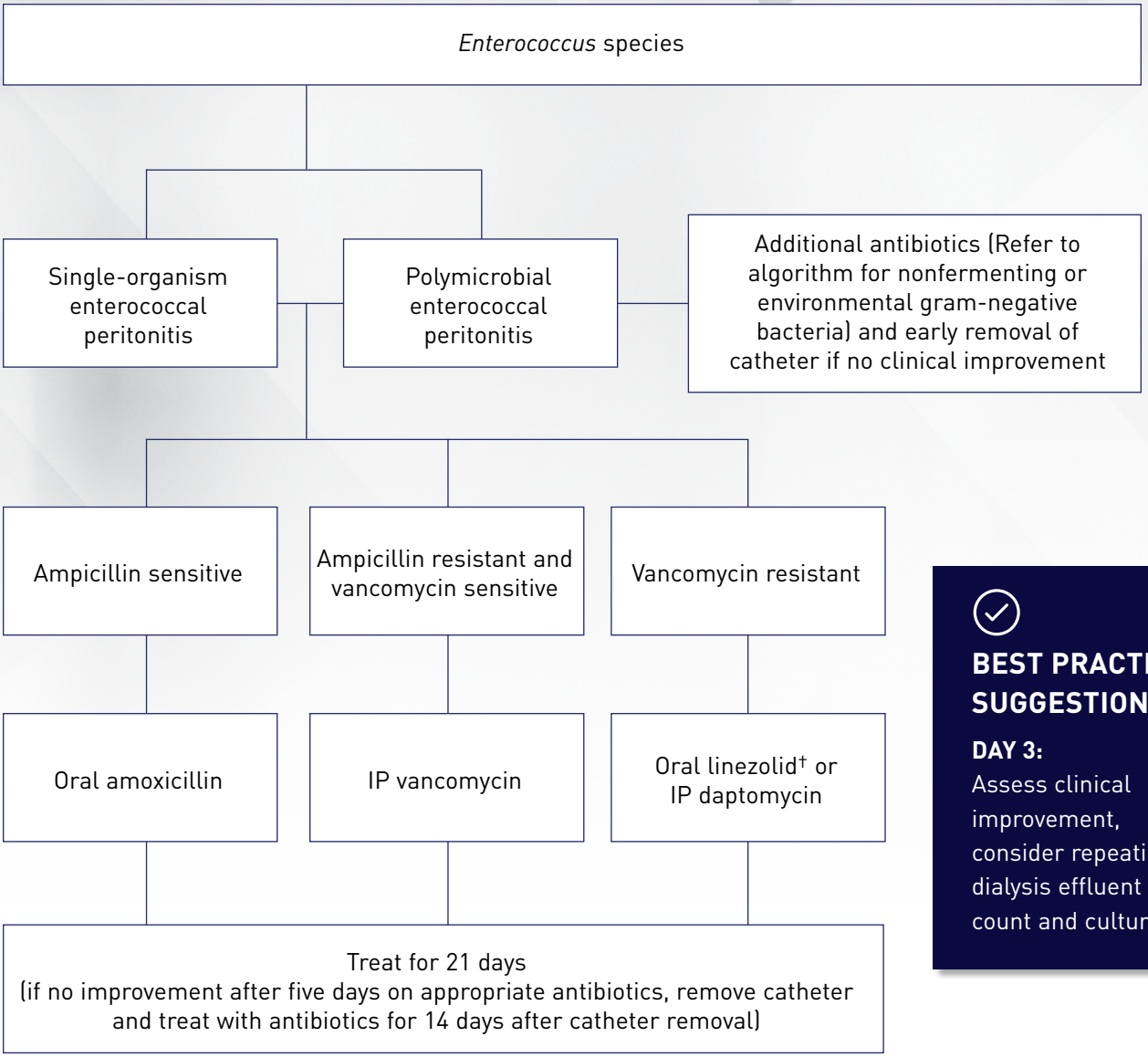
No clinical improvement by 5 days on appropriate antibiotics

Surgically remove PD catheter
After catheter removal: patient to remain on treatment for 14 days

* A day 3 peritoneal dialysate WBC count ≧ 1,000 mm^3 has a 64% likelihood of treatment failure.[8]

INFECTIOUS COMPLICATIONS: PERITONITIS MANAGEMENT

Enterococcus Peritonitis[1]



BEST PRACTICE SUGGESTION

DAY 3:
Assess clinical improvement, consider repeating dialysis effluent cell count and culture.*

† IP route for ampicilllin and linezolid is not recommend due to reduction of bateriostatic effect on E. facaelis by peritoneal fluid.[1]

* A day 3 peritoneal dialysate WBC count ≧ 1,000 mm^3 has a 64% likelihood of treatment failure.[8]

INFECTIOUS COMPLICATIONS: PERITONITIS MANAGEMENT

Streptococcus Peritonitis[1]

Streptococcus on culture

Continue cefazolin IP
Stop gram-negative coverage

If resistant or allergic to penicillin / cephalosporin, change cefazolin to vancomycin IP

Clinical improvement

Continue antibiotics IP: duration 14 days

No clinical improvement by 5 days on appropriate antibiotics

Surgically remove PD catheter
After catheter removal patient to remain on treatment for 14 days

BEST PRACTICE SUGGESTION

DAY 3:
Assess clinical improvement, consider repeating dialysis effluent cell count and culture.*

* A day 3 peritoneal dialysate WBC count ≥ 1,000 mm^3 has a 64% likelihood of treatment failure.[8]

It is important to avoid inadequate IP antibiotic levels which may lead to relapsing peritonitis. When dosing cefazolin in APD, put total antibiotic dose in heater bag[7]

INFECTIOUS COMPLICATIONS: PERITONITIS MANAGEMENT

Coagulase-negative Staphylococci and other gram-positive organisms[1]

Other gram-positive organism including coagulase negative staphylococcus on culture

Continue gram-positive coverage based on sensitivities
Stop gram-negative coverage

Assess clinical improvement, repeat dialysis effluent cell count and culture at day 3*

Clinical improvement

Continue antibiotics IP: duration 14 days

No clinical improvement by 5 days on appropriate antibiotics

Surgically remove PD catheter
After catheter removal patient to remain on treatment for 14 days

* A day 3 peritoneal dialysate WBC count ≧ 1,000 mm^3 has a 64% likelihood of treatment failure.[8]

It is important to avoid inadequate IP antibiotic levels which may lead to relapsing peritonitis. When dosing cefazolin in APD, put total antibiotic dose in heater bag[7]

INFECTIOUS COMPLICATIONS: PERITONITIS MANAGEMENT

Nonfermenting or environmental gram-negative bacteria: Pseudomonas, Acinetobacter, Stenotrophomonas[1]

Nonfermenting or environmental gram-negative bacteria

No clinical improvement: re-culture and evaluate

No clinical improvement by 5 days on appropriate antibiotics: remove catheter

Pseudomonas	Acinetobacter	Stenotrophomonas
Give 2 effective antibiotics with different mechanisms based on sensitivity; re-evaluate exit site and tunnel	Oral ciprofloxacin or oral trimethoprim-sulfamethoxazole or IP meropenem or IP aminogycoside	Give 2 effective antibiotics with one of them being oral trimethoprim-sulfamethoxazole
IP ceftazadime or cefepime + IP gentamicin / tobramycin / amikacin or oral ciprofloxacin	If CRAB (Carbapenem-resistant Acinetobacter baumannii), IP amikacin or IP colistin +/- ampicillin/sulbactam	

BEST PRACTICE SUGGESTION

DAY 3: Assess clinical improvement, consider repeating dialysis effluent cell count and culture.*

Treat for 21 days

(if no improvement after 5 days on appropriate antibiotics, remove catheter and treat with antibiotics for 14 days after catheter removal)

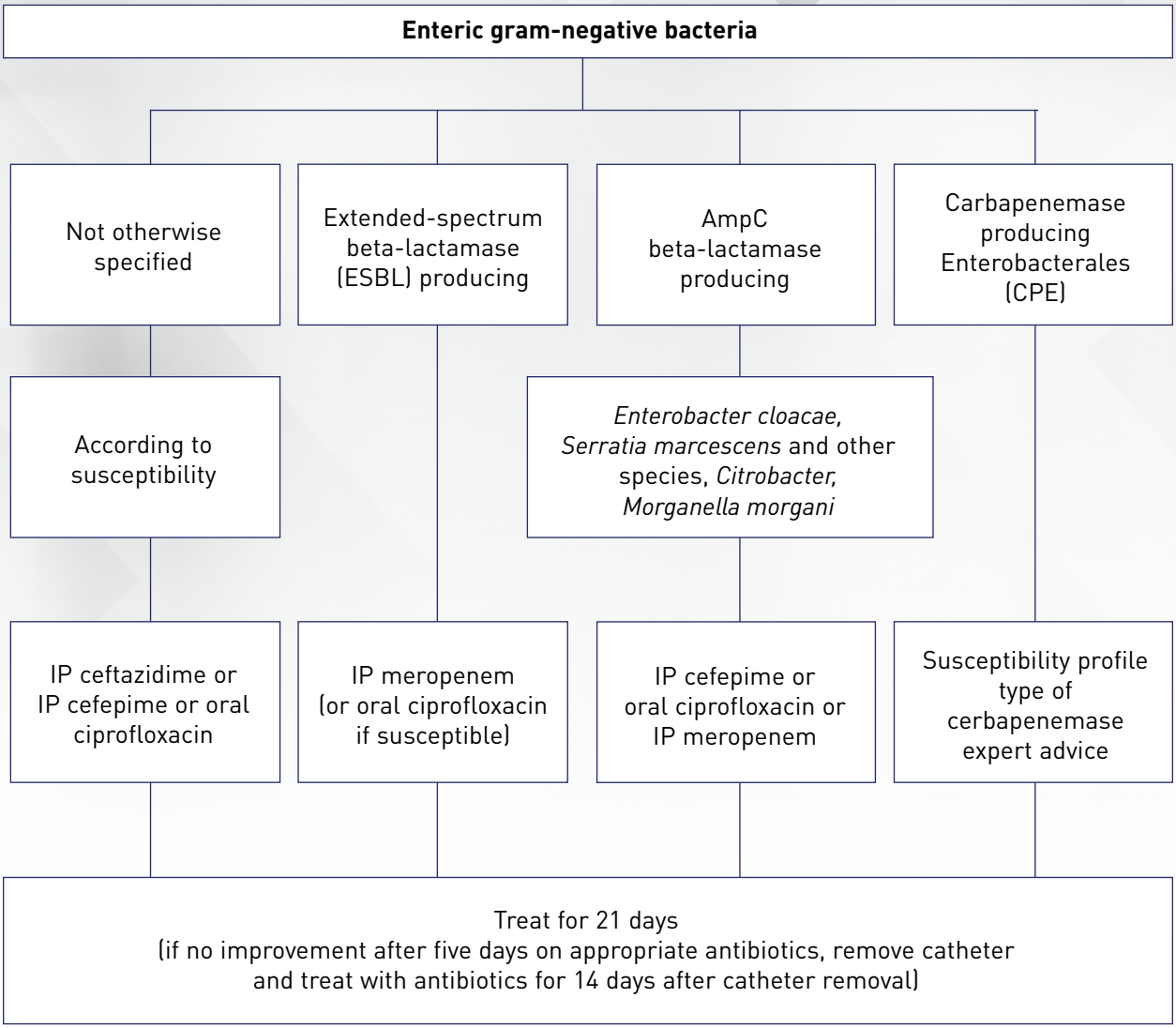
Peritonitis resolves but persistent exit site or tunnel infection

Consider simultaneous catheter removal and re-insertion

* A day 3 peritoneal dialysate WBC count ≥ 1,000 mm^3 has a 64% likelihood of treatment failure.[8]

INFECTIOUS COMPLICATIONS: PERITONITIS MANAGEMENT

Enteric gram-negative Bacteria[1]



BEST PRACTICE SUGGESTION

DAY 3: Assess clinical improvement, consider repeating dialysis effluent cell count and culture.*

* A day 3 peritoneal dialysate WBC count ≧ 1,000 mm^3 has a 64% likelihood of treatment failure.[8]

INFECTIOUS COMPLICATIONS: PERITONITIS MANAGEMENT

Polymicrobial Peritonitis[1]

Polymicrobial Peritonitis

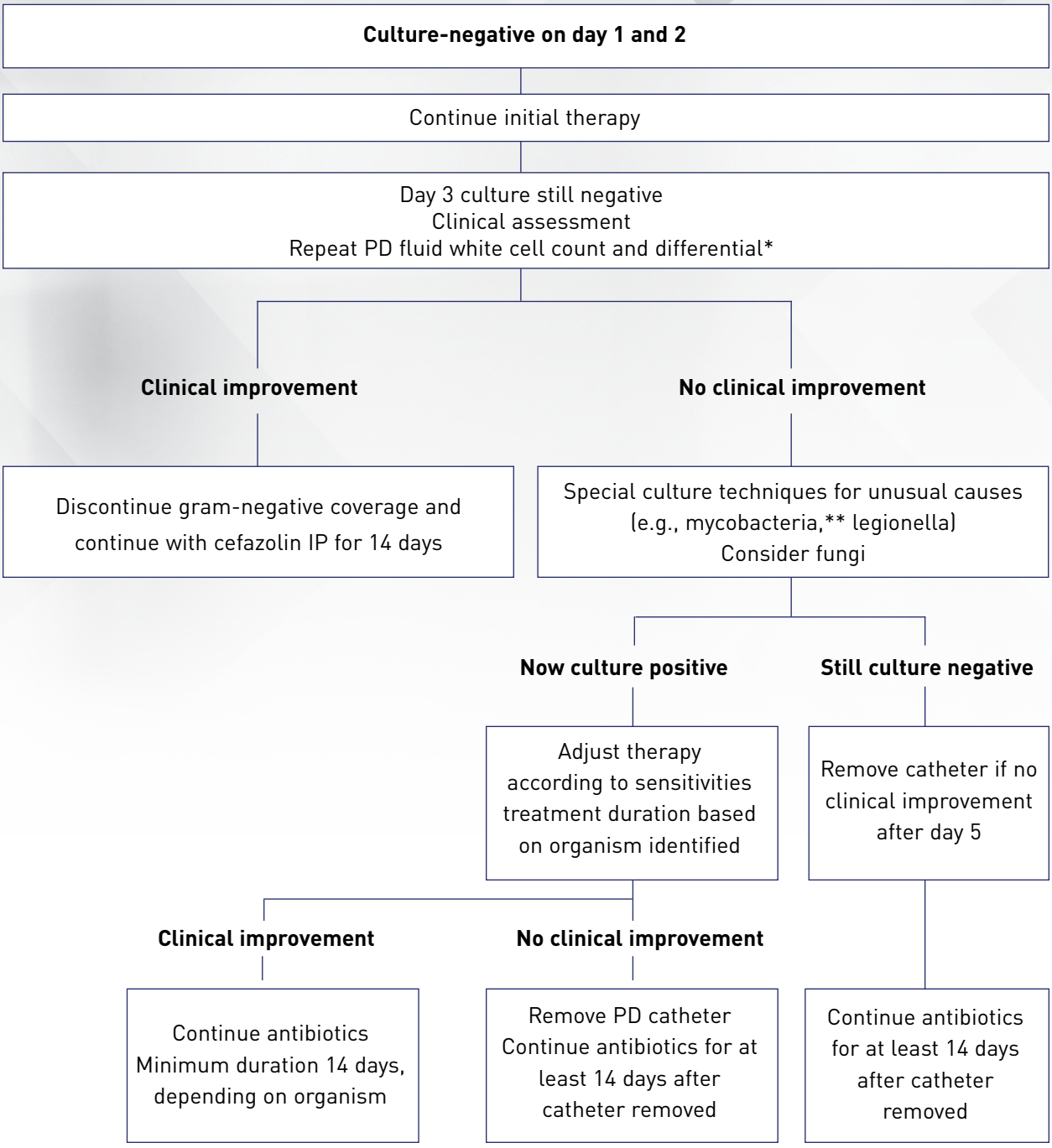
Multiple Gram-negative organisms mixed Gram-negative/Gram-positive	Multiple Gram-positive organisms
Consider GI problem	Consider touch contamination Consider PD catheter infection
Change therapy to oral metronidazole in conjunction with either oral amoxicillin[9] and gentamicin IP†; or ceftazidime IP	Continue therapy based on sensitivities minimum duration 21 days
Obtain urgent surgical assessment	**Without exit site or tunnel infection** / **With exit site or tunnel infection**
If laparotomy is needed, PD catheter is usually removed and continue IV antibiotics	**BEST PRACTICE SUGGESTION** **DAY 3:** Assess clinical improvement, consider repeating dialysis effluent cell count and culture.*
Continue antibiotics IP Minimum duration 21 days	Continue antibiotics Minimum duration 21 days / Remove PD catheter

Prolonged treatment with gentamicin should be avoided and treatment >7 days should *only* proceed following direct advice from nephrologist or infectious disease specialist

† ISPD 2022 suggests using adjunctive oral N-acetylcysteine therapy with aminoglycosides to help mitigate the ototoxicity.[1]
* A day 3 peritoneal dialysate WBC count ≥ 1,000 mm3 has a 64% likelihood of treatment failure.[8]

INFECTIOUS COMPLICATIONS: PERITONITIS MANAGEMENT

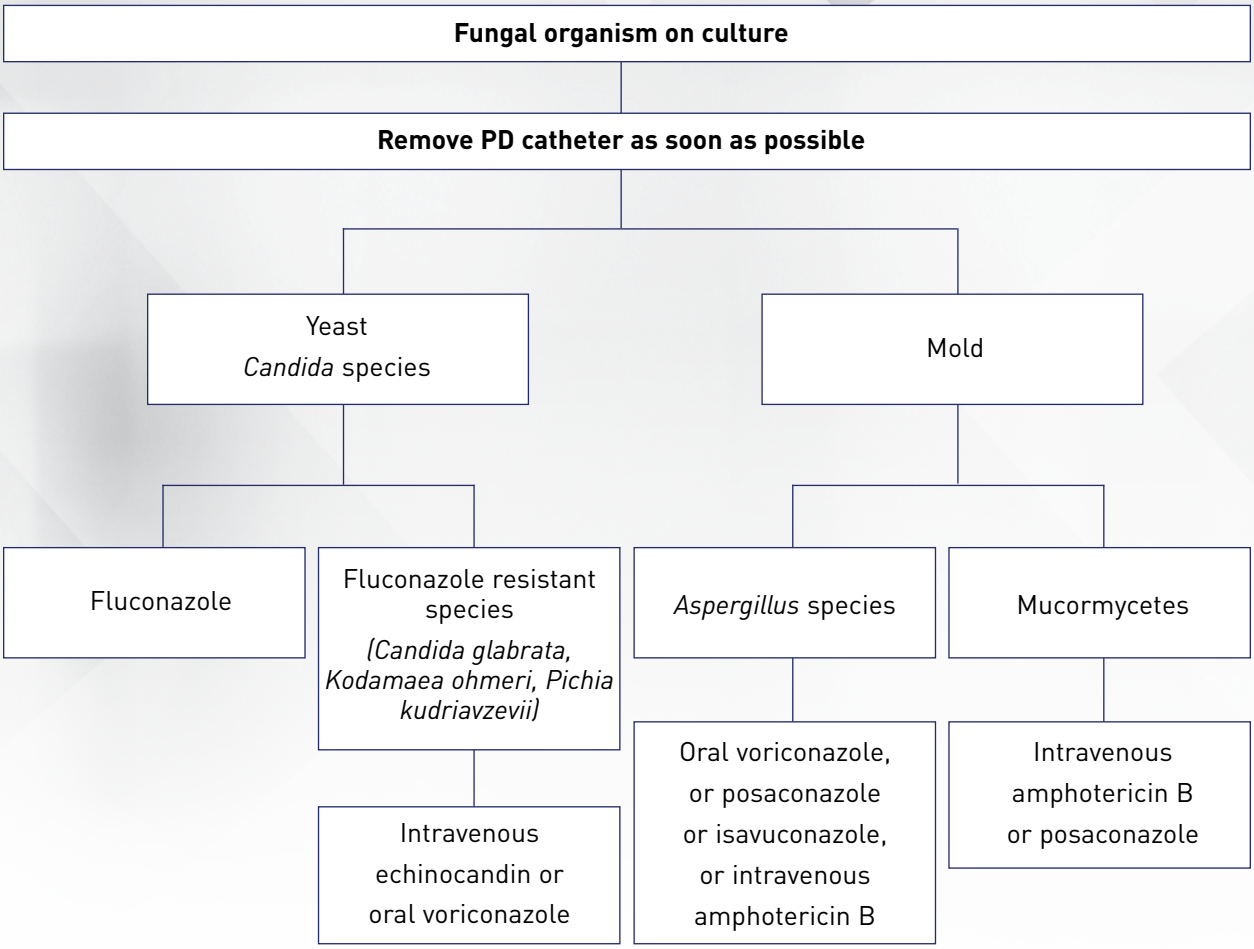
Culture-negative Peritonitis[1]



* A day 3 peritoneal dialysate WBC count ≥ 1,000 mm^3 has a 64% likelihood of treatment failure.[8]
** Persistent culture negative peritonitis: consider Ziehl-Neelsen staining for acid-fast bacilli[1]

INFECTIOUS COMPLICATIONS: PERITONITIS MANAGEMENT

Fungal Peritonitis[1]



INFECTIOUS COMPLICATIONS: PERITONITIS MANAGEMENT

Mycobacterium Peritonitis[1]

M. tuberculosis or *Non-tuberculous mycobacterium* on culture
Special culture technique may be required*

M. tuberculosis
Recommend drug therapy vs. catheter removal use 4 drugs for 2 months followed by isoniazid** and rifampicin for at least 10 additional months

Non-tuberculous mycobaterium
Little data on optimal therapy. Recommend two agents for a minimum of 6 weeks (consult Infectious Disease specialist)

Suggest PD catheter removal

* Consider Ziehl-Neelsen stain for acid fast bacilli as well.[1]
** Pyridoxine 50–100 mg should be given to avoid isoniazid-induced neurotoxicity[2]

INFECTIOUS COMPLICATIONS: PERITONITIS MANAGEMENT

Peritonitis Terminology[1]

Recurrent Peritonitis

An episode that occurs within 4 weeks of completion of therapy of a prior episode but with a different organism

Relapsing Peritonitis*

An episode that occurs within 4 weeks of completion of therapy of a prior episode with the same organism or one sterile episode

Repeat Peritonitis*

An episode that occurs more than 4 weeks after completion of therapy of a prior episode with the same organism

Refractory Peritonitis

Failure of the effluent to clear after 5 days of appropriate antibiotics

Refractory Peritonitis Treatment ISPD Guidelines:[1]

We recommend that the PD catheter be removed in refractory peritonitis episodes, defined as failure of the PD effluent to clear after 5 days of appropriate antibiotics.

We suggest that observation for antibiotic effect longer than 5 days is appropriate if PD effluent white cell count is decreasing towards normal, instead of mandatory PD catheter removal if effluent does not clear up by day 5.

*Relapsing episodes should not be counted as another episode during the calculation of peritonitis rates; recurrent and repeat episodes should be counted.[2]

INFECTIOUS COMPLICATIONS: PERITONITIS MANAGEMENT

Relapsing, Repeat and Recurrent Peritonitis[1]

Relapse is defined as an episode that occurs within 4 weeks of completion of therapy of a prior episode with the same organism or 1 sterile episode.

Repeat is defined as an episode that occurs more than 4 weeks after completion of therapy of a prior episode with the same organism.

Recurrent is defined as an episode that occurs within 4 weeks of completion of therapy of a prior episode but with a different organism.

Initiate appropriate antibiotic based on culture*

↓

Recommend timely catheter removal be considered

↓

Suggest simultaneous PD catheter removal and reinsertion after culture of effluent is negative and WBC< 100/uL in the absence of concomitant ESI or tunnel infection

* Refer to therapy recommendations for organism.

INFECTIOUS COMPLICATIONS: MANAGEMENT OF EXIT-SITE/TUNNEL INFECTION

"An exit-site infection is defined by the presence of purulent drainage with or without erythema of the skin at the catheter-epidermal interface."[10]

"Tunnel infection is defined as the presence of clinical inflammation (erythema, swelling, tenderness or induration) with or without ultrasonographic evidence of a fluid collection anywhere along the catheter tunnel."[10]

KEY ASSESSMENTS

- Purulent discharge from exit-site, spontaneous or expressed from tunnel, cuff or sinus[11]
- Persistent erythema may be precursor to purulent drainage[10]
- Erythema, induration, or tenderness at exit-site or over the tunnel[10]

  Possible indications for ultrasound (US) of catheter tunnel:[10]
  - Initial evaluation of suspected tunnel infection, e.g. tunnel swelling without erythema and tenderness
  - Initial evaluation of exit-site infection after antibiotic treatment (especially if caused by *S. Aureus*)
  - Follow-up of exit-site and tunnel infection after antibiotic treatment
  - Relapsing peritonitis (may be due to an occult tunnel infection)
- Positive culture with normal-appearing exit-site may indicate colonization[10]
- Erythema or skin reaction may be noted following catheter implantation or trauma[10]
- *Staphylococcus aureus* carrier status/use of prophylaxis[10]
- Compliance with prophylaxis
- Precipitating or contributing conditions (a break in technique, gross contamination, etc.)
- Suboptimal exit-site care
- Exit-site infection with *S. Aureus* and *Pseudomonas* are often associated with concomitant tunnel infection[11]

KEY ACTIVITIES

Initiate the following:

- Culture and Gram stain of purulent exudate and/or drainage
- Tunnel should be inspected and palpated[10]
- Tenderness over tunnel and drainage from exit-site after milking the tract indicates tunnel infection[10]
- Initiate empiric antibiotic therapy as indicated by clinical appearance[10]
  - Empiric therapy should include *Staphylococcus aureus* coverage[10]
  - In patients with history of Methicillin-resistant *S. aureus* or *Pseudomonas* ESI, empiric therapy should include targeted antibiotic therapy[10]
- In the absence of purulence, tenderness, or swelling, consider intensified local care (e.g. hypertonic saline soaks)[3]
- Monitor and document condition of exit-site, sinus, and tunnel[11]
  - Evaluate exit-site and tunnel within 1 week after treatment begins[10]
  - Adjust treatment according to both clinical response and microbiological results[10]
- Exit-site infection due to *S. aureus* and *Pseudomonas* are often associated with tunnel involvement[11]
- If tunnel infection suspected, ultrasound of subcutaneous pathway may be helpful[10]
- Increase intensity of exit-site care and dressing changes[10]
- Retrain patient on appropriate exit-site care[13]
- Close follow-up with patient to evaluate response to treatment plan

INFECTIOUS COMPLICATIONS: MANAGEMENT OF EXIT-SITE/TUNNEL INFECTION

PATIENT EDUCATION

- Intensified exit-site care
  - Clean at least once daily[10]
  - Avoid toxic agents entering sinus[12]
- In the case of severe exit-site infection, hypertonic saline soaks in addition to antibiotics may be used. To make hypertonic saline, add 1 tablespoon of salt to 1 pint (500mL) sterile water. This solution is applied to gauze and wrapped around the exit-site for 15 minutes, 1 to 2 times per day[3]
- Soften crust and scabs with saline or soap and water[12]
- Never forcibly remove crusts and scabs[12]
- Apply new sterile dressing with each cleansing procedure until infection resolved, even if not routinely used[12]
- Protect exit-site and tunnel from trauma[12]
- Review antibiotic/antacid/food interactions

Note:

- Quinolone absorption may be reduced when given in combination with sevelamer hydrochloride, calcium salts, oral iron preparations, magnesium/aluminum containing antacids, zinc, sucralfate, or milk. Administration should be staggered as much as possible. The quinolone should be administered first, allowing at least 2 hours between each preparation[11]
- Rifampin interacts with many other medications.[11] Patient medication review is warranted before use of rifampin

OUTCOMES EVALUATION

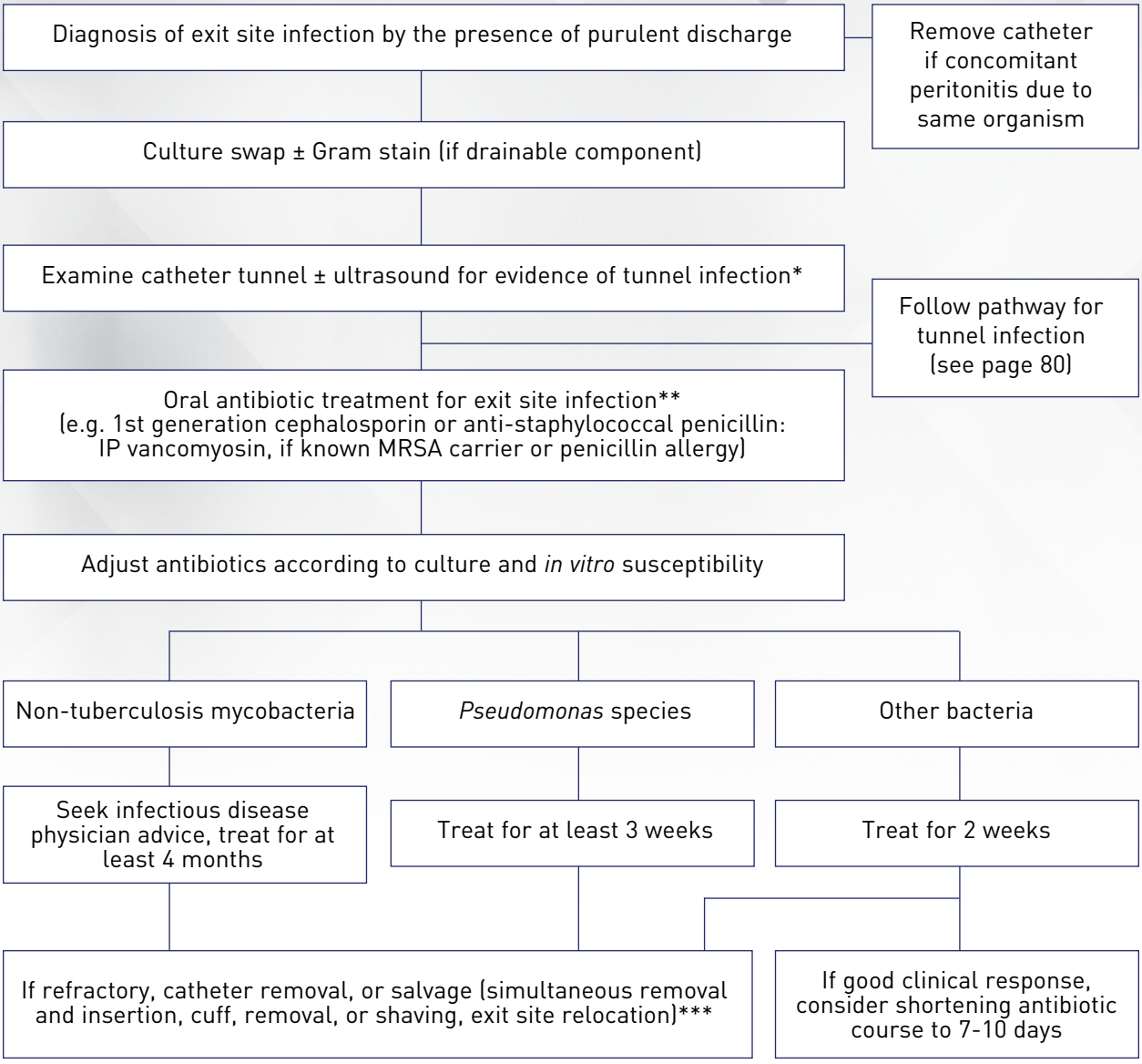
Collect data to include:

- Date of culture, organism identified, drug therapy used
- Date antibiotic course completed
- Recurrent organisms, date of drug therapy
- Date of re-education/training
- Antibiotic prophylaxis regimen used

Enter data into infection tracking tool

INFECTIOUS COMPLICATIONS: MANAGEMENT OF EXIT-SITE INFECTION

Diagnosis and Management of Exit-Site Infection[10]



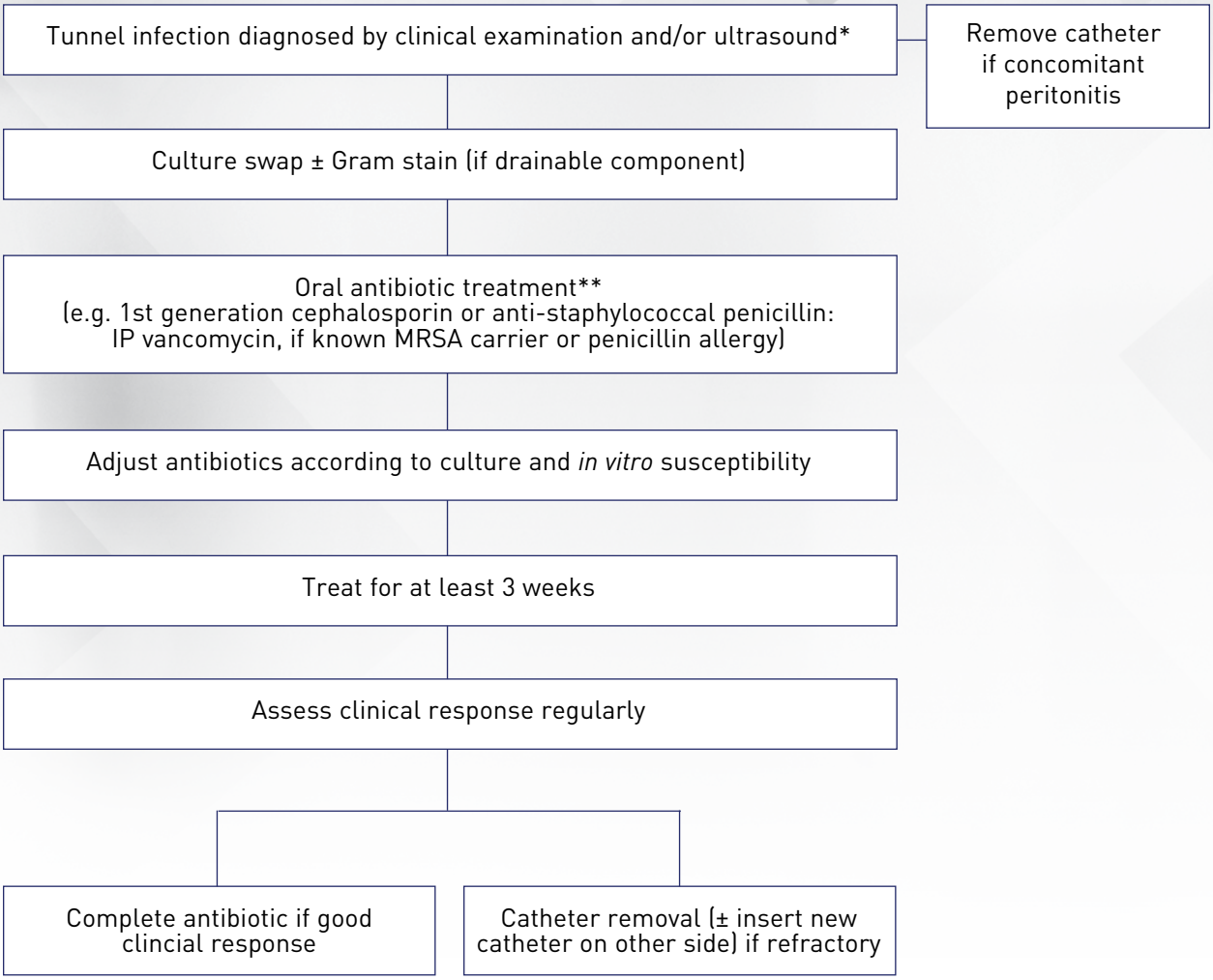
*Tunnel infection defined: presence of clinical inflammation (erythema, swelling, tenderness or induration) with or without ultrasonographic evidence of fluid collection along the catheter tunnel[10]

**PD patients are recommended to receive concomitant antifungal prophylaxis[10]

***Suggest simultaneous removal and reinsertion of PD catheters with a new exit site under antibiotic coverage when ESI or tunnel infection do not resolve with effective antibiotic therapy; except when there is deep Dacron cuff involvement[10]

INFECTIOUS COMPLICATIONS: MANAGEMENT OF TUNNEL INFECTION

Diagnosis and Management of Tunnel Infection[10]



*Tunnel infection defined: presence of clinical inflammation (erythema, swelling, tenderness or induration) with or without ultrasonographic evidence of fluid collection along the catheter tunnel[10]

**PD patients are recommended to receive concomitant antifungal prophylaxis

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US-RC55-210079 v6.0 11/2023

SECTION 4

ANTIBIOTIC DOSING GUIDELINES

MANAGEMENT OF EXIT-SITE/TUNNEL INFECTION

Oral Antibiotics Used in Catheter-Related Infections[1]

FIRST-LINE EMPIRICAL ORAL ANTIBIOTICS USED IN CATHETER-RELATED INFECTIONS[1]

Amoxicillin/clavulanate	500 mg/125 mg or 250 mg/125 mg BID
Cephalexin	250-500 mg BID
Cloxacillin or dicloxacillin	500 mg QID

BID=two times per day; QID=four times per day

ALTERNATIVE ORAL ANTIBIOTICS USED IN CATHETER-RELATED INFECTIONS[1]

Ciprofloxacin	500-750mg daily
Clarithromycin	500mg loading; then 250mg BID
Clindamycin	300-450mg TID to QID
Levofloxacin	250 daily or 500 mg every 48 h
Linezolid	600 mg BID for 48 h, then 300 mg BID 600 mg daily if used for NTM infection
Moxifloxacin	400 mg daily
Rifampicin[a]	450 mg daily (for BW < 50 kg) 600 mg daily (for BW ≥ 50 kg)
Trimethoprim/sulfamethoxazole	80 mg/400 mg (one single-strength tablet) daily or BID or 160 mg/800 (one double-strength tablet) daily

BID=two times per day; BW=body weight; QID=four times per day; TID=three times per day; NTM=non-tuberculous mycobacteria
[a]Rifampicin is used for treating *S. aureus* synergistically with other antibiotics and should not be given as single-agent therapy.

ANTIBIOTIC DOSING GUIDELINES: EXIT-SITE PROPHYLAXIS

Exit-Site Antibiotic Prophylaxis

Cleanse exit site frequently, preferably daily,[3]
ISPD recommends cleansing at least 2 x week and after every shower or vigorous exercise[1]

Apply daily topical antibiotic cream to exit site. Choose option A or B below:[1]

A

Apply gentamicin cream or ointment to exit-site daily in all patients[1]‡

Apply to skin around catheter exit-site only, not catheter[1,5]**

B

Apply mupirocin cream or ointment to exit-site daily in all patients[1]

Apply to skin around catheter exit-site only, not catheter[1,5]**

Important Points[1]

- Alternating mupirocin & gentamicin has been associated with increased risk of fungal peritonitis
- Keep catheter immobilized[1]
- Chronic dressing is optional
- Screen for nasal *S. Aureus* carriage prior to PD catheter insertion
  If positive treat with topical nasal application of mupirocin

‡ Gentamicin may be associated with increased non-TB, enterobacteriacea,[1] and fungal exit-site infections[5]

** Excessive application of antibiotic cream directly to catheter has been reported to cause catheter damage[4]

ANTIBIOTIC DOSING GUIDELINES: PERITONITIS MANAGEMENT

Intraperitoneal Antibiotic Dosing Recommendations Studied in CAPD Patients[6*]

Extrapolation of antibiotic dosing from CAPD to APD is not recommended.[6]

	INTERMITTENT one exchage per day (minimum 6 h dwell)	CONTINUOUS mg per liter, all exchanges
Aminoglycosides		
Amikacin	2 mg/kg	Not advised
Gentamicin	0.6 mg/kg	Not advised
Netilmicin	0.6 mg/kg	Not advised
Tobramycin	0.6 mg/kg	Not advised
Cephalosporins		
Cefazolin	15 mg/kg daily (for long dwell)	LD 500 mg/L, MD 125 mg/L[a]
Cefepime	1000 mg	LD 500 mg/L, MD 125 mg/L[a]
Cefoperazone	ND	LD 500 mg/L, MD 62.5–125 mg/L
Cefotaxime	500–1000 mg	ND
Ceftazidime	1000–1500 mg (for long dwell)	LD 500 mg/L, MD 125 mg/L[a]
Ceftriaxone	1000 mg	ND
Penicillins		
Penicillin G	ND	LD 50,000 unit/L, MD 25,000 unit/L
Amoxicillin	ND	MD 150 mg/L
Ampicillin[b]	4 gm	MD 125 mg/L
Ampicillin/sulbactam		LD 1000 mg/500 mg, MD 100mg/L[7,8,9]
Piperacillin/tazobactam	ND	LD 4 gm/0.5 gm, MD 1 gm/0.125 gm
Ticarcillin/clavulanic acid	ND	LD 3 gm/0.2 gm, MD 300 mg/20 mg/L

[a] Increase in doses by 25% may be needed for patients with significant residual kidney function.

[b] IP ampicillin is not recommended for treatment of enterococcal peritonitis.

* adapted from table 5

For dosing of drugs with renal clearance in patients with residual renal function (defined as >100mL/day urine output), dose should be empirically increased by 25%.[9]

ND = no data
LD = loading dose, in mg
MD = maintenance dose, in mg
kg = kilograms

ANTIBIOTIC DOSING GUIDELINES: EXIT-SITE PROPHYLAXIS

Intraperitoneal Antibiotic Dosing Recommendations Studied in CAPD Patients[6] (continued)*

	INTERMITTENT **one exchage per day (minimum 6 h dwell)**	CONTINUOUS **mg per liter, all exchanges**
Others		
Aztreonam	2 gm	LD 500 mg/L, MD 250 mg/L
Ciprofloxacin	ND	MD 50 mg/L
Clindamycin	ND	MD 300mg/L
Daptomycin	300 mg	LD 100 mg/L, MD 20 mg/L
Fosfomycin	4 g daily	ND
Imipenem/cilastatin	500 mg in alternate exchange	LD 250 mg/L, MD 50 mg/L
Ofloxacin	ND	LD 200 mg, MD 25 mg/L
Polymyxin B	ND	150,000 unit (15mg)/L
Quinupristin/dalfopristin	25 mg/L in alternate exchanges[c]	ND
Meropenem	1000 mg (for short dwell in CAPD)	MD 125 mg/L
Teicoplanin	15 mg/kg every 5 days	LD 200mg/L, MD 20 mg/L
Vancomycin	15–30 mg/kg every 5–7 days[d]	LD 20–25 mg/kg, MD 25 mg/L
Antifungal		
Fluconazole	IP 150–200 mg every 24 to 48 h (oral route is preferred)	ND
Voriconazole	IP 2.5 mg/kg daily (oral route is preferred)	ND

LD: loading dose in mg; MD: maintenance dose in mg; IP: intraperitoneal.

[a] Increase in doses by 25% may be needed for patients with significant residual kidney function.

[b] IP ampicillin is not recommended for treatment of enterococcal peritonitis.

[c] Given in conjunction with 500 mg intravenous twice daily.

[d] Supplemental doses may be needed for APD patients and dwell time of at least 6 h is preferred.

*adapted from table 5

For dosing of drugs with renal clearance in patients with residual renal function (defined as >100mL/day urine output), dose should be empirically increased by 25%.[9]

ND = no data
LD = loading dose, in mg
MD = maintenance dose, in mg
kg = kilograms

ANTIBIOTIC DOSING GUIDELINES: PERITONITIS MANAGEMENT

Intermittent Dosing of Antibiotics Studied in Automated Peritoneal Dialysis (APD)

DRUG	**Cefazolin**
IP DOSE	20 mg/kg IP every day, in short dwells on cycler[6] (put entire dose in heater bag)[10*]
DRUG	**Cefepime**
IP DOSE	1 g IP in one exchange per day (at least 6 hour dwell)[9]
DRUG	**Ceftazidime**
IP DOSE	20 mg/kg, in short dwells on cycler[6] (put entire dose in heater bag)[10*]
DRUG	**Fluconazole**
IP DOSE	200 mg IP in one exchange per day every 24-48 hours[9] (at least 6 hour dwell). (Oral route preferred; LD 200mg MD 100mg)[6]
DRUG	**Meropenem**
IP DOSE	500 mg in long dwell with APD[6]
DRUG	**Tobramycin**
IP DOSE	Loading dose 1.5 mg/kg IP in long dwell[9] Maintenance dose 0.5 mg/kg in one exchange per day in long dwell[9]
DRUG	**Vancomycin**
IP DOSE	15mg/kg every 4 days for APD[6] (keep trough levels >15 µg/mL)[8] (at least 6 hour dwell,[6] preferably 10-15 hour dwell[10])

IP: intraperitoneal; LD: loading dose; MD: maintenance dose.
Aminoglycosides should be given intermittently while on APD or CAPD[6]

*The study used 5 exchanges of 2-L over 10 hours with a dry day. Entire dose of antibiotic was put into bag on the heater[11]

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SECTION 5

SURGICAL SALVAGE PROCEDURES FOR INFECTIOUS COMPLICATIONS

SURGICAL SALVAGE PROCEDURES FOR INFECTIOUS COMPLICATIONS

EXIT-SITE AND TUNNEL INFECTIONS

KEY ASSESSMENTS

- Extruding or extruded superficial Dacron cuff[1]
- Persistent purulent discharge from exit-site, spontaneous or expressed from tunnel, cuff or sinus despite appropriate antibiotic therapy, and intensified local exit-site care
- Pain, erythema, tenderness, induration, or swelling over the tunnel[2]
- Appraise exit-site location. Suboptimal exit-site location may contribute to condition[3]

CLINICAL INTERVENTIONS

Diagnostic:

- Perform physical exam including palpation over catheter tunnel to assess for induration, inflammation, and pain, and presence of purulent discharge and/or granulation tissue at exit-site
- Palpation of superficial cuff or gentle downward pull of catheter produces purulent discharge from exit sinus
- Ultrasound imaging of subcutaneous track and Dacron cuffs to assess for fluid around catheter and cuffs[1,4]
- Refer to surgeon to determine intervention

Therapeutics:

- Surgical interventions may include shaving of extruded superficial cuff, unroofing of catheter tunnel with shaving of superficial cuff, catheter splicing procedure to new exit-site location with removal of infected segment of catheter including the superficial cuff, or simultaneous catheter replacement[1,3,5,6]
- Infected wounds left open at the time of surgical intervention will require appropriate local care until healed by secondary intention[7]
- Surgical interventions may be performed without interruption of PD, thereby avoiding temporary HD[1,3,5,6]
- If simultaneous catheter replacement performed, utilize intermittent regimen of supine, low-volume PD during interval of postoperative recovery; leave peritoneum dry during ambulatory periods[7]
- Continue appropriate antibiotic coverage
- Monitor wound healing

SPECIFIC SURGICAL INTERVENTIONS

Cuff Shaving for Superficial Cuff Extrusion:[1]

The process leading to superficial cuff extrusion begins with shape memory resiliency forces of a straight tubing segment bent into an arcuate configuration (Figure 10, A, B). Depending on the magnitude of these shape memory forces and the proximity of the cuff to the exit-site, straightening of the tubing

may cause the cuff to extrude through the exit-site. If the extruding cuff is not managed, it soon becomes seeded with bacteria and predisposes to exit-site infection. A cuff that has completely extruded still remains a source of bacteria in the vicinity of the exit-site. During routine exit-site care, unavoidable wetting of an extruded bacterial-laden cuff leads to constant exit-site contamination.[1]

If the cuff has not completely extruded, gentle traction and stretching of the skin with a hemostat will allow complete cuff exteriorization. In the presence of purulent drainage, collection of specimens for culture and Gram stain should be performed, empiric antibiotics started, and exit-site care adjusted to manage the degree of inflammation and drainage. Exercising care not to cut into the lumen of the catheter, an extruded cuff is removed with repetitive slices using a #15 knife blade.[5,6] The knife blade should be changed often to facilitate safe removal of the cuff material, thereby avoiding undue pressure with a dull blade on the catheter tubing. Removal of the cuff and treatment of infection, if present, allows prompt recovery of the exit-site.[1]

Unroofing of the Subcutaneous Track and Superficial Cuff Shaving for Chronic Exit-site Infection:

An exit-site infection becomes chronic when the patient has previously received 2 to 4 weeks of appropriate antibiotics and intensified wound care and continues to have a smoldering or relapsing infection.[3] If not treated, infection will eventually extend to peritoneum and result in loss of catheter. Unroofing the subcutaneous tunnel track and shaving of the superficial cuff can achieve long-term salvage of the catheter.[1,3,5,6] Since the peritoneal cavity is not entered, it is not necessary to interrupt or modify PD therapy. Unroofing/cuff shaving is not indicated if the deep cuff is involved or if there is concurrent peritonitis.[3] Ultrasound can be a useful tool to diagnose the extent of an exit-site infection and cuff involvement. The PD catheter must have acceptable flow function to be eligible for salvage by unroofing/cuff shaving; otherwise, simultaneous catheter replacement should be considered.[1]

The technique of unroofing and cuff shaving is illustrated in Figure 1. An incision is made to encompass the skin of the exit-site and extends over the subcutaneous route of the catheter until the superficial cuff is encountered. The cuff is mobilized by dividing the fibrous sheath around the catheter just deep to the

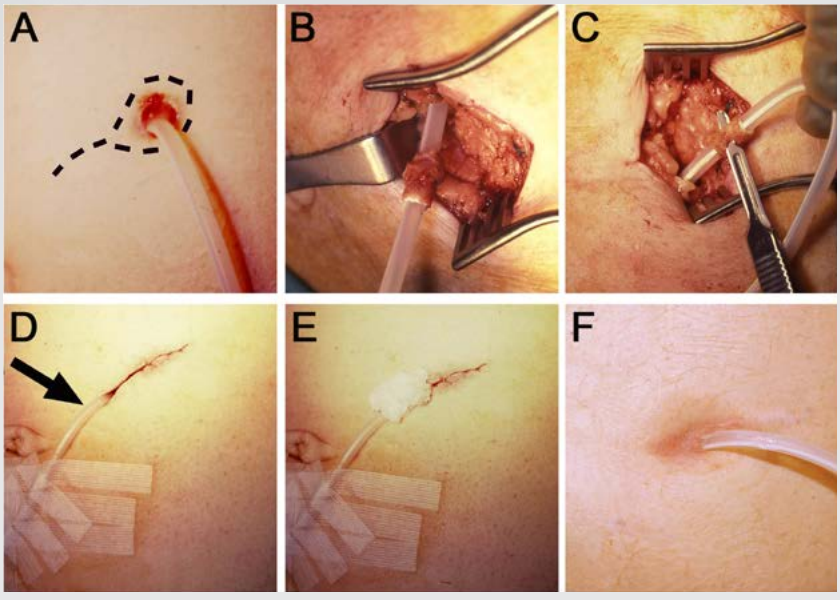

FIG. 1 Photos courtesy of Dr. J Crabtree

Unroofing and cuff shaving procedure: (A) Chronically infected exit-site with exuberant granulation tissue. Dotted line shows planned incision. (B) Superficial cuff is dissected free and infected tissues are excised. (C) Cuff is shaved with scalpel blade. (D) The catheter is immobilized at the medial aspect of the wound. Arrow points to shaved cuff. (E) Wound is packed open and allowed to heal secondarily. (F) Healed exit wound.[3]

cuff. This will allow the catheter cuff to be delivered to the surface of the wound. The exit-site skin and granulation tissue within the track are completely excised. Inspection is performed to make sure that the infectious process has not progressed to the deep cuff. The cuff is carefully shaved with repetitive slices of a #15 knife blade. The catheter is directed out of the medial end of the wound and immobilized with medical tincture adhesive and sterile adhesive strips, thereby positioning the shaved section of the catheter tubing external of the wound and promoting healing by minimizing motion of the tubing within the wound. The wound is packed open with a saline wet-to-dry dressing and allowed to heal secondarily.[3] Most wounds are healed within 4-8 weeks. Long-term, the patient will develop a mature healthy exit-site.

Catheter Splicing Procedure[6]

Chronic exit-site infections can result from poorly chosen exit-site locations placed in an infection prone area such as within a skin crease, below or on the floppy apex of a skin fold, or under the belt line. Splicing a new subcutaneous catheter tubing segment to the clean intercuff portion of the existing catheter and routing this segment to a more suitable abdominal wall exit-site is a useful strategy to resolve chronic exit-site infections.[6] Catheter splicing is also a useful technique to salvage catheters with external tubing damage that is too short to repair. Since the peritoneal cavity is not entered, PD is not interrupted. Catheter splicing is contraindicated if infection is encountered in the deep tunnel track, the deep cuff is involved, or there is concurrent peritonitis. Preoperative screening with ultrasound is useful to look for infected fluid in the intercuff segment or around the deep cuff. The PD catheter must have acceptable flow function to be eligible for salvage by splicing; otherwise, simultaneous catheter replacement should be considered.[1]

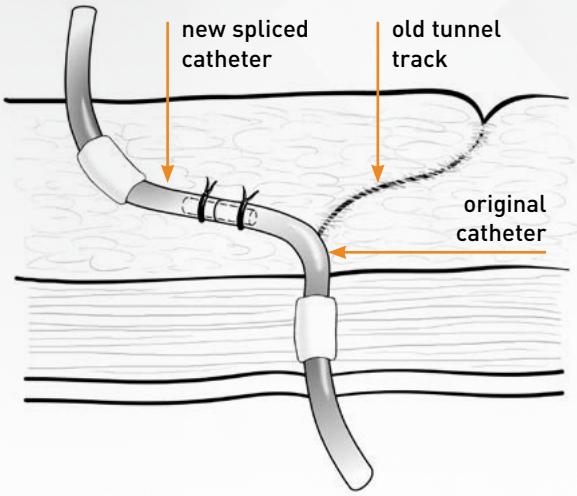

FIG. 2

Catheter splicing procedure for chronic exit-site infection permits routing of tubing to a new location. Procedure also applicable for catheter tubing breaks that are too short for external repair.

Figure 2 illustrates the catheter splicing procedure. The previous insertion incision scar is entered and the catheter tubing is intercepted as it emerges from the fascia. The catheter is divided and a splice tubing segment prepared from a new catheter is attached with a double-barbed titanium connector. The spliced segment is tunneled to a new exit-site location. After the wound is closed and the exit-site protected with dressings, the remaining remnant of the catheter at the old exit-site is removed to complete the procedure.[6]

Figure 3 shows an example of salvaging a catheter with a chronic exit-site infection due to poor location.

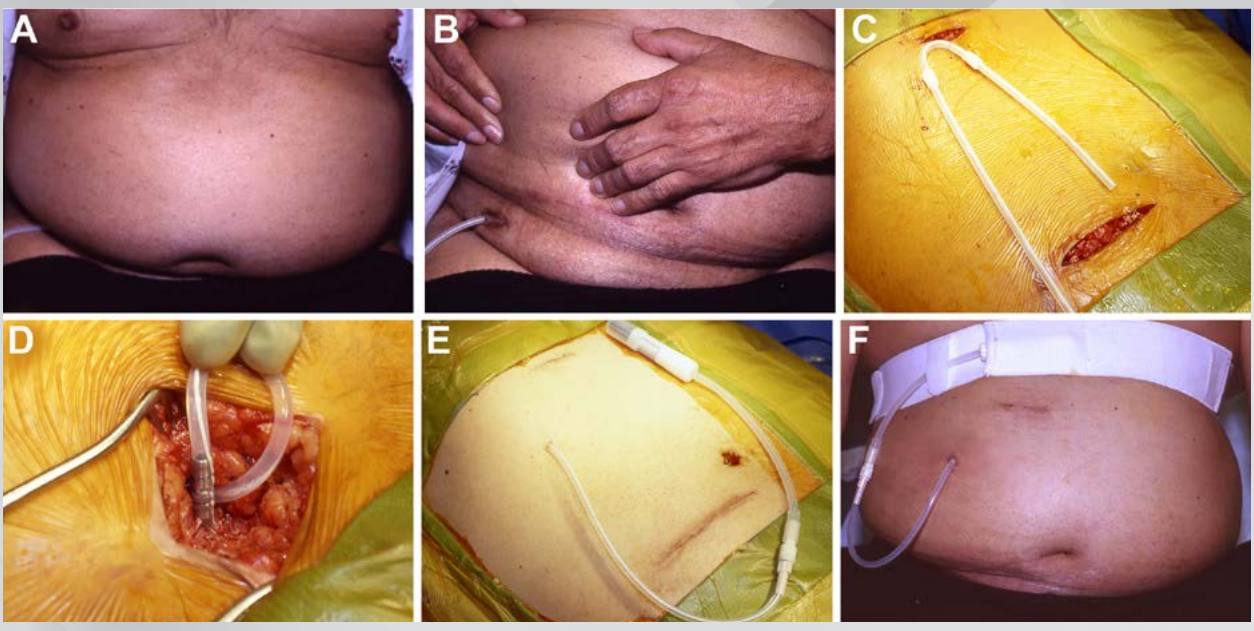

FIG. 3

Photos courtesy of Dr. J Crabtree

(A) Dialysis catheter exit-site hidden in skin crease below pendulous abdomen. (B) Patient is required to lift skin fold in order to visualize exit-site. (C) Intraoperative photograph showing prepared splice segment to extend catheter to upper abdomen. (D) Splice segment is joined to intercuff segment of existing catheter with a titanium connector. (E) Splice segment is exited through new exit-site and incisions are closed. Remnant of old catheter is removed from old exit-site (not shown). (F) Postoperative photograph of relocated exit-site.

Simultaneous Catheter Replacement

The alternative to unroofing/cuff shaving or splicing is simultaneous catheter insertion and removal.[1,7] This option is indicated when the exit-site location is unsatisfactory, not improved by unroofing/cuff shaving, infection is present in the intercuff segment preventing splicing, and flow function of the existing catheter is suboptimal. The clean step, insertion of the new catheter on the opposite side of the abdomen, is performed first, followed by the dirty step, removal of the old catheter. Care is exercised to avoid cross contamination of wounds. Removal of the catheter with staged reinsertion at a later date is indicated if there is deep cuff involvement or concurrent peritonitis.[1]

PATIENT EDUCATION

- Protect new surgical wounds from cross contamination from infected wounds
- Provide instruction in dressing care of any open surgical wounds
- Review changes in PD technique or modifications in cycler settings based upon performed surgical intervention
- Review antibiotic regimen

OUTCOMES EVALUATION

Collect data to include:

- Surgical intervention used
- Date of surgical intervention
- Modifications in PD regimen during convalescence
- Wound care employed
- Date infection resolved
- Antibiotic regimen used

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US-RC55-210081 v3.0 11/2023

SECTION 6

ADDITIONAL CLINICAL RESOURCES (ACR)

A. PREOPERATIVE MAPPING TO DETERMINE THE MOST APPROPRIATE CATHETER TYPE, INSERTION SITE, AND EXIT-SITE LOCATION

Since patients come in all sizes and shapes with a variety of medical conditions, one catheter type cannot be expected to fit all. Choice of catheter type should take into consideration the patient's belt line, obesity, skin creases and folds, presence of scars, chronic skin conditions, incontinence, physical limitations, bathing habits, and occupation.[1] It is imperative that the peritoneal dialysis access team, including the surgeon, interventional radiologist, nephrologist, and PD nurse, be familiar with a basic inventory of catheter types to enable customization of the peritoneal access to the specific needs of the patient and to afford maximum flexibility in exit-site location. A poor exit-site location that the patient cannot easily see or take care of predisposes to exit-site and tunnel infection.[2,3,4,5]

Often, hospital vendor contracts and purchasing agents may determine the kind of peritoneal catheter maintained in stock. Potentially, the type of catheter provided is subject to change without notice. Considering current progress in peritoneal access technology, the PD team must agree on a basic catheter inventory and insist that these specific items are made available for the peritoneal access procedure. For a PD program to develop a dependable protocol for catheter selection, catheter types and dimensions must not be constantly changing. In addition, it is essential that each member of the PD access team understands and acknowledges that the preoperative mapping procedure described herein is a definitive and reproducible method that can be performed by any of the team members for selecting the most suitable catheter type, insertion site, and exit-site location.

Preoperative Mapping Using a Catheter Sample

The most appropriate choice of catheter is the one that produces the best balance of pelvic location of the catheter tip, exit-site easily visible to the patient, and can be inserted through the abdominal wall with the least amount of tubing stress.[1] The catheter insertion site is the fulcrum of this best balance and will determine the pelvic position of the catheter tip and the range of reachable exit-sites. Therefore, catheter selection begins with determination of the insertion site. With the patient in the supine position, the insertion site for each style and size of catheter is determined by marking the upper border of the deep cuff in the paramedian plane when the upper border of the catheter coil is aligned with the upper border of the pubic symphysis[1] (**Figure 1**). For straight-tip catheters, a point 5 cm from the end is aligned with the upper border of the pubic symphysis. If a straight-tip catheter design is preferred, choose a version that provides no more than 15 cm of length below the deep cuff[1] to avoid having excess tubing crowded in the pelvis. During the catheter placement procedure, the deep cuff is implanted within the

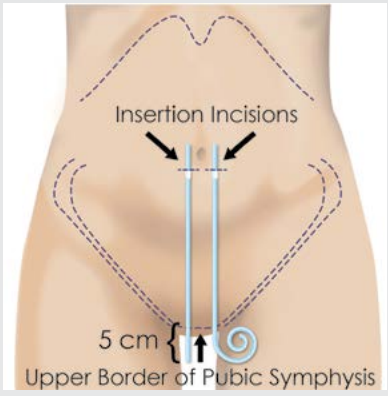

Figure 1. Schematic of a supine patient showing the manner in which the catheter insertion site and deep cuff location are selected in order to achieve optimal pelvic position of coiled- and straight-tip catheters.

rectus muscle (or just below) at the level of the insertion incision. Using this convention to determine the insertion site will prevent the catheter tip from being implanted too low in the pelvis, producing pressure or poking discomfort, early termination of dialysate outflow, and severe end of drain pain.[6]

After determining the catheter insertion site, the subcutaneous tunnel path and exit-site location for catheters with a preformed swan neck bend simply follows the configuration of the tubing, marking the skin exit-site 2–3 cm beyond the superficial cuff. Catheters with a straight intercuff segment should assume a gentle arc in the subcutaneous tissues to produce more of a laterally directed exit-site. To enable a gentle arc bend of the straight intercuff tubing segment, choose a catheter version with 5 to 6 cm between the Dacron cuffs. Illustrated in **Figure 2** is a convenient 3-step algorithm for catheters with a straight intercuff segment to design a laterally directed tunnel and exit-site that minimizes creation of excessive tubing stress and shape-memory resiliency forces that can lead to catheter tip migration and superficial cuff extrusion. The inherent properties of this algorithm prevent the superficial cuff from coming any closer than 2 cm of the exit-site, even use in the worst-case scenario of tube straightening.[7]

If the catheter needs to be bent more than a laterally directed exit-site, a catheter with a preformed swan neck bend should be used instead to eliminate these excessive forces. Upwardly directed exit-sites should be avoided to prevent pooling of cutaneous bacteria and debris, perspiration, and shower water in the exit sinus, predisposing the patient to exit-site and tunnel infection.[1]

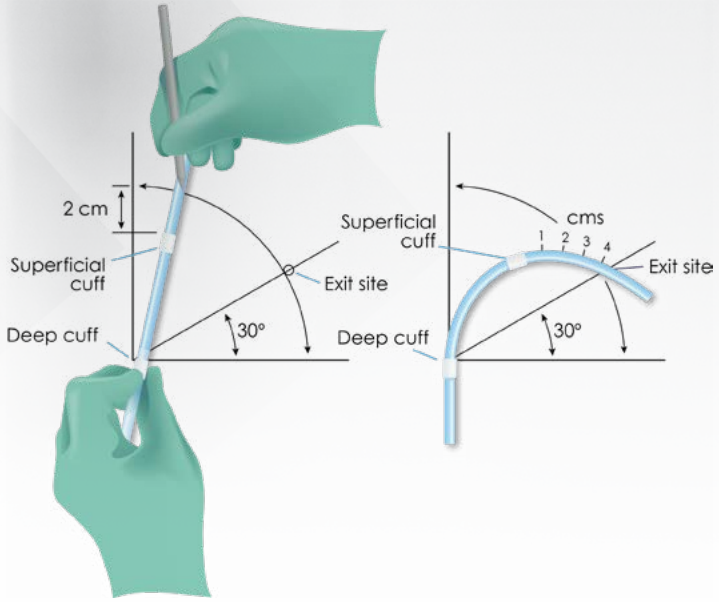

Figure 2. Three-step algorithm for lateral tunnel track and exit-site design. *Step 1:* scribe arc from vertical to horizontal plane using catheter as compass from point 2 cm external of superficial cuff. *Step 2:* mark exit-site at junction of medial 2/3 and lateral 1/3 of arc. *Step 3:* indicate tunnel track shape by bending catheter over from point 4 cm external of superficial cuff to exit-site.[8]

After mapping exit-site locations, the patient assumes a sitting position and the marked exit-sites are checked to see which is best visualized by the patient and does not conflict with the belt line, skin creases, or apices of bulging skin folds. If none of the marked exit-sites for the standard abdominal catheters are satisfactory, the patient is then considered for an extended catheter to produce an upper abdominal or presternal exit-site location.[1]

Stencil-Based Preoperative Mapping

Marking stencils are provided by some dialysis catheter manufacturers for the most commonly used catheter designs. Properly constructed stencils contain critical catheter design information, including the distance between the deep cuff and the coil, suggested subcutaneous tunnel configurations, and recommended exit-site locations relative to the position of the superficial cuff. Additional features of a well-designed stencil plate permit its precise orientation on the trunk region according to fixed anatomical landmarks, such as the upper edge of the pubic symphysis, representing the anterior upper border of the true pelvis, and the anatomical midline of the torso. Stencils permit accurate and reproducible association of the catheter design elements to these anatomical landmarks to help determine the best catheter style and insertion site that will produce optimal pelvic position of the catheter coil and ideal exit-site location. In addition to the preoperative evaluation, the marking stencil is used again at the time of the catheter placement procedure to retrace the previously determined insertion incision, tunnel configuration, and exit-site location.[7]

Figure 3 demonstrates use of a marking stencil to determine insertion site, tunnel track configuration, and exit-site location for Tenckhoff-style catheters with a straight and preformed swan neck bend in the intercuff tubing segment. With the patient supine, the reference point toward the lower border of the stencil is aligned with the upper border of the pubic symphysis and the medial border of the stencil with the midline of the abdomen (**Figure 3A**). During preoperative assessment for catheter selection, it is sufficient to only mark the prospective exit-site. At the time of the catheter insertion procedure, the insertion site, tunnel track, and exit-site cutouts on the stencil are marked (**Figure 3B**).

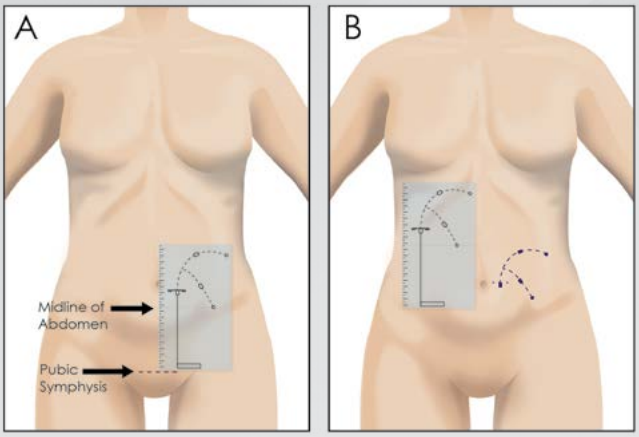

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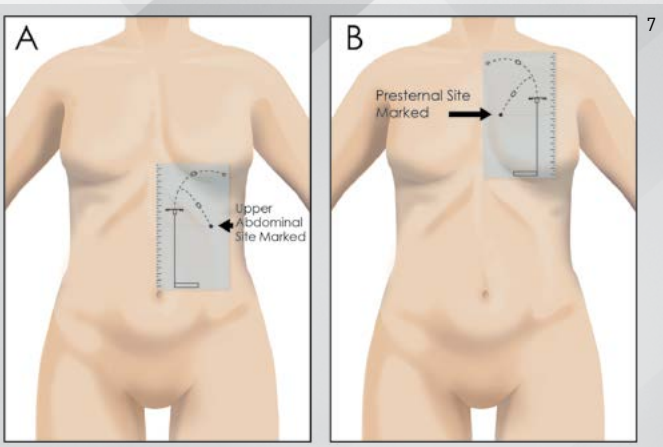
Figure 3A. Mapping using stencil for Tenckhoff catheters with straight and swan neck intercuff segments. With supine patient, align medial border of stencil with midline of abdomen and stencil reference line for pubis with the upper border of the pubic symphysis. Mark exit-sites for both catheter configurations.
Figure 3B. On day of procedure, mark cutouts for the insertion incision, tunnel configuration, cuff positions, and exit-site location for selected catheter. It is sufficient to mark only the exit-site cutout during preoperative assessment to select catheter type.

Preoperative Mapping for Upper Abdominal and Presternal Catheters

Stencils are exceedingly helpful in determining optimal upper abdominal and presternal exit-site locations. Mapping for an upper abdominal exit-site begins with the patient in a sitting position. The stencil plate possessing cutouts for the secondary incision, tunnel configuration, and exit-site is positioned over the patient's upper abdomen (**Figure 4A**). Align the medial border of the stencil with the midline of the abdomen. Adjust the stencil cranially or caudally until the exit-site cutout is in a position that is easily visible to the patient, does not conflict with belt line or bra line, is free of skin creases or blind side of skin folds, and does not fall on the apex of a bulging or floppy skin fold.[7] Confirm that cutouts for the subcutaneous arcuate tunnel do not conflict with the costal margin. After achieving a suitable location, mark the skin at the exit-site cutout. If a suitable exit-site cannot be obtained, proceed to assessment for a presternal exit-site location.



[7]

Figure 4. With the patient sitting, stencils can be used to select a suitable upper abdominal or presternal exit-site. Only the swan neck bend pattern of the stencil is used for marking because all commercially available extended catheters are equipped with preformed arc bends. **Figure 4A.** The preformed arc bend is directed laterally for upper abdominal catheters. **Figure 4B.** The preformed arc bend is directed medially for presternal catheters.

Mapping for a presternal catheter exit-site is performed with the patient in a sitting position. Female patients should wear their normal bra in order to note the point of rise of the breast mound. The stencil plate, possessing cutouts for the secondary incision, tunnel configuration and exit-site, is positioned over the patient's upper chest (**Figure 4B**).[9] Align the medial border of the stencil with the midline of the chest. Adjust the stencil cranially or caudally until the exit-site cutout is in a position that is not in the open collar area, does not conflict with a possible future midline sternotomy, is free of the fleshy or bulging part of the breast, and does not conflict with the bra line.[4,9] Confirm that cutouts for the subcutaneous arcuate tunnel do not clash with the clavicle. After achieving a suitable location, mark the skin at the exit-site cutout.[9]

After a satisfactory upper abdominal or presternal exit-site has been marked, the patient assumes a recumbent position. Female patients should remove the bra at this point to duplicate the conditions present during the catheter implantation procedure. Measurements are made, recording the horizontal distance from the marked exit-site to the abdominal or chest midline and the vertical distance from the point of intersection of the horizontal line with the midline to a landmark such as the umbilicus for upper abdominal catheters or the jugular (suprasternal) notch for presternal catheters. Distinctive moles or scars also can be used as landmarks to locate the exit-site. Measure and record the distance from the selected exit-site to these distinguishing marks.[9]

Procedure Day Mapping

On the day of procedure in the preoperative holding area or operating room, the exit-site is marked based upon the previous measurements. For standard Tenckhoff catheters, the stencil is superimposed over the denoted exit-site, and the cutouts for the subcutaneous tunnel, superficial cuff location, and insertion incision are marked (**Figure 3B**). For upper abdominal and presternal catheters, after marking the exit-site and superimposing the exit-site cutout of the stencil over this point, the secondary incision, subcutaneous tunnel, and superficial cuff cutouts are marked (**Figure 5**). For upper abdominal and presternal catheters, the stencil for the lower abdominal segment of this 2-piece extended catheter is positioned on the abdominal wall. Align the medial border of the stencil with the midline of the abdomen. Adjust the stencil so that the mark for the pubis is superimposed over the palpated upper border of the pubic symphysis. Mark the primary incision site for insertion of the lower abdominal catheter segment (**Figure 5)**.

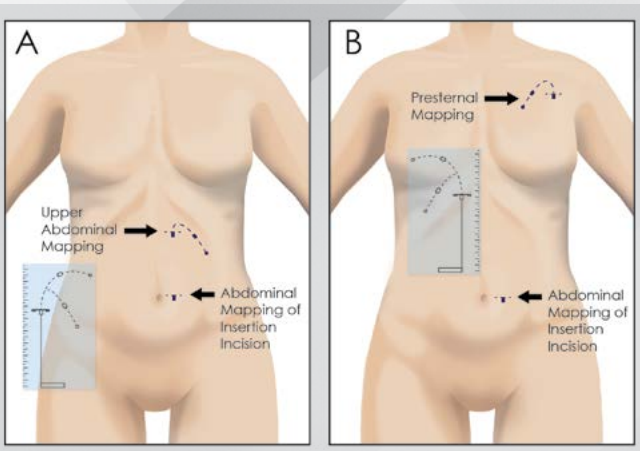


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Figure 5A. For upper abdominal catheters, the stencil cutouts for the secondary incision, tunnel configuration, cuff positons, and exit-site location for the upper abdominal catheter segment are marked on day of procedure. In addition, a stencil is used to mark the primary insertion incision for the lower catheter segment.
Figure 5B. For presternal catheters, the stencil cutouts for the secondary incision, tunnel configuration, cuff positons, and exit-site location for the upper chest catheter segment are marked on day of procedure. A stencil is also used to mark the primary insertion incision for the lower catheter segment.

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B. PREOPERATIVE AND POSTOPERATIVE PD CATHETER INSERTION PATIENT INSTRUCTIONS

It is essential to establish appropriate communication between the surgeon and the nephrology/dialysis clinic during preparation and follow-up to PD catheter placement.

A variety of procedures exist for catheter insertion. Your patient should always consult your individual healthcare practitioner for his or her specific recommendations.

The instructions below may offer your patients guidance during the process of planning, PD catheter placement, and follow-up with their healthcare team in order to assure both patient education and successful outcomes during initial access placement.

Before Surgery

The catheter placement procedure will be thoroughly explained. Marking of the catheter site (determination of the optimal location, e.g., away from the belt line, within easy reach and sight, right or left side) may be completed at this time. Questions and concerns will be addressed.

Shower with a disinfectant soap, as directed: _____

Do not eat or drink after: _____

Bowel preparation (if required): _____

Alert the surgeon/doctor of any known hernias: _____

Medications:

Take: _____

Do not take (hold): _____

Adjust dosage: _____

Antibiotics: _____

Report any unusual cough, fever, chills, or ill feelings prior to surgery.

Date of catheter placement: _____

Report to (location): _____

Please notify the dialysis clinic when your catheter surgery has been scheduled.

Additional instructions/notes: _____

_____

_____

_____

_____

_____

After Surgery

- Report any of the following to your surgeon/doctor:
  - Bleeding
  - Fever
  - Vomiting
  - Severe cough
  - Severe pain
  - Wet or dirty/soiled dressing
  - Dressing falls off

Emergency Contact: _____

- The surgical dressing SHOULD BE LEFT IN PLACE FOR AT LEAST 7 DAYS
- The dressing should only be changed by your doctor or nurse at the dialysis clinic
- Do not shower or bathe until advised by the dialysis clinic that the exit-site is healed
- Avoid heavy lifting, stair climbing, straining, and constipation. Your activities for the next few weeks should be light
- Resume all routine medications and diet as instructed by your doctor
- Talk with the surgeon about the need for pain medication
- If antibiotics are ordered, take as directed until they are gone
- Call your dialysis clinic to schedule your follow-up appointment

The telephone number is: _____

C. PERITONEAL DIALYSIS CATHETER INSERTION IN PATIENTS ON ANTIPLATELET AND ANTICOAGULANT THERAPIES

Antiplatelet Therapy

One of the most common questions that prompts cardiology consultation is management of antiplatelet therapy in patients undergoing peritoneal dialysis (PD) catheter insertion or whether or not the necessity for antiplatelet therapy will even permit timely placement of the peritoneal catheter. Antiplatelet agents are prescribed following percutaneous coronary artery stent implants and balloon angioplasties to lower the risk of future ischemic and atherothrombotic events. Interrupting antiplatelet therapy to reduce the risk of bleeding during surgical procedures may expose patients to the potential risk of stent thrombosis, perioperative myocardial infarction, and cardiovascular death.[1,2] Postponing PD catheter placement due to concerns for disrupting antiplatelet therapy may result in patients being relegated to hemodialysis with a central venous catheter.

Decisions regarding antiplatelet therapy management are individualized based upon risks of perioperative bleeding and ischemic complications. PD catheter insertion is considered a low to intermediate risk procedure for bleeding; therefore, perioperative antiplatelet strategies are largely based upon thrombotic risks associated with the extent of the coronary lesions and the time interval following balloon angioplasty or implantation of bare metal or drug-eluting stents. The cardiologist will assess the patient as low, intermediate, or high risk based upon the extent of coronary artery disease, the coronary interventions employed, and the elapsed time following interventions[1] (Table A).

Table A

Determination of Thrombotic Risk*		
Low Risk (<1%)**	**Intermediate Risk (1%-5%)****	**High Risk (>5%)****
>4 weeks after PCI with POBA	>2 weeks and ≤4 weeks after PCI with POBA	≤2 weeks after PCI with POBA
>6 months after PCI with BMS	>1 month and ≤6 months after PCI with BMS	≤1 month after PCI with BMS
>12 months after PCI with DES	>6 months and ≤12 months after PCI with DES	≤6 months after PCI with DES
	>12 months after complex PCI with DES (long stents, multiple stents, overlapping, small vessels, bifurcations, left main, last remaining vessel)	≤12 months after complex PCI with DES
		≤6 months after PCI for MI Previous ST

* Modified from Table 1. Banerjee S, et al. *J Am Coll Cardiol* 2017;69(14):1861-70.

**30-day ischemic event rates of cardiovascular death and MI

BMS = bare-metal stent(s); DES = drug-eluting stent(s); MI = myocardial infarction; PCI = percutaneous coronary intervention; POBA = plain old balloon angioplasty; ST = stent thrombosis.

Many patients are treated with two types of antiplatelet agents to prevent blood clotting (dual antiplatelet therapy). One antiplatelet agent is low dose aspirin. The second type of antiplatelet agent, called a $P2Y_{12}$ inhibitor, is usually prescribed for months or years in addition to the aspirin therapy. $P2Y_{12}$ inhibitors include clopidogrel, prasugrel, and ticagrelor.[1]

A prudent approach to perioperative management of dual antiplatelet therapy for patients undergoing PD catheter placement who are assessed as low or intermediate risk for a thrombotic event is to continue low dose aspirin throughout the perioperative period, stop the $P2Y_{12}$ inhibitor 5 to 7 days before the procedure, and resume the $P2Y_{12}$ inhibitor postoperatively with a loading dose.[1] Patients with high thrombotic risk, who are unsuitable for hemodialysis or demonstrate significant hemodynamic instability on hemodialysis, managed by PD can be assessed for continuing both aspirin and the $P2Y_{12}$ inhibitor throughout the perioperative period. Alternatively, aspirin is continued but the $P2Y_{12}$ inhibitor is stopped before PD catheter insertion, bridging the interrupted period before the procedure with a short acting intravenous fibrinogen antagonist (tirofiban, eptifibatide) or $P2Y_{12}$ receptor antagonist (cangrelor). In either scenario, the $P2Y_{12}$ inhibitor is resumed postoperatively. These regimens are highly customized based upon patient-specific factors and requires the collaboration of a cardiologist for management. Dosages, timing for stopping and resuming $P2Y_{12}$ inhibitors, and utilization of bridge therapy are determined by the specific agents used and the balancing of thrombotic and hemorrhage risks.[1,2] Timely placement of a peritoneal catheter is not necessarily hindered by antiplatelet therapy, but it does demand careful patient evaluation and team-based decision making to assure the safest possible performance of the procedure.

Anticoagulant Therapy

Long-term oral anticoagulant therapy is often used in patients with atrial fibrillation, mechanical heart valves, or history of venous thromboembolism. Bleeding risks for hemodialysis patients on anticoagulants is greater than that experienced by peritoneal dialysis patients, a factor that should be included in predialysis education to assist in informed decision-making regarding modality choice.[3] Nonetheless, anticoagulant therapy will require adjustments during the perioperative period around peritoneal catheter placement.

Warfarin, a vitamin K antagonist, remains the gold standard for anticoagulation in dialysis patients. The use of newer direct-acting oral anticoagulants (dabigatran, rivaroxaban, apixaban, edoxaban) should be avoided when creatinine clearance is < 15 ml/min.[4] In warfarin-treated patients who need periprocedural treatment interruption, warfarin is typically stopped 5 days prior to the surgical procedure to allow its anticoagulant effect to dissipate. Warfarin is resumed within 24 hours postprocedure, usually with a loading dose to minimize the period of subtherapeutic anticoagulation.[5,6]

An important clinical question arises regarding whether or not bridging anticoagulation is needed during the interval the warfarin effect is wearing off. If the patient has a high stroke risk, recent deep vein thrombosis, or a high-risk mechanical heart valve, consideration should be given to using low molecular weight heparin (LMWH) bridging, e.g., enoxaparin, beginning 3 days before surgery and continued up until 24 hours before the procedure. The LMWH is resumed 24 – 72 hours after surgery and continued until warfarin anticoagulation has reached therapeutic levels.[5] Similar to perioperative management of antiplatelet therapy, these treatment strategies are highly individualized based upon patient-specific factors and should include the collaboration of cardiologists and, if available, clinical pharmacist-led anticoagulation services in team-based decision-making approaches.[7]

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D. EXTERNALIZATION OF EMBEDDED CATHETERS

Externalization of an embedded catheter presumes that the patient has selected a dialysis care provider and that a nephrologist has ordered a planned start date for peritoneal dialysis (PD) treatment and training. The externalization procedure is preferably performed in the clinic or office environment provided there is a suitable treatment room for sterile procedures.[1,2] Externalization of the embedded catheter can be performed by anyone possessing basic surgical skills and who has been mentored in the procedure. In addition to the PD access provider, externalizations have been performed by nephrologists, physician assistants, and nurse practitioners.

While chronic constipation is recognized as a common cause for catheter flow dysfunction in the postoperative period following PD catheter insertion, it can also represent a problem with flow dysfunction at the time of embedded catheter externalization. If time permits, patients with a history of constipation should undergo bowel preparation with oral osmotic agents such as lactulose or polyethylene glycol solution prior to the externalization procedure.[2] If the externalization procedure is performed outside of the dialysis facility, the patient should be provided a sterile titanium catheter adapter, transfer set, and mini-cap to bring with them to the offsite location. Preoperative antibiotics have not been commonly used for this minor operative procedure.[1]

A PD access provider knowledgeable in embedding catheters will have employed several procedural techniques during catheter implantation that facilitate the externalization process. At the time of catheter placement, the provider should have temporarily externalized the tubing through the skin at the future exit-site location. The catheter is tested for flow function, infused with heparin solution, and embedded in a linear or curvilinear subcutaneous pathway with a commercially available stylet equipped with a tubing plug. The stylet is exited through an additional incision at the lower end of the embedding track, separated from the tubing plug, the plugged end of the catheter is tucked into the subcutaneous tissues, and all skin wounds are closed. The catheter tubing should rest superficially in the subcutaneous tissues at the level of the future exit-site. The future exit-site scar serves as the landmark where to externalize the catheter. The catheter tubing should be palpable below the exit-site scar. The linear or curvilinear subcutaneous track enables easy extraction of the embedded limb of the catheter.[1,2]

The surgical site for externalization is prepped with an antiseptic agent and sterile drapes are applied around the surgical field. Local anesthetic agent is injected in the skin at the future exit-site scar and a small incision is made with care not to stick or cut the catheter. Blunt hemostat dissection is performed to expose the catheter tubing. The fibrous sheath that envelops the tubing is disrupted with a hemostat and the catheter is delivered to the skin surface. Steady traction on the catheter tubing is performed to pull it from the subcutaneous track.[1] The end of the catheter tubing with the plug is amputated, the catheter adapter inserted, and the transfer set attached. Catheter patency is tested with syringe irrigation or a formal flush with 500-1,000 mL of saline solution.[1,2] The catheter is immobilized at the exit-site with medical tincture adhesive, sterile adhesive strips, and a non-occlusive dressing. The exit-site is managed identical to the protocol used for primarily externalized catheters.[2]

It is not uncommon to recover fibrinous debris during the initial syringe irrigation of the catheter. Forceful push-pull irrigation may be necessary to dislodge a fibrin plug. Causes of continuing flow dysfunction include constipation, extensive fibrin plug, bladder distention, catheter malposition, tissue entrapment, and adhesions. Trial intraluminal dwelling of tissue plasminogen activator, an abdominal x-ray, and bladder scan are useful steps in the initial investigation of flow dysfunction. Persistent flow

dysfunction will require laparoscopic or radiological intervention. Catheters have been embedded for months to years with an 85% to 93% immediate function rate upon externalization.[1-5] Overall, 94% to 99% of embedded catheters are successfully used for dialysis after laparoscopic or radiologic revision for nonfunctioning catheters.[2,3,5]

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E. NON-TRADITIONAL PD INITIATION

Non-traditional PD initiation includes urgent start PD and acute PD for AKI. Many End Stage Kidney Disease (ESKD) 5 patients present with no pre-dialysis care or dialysis initiation plan. Historically they have all been treated with insertion of a central venous catheter (CVC) and hemodialysis (HD). Urgent start PD allows PD to be an initial modality option which avoids the automatic CVC to in-center HD paradigm. It can be utilized in stable outpatients or inpatients.

PD is the original continuous renal replacement therapy (CRRT) used to successfully treat acute kidney injury (AKI). Development of modern CRRT machines resulted in a decline in use of acute PD. COVID-19 resulted in an unexpected volume of AKI, for which CRRT supplies were inadequate. Acute PD emerged as a valid alternative.[1]

Urgent Start PD

Benefits of urgent start PD:

- Avoids CVC for dialysis initiation in ESKD 5 patients who present without modality plan
  - Dialysis initiation with PD catheter is associated with statistically better survival vs CVC.[2]
- PD protects RKF better than HD[3,4,5,6,7]
  - RKF and urine output correlate with improved survival[8]
- Improves PD census growth[9]
- Provides benefits of PD vs HD to patient
  - Bloodless therapy; no needles
  - Preserves vasculature for future use
  - Provides early survival benefit[9]
  - Continue employment
  - Flexible schedule, greater sense and independence
  - Easier to travel

Required Infrastructure:[10]

- Objective patient selection method (based on established PD medical and social eligibility criteria)
- Pt education protocols
- PD catheter placement on demand
- Nursing: appropriate training and adequate nurse to patient ratio
- Hospital and dialysis unit administrative support
- Protocol-driven orders
- Gurney or dialysis chair that lays flat
- PD cycler
- PD supplies

Urgent Start Process:[10] (modified from Ghaffari 2013)

Patient presents with advanced CKD without a plan for dialysis

- Receives modality education
- If pt is a candidate for PD, PD is recommended
- Patient agrees with urgent-start PD

→ **Patient referred for urgent PD catheter placement (within 24-48 hours)**

→
- **Inpatient urgent-start PD** (if patient has other reasons for hospitalization)
- **Outpatient urgent-start PD** (if no other need for hospitalization)

→ **Patient receives in-center low-volume recumbent APD based on protocol-based prescription for two weeks (or until ready for discharge home)**

- PD training begins on non-dialysis days in week 2
- After training is complete, pt is independent and dialyzes at home

Urgent Start Prescription:[11]

- Usually done intermittently 3x per week
- Use cycler with patient supine
- Patient must always be supine when dialysate in peritoneum
  - Must drain if patient needs to sit or stand up
- Cycler time 5-8 hours with 4-6 cycles
- Fill volume of 500-1200 mL, based on body size and GFR
- Dialysate Dextrose-1.5% or 2.5%
  - 4.25% may be needed dependent on volume status
- Avoid constipation and straining
- With severe volume overload may need high does oral diuretic and 4.25% Dextrose

Acute PD for AKI:

Benefits of Urgent Start PD:

- Catheters may be placed in any manner. During COVID-19 open dissection at the bedside was frequently used.
- APD is preferable to CAPD to minimize nursing time and interaction
- ISPD Guidelines[12]
  - Weekly Kt/V target 3.5 is comparable to a daily HD in critically ill pts. In many pts weekly kt/V 2.1 has been adequate
  - "Cycle times should be dictated by the clinical circumstances. Short cycle times (1–2 h) are likely to more rapidly correct uremia, hyperkalemia, fluid overload and/or metabolic acidosis; however, they may be increased to 4–6 hourly once the above are controlled to reduce costs and facilitate clearance of larger sized solutes"

Sample APD Prescription Protocol:[1]

- **Initial 24 hours:**
  - Fill volumes: 1-1.5L (dependent on weight <70KG vs. >70 Kg)
  - Exchange time: 1 hour
  - Daily therapy time: 8-24 hours
- **After 24-48 hours if no leaks:**
  - Fill volume: increase by 500 mL
  - Exchange time: 2 hours
  - Daily therapy time: 8-24 hour

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F. PERITONEAL IMAGING

Various imaging techniques can be used to diagnose suspected dialysate leaks into the subcutaneous tissue, pleural cavity, retroperitoneal space, or the genitals. Computerized tomography (CT) imaging peritoneography, peritoneal scintigraphy, or magnetic resonance imaging (MRI) can be used to confirm abnormal dialysate locations.[1,2,3] CT and scintigraphy involve the addition of either CT contrast material into the dialysate or a radioactive isotope.

After injection of the contrast material or isotope into the dialysate and the dialysate is allowed to dwell, the radiographic images are obtained to assist in diagnosis.[2] With MRI no contrast agent is required as the dialysate itself brightly enhances during MRI.[3] This information is important in order to localize the leakage site and to assist the surgeon if surgical intervention is necessary.[2] Peritoneal imaging can also be used to identify fluid loculation, a result of peritoneal adhesions.

Note: Communicate the purpose of the test to the radiologist and review radiographs personally. It is advisable to coordinate the diagnostic study with the PD (Peritoneal Dialysis) nursing staff to perform the addition of the imaging marker to the dialysate and to make the tubing connections to prevent contamination of the catheter by healthcare personnel who may be unfamiliar with dialysis technique.

Magnetic Resonance Imaging (MRI):[3]

No contrast is required. Patient is allowed to dwell the dialysate exchange while positioned in the MRI scanner. Images are obtained of suspected area of leakage using T2-weighted images.

Peritoneal Scintigraphy:[2]

Procedure:

- Add 2 mCi of technetium-99m sulfur colloid to 2 L of dialysis solution
- Infuse radionucleotide-containing dialysate into supine patient with anterior dynamic images obtained at 1 frame per minute for 15 minutes
- Instruct patient to move and walk for 30–60 minutes to promote intraperitoneal mixing and to raise intra-abdominal pressure to drive the radiotracer into the source of the leak
- Obtain 5-minute postambulatory static images in anterior, posterior, and both lateral views
- Drain dialysate from peritoneal cavity and repeat 5-minute static images in anterior, posterior, and both lateral views

Include chest if pleuroperitoneal fistula is suspected. Include inguinal region if scrotal swelling has been noted.

CT Peritoneography:

Brief Procedure Outline:

- Add 100 mL of a nonionic contrast media (100 mL iopamidol-300, 100 mL iohexol-300, or 100 mL iodixanol-320) to 2 L of dextrose 1.5%[4]
  - Do not use normal saline for infusion as it will be absorbed. Patient could potentially become fluid overloaded.[5]
- Infuse dialysis solution with radiocontrast into supine patient. Infusion should be performed by trained staff only[4]
- Instruct patient to move and walk to promote intraperitoneal mixing and to raise intra-abdominal pressure to drive the contrast into the source of the leak[2,4]
- Wait for at least 1-2 hours before doing CT scan. Must allow time for dialysate with contrast to spread through any leaks before doing CT scan.[4,6]

If pleuroperitoneal fistula is suspected, CT should include the chest. If scrotal swelling has been noted, the examination should include this area, otherwise avoid radiation of the testes.

DETAILED PROCEDURE GUIDE FOR CT PERITONEOGRAPHY FOR USE IN RADIOLOGY:[7]

CT peritoneography procedure checklist using PD solution in a twin-bag CAPD system

Preparation

- When possible, arrange attendance of a PD nurse
- Patient should arrive for CT scan with abdomen fully drained
- Supplies brought by PD nurse or patient to radiology appointment: 2 L 1.5% dextrose, low calcium solution twin-bag CAPD (Continuous Ambulatory Peritoneal Dialysis) system, two tubing clamps, and a replacement disconnect cap. Do not proceed unless all supplies are available
- Masks worn by all present in the room during all connections and solution transfers
- Handwashing and aseptic technique required during all connections and solution transfers

Step 1: Add contrast to dialysate

- Add 100 mL nonionic contrast medium, 300 mgI/mL, to 2 L of 1.5% dextrose solution of twin-bag CAPD system using strict aseptic technique[a]
  - Prepare medication port site using aseptic technique[b]
  - Prepare 100 ml of nonionic contrast for injection using Luer lock syringes and blunt needles. Inject the contrast into dialysis solution via medication port.* Do not inject air into vial and use no more than 2 needle entries into any one container
  - Reposition container with container ports up and evacuate medication port by squeezing and tapping it
  - Mix solution and contrast thoroughly
- The dialysate-contrast mixture is administered within 1 hour of compounding the solution

[a] Do not use normal saline for infusion, as it will be absorbed, and the patient could potentially become fluid overloaded
[b] Commonly used disinfectants are povidone-iodine or sodium hypochlorite. (Disinfectant must be in contact with injection port for several minutes to be effective. Consult your hospital's policy)
* See figure 1

Step 2: Connect twin-bag CAPD system with contrast solution to patient and infuse into abdomen

- Must be done by trained staff using sterile technique
- Masks, handwashing, and aseptic technique required during connection of the twin-bag CAPD system to the PD catheter transfer set
  - Ensure transfer set is closed
  - Break the blue frangible* in the patient connector line of twin-bag CAPD system
  - Remove the yellow pull ring* from twin-bag CAPD system. Do not touch sterile end.
  - Using aseptic technique, remove and discard the disconnect cap from the transfer set*
    - Do not allow the exposed end of the transfer set to touch anything; it must remain sterile
  - Immediately attach the twin-bag CAPD system to transfer set
    - Twist patient connector of twin-bag CAPD system onto transfer set until firmly secured
  - Clamp solution infusion line
  - Break green frangible* near solution bag
  - Hang solution container and place the drain bag below the level of the abdomen
  - Open transfer set and attempt to drain any residual peritoneal fluid
  - After drain is complete close the transfer set
  - Perform flush, before filling the patient, to prime line
    - Remove the clamp from solution line (also known as the infusion line*), allow dialysate to flow into drain bag for 5 seconds, then clamp drain line
  - Open transfer set to allow solution to fill abdomen. (May take 10-15 minutes)
  - When fill is complete, close transfer set and clamp infusion line.
  - Leave twin-bag CAPD system attached to PD catheter during scan. (Avoids the need for a second twin-bag CAPD system)
- The patient should be ambulatory for at least 1 hour before undergoing the CT scan. If the patient is unable to ambulate, frequent turning from side to side should be performed

Step 3: Perform CT scan

- When CT peritoneography performed for suspected abdominal wall leak, consider performing the CT scan with the patient prone
- The genitalia are included in the scan if genital edema is present
- The lower thorax is included if a leak into the pleural space is suspected

Step 4: Drain peritoneum post CT utilizing the twin-bag CAPD system still connected to patient

- Place drain bag on floor and unclamp drain line
- Open transfer set
- Allow dialysate to drain into drain bag via gravity. (May take up to 20 minutes to fully drain)

*see figure 1 for location

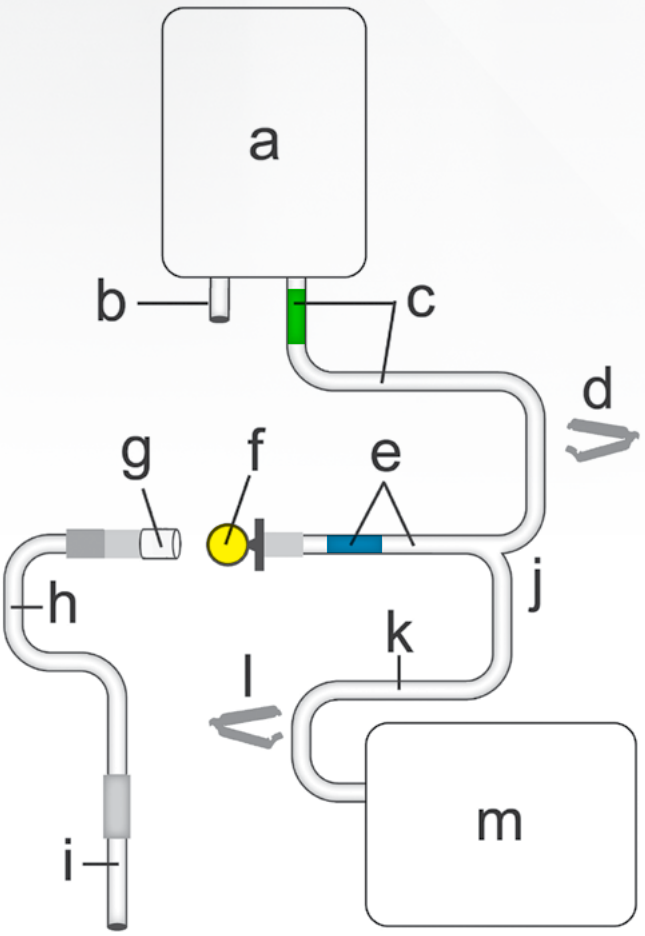
Step 5: Disconnect twin-bag CAPD system

- Masks, handwashing, and aseptic technique required during disconnection of the twin-bag system from the PD catheter transfer set
  - Assure both lines are clamped
  - Open new disconnect cap package
  - Disconnect twin-bag CAPD system from transfer set
  - Put new disconnect cap onto transfer set.
  - Twin-bag CAPD system is discarded
  - Return tubing clamps to the PD nurse or patient upon completion of the procedure.

Figure 1. Twin-bag CAPD system used during performance of CT peritoneography[8]

Illustrated is a twin-bag CAPD system:

(a) dialysis solution bag
(b) medication injection port
(c) green frangible inside infusion line
(d) infusion line clamp
(e) blue frangible inside patient connector line
(f) yellow pull ring
(g) disconnect cap
(h) transfer set
(i) peritoneal dialysis catheter
(j) Y-junction
(k) drain line
(l) drain line clamp
(m) drain bag



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G. PRINCIPLES OF ACCURATE PERITONEAL DIALYSIS EFFLUENT SAMPLING AND CULTURING

Identifying appropriate antibiotic therapy is dependent on accurate specimen collection and microbiological diagnosis of peritonitis.

Key Points for Specimen Processing:

- Culture should be obtained as early as possible
- The first bag of cloudy solution is the best specimen, as the probability of a positive diagnostic culture is the greatest
- Patients or PD staff should send the first cloudy bag or an aliquot thereof to the laboratory as quickly as possible
- As large a volume (20 to 100 mL) as possible should be cultured or concentrated to maximize bacterial recovery rates
- Draw fluid from medication port
- Inject fluid into standard blood culture medium (5–10 mLs required per bottle)[1]
  - If immediate delivery to the lab is not possible, ideally the inoculated bottles should be incubated at 37° C.[1]
- The collection and processing of specimens require meticulous care in order to avoid contamination of the fluid
- Laboratory should be notified of specimens obtained from patients receiving antibiotic therapy, as they may require special handling
- Identification and sensitivity testing should be expedited to facilitate initiation of specific antibiotic therapy

Sterile or Culture-negative Peritonitis:[1]

- Incidence of sterile peritonitis varies from 2% to 20% and is more common when the laboratory facility does not have experience in processing peritoneal dialysis effluent
  - If >15% of peritonitis episodes are culture negative, review sampling and culture methods[1]
- Other factors contributing to a high incidence of sterile peritonitis include:
  - Insufficient culture sample volume
  - Causative organism difficult to culture
  - Causative organism requiring specialized culture media (e.g., mycobacteria)
  - Patient may not have informed PD center of current antibiotic treatment
  - Patient's signs and symptoms related to other medical condition (e.g., pancreatitis)

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H. PERITONEAL EFFLUENT CULTURE LABORATORY PROCESSING

The correct microbiological culturing of peritoneal effluent is of utmost importance to establish the microorganism responsible for the infection. Identification of the organism and subsequent antibiotic sensitivities will not only help guide antibiotic selection, but, in addition, the type of organism can indicate the possible source of the infection.[1] Culture-negative peritonitis rates should not be more than 20% of episodes. Standard culture technique is the use of blood culture bottles, but culturing the sediment after centrifuging 50 mL of effluent may lower the risk of a culture-negative occurrence.[1]

Procedure:[1]

- Centrifuge 50 mL of peritoneal effluent at 3000 g for 15 minutes
- Follow centrifugation with resuspension of the sediment in 3 to 5 mL of sterile saline
- Inoculate this material both on solid culture media and into a standard blood-culture medium (method most likely to identify the causative organisms; with this method, less than 5% will be culture-negative)
- The solid media should be incubated in aerobic, microaerophilic, and anaerobic environments
- Blood-culture bottles can be directly injected with 5–10 mL of effluent if equipment for centrifuging large amounts of fluid is not available (this method generally results in a culture-negative rate of 20%)
- The removal of antibiotics present in the specimen may increase the isolation rate if the patient is already on antibiotics

Important Points:

- The speed with which bacteriological diagnosis can be established is very important
- Concentration methods not only facilitate correct microbial identification but also reduce the time necessary for bacteriological cultures to turn positive
- Rapid blood-culture techniques (e.g., BACTEC, SEPTI-CHEK, BacT/ALERT) may further speed up isolation and identification.[1] A resin culture bottle should be used if patient is on antibiotics or antibiotics were discontinued less than 24 hours prior to culture
- The majority of cultures will become positive after the first 24 hours and, in over 75% of cases, diagnosis can be established in less than 3 days[1]

Mycobacterium Examination:[1]

- Examine smear of the peritoneal effluent with the Ziehl-Neelsen stain ("smear-negative" disease is common)
- The sensitivity of the smear examination by the Ziehl-Neelsen technique can be enhanced by centrifuging 100–150 mL of the dialysate sample
- Prepare smear from the pellet
- A specific diagnosis can be made by culturing the sediment, after centrifugation of a large volume of effluent (50–100 mL), using a solid medium (such as Lowenstein-Jensen agar) and a fluid medium (SEPTI-CHEK, BACTEC; Becton Dickinson; etc.)

- The time of detection for growth of mycobacteria is decreased considerably in fluid medium
- Repeat microscopic smear examination and culture of dialysis effluent is mandatory for better yield in suspected cases of mycobacterial peritonitis

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I. PERITONITIS RATE CALCULATIONS

The most accurate peritonitis rate is one that is cumulative over a period of 12 months. Measuring peritonitis rates both for the individual patient and PD facility provides insight into the peritoneal dialysis outcomes leading to interventions that may improve results. Knowing peritonitis rates also allows for intercenter comparisons at different time points.

METHOD 1: Peritonitis Rate: One episode per number of patient months[1]

STEP 1	Total number CAPD/APD patient days at risk/30.4 days per month = patient months experience **Example:** 2,000 days/30.4 days per month = 65.8 months experience
STEP 2	Number of patient months/number of episodes of peritonitis = 1 episode per number of patient months **Example:** 65.8 months/2 episodes = 32.9 or 1 episode every 32.9 patient months

METHOD 2: Peritonitis Rate: Episodes per patient year[1]

STEP 1	Total number CAPD/APD patient days at risk/365 days per year = patient years experience **Example:** 2,000 days/365 days per year = 5.5 years experience
STEP 2	Number of episodes of peritonitis/number of years experience = Episodes per patient year **Example:** 2 episodes peritonitis/5.5 patient years = 0.36 episodes per patient year

Important points:

- Include hospital days (once home therapy begins) in total days at risk
- Include hospital acquired peritonitis (once home therapy begins) in total peritonitis rate[2]
- Relapsing episodes of peritonitis are counted as a single episode of peritonitis[2]
- Recurrent peritonitis is a new episode of peritonitis and should be counted as an individual occurrence[2]
- Peritonitis rates should be no more than 0.5 episodes per year at risk (one episode per 24 patient – months) per ISPD 2016 recommendations[2]
- Programs should also be aware of the percentage of patients who are peritonitis free to include in unit's quality management programs
- Exit-site infection rates are calculated in the same manner as above

J. CALCULATING PERITONITIS RATES: AN EXAMPLE

XYZ Dialysis Center has the following 1st quarter patient census:

January 1–January 31	20 patients = 20 pt x 31 days = **620 patient days for January**
February 1–February 28	20 patients = 20 pt x 28 days = 560 patient days
February 5–February 28	1 new patient started PD 2/5 = 1 pt x 24 days = 24 patient days
February 10–February 28	2 new patients started PD 2/10 = 2 pts x 19 days = 38 patient days
	560 + 24 + 38 = 622 patient days for February
March 1–March 31	23 patients = 23 pt x 31 days = 713 patient days
March 12–March 31	2 new patients started 3/12 = 2 pt x 20 days = 40 patient days
March 21–March 31	2 new patients started 3/21 = 2 pt x 11 days = 22 patient days
	713 + 40 + 22 = 775 patient days for March

Total patient days for 1st quarter: 620 + 622 + 775 = 2017 pt days at risk
Total number of peritonitis episodes during 1st quarter: 2

To calculate peritonitis rates in episodes per patient month:

Take patient days at risk, 2017 ÷ 30.4 (days per month: comes from 365 days/12 months) = 66.34 patient months experience

Take patient months experience, 66.34 ÷ 2 (number of peritonitis episodes) = 33.17

So the peritonitis rate for the first quarter is: 1 episode every 33.17 patient months

To calculate peritonitis rate in episodes per patient year:

Take patient days at risk, 2017 ÷ 365 (days per year) = 5.52 patient years experience

Take the number of peritonitis episodes, 2 ÷ 5.52 (patient years experience) = .36

So the peritonitis rate for 1st quarter is: 0.36 episodes per patient year

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K. DIFFERENTIAL DIAGNOSIS OF NON-INFECTIOUS CLOUDY EFFLUENT

Cellular causes

1 Increased neutrophils

- Intra-abdominal pathology
  - Cholecystitis[1]
  - Appendicitis[1]
  - Bowel ischemia[1]
  - Pancreatitis[1]
  - Organ infarction[1]
- Drug associated[1]
  - Amphotericin B[1]
  - Vancomycin[1]
- Contamination of PD fluid
  - Endotoxin[1]
- Specimen from "dry" abdomen

2 Increased eosinophils[2]

- Allergic reaction to sterilant or plasticizer
  - Tubing/transfer sets
  - Dialysis solution bags
  - Peritoneal catheter
- Intraperitoneal air
- Drug associated
  - Vancomycin
  - Gentamicin
  - Cephalosporins

3 Increased erythrocytes

- Any cause of hemoperitoneum
- Retrograde menstruation[2]
- Ovulation[2]
- Ovarian/hepatic cyst rupture[2]
- Peritoneal adhesions[2]
- Strenuous exercise[2]
- Catheter-associated trauma[2]

4 Increased malignant cells

- Lymphoma[2]
- Peritoneal metastases[2]

Noncellular causes

5 Increased fibrin

- Post peritonitis
- Starting PD

6 Increased triglycerides[1, 2]

- Acute pancreatitis
- Neoplasms/lymphoma
- Superior vena cava syndrome
- Drug associated
  - Calcium channel blockers
- Chylous ascites

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L. PROVIDING FOR A SAFE ENVIRONMENT FOR PERITONEAL DIALYSIS

Prevention of exit-site infections and peritonitis requires that both clinicians and patients understand and practice aseptic technique. In the course of daily practice, staff must demonstrate and teach patients how to recognize the potential sources of contamination and to practice measures that will decrease the risk of infection. These preventative measures will reduce complications and promote positive patient outcomes.

Recommendations for a Safe and Clean Environment:[1]

- Prior to each exchange, clean the work area
- The exchange area must:
  - Be well-lit and private
  - Have no open windows or doors
  - Have fans and air conditioners turned off
  - Be free of pets
- For handwashing, use soap and/or alcohol-based products, followed by thorough drying with paper towels[2]
- The patient and partner or nurse must wear a face mask when performing exit-site care and dialysis exchange procedures
- Do not touch STERILE areas of the PD system[3]
- Encourage the patient to practice good hygiene
- Perform connections of PD/APD sets to solution bags and transfer sets using aseptic technique each time an exchange is performed
- Use only clean and dry port clamps. Wash clamps with soap and water.

REFERENCES

1. Ponferrada LP, Prowant BF, Satalowich RJ. Peritoneal dialysis complications. In: Counts CS, ed. Core curriculum for nephrology nursing. Pitman, NJ: *American Nephrology Nurses' Association*; 2008:824-847.
2. Firanek C, Guest S. Hand hygiene in peritoneal dialysis. *Perit Dial Int* 2011;31:399-408.
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M. HOME VISIT ASSESSMENT

Home visits are critical in the care of PD patients. It allows the nurse the opportunity to see the patient in their environment while evaluating the environment for any potential hazards. CMS conditions of coverage require a home visit at the initiation of therapy and whenever a problem is identified related to treatment at home.[1] Participation by the social worker improves the overall effectiveness of the visit. A sample Home Visit Assessment form is provided.

BEFORE THE VISIT

■ What is the goal of the visit?

- ❍ Pre-PD visit
- ❍ Discharge PD training
- ❍ 6 month visit
- ❍ Post-infection
- ❍ Other

■ Who will be performing the visit?

- ❍ PD RN(s)
- ❍ Dietician
- ❍ Social Worker
- ❍ Other

■ Have you explained the reason(s) for the visit to the patient and/or family/significant others?

❍ Yes _____Date ❍ No

■ Have the pets and/or animals been placed in a secure location?

❍ Yes _____Date ❍ No

DURING THE VISIT

Assessment of the home environment:

■ Is there a clean, clutter free work area for performing exchanges? ❍ Yes ❍ No

■ Are any of the following present in treatment room? *(check all that apply)*

- ❍ open windows
- ❍ ceiling fans
- ❍ telephone
- ❍ fans
- ❍ wall vents
- ❍ plant(s)
- ❍ window air conditioner
- ❍ pets/animals
- ❍ other person(s) present during the exchange

■ Is adequate lighting available? ❍ Yes ❍ No

Comments: _____

_____

■ Are the following handwashing tools available? *(check all that apply)*

- ❍ running water
- ❍ antibacterial pump soap
- ❍ clean paper towels
- ❍ paper towel holder
- ❍ alcohol-based hand sanitizer

If the patient uses well water, how often is it treated? _____

Comments: _____

_____

_____

DURING THE VISIT, CONTINUED

Assessment of dialysate supply and storage:

- **Dialysate Storage:** Are any of the following present? *(check all that apply)*
  - ❍ Inadequate space for dialysate
  - ❍ Dampness
  - ❍ Bug infestation
  - ❍ Water damage
  - ❍ Incorrect temperature for storage
- **Dialysate Supply:** Are any of the following present? *(check all that apply)*
  - ❍ Expired dialysate present
  - ❍ No emergency stock present
  - ❍ Incorrect dialysate type for current prescription
  - ❍ Incorrect amount of dialysate for current prescription
  - ❍ Dialysate stock is not being rotated by supplier

Comments: _____

_____

_____

_____

_____

_____

Assessment of procedures/technique:

- Instructed patient/helper to perform an exchange (including setting up the cycler if applicable). Note whether the following steps were performed during the procedure: *(check all that apply)*
  - ❍ Preparing of work area/room
  - ❍ Gathering of supplies
  - ❍ Handwashing for the appropriate amount of time and using the correct technique
  - ❍ Wearing a mask
  - ❍ Maintaining aseptic technique, following procedure as trained
  - ❍ Any shortcuts made
  - ❍ Any mistakes made
  - ❍ If a mistake was made did the patient/helper recognize mistake ❍ Yes ❍ No
  - ❍ Using correct solution strength/volume
  - ❍ Proper disposal of solution
  - ❍ Drawing up/adding medication to the dialysis bag using aseptic technique (if applicable)

Comments: _____

_____

_____

_____

_____

_____

DURING THE VISIT, CONTINUED

Assessment of medical equipment:

■ Assess that the pieces of equipment are clean and in working order: (check all that apply)

❍ BP machine
❍ IV pole (CAPD)
❍ Heating pad (CAPD)
❍ Floor/waist high scale
❍ Spring scale (CAPD)
❍ Thermometer

List any pieces that were NOT clean and in working order:

_____

_____

■ **For diabetic patients,** verify that the blood glucose meter is: (check if applies)

❍ Clean and in working order
❍ Calibrated

What is the glucose meter brand?

_____

■ **For cycler patients:**
Is the correct prescription programmed?

❍ Yes ❍ No

Comments:

_____

_____

Assessment of medicines:

■ Do a complete medication review with patient. Note any discrepancies and discuss with physician.

_____

_____

Review of findings/recommendations:

■ What were the findings and recommendations that you made to your patient and/or helper?

_____

_____

■ Were there any follow up activities that were agreed-upon? Please list them:

_____

_____

Facility member(s) signature:

_____

Date: _____

Patient/Partner signature:

_____

Date: _____

AFTER THE VISIT

- Did you review the results of the visit with all team members?

  ❍ Yes _____Date ❍ No

- Please list the necessary follow-up issues:

_____

_____

- Was there a resolution to these follow up issues?

  ❍ Yes _____Date ❍ No

Comments:

_____

_____

Signature(s):

_____

Date: _____

REFERENCES

1. ESRD Surveyor Training Interpretive Guidance: CMS Part 494 Conditions of Coverage. October 3, 2008 Final Version 1.1, revised 5/7/2014.

N. EXIT SITE ASSESSMENT

Exit site assessment is a vital part of providing excellent PD care. Routine consistent exit-site assessment enables early identification of potential exit-site problems and interventions to prevent infection. Exit site infections are associated with an increased risk of peritonitis. An observational study showed an 11-fold increase for the risk of peritonitis at 15 days post diagnosis of exit-site infection.[1]

A thorough visual inspection is necessary to evaluate the exit-site. It may be beneficial to use a magnifying glass. Palpate the tunnel for tenderness or fluctuance. Examine the visible sinus track by lifting the catheter and / or moving it laterally.[2] See Table A for sample exit-site assessment form.

Obtain a history while examining the exit-site to include:

- Frequency of exit-site care
- Routine for exit-site care
- Any recent trauma to exit-site
- Immobilization method

Exit-site Assessment:

- See chart below for comprehensive exit-site assessment
- Document findings of exit-site post assessment. Document findings in a way that will allow for future comparison, ie. scab between 2 and 3 o'clock or 1cm of erythema surrounding exit-site.

TABLE A[3]

External Evaluation		Sinus Evaluation	Trauma
Pain/Tenderness ❍ Present ❍ Absent **Skin Colour** ❍ Natural ❍ Pale pink ❍ Purplish or dark ❍ Erythema ❍ Pink ❍ Red ❍ mm measurement from border to border **Crust** ❍ None ❍ Small ❍ Large ❍ Easy to remove ❍ Difficult to detach	**Scab** ❍ Present ❍ Absent **Granulation Tissue** ❍ Absent ❍ Slightly exuberant ❍"Proud flesh" **Drainage** ❍ None ❍ Dried exudate on dressing ❍ Serous (clear) ❍ Purulent ❍ Bloody **Swelling** ❍ Present ❍ Absent	**Drainage (Sinus)** ❍ Absent ❍ Serous (clear) ❍ Purulent ❍ Bloody **Granulation Tissue (Sinus)** ❍ Absent ❍ Plain beyond epithelium ❍ Slightly exuberant ❍"Proud flesh" **Epithelium** ❍ Strong, mature, covers visible sinus ❍ Covers part of sinus ❍ Absent	**Recent Trauma** ❍ Yes ❍ No **Indications often seen with Trauma:** Pain, bleeding, scab, deterioration of exit apearance. Exit apearance will depend on intensity of trauma and length of time before evaluation.

Modified from Prowant BF & Twardowski ZJ. *Perit Dial Int* 1996;16 Suppl 3:S94-S99.

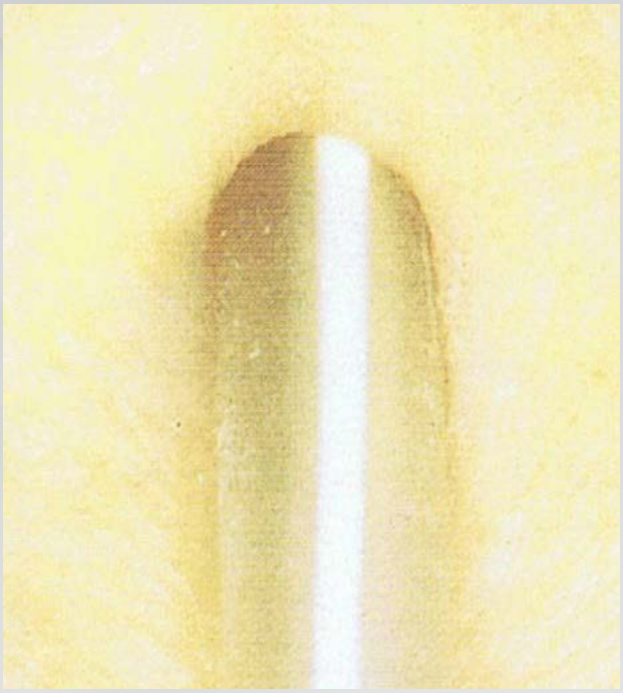
Exit-site Types:

IDEAL EXIT SITE

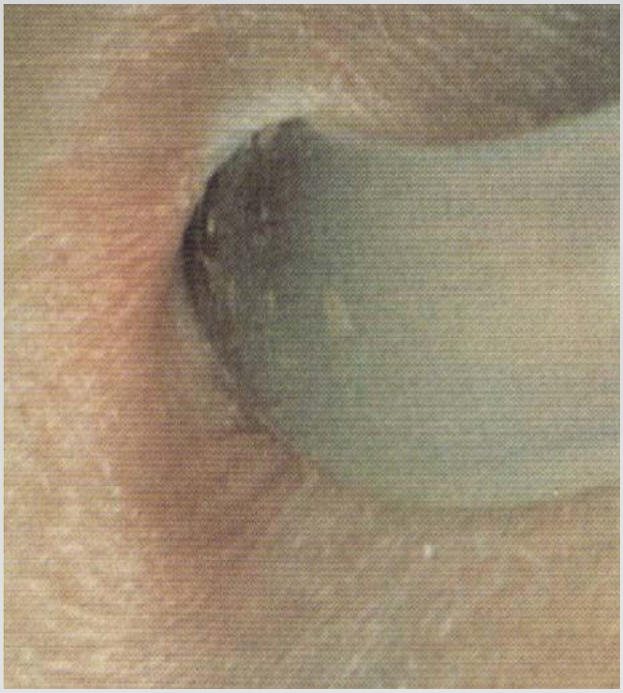
Natural skin color, sinus tract has strong mature epidermis. No drainage, scabs, or crusts.[4]

FIGURE A

EXTERNAL VIEW



SINUS VIEW



"Peritoneal Dialysis Catheter Exit Site Classification Guide" Baxter Healthcare Corporation, 1999

Exit-site Types:

EQUIVOCAL EXIT SITE

No infection present but other abnormalities seen. An equivocal site requires intervention to prevent acute infection.[4]

Possible clinical characteristics present:[4]

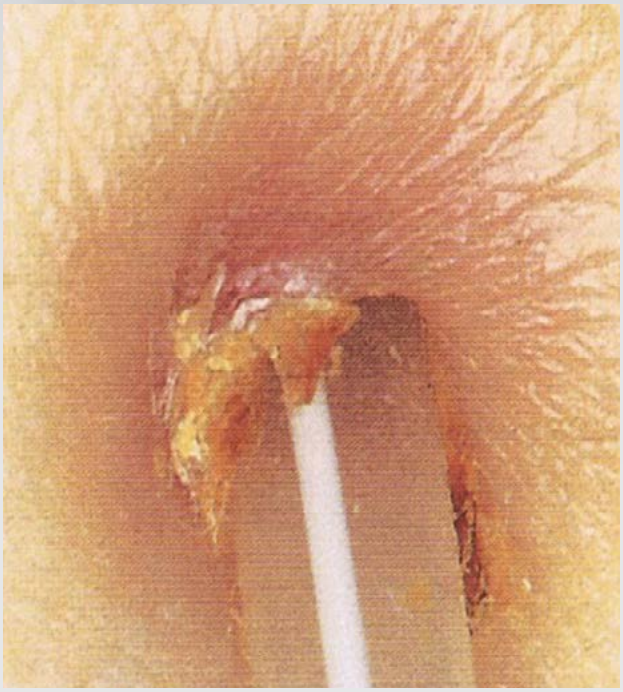
- Bright pink or redness at exit-site but <13mm
- Crusts present (may be large)
- No purulent drainage, even when pressure applied to sinus tract
- Exuberant granulation tissue may be present

Consider:

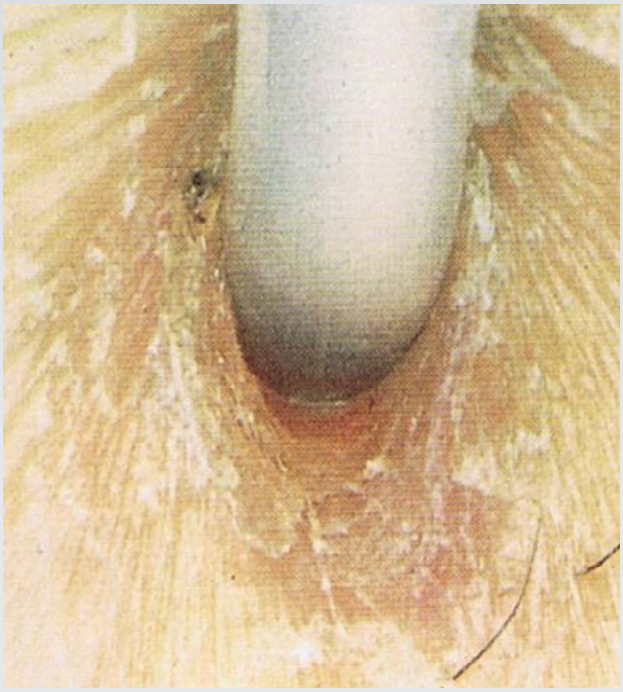
- Increased frequency of exit-site care
- More frequent assessment is essential to identify worsening condition
- Assure immobilization of catheter
- Cauterization of exuberant granulation tissue may be necessary[4]

FIGURE B

EXTERNAL VIEW



SINUS VIEW



"Peritoneal Dialysis Catheter Exit Site Classification Guide" Baxter Healthcare Corporation, 1999

Exit-site Types:

EXIT-SITE INFECTION

Exit-site infection

- "We suggest that exit-site infection is defined as the presence of purulent discharge, with or without erythema of the skin at the catheter-epidermal interface"[5]

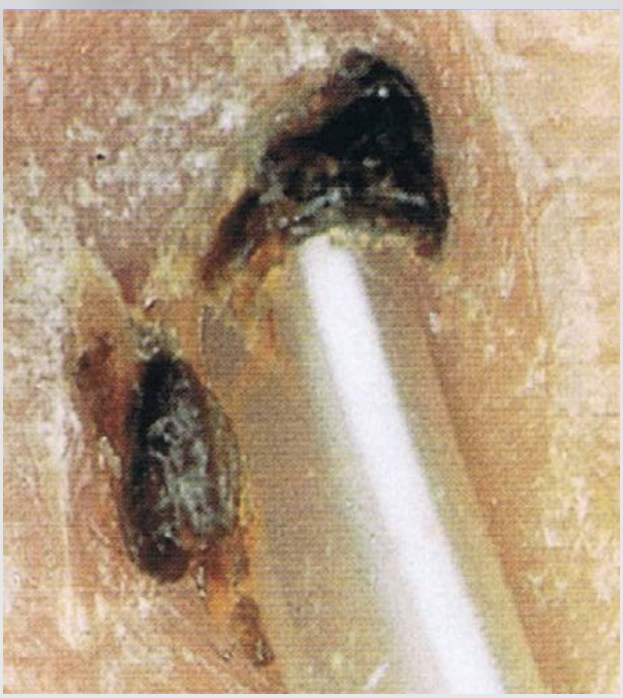
Clinical findings:

- Purulent drainage present[5]
- Redness may or may not be present[5]
- Other possible clinical characteristics:[4]
  - Crusts usually present (may be large)
  - Exuberant granulation tissue may be present

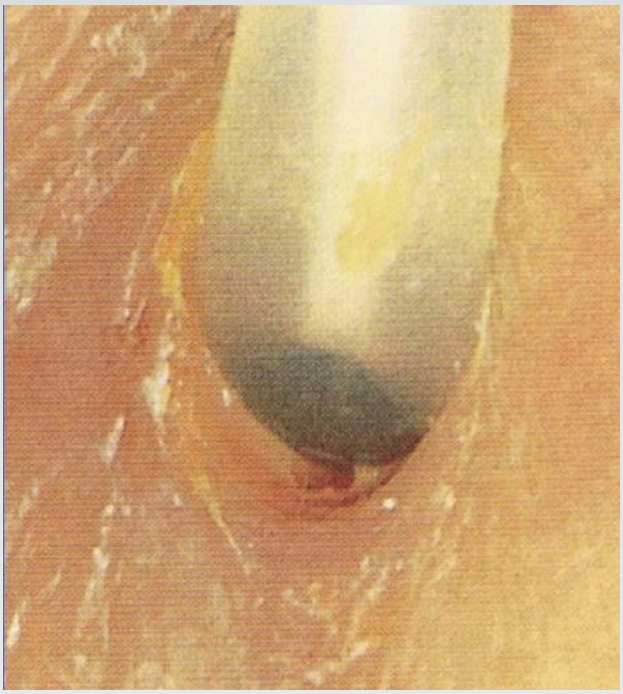
See section 3 for ISPD guidelines on treatment of an exit-site infection

FIGURE C

EXTERNAL VIEW



SINUS VIEW



"Peritoneal Dialysis Catheter Exit Site Classification Guide" Baxter Healthcare Corporation, 1999

Exit-site Types:

TRAUMATIZED EXIT-SITE

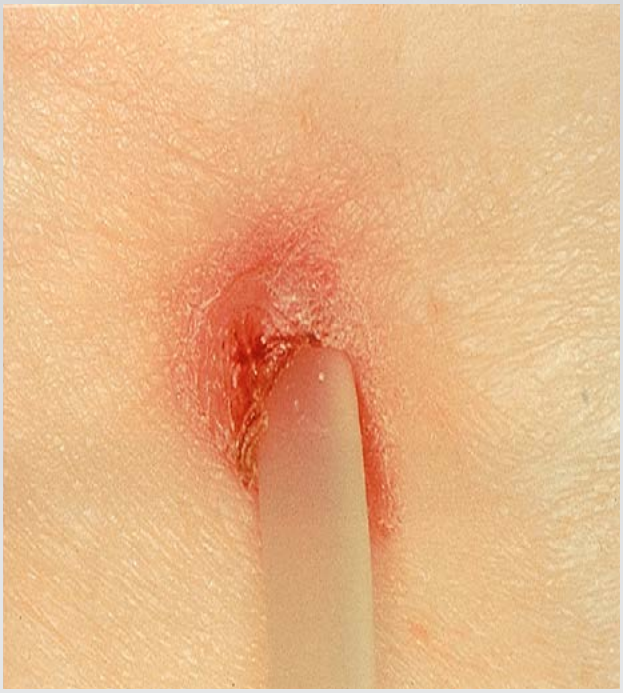
Traumatized Exit-site: Patient may experience pain, bleeding and a distorted exit-site appearance.[6] Post trauma the exit-site may deteriorate to an equivocal or infected exit-site.[2]

Clinical Considerations for the Care of the Traumatized Exit-site:

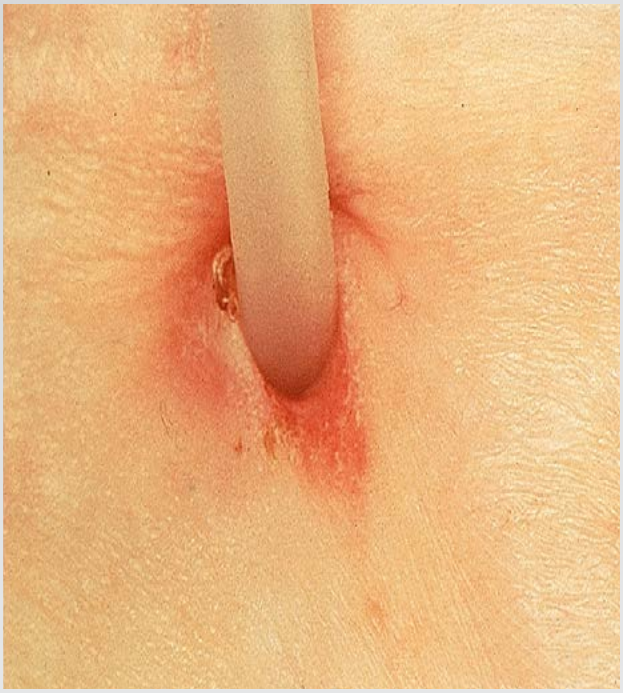
- Consider antibiotic course to prevent acute infection[6]
- More frequent exit-site care[6]
- Assure catheter immobilization[6]

FIGURE D

EXTERNAL VIEW



SINUS VIEW



"Peritoneal Dialysis Catheter Exit Site Classification Guide" Baxter Healthcare Corporation, 1999

Prevention of Exit-site Trauma:

PATIENT EDUCATION

- Avoid tension or pulling on catheter
  - An accidental pull[3]
  - Excessive tension or movement during exit-site care
  - Anchoring catheter in an unnatural position[3]
  - Anchoring the catheter too tautly
- Avoid pressure against the catheter
  - Belts, seatbelts, tight clothing[3]
  - Sleeping on the abdomen[3]
  - Prolonged leaning against the exit-site[3]
- Avoid other sources of trauma
  - Irritation from or allergy to cleansing agent, topical disinfectant or other agents used for exit site care[3]
  - Tape[3]
  - Overly vigorous exit site care/ cleansing[3]
  - Forcibly removing a crust or scab[3]
  - Scratching or picking at exit site[3]
  - Lack of immobilization of the catheter[3]

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2. Twardowski ZJ & Prowant BF. Exit-site study methods and results. *Perit Dial Int* 1996;16 Suppl 3:S6-S29.
3. Prowant BF & Twardowski ZJ. Recommendations for Exit Care. *Perit Dial Int* 1996;16 Suppl 3:S94-S99.
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5. Szeto CC, Li PK, Johnson DW, et al. ISPD catheter-related infection recommendations: 2017 update. *Perit Dial Int* 2017;37:141-154.
6. Khanna R & Twardowski ZJ. Recommendations for treatment of exit-site pathology. *Perit Dial Int* 1996;16 Suppl 3:S100-S105.

0. NORMAL BACTERIAL FLORA OF THE HUMAN BODY

Nose, Mouth, and Upper Respiratory Tract

- ***Staphylococcus aureus*** (Gram-positive)[3]
- ***Staphylococcus epidermidis*** (Gram-positive)[3]
- ***Streptococcus*** species (Gram-positive)[1]
- ***Actinomyces*** species(Gram-positive)[3]
- ***Corynebacterium diphtheriae*** (Gram-positive)[3]
- ***Haemophilus*** species (Gram-negative)[3]
- ***Non-pathogenic Neisseria*** species[1] (Gram-negative)

Skin

- ***Staphylococcus aureus*** (Gram-positive)[3]
- ***Staphylococcus epidermidis*** (Gram-positive)[3]
- ***Acinetobacter*** species (Gram-negative)[1]
- ***Pseudomonas aeruginosa*** (Gram-negative)[2]
- ***Candida*** species (fungi)[2]
- ***Corynebacterium diphtheriae*** (Gram-positive)[2]

Genitalia

- Corynebacterium species (Gram-positive)[2]
- Lactobacillus species (Gram-positive)[1]
- Alpha-hemolytic and non-hemolytic streptococci (Gram-positive)[2]
- ***Non-pathogenic Neisseria*** species (Gram-negative)[3]
- ***Candida albicans*** (fungi)[1]

Intestinal Tract

- ***Escherichia coli*** (Gram-negative)[3]
- ***Proteus*** species (Gram-negative)[3]
- ***Enterococci*** (Gram-positive)[3]
- ***Klebsiella*** (Gram-negative)[1]
- Alpha-hemolytic and nonhemolytic ***streptococci*** (Gram-positive)[1]
- ***Candida*** species *(Fungi)*[3]
- ***Clostridium*** species (Gram-positive)[3]
- ***Enterobacteriaceae*** (Gram-negative)[3]
- ***Pseudomonas aeruginosa*** (Gram-negative)[2]

Potential Environmental Sources of Bacteria

- ***Pseudomonas*** (Gram-negative)—soil, water, plants, and animals[1,3]
  - ***Pseudomonas*** thrives in moist environments—special attention should be paid to sink, water baths, showers, hot tubs, and other wet areas[2]
- ***Acinetobacter*** species (Gram-negative)—soil and water[1,3]
- ***Pasteurella*** species (Gram-negative)—cats and dogs[1]

REFERENCES

1. Brooks G, Carroll K, Butel J, Morse S. Medical Microbiology, 24th ed. New York, NY: McGraw Hill; 2007.

2. Jorgensen J, Pfaller M. A Clinician's Dictionary of Pathogenic Microorganisms. Washington, DC: AMS Press; 2004.

3. Ponferrada L, Prowant B, Satalowich R. Peritoneal dialysis complications. In: Counts CS, ed. Core Curriculum for Nephrology Nursing, 5th ed. Pitman, NJ: *American Nephrology Nurses' Association*; 2008:824-851.

P. CONSTIPATION PREVENTION AND MANAGEMENT

Constipation is associated with many chronic diseases including end stage kidney disease and there are many contributing factors that increase the incidence of constipation in PD patients. Constipation has been identified as a cause of transmural migration of enteric organisms increasing the risk of peritonitis, technique failure, and mortality.

Constipation and Peritonitis Risk:

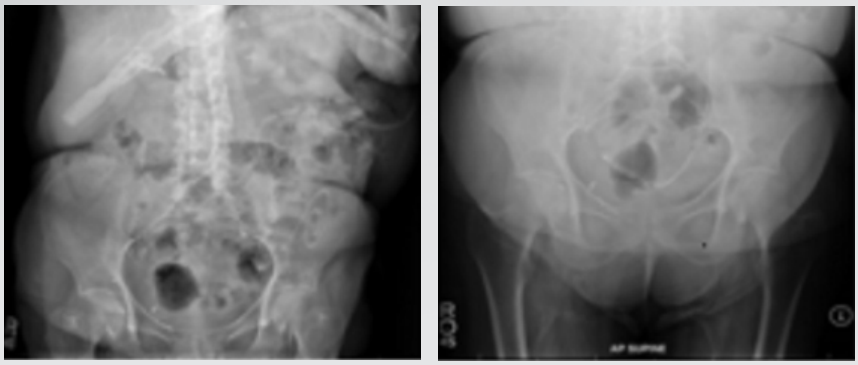
Increased intracolonic pressure allows the translocation of bacteria into the peritoneum, especially during the straining process of defecation and increases the risk of peritonitis[1]. Hernias may also occur as a result of straining during defecation.[1]

Constipation and Catheter Flow Dysfunction:

Constipation can result in a large stool burden that interferes with the peritoneal dialysis catheter flow, particularly outflow as seen in the imaging studies below. Compromised fluid drain occurs when the PD catheter tip becomes trapped between loops of bowel or displaced resulting in poor catheter outflow/ drain.[1]

EXTRINSIC COMPRESSION OF CATHETER TIP DUE TO CONSTIPATION

Before
Constipation



After
After cathartics

Images courtesy of John Crabtree, MD

Factors Contributing to Constipation in PD patients[2]

Pre-Existing Comorbidities:

- Hypothyroidism
- Hypokalemia
- Hypercalcemia
- Diabetes
- Depression
- Cerebrovascular disease
- Neurological disorders

Medications:

- Phosphate binders
- Calcium channel blockers
- Opiates
- Iron preparations
- Anti-depressants
- Diuretics
- Anticholinergics

Additional Contributing Factors:

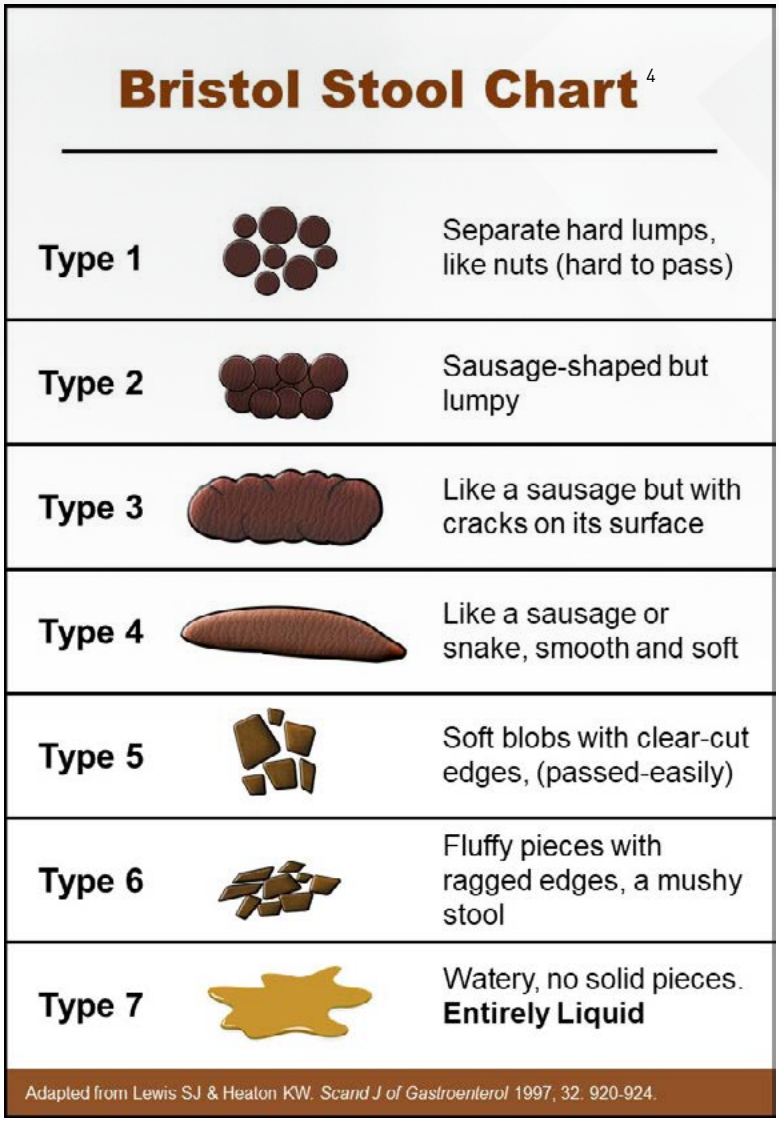
- Inadequate hydration
- Low fiber dietary intake
- Sedentary lifestyle

CLINICAL ASSESSMENT

- Routine assessment of daily bowel patterns is recommended.
  - The Bristol Stool Form Scale (BSFS) is a simplistic tool that can assist in the evaluation and diagnosis of constipation[3]
- Routinely assess for catheter outflow or drain issues.
  - Unexplained diminished UF response
  - Increase in frequency of cycler drain alarms
  - Increase in manual drain or cycler drain times impacting therapy efficacy

PATIENT EDUCATION

- Ongoing patient education on bowel health. Utilization of the Bristol Stool Form Scale (BSFS) to identify their stool form routinely.
- Ongoing education about the potential risks of constipation on PD therapy.
- Provide patients with a clear laxative treatment plan.
- Establishing a routine to have a bowel movement every day at the same time (bowel retraining) can prevent constipation.[1]
- Gentle abdominal massage with the palm rotating in a clockwise motion stimulates bowel motility.[1]



Pharmaceutical Approaches for Treatment of Constipation in Peritoneal Dialysis Patients[1,2]

DRUG CLASS	DRUG NAME	MECHANISM OF ACTION
Bulk Forming Agents	Psyllium, Calcium-polycarbophil, Bran	Increases fecal mass Stimulates peristalsis
Osmotic Laxative Agents	Lactulose, Sorbitol, Polyethylene glycol	Increases fluid content of the intestinal lumen and softens stool
Stimulant Laxatives	Senna, Bisacodyl, Aloe, Sodium picosulfate	Stimulates the intestinal wall causing increased peristalsis that moves the stool along the digestive tract
Stool Softeners	Docusate sodium	Soften stool by promoting luminal water binding/detergent-like action

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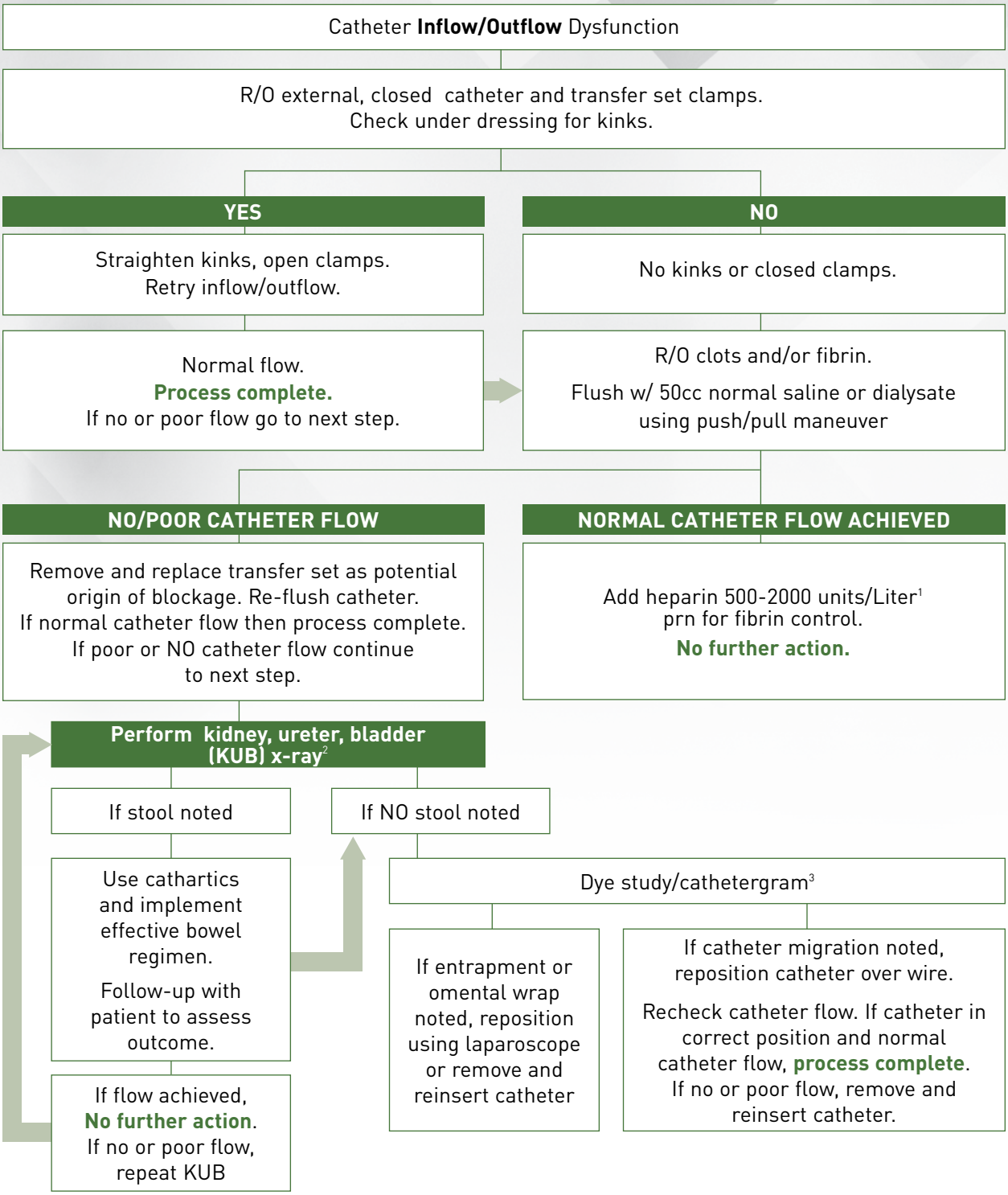
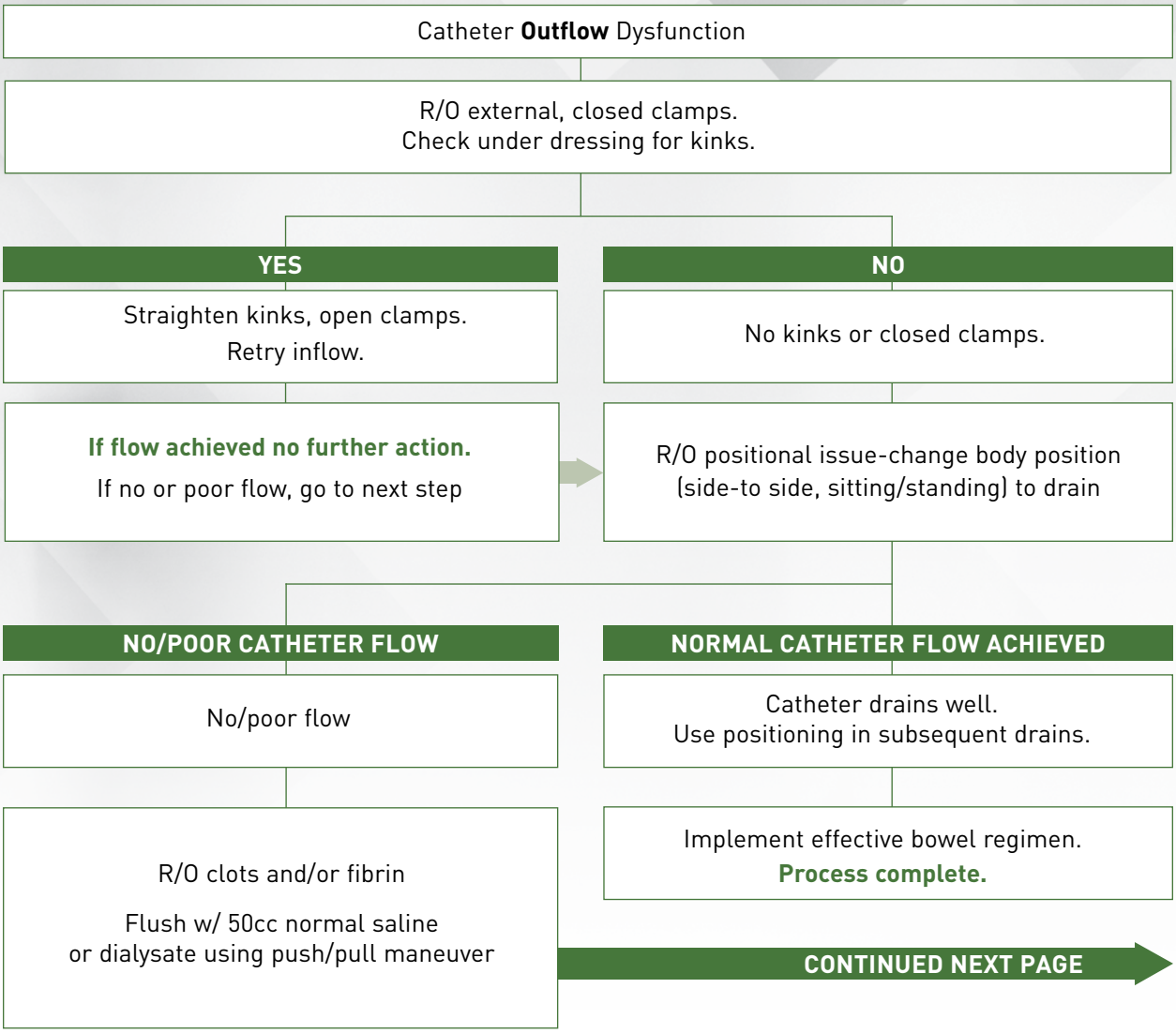
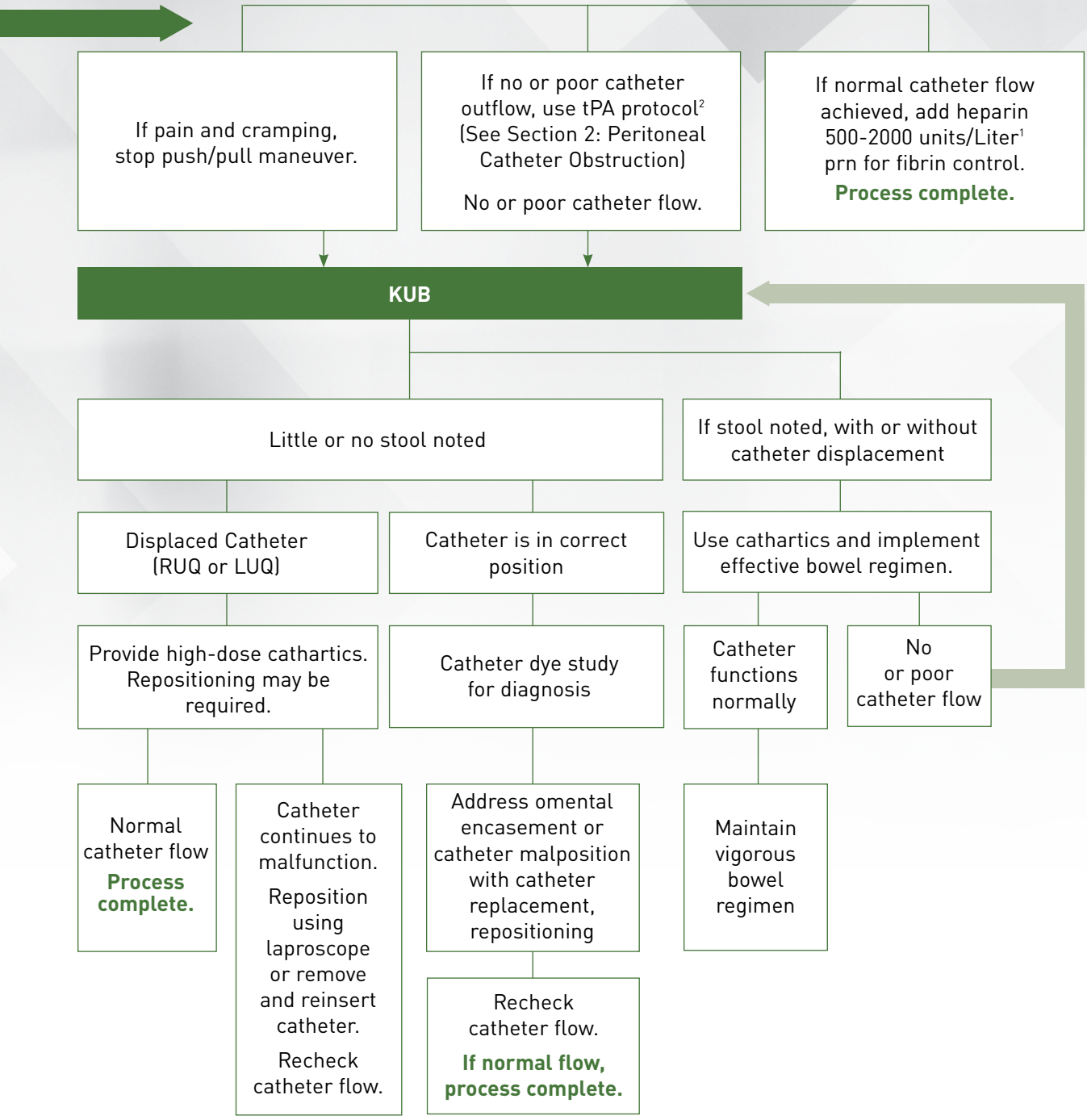
2. Kosmadakis G, Albaret J, Da Costa Correia E, et al. Constipation in peritoneal dialysis patients. *Perit Dial Int* 2018;39:399-404.
3. Lee A. Constipation in patients on peritoneal dialysis: A literature review. *Ren Soc Australas J* 2011:7(3):122-129.
4. Lewis SJ & Heaton KW. Stool form scale as a useful guide to intestinal transit time. *Scand J of Gastroenterol* 1997;32:920-924.

Q. CLINICAL ALGORITHM FOR CATHETER INFLOW / OUTFLOW DYSFUNCTION







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3. Xie, J, Ren H, Kiryluk K, Chen N. Peritoneal dialysis outflow failure from omental wrapping diagnosed by catheterography. *Am J Kidney Dis* 2010;56(5):1006-1011.

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SECTION 7

INTERNATIONAL SOCIETY OF PERITONEAL DIALYSIS (ISPD) SPONSORED EDUCATIONAL RESOURCES

INTERNATIONAL SOCIETY OF PERITONEAL DIALYSIS (ISPD) MISSION STATEMENT:

The purpose of the International Society for Peritoneal Dialysis is to increase the global uptake, promote quality practice, and achieve optimal outcomes of peritoneal dialysis through enhanced advocacy, research, and education, in order to improve the health and well-being of people living with end-stage kidney disease or suffering from acute kidney injury.[1]

ISPD CLINICAL GUIDELINES

Website: https://ispd.org/guidelines/

GUIDELINES INCLUDE:[2]

- ISPD Guidelines for Peritoneal Dialysis in Acute Kidney Injury
- Cardiovascular and Metabolic Guidelines in Adult Peritoneal Dialysis Patients
  - Part I- Assessment and Management of Various Cardiovascular Risk Factors
  - Part II- Management of Various Cardiovascular Complications
- EPS Position Paper
- ISPD Catheter-related Infection Recommendations
- ISPD Peritonitis Recommendations
- Creating and Maintaining Optimal Peritoneal Dialysis Access in the Adult Patient
- ISPD Recommendations for the Evaluation of Peritoneal Membrane Dysfunction in Adults
- ISPD Practice Recommendations: Prescribing High-quality Goal-directed Peritoneal Dialysis
- A Syllabus for Teaching Peritoneal Dialysis to Patients and Caregivers

ISPD EDUCATIONAL RESOURCES

- ISPD Lecture Series: delivered by international experts[3]
  ISPD Lecture Series - International Society for Peritoneal Dialysis
- Resources to teach nurses to teach PD[4]
  Teaching Nurses - International Society for Peritoneal Dialysis (ispd.org)
- Catheter implantation videos[5]
  PD Implantation - International Society for Peritoneal Dialysis (ispd.org)

ISPD SPONSORED LIVE EDUCATIONAL EVENTS

Peritoneal Dialysis University for Surgeons[6]
Website: www.pdusurgeons.com

PD (Peritoneal Dialysis) University for Surgeons provides a two-step approach to training general surgeons to place catheters for peritoneal dialysis using laparoscopic techniques. The first step involves a series of comprehensive lectures covering all aspects of creating and maintaining PD access including:

- Peritoneal dialysis as renal replacement therapy: basic concepts and clinical indications and contraindications for PD catheter insertion

- Preoperative assessment, planning, and preparation: principles and best practices for creating reliable long-term access
- Peritoneal dialysis catheter implantation: surgical approaches for creating long-term peritoneal access
- Special peritoneal access methods: extended 2-piece catheters and catheter embedding
- Managing PD catheter complications: salvaging catheters from infectious and mechanical complications

The second step of the program is comprised of hands-on training of catheter placement techniques in the surgical laboratory under the guidance of expert surgical faculty. The course provides AMA PRA Category 1 Credits.™ Surgery residents in training are welcome.

Peritoneal Dialysis University for Interventional Nephrologists and Interventional Radiologists[7]

Website: www.pduinir.com

PD (Peritoneal Dialysis) University for Interventionalists provides a two-step approach to training Interventional Radiologists and Interventional Nephrologists to place catheters for PD using image guided techniques. The first step involves an online series of comprehensive lectures covering all aspects of creating and maintaining PD access including:

- PD as renal replacement therapy: basic concepts and clinical indications and contraindications for PD catheter insertion
- Urgent PD program
- Image-guided percutaneous PD catheter placement
- Managing PD complications: an interventionalist-surgeon collaborative approach to management of infectious and mechanical complications

The second step of the program is comprised of hands-on training in the surgical laboratory including image-guided catheter placement under the guidance of expert interventional faculty. The course provides AMA PRA Category 1 Credits.™

Home Dialysis University[8,9]

Website: www.hduphysicians.com

HD (Home Dialysis) University for physicians provides therapy education on both PD and Home HD. It is a course presented by home dialysis thought leaders. There are didactic sessions, small group sessions and group discussions to facilitate learning.

It is open to nephrologists, nurse practitioners, physician assistants and those working closely with patients on a home dialysis therapy. The course provides AMA PRA Category 1 Credits.™

If you are in a nephrology fellowship program, please visit www.hdufellows.com for details on the Home Dialysis University for Fellows program.

REFERENCES

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