How to build a successful urgent-start peritoneal dialysis program

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ABSTRACT:

In-center hemodialysis (HD) remains the predominant dialysis therapy in patients with end-stage kidney disease (ESKD). Many patients with ESKD present in late stage requiring urgent dialysis initiation, and the majority start HD with central venous catheters (CVC) that is associated with poor outcomes and high cost of care. PD catheters can be safely placed in such late-presenting ESKD patients, obviating the need for CVC. PD can begin almost immediately in recumbent position using low fill-volumes. Such PD initiations commencing within two weeks of the catheter placement are termed urgent-start PD (USPD). Most patients with intact peritoneal cavity and stable home situation are eligible for USPD. While there is a small risk of PD catheter-related mechanical complications, most can be managed conservatively. Moreover, overall outcomes of USPD are comparable to those with planned-PD initiations in contrast to high rate of catheter-related infections and bacteremia associated with urgent-start HD. The ongoing-COVID-19 pandemic has further exposed the vulnerability of ESKD patients getting in-center HD. PD can mitigate the risk of infection by reducing environmental exposure to the virus. Thus, USPD is a safe and cost effective option for unplanned dialysis initiation in late-presenting ESKD patient.

To develop a successful USPD program, strong infrastructure with clear pathways are essential. Coordination of care between nephrologists, surgeons or interventionalists, along with hospital and PD center staff is imperative so that patient-education, home-visit, PD-catheter placement, and urgent PD initiation are accomplished expeditiously.
Implementation of urgent-start will help to increase PD-utilization, reduce cost and improve patient outcomes, and will be a step forward in fostering the goal set by the Advancing American Kidney Health initiative.
BACKGROUND/INTRODUCTION:

With the increased global burden of end stage kidney disease (ESKD), there is a need for optimal renal replacement therapy (RRT) [1]. Although most cost-effective, timely transplant is challenging due to logistics and scarcity of organs. Therefore, most ESKD patients need dialysis to sustain life. Given progressive upsurge of ESKD population, equitable growth of various dialysis modalities is expected. However, the default RRT in ESKD remains in-center hemodialysis (HD[2, 3]. In 2017, 86.9% of the US incident-ESKD patients began RRT with HD and only 10.1% started with peritoneal dialysis (PD) [3]. Large number of patients do not get pre-ESKD education or access planning due to inadequate or lack of kidney care [4]. For instance, 33% of incident ESKD patients received little or no pre-ESKD nephrology care in 2017 [3]. Consequently, such patients present to hospitals with advanced ESKD requiring urgent-dialysis initiation. In addition, some patients with advanced kidney disease and established nephrology care may develop unanticipated accelerated progression of kidney disease. Majority of such patients start HD with central venous catheters (CVC), as most physicians and hospital staff are more comfortable with HD than PD initiation [2, 5, 6]. In 2017, 80% of the patients initiated HD with CVC [3]. Most patients who begin dialysis in inpatient setting stay on the same dialysis modality as outpatients [2]. Individuals initiating HD with CVC have much higher mortality, morbidity, length of stay and cost of care compared to those initiating PD or HD with appropriate vascular access [7-10]. The reported one-year risk of catheter-related bloodstream infections is quite variable ranging from as low as 9% to high at 79% [8]. In an observational study of all Medicare facilities that provided outpatient HD in New England throughout 2015 and 2016, mean bloodstream
infection rate per 100 patient-months was 2.15±6.5 and 0.23±0.8 for patients with and without catheters, respectively [11]. Stated otherwise, the mean catheter associated blood stream infection rate was 0.71 per 1000 catheter days. The relative risk of a bloodstream infection in patients with a catheter compared with those without a catheter was 7.5 (95% CI, 6.3-8.9)[11].

PD is more cost-effective and provides similar or superior outcomes compared to HD [9,10]. PD can commence almost immediately following PD-catheter implantation. Thus urgent-start PD avoids the need for temporary vascular access and repeat vascular procedure to establish a permanent access. In addition, it allows for the better preservation of residual kidney function and offers lifestyle benefits that can be achieved with a home-based therapy [12]. Therefore, initiation of PD as urgent-start is an attractive option in late-presenting ESKD patients. This review will focus on strategies, logistics, challenges and benefits to develop a successful urgent-start peritoneal dialysis program.

**ECONOMIC COST OF DIALYSIS MODALITIES:**

Though ESKD comprises 1% of the US Medicare population, it consumes more than 7% of the annual Medicare expenditure at $35.9 billion [3]. In the landscape of rising healthcare expenditure, cost of HD is 1.25 to 2.35 times higher than that of PD in most developed countries [13]. Likewise, annual per patient cost of HD in the USA is $13,000 higher than that of PD [3]. This makes PD a more cost-effective dialysis modality than HD. In January 2011, in an attempt to control costs, the US Center for Medicare and Medicaid Services (CMS) instituted a single bundled prospective payment system (PPS) for all dialysis modalities, making PD financially more attractive [14]. However, despite financial incentive from the CMS-PPS, the
growth of PD has been modest so far [15]. One reason for slow PD growth is low utilization of urgent-start PD in the United States. In reality, urgent-start PD should be a valuable option among patients requiring unplanned dialysis initiation. A recent study found the first 90-day cost of urgent-start PD to be $3000 lower than that of urgent-start HD [16]. Indeed, urgent-start PD can be a step towards achieving the goal of 80% incident dialysis patients initiating home dialysis by 2025, as stated in ‘Advancing American Kidney Health’ Initiative [17].

**DEFINING URGENT-START PERITONEAL DIALYSIS:**

The major goal in management of patients who crash in with advanced ESKD needing urgent dialysis initiation is to avoid CVC placement and associated complications. PD catheters can be safely placed in such patients, averting the need for CVC. Typically, a two-week break-in period is recommended after placement of catheter to facilitate healing, prevent catheter complications, and allow patients and family members to get trained in the PD technique [18-20]. However, if needed, PD can be initiated almost immediately using a modified protocol [21]. By definition, all PD initiations that begin within two weeks of the catheter placement are considered urgent-start PD [20,22].

**LOGISTICS AND INFRASTRUCTURE OF URGENT-START PD:**

**Barriers to urgent start PD**

Numerous barriers at multiple levels impede initiation of urgent PD (Table 1). Lack of awareness of home dialysis options among patients is a major barrier that can be surmounted with implementation of in-hospital educational intervention [2]. Inadequate knowledge and experience and misperceptions about urgent-start PD is another important barrier that limits
clinicians utilize PD [23]. Nearly 50% of US nephrologists feel uncomfortable in caring PD patients [5,24]. Education of trainee nephrologists on all aspects of peritoneal dialysis can help overcome this barrier [25]. Similarly, training of US surgeons in PD catheter-insertion is inadequate [26]. Improvement in training and increasing availability of other operators such as interventional radiologists and nephrologist for PD catheter placement, as well as providing financial incentive to surgeons and other operators may help improve urgent-start PD utilization [27]. Lack of infrastructure at hospital or dialysis center is yet another major barrier, as inability to train and dialyze urgent-start patients may discourage physicians to consider home dialysis therapy for acute starts [28]. Developing sound infrastructure to overcome the aforesaid and additional barriers is the main goal for a successful urgent-start PD program, as discussed below.

**Components of successful urgent-start PD program**

Only well-organized PD programs with robust infrastructure are successful, safe and feasible for unplanned PD initiations [20,21]. Support from hospital administration is essential to establish a successful urgent-PD program. Not only should hospital assure adequate surgical or interventionists staffing familiar in urgent placement of PD catheters, adequate space and PD-equipment, as well as sufficient nursing staff adequately trained in performing urgent-PD should be provided. A delay in PD catheter placement and PD initiation can increase the length of hospitalization, thereby increasing the cost of inpatient care. A structured urgent-start PD program can streamline expeditious PD initiation process and can offer an efficient and cost-saving approach for dialysis initiation [16].
It is crucial that dialysis-modality selection process should be taken jointly with patients, nephrologists, surgeons and the dialysis center. Interdisciplinary coordination and efficiency of care are essential and include prompt patient selection, expedited dialysis modality education and home evaluation, urgent PD catheter placement, as well as nursing and hospital administration support (Table 2). Furthermore, clear protocols should be developed and standardized for urgent-start PD to ensure smooth transition from hospital to outpatient PD center.

The key elements for a successful urgent-start PD include:

1. Dialysis Modality Education
2. Patient selection Process
3. Home evaluation
4. Urgent placement of PD catheters
5. Urgent initiation of PD in Hospital.
6. Urgent-start PD and training in outpatient PD center.

_Dialysis Modality Education:_

Most patients who crash-in with advanced ESKD have not had formal pre-dialysis education [2,3]. Besides, the demands from an educational program in unplanned settings are different than those in pre-dialysis settings, as the ability of many patients to comprehend and make quick decisions about dialysis modality may be impaired because of sickness and uremic state. Nonetheless, expedited dialysis modality education should be provided and, if possible, family members should be involved in the decision-making process. Providing dialysis education
considerably increases the use of PD, even in unplanned dialysis initiation [2,29]. In a retrospective study, patients starting urgent home-dialysis increased from 13% to 35% after implantation of in-hospital education program [2]. Having a dedicated dialysis educator to offer individual guidance, and providing printed materials and educational video will immensely help patients and families choosing appropriate dialysis modality fitting their lifestyles (Table 3). Translators and if feasible, printed material in patient’s native language should be available for non-English speaking patients.

**Patients Selection:**

Selection of appropriate candidates is central to develop a thriving urgent-start PD program [30]. The selection process should include evaluation of medical, psychosocial and surgical barriers to PD. Screening questionnaire may help in facilitating patient selection and can be developed in collaboration with hospital staff, chronic kidney disease (CKD) clinic and PD center [21]. Patient-preferences and life-goals should be reviewed, and home situation, living environment, and family and social support should be assessed. Visual acuity and manual dexterity should be examined and abdomen should be inspected for presence of extensive scars from previous abdominal surgeries or large hernias. (Figure 1).

There are very few contraindications against urgent-start PD. Most patients with intact peritoneal cavity, stable home situation and desire to do PD are eligible for urgent-start PD. Patients with recent abdominal surgery compromising peritoneal membrane, acute bowel inflammation, colostomies and uncorrected hernias are not candidates for urgent-start PD. Previous abdominal surgeries, however, should not be absolute contraindications for PD. Some patients do develop peritoneal adhesion after abdominal surgeries, but the extent of adhesions
is difficult to predict without laparoscopic exploration [31-33]. Direct visualization of the peritoneum and placement of PD catheter by advanced laparoscopy has been very successful in most instances [34, 35]. Frailty, advanced age, poor vision, psychiatric or memory issues and lack of motor skills are not contraindications to PD but mere barriers that can be overcome with assisted PD, either provided by the family members at home or by trained personnel at home or nursing facilities [36-40]. Assisted PD programs have been successful in other countries such as Canada, Denmark, and France [38, 41-43]. The CMS does not fund assisted PD program in the USA. Similarly, poor literacy should not be considered a barrier to PD. A vigorous, thorough and simplified training process to accommodate patients with limited health literacy can lead to successful PD in such patients [44].

Some patients may present with severe hyperkalemia, metabolic acidosis, volume overload, or uremic pericarditis and need emergent dialysis. Such patients should not be excluded from urgent-start PD. They should be initially managed with emergent HD using temporary CVC. Once stabilized, the patients should be re-evaluated for urgent-start peritoneal dialysis as discussed above (Figure 1).

**Home Visit:**

If possible, an expedited home visit, either virtual or in-person, should be considered within 24-48 hours of patient’s selection (Table 4). Typically conducted by a licensed PD-nurse, home evaluation entails an overall assessment to determine if home conditions are safe and supportive of PD (Table 4). The patient should have clean and adequate confined space to perform PD. In addition, sufficient temperature controlled space should be available to store PD supplies. The home should have proper plumbing and running water supply. Moreover,
appropriate electric supply including grounded three-prong outlets is needed, particularly for patients choosing automated peritoneal dialysis (APD). As APD is usually performed at night, the patient should have easy access to the toilet. During the visit, the nurse documents the number of households and pets living in the house, identifies any barriers, and recommends appropriate changes.

**Urgent placement of PD catheters:**

A crucial step in the success of an urgent-start PD program is prompt and timely placement of PD catheter. Currently, there are no evidence-based recommendations for preferred catheter design or optimal insertion technique for urgent-start PD. Catheters can be placed surgically by open-surgical or laparoscopic techniques. Alternatively, percutaneous approach using peritoneoscopic (Y-Tec) or fluoroscopic guidance can be utilized [34, 45]. To minimize post-operative risk of pericatheter leaks, purse-string sutures can be placed around the deep cuff in the posterior rectus sheath to obtain a watertight seal [38, 46-50]. The advantages and disadvantages of various techniques are outlined in Table 5. Successful placement of PD catheters by laparoscopic, open surgical and percutaneous approaches has been accomplished in various urgent-start PD programs [41, 46, 50-56] (Table 6).

There are no studies comparing outcomes of various operative techniques in urgent-start PD. Conversely, investigators have observed comparable outcomes from various PD catheter implantation methods in planned PD settings [51-57]. However, a recent meta-analysis comparing open dissection, basic laparoscopic, and advanced laparoscopic procedures demonstrated significantly superior outcomes for advanced laparoscopy over the other two approaches [58]. Quite likely, the advanced laparoscopic technique allows adjunctive
procedures such as lysis of adhesions, omentopexy, identification and repair previously unsuspected hernias that can further improve catheter outcomes [32, 59].

While current guidelines do not recommend a specific procedure for catheter placement, the choice of operator (surgeon, nephrologist or interventional radiologist) and the technique (open-surgical, laparoscopic or percutaneous) should be dictated by the local experience and resources at the individual site. Hospitals should encourage training of interventional radiologists and nephrologists in urgent PD catheter placement. While many interventionlists are not familiar with PD catheter placement techniques, workshops and training courses to obtain necessary skills are readily available (Information available at www.ispd.org). One advantage of interventionlists placing urgent PD catheter is eliminating the need for general anesthesia and operating room scheduling. This can expedite the entire process of urgent-start PD. Some patients, such as those with prior major abdominal surgeries or obesity may not suitable for percutaneous techniques and should instead have laparoscopic or open-surgical implantation [32, 54].

_Urgent initiation of PD in hospital:_

Hospital stay should be minimized after PD catheter placement. Unless there are medical reasons for continued hospitalization, the patient may be discharged on the same day of the PD catheter surgery, and should follow up at the outpatient PD center in 1-2 days. However, if the patient remains admitted, PD can commence inpatient, if needed. Initially, a rapid manual exchange with low fill-volume (FV) of 500 ml with patient in recumbent position should be performed to evaluate the patency of the catheter and presence of any
pericatheter leak (Figure 2). If successful, further exchanges of low FV (500-750 ml) in supine position can be performed either manually or by automated peritoneal dialysis (APD) with cycler, if available (Figure 3). APD may reduce the burden of frequent manual exchanges on the staff and facilitate accurate delivery of the prescribed fill-volume. The number of exchanges and the tonicity of the dialysate is determined by the extent of uremic symptoms and volume status respectively, as discussed in more details in the following section. Unlike out-patient center, inpatient setting gives more flexibility in terms of time to perform exchanges. Therefore, if needed, frequent exchanges over a longer time-period can be performed, as dictated by the clinical status of the patient.

**Urgent-start PD and training in outpatient PD center:**

Upon discharge, the patient should be seen in the PD center within 24-48 hours. Initial evaluation includes assessment of volume status and uremic symptoms to determine the urgency of initiating PD (Figure 4). If there is no immediate need to start PD, patient can wait a few days to promote healing and reduce the risks of catheter complications [19]. However, if needed, PD can be initiated immediately after admission [19, 38, 60, 61]. Successful initiation of PD within 2 to 6 days have been reported in many studies [47, 48, 50, 62-65]. As discussed in the above section. PD catheter patency and presence of any leaks should be assessed upon admission (Figure 2).

As higher FV and upright position raise intraperitoneal pressure with associated risks of mechanical complications, urgent-start PD should be initiated using low FV with the patient in the supine position [66, 67]. There is no consensus on the initial FV. Fill-volumes of 0.5-1L, based upon patient-weight were used in 17 patients initiated on cycler in one study [68]. In a
RCT, patients started with larger FV of 1L that were rapidly up-titrated to 2 L by 5 days [19]. In contrast, a recent study from Brazil started with high FV (30 ml/kg] right from the outset [69]. More individualized prescription based upon body surface area (BSA) has been used by other groups [21]. In general, FV should be determined based upon the size and comfort of the patient. A typical starting volume is 500-750 ml. FV should be slowly increased every 3-4 days, as tolerated, while monitoring for catheter leaks and overfill until the patient reaches a maximum FV of 1.5-3 L, typically in 2-4 weeks.

The tonicity of the dialysate, and number and frequency of PD exchanges are determined by the extent of symptoms and volume status. Depending upon the clinical judgement, 3-5 exchanges over 4-8 hours a day are performed by the PD nurse, 3-5 times a week. PD prescription should be evaluated and adjusted frequently depending upon the clinical status of the patient. PD fluid should be completely drained when breaks in treatment are needed. In addition to PD exchanges, diuretics should be prescribed in patients with good residual kidney function. Bowel regimen should be included to avoid constipation. Heparin (500 units/L) is usually added to dialysate as long as the effluent is bloody (Table 7).

The PD center requires specific set-up to support urgent-start PD. The clinic should have two or more rooms. The training room should be large enough to lodge the reclining chair, and equipment and supplies for dialysis. PD centers with more than one nurse are more suitable for urgent-start PD, so that while one nurse is busy with the urgent-start, the other can address issues of the established patients. While one-to-one nursing is not required for the entire treatment, the patient should have call light or bell to seek nurse for any help.
The time spent in the center during urgent-start PD provides opportunity to commence training to the patient and the family members. Depending upon the state of uremia, the training process can start right away or after a gap of 1-2 weeks. PD training should preferably involve printed material, video, verbal instructions and several days of hands-on training. Initially, patients get a basic understanding of PD by observing the PD nurse on the basic technique and concept of PD. The training is then advanced at a pace determined by the comprehension of the patient and the family members involved in patient-care, till the training is complete and the patient is ready to be discharged home, usually by 2-4 weeks.

**Outcomes of Urgent-start PD:**

Urgent-start PD may be associated with increase in catheter-associated mechanical complications as compared with planned PD (PPD).

In a large retrospective single-center study enrolling 2059 urgent-start PD patients, 4.1% patients developed catheter malfunction and 1.77% patients experienced abdominal wall complications, including hernia, hydrothorax, hydrocele, and leakage within the first month after catheter insertion. The rates of early peritonitis and exit site infections were 0.28 per patient-year and 0.08 per patient-year respectively [70]. However, the study did not compare urgent start and planned-PD patients. In the only RCT comparing urgent-start PD to PPD in 122 patients, a significantly higher rate of pericatheter leaks was observed in patients who initiated PD at 1-week compared with those who commenced at 2 weeks or 4 weeks following surgical catheter implantation [19]. The risks of infection were similar in the three groups. Most leaks were conservatively managed without surgical intervention, yet significantly higher number of patients in the 1-week group required temporary HD than the other two groups [19]. Similar
results have been observed in several observational and retrospective studies. In a single-center, matched case-control study of 104 patients, urgent-start PD patients experienced more frequent mechanical complications but similar technique survival or peritonitis episodes compared with PPD subjects [61]. In a large retrospective study from China, patients initiating PD within 7 days more frequently experienced mechanical complications than those commencing PD between 8-14 days or beyond 14 days after open surgical PD catheter insertion [71]. Outcomes and complications associated with urgent start PD are summarized in Table 6 [21, 48, 50, 54, 68-75]. Altogether the studies observe higher catheter-related mechanical complications with urgent-start PD, but no significant differences in risk of infection, PD-technique survival, hospitalizations or mortality between urgent-start and PPD [20, 21, 50, 61, 76, 77]. Importantly, most catheter-related complications can be managed conservatively without need for catheter removal or change in dialysis modality [61, 72].

Data comparing complications associated with urgent-start PD and unplanned HD (UHD) are limited and is shown in Table 8. A retrospective observational study in 176 patients from China observed a significantly higher rates of bacteremia and all-cause infectious complications in patients receiving UHD than those initiating urgent-start PD [78]. Similarly, a significant increase in catheter related bacteremia in the first 6 months was observed in UHD patients compared to those receiving urgent-start PD in an observational cohort study of 123 patients from Germany [63]. In another retrospective study from China involving 94 patients, the incidence of composite infectious and non-infectious dialysis-related complications during the first 30 days was significantly lower in urgent-start PD compared to UHD patients [79]. Contrariwise, a recent non-randomized prospective study from Brazil, showed no significant difference in bacteremia but a
significantly higher rate of catheter exit-site infections in UHD patients than in urgent-start PD patients [80]. Despite higher dialysis-related complications associated with UHD, no difference in overall mortality between the two groups has been reported [20, 63, 78-80]. A systemic review comparing outcomes between UHD and urgent-start PD was recently concluded [81]. The preliminary results suggest a lower risk of bacteremia and catheter malfunction but no difference in mortality among urgent-start PD patients compared to UHD patients [82].

In nutshell, based upon available evidence, risk of higher morbidity associated with initiating urgent-start HD with CVC is far higher than the perceived risks of early mechanical complications, making a strong case for initiating PD in late presenting ESKD patients.

Urgent-start PD in the midst of COVID-19 pandemic:

The ongoing COVID-19 pandemic, caused by highly infectious severe acute respiratory syndrome coronavirus 2, or SARS-CoV-2, has a mortality rate of 1.4%-3.6%, mainly from life-threatening respiratory infections [83-87]. Patients with chronic medical illnesses, including CKD, are at increased risk of serious complications from COVID-19 [88]. In fact, the first US COVID-19 related death was reported in an ESKD patient getting HD [89]. COVID-19 infection is associated with 24-31 % fatality among ESKD patients [90,91]  In the midst of the pandemic, ESKD poses unique challenge in management, both in hospital and outpatient settings. HD Patients visiting dialysis centers 3-times a week are highly susceptible to get environmental exposure that greatly increases the risk of transmission of infection to themselves, other patients, staff, family members and individuals exposed during the transit. ESKD patients with suspected infection are commonly sent to the hospital, stretching emergency rooms and hospitals to their limits. With increasing burden of hospitalized patients requiring RRT,
hospitals are experiencing acute shortage of supplies and staff to perform dialysis procedures, and are rationing HD and continuous renal replacement therapy for patients with ESKD and AKI [92,93]. In this unprecedented resource-constrained crisis, urgent-start PD in acutely ill ESKD and AKI patients can be an invaluable option [94-97]. Not only urgent-start PD can help to conserve the resources and supplies, but will also mitigate the risk of COVID-19 transmission by reducing the exposure of staff and other individuals both in hospitals and at dialysis centers. Such observation was made during the 2009 influenza H1N1 pandemic when much lower incidence of the viral infection was noted among PD patients compared to their HD counterparts [98].

SUMMARY

Urgent-start PD is a safe and cost effective option for unplanned dialysis initiation in late-presenting ESKD patient. Robust infrastructure with clear pathways are paramount in developing a successful urgent-start PD program. The ongoing COVID-19 pandemic has exposed the fragility of ESKD patients, particularly those undergoing in-center HD, and underscores the need for urgent-start PD in this highly vulnerable population. Implementation of urgent-start will help to increase PD-utilization, reduce cost and improve patient outcomes, bolstering the goal set by the Advancing American Kidney Health initiative.
Disclosures: All authors have nothing to disclose.

Funding: None

Acknowledgements: Olivia Rodriguez for secretarial assistance.

Author Contributions:
N Rajora: Writing - original draft
S Shastri: Writing - original draft
G Pirwani: Writing - original draft
R Saxena: Conceptualization; Writing - review and editing
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<th>Interventions</th>
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<td><strong>Provider related factors</strong></td>
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<tr>
<td>Lack of knowledge and experience among clinicians</td>
<td>Education of nephrologists, surgical trainees/interventionalists about PD catheter insertion techniques</td>
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<td>Misconceptions or biases about PD</td>
<td>Visits to centers of excellence for fellows and nephrologists for hands on experience</td>
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<tr>
<td>Timely PD catheter insertion</td>
<td>Identify dedicated surgeons, interventional radiologists or nephrologists for PD catheter insertion for urgent starts</td>
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<td></td>
<td>Education of surgical trainees/interventionalists about PD catheter insertion techniques</td>
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<td></td>
<td>Courses for surgeons and interventionalists to provide hands on experience about catheter-implantation procedures</td>
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<td><strong>Infrastructure related factors</strong></td>
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<td><strong>In hospital:</strong></td>
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<tr>
<td>Delay in PD catheter insertion</td>
<td>Having structured protocol for urgent-start PD</td>
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<td>Lack of effective communication between hospital and outpatient PD center staff</td>
<td>Identify dedicated personnel to streamline the process of education, and coordination of care between hospital and out-patient PD center</td>
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<td><strong>Outpatient PD unit:</strong></td>
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<tr>
<td>Unable to accommodate urgent initiation due to lack of individual rooms for training or trained staff</td>
<td>Identify dedicated personnel to communicate with in hospital team and for home visit</td>
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<td>Availability of adequate clinic rooms in the PD unit</td>
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<td>Ensuring adequate PD nurses and resources</td>
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<td><strong>Patient related factors</strong></td>
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<td>Lack of patient awareness about home modalities</td>
<td>Well designed in-hospital patient education program</td>
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<td>Patient refusal</td>
<td>Assess the cause of refusal</td>
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<tr>
<td>Physical</td>
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<tr>
<td>Reduced physical strength to lift PD bags</td>
<td>Assistance by home care partner</td>
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<td>Reduced dexterity to make connections</td>
<td>Assisted PD if available</td>
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<td>Reduced vision/hearing</td>
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<td>Cognitive impairment such as dementia or learning disabilities</td>
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Table 2: Logistics and infrastructure requirements for urgent-start peritoneal dialysis (PD) program

**Hospital Support**

1. Multidisciplinary patient selection approach
2. Expedited patient education process
3. Prompt communication with PD center to expedite home visit
4. Easy availability of surgeons or interventionalists (radiology or nephrology) to urgently place PD catheter
5. Provision of nursing staff trained in urgent-start peritoneal dialysis.
6. Providing equipment and supplies to conduct PD
7. Clear protocols to standardize urgent-start PD
8. Coordination of care with out-patient PD center for seamless discharge process

**Dialysis Center support**

1. Prompt conduction of home visit
2. Ability to evaluate patient within 1-2 days following hospital discharge
3. Provision of ample space and equipment to conduct urgent-start PD
4. Availability of adequate nursing staff trained in urgent-start PD
5. Providing education and training to the patient about urgent-start PD
6. Administrative support for smooth transition of care from hospital to PD center
Table: 3. Patient Education about Dialysis Modalities

Discuss dialysis options for treatment for ESKD

In-center and home hemodialysis
Peritoneal Dialysis

Discuss pros and cons of dialysis modalities

Pros of PD
- Self-therapy. Improves self-esteem
- Needleless
- Flexible schedules
- No frequent travel to the dialysis center
- Provides more even dialysis with minimal fluctuation of blood pressure
- Less fluid and dietary restrictions
- Greater freedom to travel
- Patient can remain in workforce while dialyzing at night
- Better quality of life compared to HD
- Lower morbidity and mortality compared to HD
- Better transplant outcomes compared to HD
- Lower cost

Cons of PD
- Daily therapy.
- Body image issues
- May cause abdominal pain and discomfort
- Risk of hernias
- Restriction on lifting weight
- Restriction on certain types of exercises
- Can be associated with infection of catheter if not careful

Pros of in-center HD
- Only 3-times a week therapy
- Treatment performed by trained staff
- No catheter placed in abdomen
- No restriction on lifting weight
- No restriction on exercises

Cons of in-center HD
- Need to travel three times a week to dialysis center
- Two large needles placed on every treatment (Unless patient has catheter)
- Fluctuation in blood pressure during HD treatment
Less freedom to travel (Need to find a dialysis center when traveling)
More dietary and fluid restrictions
More expensive than PD
Lower quality of life compared to HD

*Discuss home requirement for PD*

Require sufficient clean and enclosed space for treatment.
Indoor space for storage of supplies
Water and electric supply

ESKD: End-stage kidney disease, HD: hemodialysis, PD: peritoneal dialysis
Table 4: Home Evaluation for PD Candidacy

Environment:
- Proper plumbing and running water
- Cleanliness
- Electricity supply with grounded three-pong outlets
- Temperature controlled storage place
- Confined space for PD
- Easy Access to Toilet

Other Occupants:
- Pets
- House members

PD: Peritoneal Dialysis
<table>
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<th>Technique</th>
<th>Operator</th>
<th>Advantages</th>
<th>Disadvantages</th>
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<tr>
<td>Open surgical</td>
<td>Surgeons</td>
<td>• Can be done under local anesthesia</td>
<td>• Requires operating room facilities and staff</td>
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<td></td>
<td></td>
<td>• Preferred in patient with prior abdominal surgeries but high risk for general anesthesia</td>
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<tr>
<td>Laparoscopic</td>
<td>Surgeons</td>
<td>• Catheter inserted under direct vision</td>
<td>• Needs general anesthesia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Preferred in patients with prior abdominal surgeries as it allows visualization of the peritoneal cavity</td>
<td>• Higher Cost</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Allows adjunctive procedures* to be done simultaneously</td>
<td>• Requires operating room facilities and staff</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Break-in period preferred</td>
</tr>
<tr>
<td>Peritoneoscope</td>
<td>Nephrologist</td>
<td>• Performed under local sedation</td>
<td>• Does not allow for adjunctive procedures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Less invasive</td>
<td>• Risk of bowel perforation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Allows immediate use of the catheter</td>
<td></td>
</tr>
<tr>
<td>Percutaneous Needle-</td>
<td>Interventional</td>
<td>• Less invasive</td>
<td>• Blind insertion</td>
</tr>
<tr>
<td>Guidewire Technique</td>
<td>radiologist</td>
<td>• Performed under local anesthesia</td>
<td>• Risk of bowel perforation**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Can be done at bedside or procedure room</td>
<td>• Not preferred in those with prior abdominal surgeries</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Allows immediate use of the catheter</td>
<td>• Does not allow for adjunctive procedures</td>
</tr>
</tbody>
</table>

*omentopexy, identification and repair previously unsuspected abdominal wall hernias, adhesiolysis
**can be minimized using real time ultrasound guidance
<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Number of patients</th>
<th>Study</th>
<th>Insertion technique/operator</th>
<th>Time of PD initiation</th>
<th>Leak</th>
<th>Catheter migration</th>
<th>Exit site infection</th>
<th>Peritonitis rate</th>
<th>Technique survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>Song et al.</td>
<td>2000</td>
<td>48</td>
<td>21 gradual increase in fill volume</td>
<td>Prospective randomized</td>
<td>Day 0</td>
<td>9.5% (^a)</td>
<td>9.5%</td>
<td>9.5%</td>
<td>23.8%</td>
<td>85.7% (1 year)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>38 full exchange volume (2L)</td>
<td>Percutaneous</td>
<td>Day 0</td>
<td>10.5% (^a)</td>
<td>7.90%</td>
<td>5.30%</td>
<td>15.8%</td>
<td>84.2% (1 year)</td>
</tr>
<tr>
<td>Banli et al.</td>
<td>2005</td>
<td>41</td>
<td>Prospective observational</td>
<td>Open surgical</td>
<td>Day 6</td>
<td>4.8% (^b)</td>
<td>2.4%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jo et al.</td>
<td>2007</td>
<td>51</td>
<td>Prospective observational</td>
<td>Percutaneous (nephrologist)</td>
<td>Day 0</td>
<td>1.9% (^a)</td>
<td>6.0%</td>
<td>4.0%</td>
<td>4.0%</td>
<td></td>
</tr>
<tr>
<td>Casaretto et al.</td>
<td>2012</td>
<td>11</td>
<td>Laparoscopy</td>
<td>0-2 days</td>
<td>0</td>
<td>9%</td>
<td>-</td>
<td>-</td>
<td>93.3% (3 months)</td>
<td></td>
</tr>
<tr>
<td>Alkatheeri et al.</td>
<td>2016</td>
<td>30</td>
<td>Prospective</td>
<td>Percutaneous (nephrologist) or laparoscopy (surgeon)</td>
<td>0 –13 days (median 6 days)</td>
<td>10.0% (^c)</td>
<td>20.0%</td>
<td>6.6%</td>
<td>3.3%</td>
<td>-</td>
</tr>
<tr>
<td>Javaid et al.</td>
<td>2016</td>
<td>17</td>
<td>Prospective</td>
<td>Percutaneous 82% (nephrologist) or laparoscopy (surgeon)</td>
<td>1-3 days</td>
<td>0 (^d)</td>
<td>11%</td>
<td>-</td>
<td>-</td>
<td>88% (6 months)</td>
</tr>
<tr>
<td>Dias et al.</td>
<td>2017</td>
<td>51</td>
<td>Prospective</td>
<td>Percutaneous (nephrology)</td>
<td>0–3 days (median 2 days)</td>
<td>7.8%</td>
<td>15.6%</td>
<td>17.0%</td>
<td>0.5*</td>
<td>86 (6 months)</td>
</tr>
<tr>
<td>Ye at al.</td>
<td>2019</td>
<td>2059</td>
<td>Retrospective</td>
<td>Percutaneous (nephrologist)</td>
<td>Day 0</td>
<td>0.9% (^{a})</td>
<td>4.1%</td>
<td>0.3%</td>
<td>1.2%</td>
<td>97.0%(1 year)</td>
</tr>
<tr>
<td>Povlsen et al.</td>
<td>2006</td>
<td>52 acute start</td>
<td>Retrospective, unmatched control</td>
<td>Open surgical</td>
<td>Day 0</td>
<td>7.7% (^{e})</td>
<td>15.4%</td>
<td>3.9%</td>
<td>15.4%</td>
<td>86.7% (3 months)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>88 planned start</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yang et al.</td>
<td>2011</td>
<td>226 incremental PD</td>
<td>Retrospective</td>
<td>Open surgical</td>
<td>Day 1</td>
<td>2.2% (^d)</td>
<td>3.1%</td>
<td>1.3%</td>
<td>4.0%</td>
<td>35.8% (823 days)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>84 late start</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^{a}\) = p < 0.05; \(^b\) = p < 0.01; \(^c\) = p < 0.001; \(^d\) = p < 0.0001; \(^e\) = p < 0.00001; \(^f\) = p < 0.000001; \(^\ast\) = p < 0.0000001

Table 6: Clinical outcomes in some urgent-start PD studies
<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Duration</th>
<th>Study Type</th>
<th>Procedure Type</th>
<th>9 planned start</th>
<th>11.1% d</th>
<th>22.2%</th>
<th>1/42**</th>
<th>1/110**</th>
<th>-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ghaffari A.</td>
<td>2012</td>
<td>18 acute start</td>
<td>Quality improvement project</td>
<td>Percutaneous (interventional radiology)</td>
<td>-</td>
<td>33.3% d</td>
<td>11.2%</td>
<td>1/55**</td>
<td>1/110**</td>
<td>-</td>
</tr>
<tr>
<td>Liu et al.</td>
<td>2014</td>
<td>344 (&lt;7 days)</td>
<td>Retrospective</td>
<td>Percutaneous (nephrologist)</td>
<td>2.3%</td>
<td>3.5%</td>
<td>-</td>
<td>9.90%</td>
<td>94% (6 months)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>137 (8 - 14 days)</td>
<td></td>
<td></td>
<td>1.5%</td>
<td>0.7%</td>
<td>-</td>
<td>10.20%</td>
<td>99%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>176 (&gt; 14 days)</td>
<td></td>
<td></td>
<td>0.0%</td>
<td>1.1%</td>
<td>-</td>
<td>9.10%</td>
<td>98%</td>
<td></td>
</tr>
<tr>
<td>Ranganathan et al.</td>
<td>2017</td>
<td>39 (1 week)</td>
<td>Randomized control trial</td>
<td>Surgical</td>
<td>28.2% f</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>97.1% (6 months)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>42 (2 weeks)</td>
<td></td>
<td></td>
<td>9.5% f</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>94.7%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>41 (4 weeks)</td>
<td></td>
<td></td>
<td>2.4% f</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>80%</td>
<td></td>
</tr>
</tbody>
</table>

*episode/patient-year
** per patient-month
^ used high volume PD
a 1 month
b < 2 weeks
c < 1 week
d 6 months
e 3 months
f 60 days
Table 7: Considerations for urgent start peritoneal dialysis prescription

Initiate PD in recumbent position

Use of low fill volumes (500 ml to 750 ml) upon initiation.

- Slowly increase the fill volume, as tolerated every 3-4 days

Adjust dextrose concentration based on ultrafiltration requirement:

- 1.5% dextrose dialysate if no evidence of volume overload.
- 2.5% dextrose dialysate if mild to moderate volume overload.
- 4.25% dextrose dialysate if severe volume overload.

Bowel preparation to avoid constipation before and after surgery

Cough suppressants if needed

Add heparin to the dialysate bag 500 units/L of solution

High dose diuretics to aid with volume management when appropriate
Table 8: Studies comparing unplanned peritoneal and hemodialysis in patients with end stage kidney disease

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Number of patients</th>
<th>Follow-up</th>
<th>Mortality</th>
<th>Bacteremia</th>
<th>Peritonitis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lobbedez et al.</td>
<td>2008</td>
<td>34 PD</td>
<td>12 months</td>
<td>Actuarial patient survival at 1 year-83% for PD</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>26 HD</td>
<td></td>
<td>79% for HD</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Koch et al.</td>
<td>2011</td>
<td>66 PD</td>
<td>6 months</td>
<td>30.3%</td>
<td>3.0%</td>
<td>1.8%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>57 HD</td>
<td></td>
<td>42.1%</td>
<td>21.1%*</td>
<td>1.5%</td>
</tr>
<tr>
<td>Jin et al.</td>
<td>2016</td>
<td>96 PD</td>
<td>1 month</td>
<td>92.1%</td>
<td>3 (3.1%)</td>
<td>2.1%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>82 HD</td>
<td></td>
<td>93%</td>
<td>11 (13.4%)*</td>
<td>0%</td>
</tr>
<tr>
<td>Dias, et al.</td>
<td>2020</td>
<td>93 PD</td>
<td>6 months-2 years</td>
<td>0.11 episodes/patient/year</td>
<td>0.36 episodes/patient/year</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>91 HD</td>
<td></td>
<td>0.58 episodes/patient/year</td>
<td>Not reported</td>
<td></td>
</tr>
</tbody>
</table>

* Statistically significant
Figure 1: Management and coordination of Urgent-start PD in late-presenting ESKD patient. CVC: Central venous catheter. ESKD: End-stage Kidney Disease, PD: Peritoneal dialysis.
Figure 2: Management of peritoneal dialysis catheter-associated mechanical complications in urgent start peritoneal dialysis. The first step in the urgent-start peritoneal dialysis initiation process is to assess the patency of peritoneal dialysis (PD) catheter and evaluate for presence of any leak around the catheter or surgical sites. This is done by instilling 500 ml of dialysate, with patient in recumbent position. In case there is problem with instilling or drainage of PD fluid, patient should be given stool softener of laxatives to ensure that they do not have constipation. If the problem with poor catheter flow persists, X-ray of abdomen should be
done to evaluate migration or malposition of the PD catheter. If catheter tip is outside the pelvis, the catheter will need repositioning either by radiologist under fluoroscopic guidance or by laparoscopic surgical procedure. If the catheter has not migrated and the tip is still in process, forceful flushing of the catheter with heparinized saline or instilling of the catheter with thrombolytic agent such as tissue plasminogen activator (1 mg/ml for a period of 1-2 hours) [34] may be attempted. If unsuccessful, the catheter will need radiological or surgical manipulation. In case the catheter is patient, but the patient experiences abdominal pain or discomfort, the fluid should be drained out, constipation, if any, should be treated and pain control measures should be taken. Reevaluate the patient in the next 12-24 hours depending upon inpatient or outpatient settings, and reattempt PD with low fill volumes (500-750 ml).

In cases, were abdominal leaks are observed, PD should be held for 1-2 days. If leak persists after 1-2 days, further management depends upon the volume status, uremic state and overall clinical status of the patients. In case patient can wait for a few more days, PD can be reattempted at that time. However, if the clinical condition does not permit more waiting or if leak persists even after waiting for several days, patient should be temporarily switched to HD and wait for leak to stop before initiating PD again.

Figure 3: **Urgent peritoneal dialysis initiation in hospital.** If possible, patient should be promptly discharged from the hospital after placement of peritoneal dialysis (PD) catheter. However, if the patient needs to stay in the hospital and requires dialysis, PD can be initiated in hospital. Low fill volumes (FV) of 500-750 ml should be used to begin with. Patient should be in recumbent position throughout the exchanges. PD exchanges can be performed either manually or by automated peritoneal dialysis (APD) with cycler. APD is preferred to manual exchanges, as using a cycler reduces the burden of frequent manual exchanges on the staff and facilitate accurate delivery of the prescribed fill-volume, thus minimizing errors. The number of exchanges and the tonicity of the dialysate is
determined by the extent of uremic symptoms and volume status respectively. In-patient settings provide more flexibility with time and number of exchanges performed compared to the outpatient settings. More exchanges over longer period of time, including night-time PD can be performed in hospital.
Figure 4: **Evaluation and Management for Urgent start peritoneal dialysis at the outpatient center.** Upon discharge from hospital, the patient is evaluated at the PD center in 1-2 days. Depending upon the urgent need for dialysis, in-center PD may be initiated within 14 days of the catheter placement using low fill volumes in recumbent position. PD prescription is adjusted as tolerated. While getting PD in center, education process begins at a pace determined by the learning ability of the patient and the family PD. Once the education is complete, and target fill-volumes are achieved, the patient is ready to be discharged home. CKD: Chronic Kidney Disease, CVC: Central venous catheter; FV: Fill Volume, PD: Peritoneal dialysis.