Clinical practice guidelines for peritoneal access and Commentary on the 2019 (ISPD) Update for the Creating and Maintaining Optimal Peritoneal Dialysis Access

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Authors:

Bhrigu Raj Sood
Consultant Nephrologist, South West Thames Renal and Transplantation Unit,
Epsom and St Helier University Hospitals NHS Trust, Carshalton

Nicos Kessaris
Consultant Transplant and General Surgeon, Guy's and St Thomas' Hospital, London,
Honorary Consultant Great Ormond Street Hospital for Children, London,
Honorary Senior Lecturer, King's College, London

Chris Reid
Consultant Children's Nephrologist, Head of Service for Paediatric Nephrology and Urology at
Evelina London Children's Hospital, London

Elaine Bowes
Senior Clinical Nurse Specialist in Peritoneal Dialysis,
King's College Hospital NHS Foundation Trust, London

Endorsements

The National Institute for Health and Care Excellence (NICE) has accredited the process used by the Renal Association to produce its Clinical Practice Guidelines. Accreditation is valid for 5 years from January 2017. More information on accreditation can be viewed at www.nice.org.uk/accreditation

Method used to arrive at a recommendation

The recommendations for the first draft of this guideline resulted from a collective decision reached by informal discussion by the authors and, whenever necessary, with input from the Chair of the Clinical Practice Guidelines Committee. If no agreement had been reached on the appropriate grading of a recommendation, a vote would have been held and the majority opinion carried. However this was not necessary for this guideline.

Conflicts of Interest Statement

All authors made declarations of interest in line with the policy in the Renal Association Clinical Practice Guidelines Development Manual. Further details can be obtained on request from the Renal Association.

Contents

Introduction

The access to peritoneal dialysis and the utilisation of this modality as therapy for ESRF varies significantly within the UK. Timely and successful catheter placement remains a key variable. PD access failure and complications not only impact on PD utilisation but also contribute to patient morbidity and poor patient experience. Clinical practice around the provision for creating PD access varies across the country and is highly dependent on the available expertise and facilities. Although there is a strong economic rationale in favour of peritoneal dialysis (PD) over haemodialysis (HD), the potentially costly effect of PD technique failure is an important consideration, and can negate that economic benefit of PD.

We started this work to review the evidence and update the 2009 Renal association Clinical practice guidelines for peritoneal access[1]. In 2019 International Society for Peritoneal Dialysis (ISPD) published the guideline - "Creating and Maintaining Optimal Peritoneal Dialysis Access in the Adult Patient" [2]. We have since then updated this document with added commentary on the ISPD guidelines.

There has been progress in improving techniques to provide PD access to the patients and significant number of publications looking at the outcome of the practice. ISPD update addresses various key issues in PD access, and we agree with and the support majority of the recommendations of the guideline. However, we realise that there are some key areas where the UK practice varies from the recommendation and the strength of the evidence does not support wide ranging change of practice. This commentary on ISPD guidelines on PD access describes supported key changes from previously published guidance. We have highlighted the areas of difference in practice, challenge in implementation, controversies and gaps of knowledge, and the suggested statement for implementation. There is paucity of good quality studies to support some of the recommendations in this document, and the available data is very heterogeneous. This limits the strength of some of the guidance. These aspects of PD access have been suggested as the focus for the audit and future research. Some aspects of care are supported by the best practice consensus amongst experts and might be driven by unique local expertise. Adoption of these recommendations should be supported by local audit process to ensure that the success of these techniques can be reproduced.

This document replaces all previously published Renal Association (RA) guidelines on the topic. In each case, we have included the guideline from the original renal association 2009 Guidelines on Peritoneal Access[3] followed by the comments on the updated recommendation or suggestion from the 2019 ISPD Update, and a summary of the rationale behind each change.

In addition to reviewing the PD access in adult patients, this document also addresses some differences in practice in providing PD access in the paediatric population. PD is widely utilised to manage ESRF in children because the simplicity of the procedure allows for dialysis at home in all but the most exceptional circumstances, thereby returning the child with end-stage renal disease (ESRD) to regular school attendance and facilitating normal family and childhood activities. [4]

The format of the commentary is as follows:

Each individual recommendation has the previous RA 2009 guidance, the ISPD 2019 updated guidance followed by the RA comment/ guidance, and then the summary of the rationale/evidence for update. A section on paediatric guidance is added where there is a specific difference from the adult practice.

2009 RA	2009 RA Guidelines
2019 ISPD	2019 ISPD Guideline
2019 RA	2019 RA guidance
2019 RA-P	2019 RA guidance on paediatric PD access

Rationale/evidence

Grading the evidence

The evidence for these recommendations has been assessed using the modified GRADE system. [5] The modified GRADE system defines both the strength of the recommendations of the guideline authors and the level of evidence upon which each of the recommendations is based. This grading system classifies expert recommendations as “strong” (Grade 1) or “weak” (Grade 2) based upon the balance between the benefits and risks, burden and cost. The quality or level of evidence is designated as high (Grade A), moderate (Grade B), low (Grade C) or very low (D) depending on factors such as study design, directness of evidence and consistency of results. Grades of recommendation and quality of evidence may range from 1A to 2D.

Authors reviewed the evidence and came to a collective decision on the guidance, with input from the chair of the guidelines committee as needed.

Commentary

Facilities

2009 RA	PD Access : Access Team • We recommend that each centre should have a dedicated team involved in the implantation and care of peritoneal catheters (1C).
2019 ISPD	• No specific recommendation
2019 RA	PD Access : Access Team • We recommend that each centre should have a dedicated team involved in the implantation and care of peritoneal catheters. • We recommend that at the core of this team there should be a lead nurse, nephrologist and surgeon who take the responsibility of running a successful team with regular MDMs, audits and governance structure. (1C). • We recommend that an access team should be developed to allow the provision of urgent PD catheter insertion to patients presenting late to the renal service (1C).

Rationale/ evidence

The access team should comprise nurses, nephrologists and surgeons who have experience in peritoneal dialysis. Each member of the team should understand the importance to the patient of successful access placement and the need for attention to detail in the reduction of complications[6]. There should be a lead nurse, nephrologist and surgeon who take the responsibility of running a successful team with regular MDMs, audits and governance structure. A well led team with focus on standardisation of procedures, education and training for operating theatre environments and harmonising activity to support a safer environment for patients, can significantly reduce harm and improve success [7].

Late presentation to the renal services with advanced CKD remains a barrier to access to home therapies[8]. Renal units should develop PD access teams to provide timely urgent insertion of PD catheters. These should include an operator to insert the PD catheter, a nephrologist to prescribe dialysis and trained nursing team to provide PD dialysis on the ward.

When to start PD

2009 RA	• No specific recommendation
2019 ISPD	• No specific recommendation
2019 RA	• There is no advantage of starting PD early vs late with eGFR 5-7 ml/min
2019 RA-P	• Acute peritoneal dialysis can be used in children with AKI for example, after cardiac surgery • Early referral to a paediatric nephrology centre, certainly by CKD stage 3, enables access to specialist care; improved management of anaemia, proteinuria, BP, and renal bone disease/growth; and allows forward planning for pre-emptive transplantation, or for planning dialysis modality

The primary determinant for the time to insert PD catheter is the renal function at the start of dialysis. The appropriate time to start dialysis has been debated over years. There has been an increase in the early start of dialysis [9], including in patients starting PD [10].

Although observational studies had indicated some benefit of early start of dialysis, a randomised controlled trial (IDEAL Study) in 2008[11] did not show any benefit of starting early (eGFR 10-14ml/min) as compared to late (eGFR 5-7ml/min) (hazard ratio for death in the early-start group, 1.04; 95% CI, 0.83 to 1.30; P=0.75), although the early start group had a lower than intended eGFR (9ml/min against intended start between 10 – 14ml/min) and there was less separation of eGFR in the 2 groups (9/min in early start and 7.2ml ml/min in late starters).[11]

50% of the patients in the early start group and 44% in the late start group started RRT with PD. Subgroup analysis of the patients starting PD showed no difference in overall outcomes, including peritonitis rates. A significant difference was in the proportion of patients planning to commence PD who actually initiated dialysis with PD, which was higher in the early-start group (80% vs 70%, p = 0.01).[12]

There is limited data comparing urgent start PD to HD. In a trial, urgent start PD in patients presenting late with ESRF has been shown to have lower incidence of early complications than urgent start HD, despite being a more co-morbid patient group, although there was no significant difference in the patient survival. [13]

In children, retrospective studies have shown no differences in mortality rates between different modalities of renal replacement therapy. Peritoneal dialysis is a simple and low-cost technique that can be used in all ages to treat ESRF as well as AKI, such as in neonates following heart surgery for congenital heart disease. [14]

Timing of PD catheter insertion

2009 RA	• PD Access : Timing and co-ordination of referral and surgery **We suggest, whenever possible, that catheter insertion should be performed at least 2 weeks before starting peritoneal dialysis. Small dialysate volumes in the supine position can be used if dialysis is required earlier**
2019 ISPD	• Catheter break-in procedures **We recommend a break-in period of at least 2 weeks before elective start on PD (1B).** **We recommend a modified PD prescription using low volume exchanges with the patient in the supine position if urgent start on PD with a break-in period of < 2 weeks is needed (1C).**
2019 RA	• Agree with the ISPD guidelines
2019 RA-P	• Agree with the ISPD guidelines

Rationale/ evidence

One randomized trial[15], a number of observational studies[16,17,18,19] and many smaller mainly retrospective single-centre studies have constantly shown that urgent start on PD with a break-in period of less than two weeks may be associated with a minor increased risk of mechanical complications but apparently no detrimental effect on patient survival, peritonitis-free survival, or PD technique survival compared with elective start on PD.

As intraperitoneal pressure is linearly related to dwell volume[20] and is increased in the upright position, we recommend a modified PD prescription using low dwell volumes with the patient in the supine position to minimize the risk of leakage if urgent start on PD is needed.

A RCT comparing outcome for patients starting full volume (2000ml) exchanges to the patients starting low volume exchanges slowly increased over 13 days, found no difference in early or late complications, as well as 1 year catheter survival in both groups.[19]

There is no evidence to support any particular catheter type or insertion technique in patients needing early start.

Early use of PD catheter in children can be limited by dialysate leakage or catheter obstruction due to omentum. The chance of fluid leakage around the wound can be reduced by tightly securing a purse string suture around the catheter where it enters the peritoneal cavity as well as by using a lower dwell volume for a few days after catheter insertion. In addition, fibrin sealants can be used to reduce the risk of leakage.[14]

Catheter selection

2009 RA	PD Access : Facilities • We suggest that no particular catheter type is proven to be better than another (2C). • We suggest that a catheter of a suitable size should be used (2C).
2019 ISPD	Catheter selection for chronic peritoneal dialysis • We recommend catheters made of silicone rubber (1B) • We recommend that standard catheters be provided with double Dacron (polyester) cuffs (1C) • We recommend the use of catheters with either a straight or coiled tip with either a straight segment or preformed arc bend in the inter-cuff section (1C) • We recommend the use of an extended catheter for remote exit-site location when standard catheters are unable to provide both optimal pelvic position and satisfactory exit-site location (1C) • Catheter choice should produce a satisfactory balance of pelvic position of the tubing tip, exit-site in a location that minimizes the risk of infection and is easily visible and accessible to the patient, and resulting in minimal tubing stresses during the course of its passage through the abdominal wall (not graded). • We recommend that the PD access team be familiar with a basic inventory of catheter types that permit selection of the most appropriate device based upon body habitus and clinical conditions (1B). • We recommend that the PD team develop a protocol for preoperative mapping to select the most appropriate catheter type from their inventory of devices (1C).
2019 RA	Agree with ISPD guidance – except for ○ No difference in catheter outcome between single of double cuff catheters, so can be considered in circumstances where there is less space for creating long enough tunnel for double cuff catheters. (2B) ○ Straight or self-locating catheter can be considered in patients with repeat catheter malposition (2B)
2019 RA-P	• Use of double cuff coiled catheter is recommended in children, with correct catheter size chosen by surgeon for size of child or infant

Rationale/ evidence

Because patients present with a range of body sizes and shapes with a variety of medical conditions, 1 catheter type cannot be expected to fit all[21]. Choice of catheter type should take into consideration the patient's belt line, obesity, skin creases and folds, presence of scars, chronic skin conditions, intestinal stomas, suprapubic catheters, gastrostomy tubes, incontinence, physical limitations, bathing habits, and occupation.

A recent Cochrane Review on type of catheter as well as insertion techniques for preventing catheter-related infections, no particular PD catheter out of 22 examined, placement or method of insertion was shown to be better in preventing catheter-related infections in peritoneal dialysis patients. Studies included were not of sufficient size or duration to evaluate outcomes such as technique and patient survival long term[22].

Catheter material

Currently, most chronic catheters are constructed of silicone rubber. A polyurethane catheter that ceased production in 2010 was made of a particular polymer extremely susceptible to oxidative stress fractures, softening, and rupture due to chronic exposure to polyethylene glycol present in mupirocin ointment used for long-term catheter exit-site prophylaxis[23]. Erosion of silicone catheters due to the use of gentamicin cream at the exit site has been reported but appears to be a rare complication[24].

Catheter configuration

There are several variations to the peritoneal catheter design that claim superiority over the others. The most usual variations concern the number of cuffs (single or double), the design of the subcutaneous tunnel (swan neck or straight/ Tenckhoff), and the shape of the intra-abdominal portion (straight or coiled). A weighted self-locating catheter with 12g tungsten weight at the tip of catheter has been developed in attempt to reduce catheter migration.

Straight catheter might be better than the coiled tip catheter with fewer mechanical complications (2B)

Studies have shown conflicting results with some finding no difference in rates of catheter migration or function. Two meta-analyses suggest better catheter survival for straight tip catheters [18,25], but the outcome of the catheters was determined by other causes of catheter removal in addition to the mechanical failure. A recent RCT also demonstrated better outcomes with straight tip catheters[26].

Straight or swan neck catheter have no difference in complications rates

Subcutaneous segment of the catheter could be straight or pre-bent in the swan-neck catheter. The design of the Swan neck catheter provides an exit site directed caudally from a subcutaneous tunnel and an internal entrance from the tunnel directed caudally into the peritoneal cavity, and is expected to reduce the exit site infection and cuff migration. Some studies have showed slightly lower[27,28] or a higher[29] incidence of ESI, although not statistically significant. Meta-analysis of 5 studies with 313 patients did not demonstrate any significant difference in the rates of ESI, tunnel infection or peritonitis, and did not demonstrate any impact on the catheter migration[25].

Number of cuffs does not offer any benefit (2C)

Dacron cuffs glued to the catheter encourage fibrosis around catheter and provide anchorage to the catheter. The idea behind the double cuffs was to reduce the peri-catheter transmission of organisms to the peritoneum. Single randomised trial showed no benefit in having 2 cuffs over a single cuff catheter in reducing the incidence of first instance of peritonitis or ESI[30], although observational data from Canadian database has suggested some benefit in reducing the peritonitis with the use of double cuff catheter, but the benefit seemed to have vanished in more recent observation in patients having catheter insertion since 2001, which the authors attributed to improved overall care of the exit site and thus reduced organism burden[31].

Extended/ Pre-sternal catheter should be considered for selected patients

An alternative peritoneal catheter exit-site location is sometimes needed in patients with obesity, floppy skin folds, chronic yeast intertrigo, intestinal stomas, urinary and faecal incontinence and children with diaper.

Two-piece extended catheters permit remote exit-site locations away from these problematic abdominal conditions. The pre-sternal peritoneal dialysis catheter is composed of two flexible (silicon rubber) tubes joined through a titanium connector at the time of implantation. The device has been dubbed as a "bath tube" catheter because, with the exit on the chest, a patient may take a tub bath without the risk of exit contamination due to submersion. Many patients prefer pre-sternal catheter because of better body image[32]. Some users have extended tunnel to as far as back of the patient to help some patients with behavioural disturbances, who are prone to pull or snatch at lines[33].

A non-randomised study, where the choice of exit site was based on patient characteristics, showed time until first exit-site infection was longer for extended catheters, and although there was no difference in exit site, subcutaneous tunnel, and peritonitis infection rates; the proportion of catheters lost during peritonitis episodes was significantly greater for extended catheters. This was attributed to interactions of body mass index (BMI) and diabetic status in determining catheter loss from peritonitis for both catheter types, the factors which also determined the choice of exit location in this study[34].

The chest was has been used sparingly as an exit site in the paediatric population in the past[35,36].

Self-locating catheter can reduce catheter malfunction (2C)

A catheter with a tungsten (Wolfram) weight was developed to reduce the rates of catheter malfunction due to catheter migration. Non randomised observational studies have suggested advantage of this catheter in reducing catheter tip dislocation[37]. Two randomised controlled studies compared the outcomes of a SLC compared to straight Tenckhoff PD catheters[38,39] and both studies suggested significantly reduced mechanical drainage problems with SLCs. In the first study, 7 of 32 inserted straight Tenckhoff catheters and none of 29 self-locating Wolfram catheter required repeat surgery for catheter malfunction[38]. In the second larger study showed the malfunction risk 4 times higher for TCs as compared to SLCs[39].

Pre-operative mapping improves catheter survival / reduces complications (1D)

There is no study data to support pre-operative mapping, but it has been demonstrated by computerized tomographic (CT) peritoneography that 30% – 55% of dialysate rests in the pelvis when the patient is supine[40], thereby supporting the concept of preferably positioning the catheter tip in the pelvis for optimal hydraulic function . It is the catheter insertion site and the length of intraperitoneal tubing that determines the pelvic position of the catheter tip[41,42].

Exit Site location

The patient should be examined in a sitting position to verify that the selected exit site is easily visible to the patient, not located within the belt line, inside a skin crease, or on the blind side or apex of an obese skin fold. If needed, long single segment[43] or double segment catheters[44,34]can be used to remotely locate the exit site away from the problematic lower abdominal region to the upper abdomen or upper chest while maintaining optimum position of the catheter tip.

Catheter placement procedures/implantation techniques

2009 RA	• We recommend that each centre should have a dedicated team involved in the implantation and care of peritoneal catheters (1C) • We recommend that renal units should have clear protocols for peri-operative catheter care including the use of antibiotic prophylaxis (1A). • We recommend that a dedicated area should be used for catheter insertion with appropriate staffing, suction, oxygen and patient monitoring facilities (1A). • We recommend that local expertise at individual centres should govern the choice of method of Peritoneal Dialysis (PD) catheter insertion (1B). • We suggest that PD catheters should be inserted as day case procedures as long as this does not compromise the quality of care. (2C).
2019 ISPD	• Adherence to a number of best practice details (Table 1) is essential in creating a successful long-term peritoneal access irrespective of the catheter implantation approach (not graded) • Choice of PD catheter implantation approach should be based upon patient factors, facility resources, and operator expertise (not graded) • We recommend that laparoscopic PD catheter implantation employ advanced adjunctive procedures that minimize the risk of mechanical complications (1C) • We recommend that percutaneous needle-guidewire insertion of PD catheters utilize image guidance (ultrasonography and/or fluoroscopy), when such means are available, to improve outcomes and minimize complications (2C)
2019 RA	• Follow National/Local guidelines for reducing risk of COVID-19 infection during the Pandemic • Single preoperative dose of prophylactic antibiotic to provide anti-staphylococcal coverage (1A) • Catheter insertion technique does not influence infection related complications of peritoneal dialysis (1C) • Units should promote development of both percutaneous and surgical PD catheter insertion to improve patient choice and timely insertion of PD catheter (1B) • Choice of PD catheter implantation approach should be based upon patient factors, facility resources, and operator expertise (1B) • Procedure team should adhere to Five Steps to Safer Surgery and WHO checklist or National/Local Safety Standards for Invasive Procedures. • It would be preferable that percutaneous needle-guidewire insertion of PD catheters utilize image guidance (ultrasonography and/or fluoroscopy), when such means are available, to minimise complications, but there is no data to support its superiority over blind insertion (2D) • We recommend that laparoscopic PD catheter implantation employ advanced adjunctive procedures (omentectomy, apiploectomy, adhesiolysis etc.), that minimize the risk of mechanical complications (1C) • The exit site care following PD catheter insertion should follow local protocol (ungraded)
2019 RA-P	• Subtotal omentectomy is recommended in all children who undergo open or laparoscopic PD catheter insertion.

Table 1 (As in ISPD 2019 guidelines)

Best Practices in Patient Preparation and Peritoneal Catheter Implantation
• Preoperative assessment performed by a multidisciplinary peritoneal dialysis access team to select the most appropriate catheter type, implantation technique, insertion site, and exit-site location[21]
• Implement bowel program to prevent perioperative constipation[45,46]
• Follow National/Local guidelines for reducing risk of COVID-19 infection during the Pandemic [47]
• Shower on the day of procedure with chlorhexidine soap wash of the planned surgical site[48]
• If hair removal is necessary, use electric clippers[48]
• Empty the bladder before procedure; otherwise, Foley catheter should be inserted[49]
• Single preoperative dose of prophylactic antibiotic to provide anti-staphylococcal coverage[50]
• Should adhere to Five Steps to Safer Surgery & WHO checklist and National/Local Safety Standards for Invasive Procedures[51,52]
• Operative personnel are attired in cap, mask, sterile gown, and gloves and ensure strict aseptic technique at all times[48]
• Surgical site is prepped with chlorhexidine-gluconate scrub, povidone-iodine (gel or scrub), or other suitable antiseptic agent and sterile drapes applied around the surgical field[48]
• Peritoneal catheter is rinsed and flushed with saline and air squeezed out of the Dacron cuffs by rolling the submerged cuffs between fingers[53]
• Paramedian insertion of the catheter through the body of the rectus muscle with deep catheter cuff within or below rectus muscle[54,55]
• Pelvic location of the catheter tip[56]
• Omentectomy should be performed in children[57,58,59,60,61]
• Placement of purse-string suture(s) around the catheter at the level of the peritoneum and posterior rectus sheath and/or the anterior rectus sheath.
• Additional sutures should be used in children to reduce the risk of hernia formation [62,63,64,65,66,67]
• Subcutaneous tunnelling instrument should not exceed the diameter of the catheter[68]
• Catheter flow test performed to confirm acceptable function
• Exit site located more than 2cm beyond superficial cuff[69]
• Skin exit site directed lateral or downward[70, 53]
• Exit site should be smallest skin hole possible that allows passage of the catheter[68]
• No catheter anchoring sutures at the exit site (use medical liquid adhesive and sterile adhesive strips to secure the catheter)
• Attach dialysis unit's requested catheter adapter and transfer set at time of procedure
• Flush catheter with saline/ heparinised saline/ dialysis fluid at the end of the procedure.
• Exit site protected and catheter immobilized by non-occlusive dressing [71]

Rationale/ evidence

Best practice details in Table 1 have been distilled through decades of observations by expert practitioners. Only a few steps have any good quality evidence to support them, but have ample common sense, observational data and expert opinion to support their routine use. It is advised that the practitioner be aware of deviations from recommended practices and be alert for the potential complications that may arise from such departures.

Safe procedure

WHO Safer Surgery Checklists greatly improve the delivery of safer care for patients undergoing operations. This approach can be extended beyond surgery towards all invasive procedures performed in hospitals. Although the checklists in themselves cannot be fully effective in protecting patients from adverse incidents, when conducted by teams of healthcare professionals who have trained together and who have received appropriate education in the human factors, these help underpin safe teamwork. Local Safety Standards for Invasive Procedures (LocSSIPs) should be created by multi-professional clinical teams and their patients, and implemented against a background of education in human factors and working as teams to provide a safe PD access procedure to the patients[51,52].

Prophylactic antibiotic

Infection related complications are the leading cause of PD technique failure necessitating conversion to HD. Most studies demonstrate benefit of prophylactic antibiotic use before PD catheter insertion in reducing the incidence of infectious complications with antibiotics including vancomycin[50,72], cefazolin[73], gentamycin [74], while 1 study using cefazolin and gentamicin found no benefit[75]. A randomised controlled trial demonstrated superiority of the use of IV vancomycin to both using IV cefazolin or not using any antibiotic prophylaxis[50]. There is no data on the use of anti-microbial impregnated dressing for exit site care after catheter insertion, although some units use it routinely. The exit site care following PD catheter insertion should follow ISPD guidelines on prevention of infection related complication and local protocol[76].

Antibiotics are also necessary in the paediatric population undergoing PD catheter insertion[77].

A recent Cochrane review concluded that pre/peri-operative intravenous vancomycin may reduce the risk of early peritonitis in the first few weeks (< 1 month) following Tenckhoff catheter insertion but has an uncertain effect on the risk of exit-site/tunnel infection. The comparisons using other antibiotics (i.e. IV gentamicin; IV cefazolin plus gentamicin; IV cefuroxime plus cefuroxime intraperitoneal) did not reduce the risk of peritonitis or exit-site/tunnel infection[72].

Catheter Insertion technique

ISPD guidance (Table 2) recommends advanced laparoscopic procedure as a preferred technique for PD catheter insertion over other techniques. In patients with previous abdominal surgery, percutaneous PD catheter insertion is not recommended at all. **This is where the UK practice varies from the ISPD recommendation.** A lot of UK centres use percutaneous PD catheter insertion as a preferred method for PD access in patients. In some centres, this technique, especially with image guidance, is also used to insert catheters in patients with previous abdominal surgery or peritonitis. The following section reviews the evidence regarding the choice of catheter insertion technique.

Catheter insertion methods include percutaneous needle-guidewire with or without image guidance, open surgical dissection, peritoneoscopic procedures usually performed by the nephrologist, and the surgical laparoscopy. The insertion technique used often depends on the local provider expertise in placing catheters and local availability of material resources. Surgical technique has the advantage of direct visualization, allowing precise catheter placement in the peritoneal cavity. However, this technique is more invasive and requires general anaesthesia. In contrast, the percutaneous catheter placement technique could be performed as a bedside procedure using local anaesthesia[78].

A significant variation in practice is observed in the UK (UK Renal Registry 20th Annual Report: 2016 Multisite Dialysis Access Audit in England, Northern Ireland and Wales and 2015 Peritoneal Dialysis One Year Follow-up: National and Centre-specific Analyses). Twenty-three centres reported use of non-surgical PD catheter placement, accounting for 35.3% of all catheters placed and 17 of these centres placed 50% of their PD catheters this way. Five centres placed 90% of their PD catheters percutaneously. At the 23 centres that placed non-surgical PD catheters, 22.0% of incident RRT patients started PD, compared with 20.0% overall. Twenty-seven percent of incident RRT patients started PD at the six centres that placed 90% of their catheters percutaneously. The report also observed that most commonly, responsive PD access pathways were achieved using a predominantly percutaneous rather than surgical catheter insertion approach[79].

Similar population based data from Canada has also suggested improved PD use in patients who have access to nephrologist-inserted percutaneous PD catheters as compared to surgical (laparoscopic or open) and radiological-inserted catheters[80].

ISPD guidelines support advanced laparoscopic techniques for PD catheter insertion, with data to suggest better outcomes, although the technique itself has limited availability. There is also an issue of best utilisation of a limited resource, as this would add burden to already very busy renal surgical lists. Nephrologist-initiated PD access programs have had a positive impact on PD penetration. The technique has been associated with good success rate and catheter survival, less postoperative pain, shorter hospital stay, and shorter catheter break-in time compared with the conventional surgical technique. The flexible availability and a short waiting time to have a catheter also make it an attractive option for patients presenting with advanced renal impairment to the renal units and choosing to have PD[81,82,83,82].

There are few randomised studies to compare the outcomes of these techniques, and even these don't always address the question of technique equivalence in selecting patients equally suited for each technique. Lack of good RCT data has led to a few meta-analyses which include the data from non-randomised trials to improve the comparison of the outcomes.

Percutaneous vs surgical

A few studies have suggested similar or improved outcomes for percutaneously inserted PD catheter as compared to the open surgical insertion[84]. There was no significant difference in 1-year catheter survival in percutaneous vs surgical PD catheter placement. Catheter dysfunction also did not differ significantly between the groups. The prevalence of peritoneal fluid leak also was similar for percutaneous and surgical groups. However, there was a significant lower incidence of peritonitis among those with percutaneous placement[85]. The addition of fluoroscopy to the procedure permits confirmation of needle entry into the peritoneal cavity by observing the flow of injected contrast solution around loops of bowel [53].Ultrasonography can be used in conjunction with fluoroscopy with the additional advantage of identifying and avoiding injury to the inferior epigastric vessels and bowel loops[86]. Although this can potentially reduce the risk of immediate complication from the procedure, there is no reason to expect influence of these interventions on long-term catheter related complications.

Another study compared percutaneous insertion with percutaneous insertion guided by radioscopy and surgical insertion of PD catheter in a group of patients comparable for gender, age, body mass index, previous abdominal surgeries, and the prevalence of diabetes mellitus. The incidence of complications including bleeding, catheter dysfunction, exit-site infections and peritonitis was not significantly different among the groups. The catheter survival rate was not significantly different by the end of the follow-up of 19 months[87]. A recent study of 178 patients compared those with <28 and >28 BMI who had either percutaneous or surgical insertions. This showed the overall one-year catheter survival to be similar in the two groups but the one-year infection-free catheter survival was superior for patients with BMI > 28 who had the percutaneous technique[88].

Paediatric studies have also suggested that the percutaneous method reduced the rate of some complications. The onset of dialysis was significantly earlier[84].

There are 2 meta-analyses reviewing outcomes of percutaneous technique. The first included 2 RCTs and 8 other studies. The pooled data demonstrate no significant difference in 1-year catheter survival between surgical and percutaneous groups. However, the sensitivity analysis of the RCTs demonstrated that the incidence of overall infectious and overall mechanical complications was significantly lower in the percutaneous groups than the surgical groups. The subgroup analyses revealed no significant difference between methods in the rates of peritonitis, tunnel and exit site infection, leakage, inflow-outflow obstruction, bleeding and hernia[78].

A second meta-analysis sourced data from wider sources, but included no RCTs. There was no significant difference in 1-year catheter survival, catheter dysfunction or the prevalence of peritoneal fluid leak; however, there was a significant lower incidence of peritonitis among those with percutaneous placement[85].

A recent Cochrane review to evaluate the role of different catheter implantation techniques and catheter types in lowering the risk of PD-related peritonitis in PD patients found that percutaneous insertion compared with open surgical insertion of a PD catheter probably makes little or no difference to exit-site/tunnel infection, early peritonitis, post-operative bleeding (haematoma or haemoperitoneum) or outflow failure[89].

Assisted PD (aPD) is increasingly used to facilitate dialysis at home, often in those patients who are older and frail and with comorbidities[90]. Unsuitability for safe use of general anaesthesia can be a significant barrier for access to PD for these patients. Percutaneous catheter insertion with the use of local anaesthesia can facilitate use of PD in this group of patients.

Paediatric access

There has been one randomised controlled study comparing percutaneous technique under sedation and local anaesthetic versus open approach under general anaesthesia[84]. The percutaneous technique was faster and had less complication but the sample was very small. The Renal Association Clinical Practice Guideline - Peritoneal Dialysis – June 2017 recommends that paediatric PD catheter insertions are performed under general anaesthetic[91].

Laparoscopic vs open surgical

Open surgical insertion is the most commonly available technique. Laparoscopic insertion needs specific expertise as well more equipment making it less available. An early RCT comparing laparoscopic to open surgical insertion reported higher early peritonitis episodes in the open surgical group, most likely related to a higher incidence of exit site leak in the surgical group. Moreover, peritoneoscopically placed catheters were found to have better catheter survival than those placed surgically[92]. More recent trials comparing open surgical with laparoscopic insertion suggest no overall difference in the complications or the catheter longevity[93,94,95].

Meta-analysis also suggests that the proportion of migrating catheters was lower and the catheter survival was higher in the laparoscopic group[96,97]. Laparoscopic insertion also significantly decreased the probability of surgical intervention or catheter revision, and obstruction[97]. The two groups were not significantly different in other catheter-related complications[98].

Another meta-analysis showed a lower incidence of catheter migration and catheter removal, but a higher incidence of bleeding with a laparoscopic approach than with the open technique. There was no significant difference in the incidence of omentum adhesion, hernia, leakage, intestinal obstruction or peritonitis between the two groups[99].

Small, observational studies have shown that PD catheter insertions can be performed safely and effectively using laparoscopy in children as well, but there are no randomised studies or meta-analyses in this group of patients.[100,101,102]

Advanced Laparoscopy

Advanced laparoscopic technique involves some additional procedures at the time of PD catheter insertion with an aim to reduce complications and improve catheter outcomes. Various authors have described tunnelling of a port device through the rectus sheath to permit placement of the catheter in a long musculofascial tunnel directed toward the pelvis to prevent catheter tip migration, peri-catheter hernias, and reduce the risk of pericatheter leak.[103,104,105,106] Other authors have described additional omentopexy [64,107], adhesiolysis, resection of epiploic appendices,[107] and colopexy[103,108]. Small studies have shown that PD catheter insertion can usually be successful, even in patients who had previous abdominal surgery such as appendectomy, ovarian resection, hysterectomy, caesarean section and segmental resection of the small intestine. Laparoscopic adhesiolysis may be necessary and there is a small risk of haemoperitoneum.[109] A recent systematic review and meta-analysis examined whether advanced laparoscopic interventions consisting of rectus sheath tunnelling and adjunctive procedures produced a better outcome than open insertion or basic laparoscopy used only to verify the catheter position. This found that, compared with basic laparoscopy, catheter obstruction and migration were significantly lower in the advanced laparoscopic group, whereas the catheter survival was similar in both groups. All outcomes, except catheter obstruction, were similar between the basic laparoscopy and open insertion. Infectious complications such as peritonitis and exit-site infections were similar between the 3 groups.[110]

Finally, one study of 231 PD catheter insertions using advanced laparoscopy, basic laparoscopy or open techniques did not show any difference in complications, dysfunction-free PD catheter survival according to obesity.[111]

Special situations

Embedded catheter

The implantation technique, developed by Moncrief and Popovich, involves embedding of the external segment of the catheter in the subcutaneous tunnel at insertion, and it is kept embedded for a few weeks before externalization. This procedure allows time for tissue ingrowth into the external cuff and catheter surface between the two cuffs, with the expectation of preventing bacterial colonization of the catheter surfaces from the exit wound and thereby reducing peri-catheter infections. Externalization of embedded catheters is easily accommodated provided that a suitable procedure room is available. Just like the arteriovenous fistula of haemodialysis, this new catheter can be inserted in advance and remains embedded in the subcutaneous tunnel. It can be exteriorised electively when the patient needs to start dialysis, thus improving the chances of patients choosing PD for RRT and starting on their preferred modality without the need for temporary haemodialysis through a line. As the catheter has healed completely before being externalised, the chances of leak of PD fluid after commencing PD are also reduced.[112,113] Some studies have suggested a lower rate of early exit-site infection, leak and obstruction, and a better catheter survival with this technique[114], while other studies have failed to show the difference in the infection rates[115] and have suggested a high rate of catheter malfunction requiring radiological or surgical/laparoscopic revision procedures.[116]

There is no data on use of this technique in paediatric population.

Conclusion - Choice of implantation technique

The available evidence demonstrates no clear advantage on comparing the different techniques.

The literature review would suggest better catheter outcomes with advanced laparoscopic techniques in comparison to standard laparoscopic insertion, although there is no good quality data to compare it with the outcomes of other techniques. The published literature is mainly based on single centre experiences or meta-analysis of cohort observational studies, and lends itself to significant bias. Some techniques are also limited by their restricted availability.

Registry data from UK and Canadian populations highlight the importance of timely availability of PD catheter insertion in facilitating patient choice to take up PD. Percutaneous techniques have the advantage over other techniques in this regard. Use of ultrasound guidance or fluoroscopy can reduce the risk of percutaneous PD catheter insertion, especially when done in patients with previous abdominal surgery.

Choice of PD catheter implantation approach should be based upon patient factors, facility resources, and operator expertise, which provides timely PD catheter insertion for patients approaching the need for dialysis, and avoids use of unplanned haemodialysis in these patients.

Advanced laparoscopic catheter insertion procedures would offer advantage of fewer mechanical complications for patients with higher risk, like previous major surgery or peritonitis, over standard laparoscopic approach.

To improve the patient choice and wider patient access to PD catheter insertion, renal units should develop staff and facilities to provide both percutaneous and surgical PD catheter insertion techniques. Surgical colleagues providing laparoscopic access should aim to provide advanced laparoscopic adjunctive procedures where appropriate and practitioners inserting percutaneous catheters should have ultrasound and/ or fluoroscopic guidance available to reduce risk.

Paediatric access

Based on observational studies, subtotal omentectomy is recommended is all children who undergo open or laparoscopic PD catheter insertion.[58,59,60,61,57]

Simultaneous abdominal surgical procedures

Hernia repair

2009 RA	No recommendation
2019 ISPD	• Abdominal wall hernias can be safely repaired at the time of the catheter placement procedure • Repair with extra-peritoneal mesh are suggested
2019 RA	• Agree with guidance
2019 RA-P	• PD fluid in the abdomen makes the diagnosis of Inguinal hernia in male infants more obvious and requires early surgical intervention[57]. In children hernial defects are repaired using sutures only.

Rationale/ evidence

Abdominal wall hernias can be safely repaired at the time of the catheter placement procedure. If the hernia is complicated and a prolonged healing time is anticipated prior to initiating PD, consider repairing early to allow healing and then PD catheter insertion when the patient is closer to needing dialysis, or combining the hernia repair with catheter embedment, which can be externalised later. Repair of hernias with prosthetic mesh is considered essential for adult patients undergoing PD catheter insertion to minimize risk of recurrence. Intraperitoneal mesh would be susceptible to getting infected in instances of peritonitis; hence an extra-peritoneal mesh repair is suggested.

Inguinal hernia is not necessarily a complication of PD in children; rather the presence of peritoneal fluid unmasks the presence of a hernia. In children hernial defects are repaired using sutures only.

Abdominal vascular prostheses

2009 RA	No recommendation
2019 ISPD	• Consider allowing 2 weeks after surgical repair of abdominal aortic aneurysm • No need to interrupt PD after endovascular repair of aneurysm
2019 RA	• Agree with guidance
2019 RA-P	• Not relevant to paediatrics

Rationale/ evidence

The two major concerns with performing PD in patients with an abdominal vascular prosthesis are, in the event of PD-related peritonitis, the graft may become infected by direct extension into the retro-peritoneum, and an associated bacteraemia may result in intravascular seeding of the prosthesis. While both of these routes of graft infection are possible, the occurrence appears to be quite rare.

Published reports describe placement of PD catheters and initiation of dialysis with simultaneous repair of ruptured abdominal aortic aneurysms or at a short interval afterwards, without infection of the prosthesis. Increasing the use of endovascular aortic and iliac artery stent grafting avoids the problem of direct retroperitoneal contamination and allows patients already on PD to continue therapy uninterrupted.

In addition, the significantly lower incidence of bacteraemia associated with PD, as opposed to haemodialysis, makes it a more logical modality choice in patients with prosthetic grafts.

Gastrostomy tubes

2009 RA	No recommendation
2019 ISPD	• High risk of severe peritonitis if PEG is inserted in patient on PD • If PD patient requires a PEG, it is recommended that the PD catheter be removed with staged reinsertion after the gastrostomy has had time to heal • Insert new PD catheter 3 to 6 weeks after inserting gastrostomy
2019 RA	• Agree with guidance
2019 RA-P	• Gastrostomy placement should ideally take place prior to PD catheter insertion • In patients already receiving PD, the open surgical procedure is usually recommended. • All patients should be referred to a paediatric surgeon experienced in gastrostomy insertion and the operative approach and peri-operative considerations carefully assessed

Rationale/ evidence

There are only individual case reports or small case series describing use of PD in patients with gastrostomy. The use of percutaneous endoscopic gastrostomy (PEG) tubes in patients receiving PD is debated due to frequent infectious complications. Leakage of peritoneal fluid around the PEG leads to a high rate of fatal peritonitis, especially by fungal organisms.[117,118] If a PD patient requires a PEG, it is recommended that the PD catheter be removed with staged reinsertion after the gastrostomy has had time to heal.[118] There are reports of successfully retaining catheters without the occurrence of infection by suspending PD for 3 to 6 weeks' healing time under the cover of prophylactic antibiotics, but failures using this approach should be expected.[117,119,120] Inserting a PD catheter into a patient with an existing PEG is considered relatively safe. The catheter exit site should be located remote from the PEG, on either the opposite side of the abdomen or a pre-sternal exit-site location to reduce the risk of catheter infection.[118]

Very small observational studies have shown that gastrostomy tubes can be inserted in paediatric patients using open and laparoscopic techniques, in a safe manner with a small risk of peritonitis.[121] The 2012 ISPD guidelines[77] recommended the preferential use of an open surgical procedure for gastrostomy placement in children who are already receiving PD. A more recent single centre review found that in children already receiving PD, laparoscopic gastrostomy insertion was similar in safety profile and efficacy to open gastrostomy.[122] Interestingly, another study, showed no difference in peritonitis in the presence of a gastrostomy, colostomy or vesicostomy on multivariable analysis.[123]

Complications of peritoneal catheters

Infectious complications and management

2009 RA	• We recommend that urgent removal of PD catheters should be available where necessary (1A) • We recommend that timely surgical support should be available for the review of PD patients (1A)
2019 ISPD	• We suggest that superficial cuff extrusion be managed by cuff shaving (2C) • We recommend ultrasonographic evaluation of the transmural catheter segment in cases of chronic exit-site infection or when the exit-site infection is responding slowly to treatment, especially for infections involving Staphylococcus aureus and Pseudomonas aeruginosa, and that these findings be used to direct definitive treatment (1B) • We suggest splicing a new catheter segment to the inter-cuff section of the existing catheter and tunnelling it to a more satisfactory exit-site location where an ultrasound exam shows absence of fluid around the superficial cuff and the location of the exit site was a contributing factor to the chronic infection (2C) • We recommend unroofing/cuff shaving or simultaneous catheter replacement for clinical or ultrasonographic findings of tunnel infection with fluid around the superficial cuff and the inter-cuff tubing segment (1C) • We recommend catheter removal, interim haemodialysis, and staged reinsertion of the PD catheter for clinical or ultrasonographic evidence of tunnel infection with fluid around the deep cuff or concurrent peritonitis (1B) • We recommend simultaneous catheter replacement for relapsing peritonitis caused by Staphylococcal species if antibiotic therapy resolves abdominal symptoms and the peritoneal cell count is < 100/µL (1A) • Consider tunnelling catheter away from original tunnel in case of simultaneous catheter removal and replacement for infection related complications. (Ungraded)
2019 RA	• Agree with guidance (2C) • Simultaneous catheter removal and insertion should not be done if infecting organism is mycobacteria, fungi, enteric, or Pseudomonas species in origin (2B) • The outcomes of these techniques should be evaluated by local audit to ensure that local expertise in the techniques results in equivalent outcome
2019 RA-P	• Agree with guidance, although in infants and small children cuff extrusion will usually require replacement of catheter rather than re-tunnelling to a new exit-site location

Rationale/ evidence

Infectious and mechanical complications of the peritoneal catheter are the 2 most common reasons for PD failure. With early and appropriate intervention, many catheters can be saved, often without interruption of therapy. On the other hand, in the event of certain infectious complications, it is important to know when urgent removal of the catheter is essential to preserving the peritoneal membrane so patients may return to PD. 2017 ISPD Update on Prevention and Treatment of peritonitis provides a detailed guidance on strategies to prevent and manage infective complications in patients on peritoneal dialysis.[76]

A systematic review and meta-analysis showed Mupirocin and topical antibiotics to be effective in reducing Staphylococcus aureus catheter exit site infection in patients having peritoneal dialysis when compared with no treatment or placebo.[124]

Shape memory resiliency forces and the proximity of the cuff to the exit site can cause extrusion of the superficial Dacron cuff through the exit site. It soon becomes seeded with bacteria and predisposes the patient to exit-site infection.[125] The cuff should be gently delivered through the sinus and shaved off the catheter. Purulent discharge or inflammation should be treated appropriately with antibiotics.[76]

Exit site infection not responding to a 2 to 3 weeks treatment as suggested by ISPD guidelines could be associated with tunnel and superficial cuff involvement, which can be confirmed with ultrasound examination of the tunnel.[126,127] This evaluation requires technician experienced in evaluation of the PD catheter tunnel. If ultrasonography reveals fluid around the superficial cuff, with or without fluid in the inter-cuff section, but without deep cuff involvement or concurrent peritonitis, then this can be managed with un-roofing/cuff shaving or simultaneous catheter replacement.[127,128,129,130,131] The variations of this procedure are discussed in detail in the ISPD update.[2]

PD peritonitis should be managed in accordance with previously published guidelines.[76] In patients with refractory peritonitis, simultaneous catheter insertion and removal can be considered if antibiotic treatment resolves clinical signs of infection, the dialysate leukocyte count is < 100/µL, especially if the infecting organism is of staphylococcal sp. and not mycobacteria, fungi, enteric, or Pseudomonas species in origin.[132,133]

Peritoneal leakage and management

2009 RA	No recommendation
2019 ISPD	• We recommend that initiation of dialysis following catheter placement be delayed for 2 weeks, when possible to minimize the risk of leaks (1B) • We recommend that acute and urgent start of PD < 2 weeks following catheter placement utilise a recumbent, low volume intermittent dialysis regimen, leaving peritoneal cavity dry during ambulatory periods to minimize the risk of leak (1C) • We recommend the use of CT peritoneography or peritoneal scintigraphy to investigate suspected peritoneal boundary dialysate leaks (1A)
2019 RA	• Agree with guidance
2019 RA-P	• Agree with guidance in terms of delay of initiation of dialysis if possible; and use of small fill volumes initially (eg 8-10 ml/kg) • Use of a continuous layer to close the anterior rectus sheath as well as the placement of extra, interrupted sutures on top can help avoid leaks or even hernias caused by excessive wound tension, due to crying in some of the smaller children. • Tissue glue can be used to help seal surgical incision in babies and infants who have very small abdomens and very little subcutaneous tissue/muscle

Rationale/ evidence

Peritoneal leaks, defined as any dialysate loss from the peritoneal cavity other than through the lumen of the catheter, are arbitrarily classified as early (< 30 days) or late (> 30 days), following catheter implantation and the start of PD. The time period in which the leak occurs may suggest its aetiology.[134,135]

Early leaks are usually related to catheter implantation technique, the timing of PD initiation, dialysate volumes used, and the strength of abdominal wall tissues. The incidence of peri-catheter leaks is higher with a midline approach to catheter placement than with a paramedian site.[54,55] No particular insertion technique has been proven to be better at preventing early leak.[85] Delaying start of dialysis for 2 weeks following catheter placement minimizes developing a leak.[136,137,134] Temporarily discontinuing dialysis for 1 to 3 weeks usually results in spontaneous cessation of an early leak. Dramatic early leaks may indicate purse string suture failure or technical error in wound repair and demands immediate exploration. Leakage through the exit site or insertion incision predisposes to tunnel infection and peritonitis. Prophylactic antibiotic therapy should be considered.[134,138] Persistent leaks warrant catheter replacement.

Peri-catheter hernias, pseudo-hernias (dialysate-filled peritoneal sac that extends alongside the catheter), or occult tunnel infections with separation of the cuffs from the surrounding tissues are pathways for late leakage around the catheter. Physical strain can be either an early or late cause of peri-catheter leakage. Strenuous physical activities can force dialysate through the abdominal wall around the catheter. Abdominal wall weakness, obesity, steroids, intraperitoneal pressure, and large dialysate volumes increase the risk of leakage from physical strain.[135,134] The leak is managed by temporary suspension of dialysis or by supine low-volume dialysate exchanges with a dry peritoneal cavity during ambulatory periods. The risk of leak can be minimized by performing sports and exercise activities with a dry abdomen.[139]

In paediatric practice, excessive wound tension, due to crying in some of the smaller children, can result in leaks or even hernias following PD catheter insertion. Use of a continuous layer to close the anterior rectus sheath as well as the placement of extra, interrupted sutures on top can help avoid these problems. Intraoperatively, the leaks can be detected by placing fluid through the PD catheter and filling the abdominal cavity after closure of the sheath. If a leak is detected, extra sutures can be placed before closing the skin. These techniques can also be used in adults where necessary.

Other peritoneal boundary leaks

Other peritoneal cavity leaks could be associated with previously undiagnosed hernias or pleuro-peritoneal connections. Leakage from previously undiagnosed hernias may present as obvious bulges, genital swelling, abdominal wall oedema, or apparent ultrafiltration failure.[140] If not revealed on physical exam, occult hernias with leaks may be identified by contrast CT peritoneography or technetium-99^{m} peritoneal scintigraphy.[140,141] A watertight closure during repair allows patients to continue PD postoperatively without interim haemodialysis. Risk of leak is minimized by using a supine, low-volume, intermittent PD regimen for 2 weeks following repair, leaving the peritoneal cavity dry during ambulatory periods.[142]

Pleural Leak

Pleuro-peritoneal connection with leakage of dialysate into the pleural space occurs in 1% – 2% of PD patients. Dyspnoea is frequently the first clinical sign of leak; however, patients may present only with pleuritic pain or a decrease in ultrafiltration. The pleuro-peritoneal leak is usually unilateral, most commonly on the right side, and occurs during the first year of PD. Diagnosis is confirmed by thoracentesis, with recovery of fluid low in protein and high in glucose concentration. Alternatively, the diagnosis can be established by contrast CT peritoneography or technetium-99^{m} peritoneal scintigraphy. Conservative management (peritoneal rest, low-volume dialysis) is rarely successful. Thoracoscopic pleurodesis with talc poudrage or mechanical rub produces 85% – 100% success rate. Interim haemodialysis is required for approximately 3 weeks following the procedure.[143,144,145,146]

Flow dysfunction and management

2009 RA	• We recommend that each PD unit should have the ability to manipulate or re-implant PD catheters when necessary (1B).
2019 ISPD	• Diagnostic studies and treatment for catheter flow dysfunction should progress in a logical order from conservative or non-invasive approaches to more aggressive interventions (not graded) • Choice of intervention for catheter flow dysfunction (radiological manipulation, laparoscopic rescue, or simultaneous catheter replacement) should be based upon patient factors, facility resources, and operator expertise (not graded)
2019 RA	• Agree with guidance
2019 RA-P	• Agree with guidance

Rationale/evidence

Flow dysfunction

Constipation contributes to dysfunction of outflow of PD fluid[45], and should be treated preferably with osmotic laxatives, due to the concern that simulative laxatives can cause trans-mural migration of bacteria, causing peritonitis.[46] Rarely urinary retention with a distended bladder can also cause similar problems .[147] Mechanical kinking of the catheter tubing or an intraluminal fibrin clot is usually accompanied by 2-way obstruction.

Simple abdominal film or a CT scan can be used to recognize a kink in the catheter tubing. The location of the kink will dictate whether revision or catheter replacement is required. After treating constipation and excluding a distended bladder or a kink as the cause of flow issues, then brisk irrigation of the catheter with saline can be tried to dislodge intraluminal debris. Fibrinolytic therapy with tissue plasminogen activator (tPA) may be attempted to clear presumed intraluminal fibrin or blood clots in a dose of 1 mg/mL based upon the calculated volume of the catheter assembly. If catheter obstruction is due to a fibrin or blood clot, recovery of flow function with tPA has been reported at nearly 100%.[148]

Catheter migration and tissue attachment

When considering approaches for catheter salvage, it is important to recognize that patients often become frustrated with multiple interventions and interruption of therapy and elect to transfer permanently to haemodialysis. Laparoscopy has the advantage of allowing identification of the underlying condition producing catheter flow dysfunction, permitting diagnosis-specific management. Laparoscopically enabled interventions have produced long-term clinical success in 63% – 100% of cases.[64,149,150,151,152] As discussed in catheter insertion techniques, laparoscopic procedures also allow proceeding with additional measures like omentopexy, adhesiolysis, epiploectomy, salpingectomy, or appendectomy, to prevent recurrence of mechanical problems. Although laparoscopy is a minimally invasive procedure that permits patients to immediately resume PD, it does require general anaesthesia and procedural costs are higher compared with radiological interventions.

Fluoroscopic guidewire, stiff rod, and aluminium bar manipulations have been used to resolve catheter tip migration and extra-luminal and intraluminal obstructions. Clinical success has been described in 46% – 75% of cases in published reports.[153,154] Radiological manipulation is difficult or impossible to perform through catheters with a preformed arc bend or through long pre-sternal catheters.

Simultaneous replacement of the catheter is also an option, especially if a technical fault in previous insertion is identified, but a new catheter would be subject to the same underlying conditions and also the risks of complications of a new catheter insertion.

External catheter damage

Catheter damage with leak is considered a contaminating event, and investigation for peritonitis is required and prophylactic antibiotics indicated. External splicing repair by the PD nursing staff using commercially available repair kits is possible if at least 2 cm of tubing is present beyond the exit-site.[155] Internal splicing repair to the inter-cuff segment can be considered if the catheter tubing is too short for external repair, flow function has been satisfactory, and there is no concurrent peritonitis.[156]

Catheter Removal

2009 RA	• We recommend that urgent removal of PD catheters should be available where necessary (1A) • We recommend that timely surgical support should be available for the review of PD patients (1A)
2019 ISPD	• Catheters may be removed by either open surgical dissection or “pull technique” (not graded) • We suggest that open surgical dissection removal of the Dacron cuffs intact with the catheter be performed when removal is for a tunnel infection or catheter infection related peritonitis, 2-piece extended catheters joined with a titanium connector, or devices equipped with a Dacron flange and silicone bead fixation components (2C) • We suggest that the “pull technique” is best suited when catheter removal is performed for non-infectious indications where retaining the Dacron cuffs in the tissues is of minimal risk (2C)
2019 RA	• We recommend that urgent removal of PD catheters should be available where necessary (1A) • We recommend that timely surgical support should be available for the review of PD patients (1A) • Catheters may be removed with dissection and removal both cuffs to avoid future infection risk from the residual cuffs (2C) • We recommend that open surgical dissection removal of the Dacron cuffs intact with the catheter be performed when removal is for a tunnel infection or catheter infection related peritonitis, 2-piece extended catheters joined with a titanium connector, or devices equipped with a Dacron flange and silicone bead fixation components (2C) • We suggest that the “Pull technique” should be used only in circumstances where dissection and removal of cuffs is not possible (not graded)
2019 RA-P	• Agree as above

Rationale/ evidence

The Dacron cuffs may shear off the tubing during extraction and be retained in the tissues during the “pull technique” commonly performed in the clinic or procedure room with or without local anaesthesia or sedation. The technique is not suitable for catheters with multiple sections or a flange or bead fixation components. Infection of the retained cuffs necessitating later excision has been reported in 2.5% to 3.2% of cases.[157,158]

Catheters with evidence of current or past infection, either exit-site or peritonitis, should always be removed with intact dissection and removal of the cuffs and fixation attachments.

Secondary embedding

2009 RA	• No recommendation
2019 ISPD	• We suggest secondary embedding of the PD catheter when renal function has improved enough to stop dialysis but recovery is not expected to be long-term, conditional to previously normal catheter flow function (2D)
2019 RA	• Agree with guidance
2019 RA-P	• No recommendation

Rationale/ evidence

There are a few reports of successfully embedding the PD catheter after initial use, when the kidney function has improved enough to stop dialysis, but the improvement is not expected to be long term.[159] The catheter can be buried subcutaneously provided the catheter has a good flow function. This can then be externalised promptly when needed.

Training

Renal trainees should be encouraged to train in percutaneous PD catheter insertion. Unlike haemodialysis catheter insertion, training opportunities for PD catheter insertion are limited due to lower numbers. Similarly, the surgeons performing PD catheter insertion should train/familiarise with advanced laparoscopic techniques. There are excellent examples of successful nurse led PD catheter insertion programmes.[160]

We recommend the UK renal community to look at US/ ISN model of developing interventional training centres to provide training in these procedures to interested trainees.

Surgeons involved in laparoscopic PD catheter insertion should be trained in adjunctive components of advanced laparoscopic technique. These additional interventions have shown to reduce the mechanical complications of PD catheters.

Developing good technical skills is dependent on iterative practice. This limits even interested trainees developing confidence in continuing to provide PD access. Use of simulation for training has become significant, alongside the development of laparoscopic techniques, and evidence suggests that skills obtained in simulation are applicable in real clinical scenarios. Simulators are becoming more common, more diverse, more authentic, and increasingly incorporated into education programs and professional practice.[161] Developing simulators of percutaneous and laparoscopic PD catheter insertion techniques will help in training more colleagues, and hence improve access to PD for the patients.

PD catheter manipulation for malfunctioning catheters is a highly variable practice and various interventions have been described. Radiological and laparoscopic interventions for malpositioned catheter should be part of training for clinicians providing PD access. There is also need for training the PD clinicians in use of ultrasound for evaluation of PD catheter tunnel in patients with ESI.

These are the considerations for the UK renal community to improve training in order to improve outcomes for PD access procedures.

Audit

A regular audit of procedure outcomes and patient complications is essential to support the practice and development of PD programs. Data from renal registry as well as international PD studies shows huge variation in practice and outcomes in PD programs. Poor outcomes from PD catheter insertion and maintenance cause significant morbidity and have major impact on PD utilisation. The time interval between a catheter complication necessitating stopping PD, and bridging it with HD, should be regularly audited with efforts towards minimising it.

Some aspects of care suggested in the guidelines are supported by the best practice consensus amongst experts and might be driven by unique local expertise. Adoption of these recommendations should be supported by local audit process to ensure that the success of these techniques can be reproduced; hence these form part of the recommendation for the audit too.

- We recommend in depth audit of PD access related complications/ outcomes every 5 years to work towards improved methods of ensuring high standards in PD access practice.

- We suggest the creation of perioperative checklists (LocSSIPs) on PD catheter insertion for the different techniques to standardise practice in UK.
- We recommend an audit of catheter insertion outcomes on at least an annual basis as part of a multidisciplinary meeting of the PD team, including attendance of access operators when feasible (1B)
- We suggest audit of timely PD catheter insertion in patients choosing PD as RRT modality
    - Number of patients who had opted for PD as RRT modality requiring to start HD
- We suggest clinical goals specific for the PD access procedure include (2C):
    - Catheter patency at 12 months of > 95% for advanced laparoscopic placement and 80% for all other catheter insertion methods
    - Exit-site/tunnel infection within 30 days of catheter insertion: < 5%
    - Peritonitis within 30 days of catheter insertion: < 5%
    - Visceral injury (bowel, bladder, solid organ): < 1%
    - Significant haemorrhage requiring transfusion or surgical intervention: < 1%
- We suggest that incidences of peri-catheter leaks within 30 days of catheter insertion be recorded separately for early PD starts (< 14 days) and late starts (≥ 14 days) (not graded)
- We suggest auditing the waiting period for patients requiring a remedial procedure and use of HD during the wait after PD catheter complication
- We suggest audit of outcome of interventions on PD catheter (deroofing, retunneling, manipulation for malposition catheters)
- Poor access results in a poor patient experience. We recommend that we work towards developing a system of patient reported outcome measures (PROMs) for PD access.

Definitions

Catheter patency is defined as the percentage or probability of catheter survival at 12 months following placement; therefore, the catheter has not been removed, replaced, or required some type of intervention (surgical or radiological) because of flow dysfunction or irremediable drain pain.

Monitoring of catheter patency for embedded catheters begins at the time of externalization.

Causes of catheter loss are censored, including death, transplant, infection, peri-catheter leakage, or transfers to haemodialysis because of inadequate dialysis, psychosocial reasons, or medical problems.

Future direction and research

In the absence of many good quality RCTs, most of the guidance is based on relatively weak evidence, and expert opinion. There is significant variation in practice between the operators using nominally similar techniques. The procedures described in the guidelines, such as advanced laparoscopic technique, un-roofing/ splicing/ secondary embedding of the catheters, are practiced in only a few units. The available trials have significant limitations as not all use the same end-points to define catheter survival. A lot of research is required with good quality trials to compare the outcomes of various techniques of PD catheter insertion with selection of patient equally suitable for the different techniques using standardised outcome measures, and requires coordination and cooperation between renal units at regional and national level.

UK National Registry for PD catheter insertion

- UK catheter study, part of UKPDOPPS, is an excellent effort on the part of UK PD community to start to look at variance in practice and outcomes. Consideration should be made by the clinical community involved in PD catheter insertion and care to develop and report nationally all PD insertions and outcomes to gain more knowledge from our current and evolving practice.
- Procedure/ technique level data should be evaluated to compare outcomes and help the units/ operators to learn from best practice.

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Abbreviations

PD	Peritoneal dialysis
PDC	Peritoneal dialysis catheter
ISPD	International Society of Peritoneal Dialysis
RA	Renal Association
HD	Haemodialysis
ESRF	End-Stage Renal Failure
AKI	Acute Kidney Injury
aPD	assisted Peritoneal Dialysis
RCT	Randomised controlled trial