Peritoneal catheter insertion: combating barriers through policy change

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ABSTRACT

Barriers to accessing home dialysis became a matter of life and death for many patients with kidney failure during the coronavirus disease 2019 (COVID-19) pandemic. Peritoneal dialysis (PD) is the more commonly used home therapy option. This article provides a comprehensive analysis of PD catheter insertion procedures as performed around the world today, barriers impacting timely access to the procedure, the impact of COVID-19 and a roadmap of potential policy solutions. To substantiate the analysis, the article includes a survey of institutions across the world, with questions designed to get a sense of the regulatory frameworks, barriers to conducting the procedure and impacts of the pandemic on capability and outcomes. Based on our research, we found that improving patient selection processes, determining and implementing correct insertion techniques, creating multidisciplinary teams, providing appropriate training and sharing decision making among stakeholders will improve access to PD catheter insertion and facilitate greater uptake of home dialysis. Additionally, on a policy level, we recommend efforts to improve the awareness and feasibility of PD among patients and the healthcare workforce, enhance and promulgate training for clinicians—both surgical and medical—to insert PD catheters and fund personnel, pathways and physical facilities for PD catheter insertion.

Keywords: catheter, COVID-19, ESRD, home dialysis, peritoneal dialysis
INTRODUCTION
Peritoneal dialysis (PD) is the home therapy option of choice for most patients with kidney failure worldwide. Best-practice PD today provides mortality and quality-of-life outcomes similar to those achieved with in-center hemodialysis (HD) [1, 2]. PD is cost saving in most global settings and recommended by professional societies, including the International Society of Nephrology (ISN) [3]. Further, while patients receiving in-center HD were 5–20 times more likely to be infected with severe respiratory syndrome coronavirus 2 compared with the age-matched general population, the risk for PD patients was the same as the general population [4–7].

A lack of focus on PD catheter insertion has been identified as an important barrier preventing PD utilization [8]. Inadequate skill training in the range of catheter insertion techniques leaves the newly trained clinician poorly equipped to optimally utilize this modality, pushing patients to the default in-center HD option. While there are excellent and dedicated surgeons passionate about PD catheter insertion, it is given low priority in some programs and, due to clinical prioritization, operating rooms are preferentially used for other procedures. Further, in some locations, PD catheter insertion was classified as a nonurgent procedure during the coronavirus disease 2019 (COVID-19) pandemic, which deprived many patients starting dialysis from benefiting from PD.

There are plenty of data from around the world to show that compared with those inserted by surgeons or interventional radiologists, catheter insertion by trained nephrologists without the need for operation theater access or general anesthesia is associated with similar or higher rates of successful PD utilization, both for elective and urgent-start PD [8]. A shared care model has been recommended, in which the decision on the initial insertion approach is made after a risk estimation—with nephrologists performing insertion in uncomplicated cases and surgeons taking care of high-risk cases that might require (advanced) laparoscopy, including additional procedures such as adhesiolysis, omentopexy or hernia repair.

Despite the acknowledgement of the critical role played by the timely creation of access to the peritoneal cavity in the success of this treatment modality, this topic needs greater attention. Therefore the aim of this article is to discuss the importance of PD catheter insertion, barriers to successful and timely insertion, and potential solutions.

HISTORY OF PD CATHETER INSERTION
Wegner performed the first PD experiments in rabbits in 1877 [9]. The first intermittent PD trial in a human patient was carried out by Ganter in 1923 [10]. He introduced 1.5 L of saline solution intraperitoneally in a woman with ureter obstruction and observed a slight improvement. In 1927, Heusser and Werder [11] conducted dialysis on three uremic patients by the continuous method, but there was no improvement, perhaps because too little fluid was used. Two techniques were used: intermittent dialysis with one tube, where both the infusion and drainage occurred through the same tube, and continuous dialysis, with two tubes placed in the peritoneal cavity, one used for the inflow of the PD solution and the other for outflow.

When Dr. Fred Boen defended his PhD dissertation in Amsterdam in 1959, PD was still ‘crawling’, but already saving and prolonging the lives of patients with acute kidney injury (AKI) and kidney failure. His thesis contains a narrative of the PD technique, including case histories of 22 patients treated with 32 treatments [12, 13]. An excerpt of his thesis gives us a clear perspective of PD access insertion:

Technique: The surgeon (Dr. van der Reyden) made an incision on the left and right side of the abdomen at the level of the spina iliaca anterior superior and brought two rubber drains into the abdomen through these openings, one tube being used for the inflow and the other for the outflow. When difficulties were encountered in the outflow, the direction of the flow was reversed. During the course of the dialysis, an enormous leakage occurred from both incisions. This was not abolished after stitching the wound again.

Present-day considerations
With the creation of the first successful indwelling peritoneal catheter by Henry Tenckhoff in 1968, PD became more regularly utilized. Over time, the vital importance of a functioning PD catheter for the patient came to be realized.

Who inserts PD catheters, the exact location of service, and the methods are influenced by a number of factors. In some countries, regulatory constraints limit who can perform PD catheter insertion or the location where it can be done, which limits the opportunities for PD catheter insertion for patients. This underscores the need to educate not only doctors, nurses, and patients, but also people in the regulatory and political spheres in every country.

Practitioners need to learn from centers, regions, or countries that have successfully developed and implemented PD catheter insertion programs in renal services. Such programs exist in many countries, including South Africa, Saudi Arabia, Mexico, Thailand, China, Guatemala, Dominican Republic, and Brazil. However, only a few of these programs have published their findings (Appendix D).

GLOBAL PICTURE OF PD CATHETER INSERTION TECHNIQUES
This section summarizes catheter insertion techniques, followed by a discussion of conditions that influence variations in observed PD access practice patterns around the world.

The insertion techniques available can be divided into percutaneous, open surgical and (advanced) laparoscopic. Not all countries have access to all techniques. Often there is substantial variability of the relative availability between centers within the same country. Variations are influenced by the availability and skill of practitioners, clinical demands, reimbursement policies, and cultural and regional historical practices.

Percutaneous technique
The percutaneous technique utilizes either a trocar or a blind modified Seldinger approach and is usually performed in a procedure room or at the bedside under local anesthesia by a nephrologist/radiologist or nurse practitioner [14–17]. The disadvantage of the trocar approach is that the large-bore trocar is placed without visualization, risking bowel or vascular injury as well as creating a track that is larger than the catheter, which may result in leakage, and this technique has been largely abandoned. A modification of this approach uses a needle, guidewire and peel-away sheath through which the catheter is inserted. As these techniques rely on the blind introduction of a needle/trocar, they are most suitable for patients who are not obese.
and have not had previous abdominal surgery, peritonitis or other reasons for suspecting intra-abdominal adhesions. The modified Seldinger technique can be supported with radiological assistance such as ultrasound to assess for visceral slide, which reassures that significant bowel adhesions at the point of insertion are unlikely and helps in determining the depth from the skin to the peritoneum. Fluoroscopic visualization can be used to determine entry into the peritoneum and appropriate positioning of the guidewire and catheter. Percutaneous catheter insertion is widely used in resource-poor countries, enabling patients to receive lifesaving therapy, and has been shown to be associated with excellent outcomes [18–21].

Open surgical technique

The open surgical technique involves dissection to the peritoneum followed by either blind insertion of the catheter in the direction of the pelvis or through a mini-laparotomy-guided direct visualization of catheter placement in the pelvis. The advantage of this technique over the percutaneous approach is the ability to visualize entering the peritoneum. It is therefore safer for patients who have had previous abdominal surgery or are obese. The advantage over the laparoscopic approach is that it is more cost effective and may be performed by nephrologists and surgeons without laparoscopic skills in a procedure room or at the bedside under local anesthesia with sedation [16, 22]. However, this technique does not allow proper visualization of the peritoneal cavity, including confirmation of the pelvic position of the PD catheter and permits only limited adhesiolysis and omentopexy at the point of entry into the peritoneum.

Laparoscopic technique

This technique involves insertion of the catheter into the pelvis under direct vision, resulting in certainty of the position of placement. This technique may be supplemented by adjunctive procedures [23, 24] including hernia correction, epiploic appendicectomy, colpolexy, musculofascial tunneling, omentopexy and fixation in the paracolic gutter when the pelvis is not accessible due to adhesions [25]. These advanced techniques have been shown to produce superior outcomes than standard laparoscopic placement [24]. The relatively small incisions and ability to suture port sites allow urgent use of catheters with minimal risk of leakage.

The laparoscopic and image-guided percutaneous techniques require more sophisticated equipment and practitioner skill and is not available everywhere [26]. Image-guided insertion is typically performed under local anesthesia with or without sedation in a radiology department or operating room [27–29].

Peritoneoscopic placement

The peritoneoscopic approach is a proprietary laparoscopic-assisted technique of peritoneal catheter placement. The procedure can be conducted in a treatment room under local anesthesia. The peritoneoscope is inserted through a sleeve introduced around a trocar and is used to confirm peritoneal entry and guide catheter placement. Studies have shown comparable or better survival and complication rates with this technique compared with the open surgical method. This technique is practiced preferentially in some locations [30–33]. Like the percutaneous method, peritoneoscopic insertion is not advisable for patients with obesity and in those with prior peritonitis, multiple abdominal operations or the inability to lie flat.

The Peritoneal Dialysis Outcomes and Practice Patterns Study in collaboration with the International Society for Peritoneal Dialysis (ISPD) performed a survey of five high-income countries for which data were available describing the international variation in PD catheter practices [34]. Table 1 summarizes PD insertion practices by country.

Although organizations such as the ISPD have released best practices for PD catheter insertion [23], how best to scale known best procedural practices to better facilitate PD adoption worldwide remains unclear. One observational study at a regional PD center in the USA showed significant gaps in adherence to ISPD best practices, with 30% of patients not being evaluated for hernias and 20% not being provided follow-up care instructions. A total of 41% of patients developed a complication postoperatively [35].

Despite numerous comparative studies along with meta-analyses comparing the various PD catheter insertion techniques, a clear benefit of one technique over another has never been demonstrated, and most studies suffer from power and bias in multiple domains. As a result, international guidelines state that the choice of technique should be determined by skill and availability [8, 23, 24, 36, 37]. Those studies that show benefits of one technique over another are likely more representative of the technical ability and enthusiasm of the practitioner rather than the modality per se. For example, in the hands of a skilled laparoscopic surgeon using advanced laparoscopic techniques the complication rate and long-term outcomes are likely excellent, but in a center where the surgeon performing the procedure is not a dedicated access surgeon or where procedures are delegated to untrained or junior surgeons, these results may be significantly worse. Therefore, the insertion technique should be determined by patient, practitioner, and health resource factors, as these are far more likely to impact on outcomes than the specific technique used. Finally, all centers should strive to set up a multidisciplinary access team to select the most appropriate catheter type, insertion technique and insertion exit site locations for individual patients, as specified in the ISPD guidelines [23].

Views on PD access insertion may differ between nephrologists and surgeons. Although many surgery programs train residents in catheter insertion, this training is often limited and affects a surgeon’s willingness and ability to perform the procedure or remedy complications. Some surgeons are perceived as reluctant to respond to referrals for PD catheter insertion in a timely fashion and may delegate it to a junior member of the team [38]. However, this deceptively simple operation can result in complications that are time consuming to resolve. Some surgeons (more often those who are not properly embedded in multidisciplinary PD teams) may also be unaware of the importance of a functional PD access from the patient’s perspective and how failure impacts patient’s the lifes. Further, PD access often comprises only a small part of their surgical practice and reimbursement often does not compensate well for the time invested. The low overall use of PD by the health system potentiates the problem by preventing surgeons from gaining enough experience in peritoneal access, perpetuating a vicious cycle of poor outcomes, dissatisfaction with PD and low PD utilization [38]. This point highlights the need for PD access teams consisting of a PD nurse, nephrologist and surgeon, thus ensuring the most appropriate use of skills for patient outcome.

In many regions, nephrologists are increasingly taking on the role of PD access providers [14–17, 22]. Multiple studies have demonstrated catheter insertion by nephrologists is associated with equal or better outcomes compared with programs relying
Table 1. Available methods of PD catheter insertion by country

| Method                        | A/NZ (n = 18) | Canada (n = 14) | Japan (n = 20) | UK (n = 28) | USA (n = 34) |
|-------------------------------|---------------|-----------------|----------------|-------------|--------------|
| Open dissection (%)           | 67            | 54              | 85             | 63          | 29           |
| Laparoscopic surgery (%)      | 83            | 77              | 40             | 70          | 94           |
| Percutaneous (blind) (%)      | 17            | 31              | 5              | 30          | 0            |
| Percutaneous (image guided) (%) | 22           | 31              | 0              | 7           | 3            |

*Adapted from Wilkie et al. [34], SP505.

n: number of participating facilities; %: percentage of participating facilities; A/NZ: Australia–New Zealand.

FIGURE 1: Percutaneous versus open surgical PD catheter insertion. Meta-analysis showing similar PD catheter survival and superior peritonitis rates with percutaneous compared with open surgical PD catheter insertion [8].

on surgical insertions (Fig. 1) [15, 39–42]. In part, this may be because of case selection, with difficult insertions being performed by surgeons. In a systematic review, no significant difference in catheter survival was noted between percutaneous placement of PD catheters [8] by nephrologists and surgical insertion, while the peritonitis risk was lower with percutaneous insertion. However, like surgical training, many nephrology fellowship programs do not offer opportunities for training in catheter insertion.

The use of more technologically intensive techniques, such as (advanced) laparoscopic and image-guided techniques is relatively limited in most countries and continues to be deprioritized because of a lack of skill and training and low demand. However, these methods expand the pool of patients eligible for PD and improve their outcomes, and it is important to ensure appropriate availability and optimal utilization of these techniques, especially in regional centers of excellence [23, 24, 29].

PRACTICE BEFORE AND DURING COVID-19

The ISPD has published guidelines on recommended PD catheter insertion techniques and postoperative care [23]. The extent of adherence to these recommendations, however, is not known. Few outcome data are available, such as from the North American PD Catheter Registry [43]. Laparoscopic PD catheter insertion approaches [44–47] have a reported 5-year patent rate of 96–99% [47]. Similar success has been reported by interventional radiologists utilizing ultrasonographic and fluoroscopic guidance [25]. The Cleveland Clinic published their 10-year experience with laparoscopic PD catheter insertion and reported minimal immediate postoperative complications (0.9%). More than half of patients were undergoing PD or were transplanted in the long term (median follow-up of 4 years); the median survival time for patients on PD was 8 years [48]. Other scenarios where timely PD catheter insertion can be lifesaving include in the emergency room [49], as urgent start [50, 51] and in patients with vascular access failure [52]. The Saving Young Lives Project of the ISN has used acute PD as a lifesaving treatment for children with AKI in Africa, Asia, and Latin America [53].

Beginning in March 2020, PD initiation was hampered when several countries suspended the insertion of PD catheters along with other elective surgeries during the COVID-19 pandemic. This seriously impacted the ability of patients with kidney failure to benefit from home dialysis. However, other health systems continued PD catheter placement programs. One study conducted in the Dominican Republic presented data from 946 patients treated across seven centers during the pandemic. Over the course of 3 months, 95 catheters were placed in incident patients, 72 by surgical and 23 by a percutaneous technique; 64 started treatments at home and the remaining patients were in training at the time of the report. The procedure followed the routine protocol applied in the clinics [54]. Similar experience has been reported from Saudi Arabia with ambulatory PD (APD) [55, 56]. Furthermore, patients on APD stayed at home, followed up by a telemonitoring system, obviating the need for in-person follow-up visits.

PD can deliver outcomes equivalent to those reported with other dialysis options, including continuous renal replacement therapy and intermittent HD for patients with AKI [57–62], as demonstrated during the COVID-19 pandemic [63]. Based on this experience, the US Centers for Medicare & Medicaid Services, Ontario Renal Network and UK Renal Association provided recommendations that PD catheter insertion was lifesaving and/or nonroutine during COVID-19. These policies allowed surgical PD catheter insertions to resume where they had been interrupted [64].
Table 2. 2021 E-survey results

| Survey question                                                                 | Response, % (n) |
|---------------------------------------------------------------------------------|-----------------|
| Respondent region                                                               |                 |
| Europe                                                                          | 51.6 (16)       |
| North America                                                                   | 35.5 (11)       |
| Middle East                                                                     | 6.5 (2)         |
| Asia                                                                            | 3.2 (1)         |
| South America                                                                   | 3.2 (1)         |
| Minimum qualifications to place a peritoneal dialysis (PD) catheter             |                 |
| MD                                                                              | 32.3 (10)       |
| Surgeon                                                                         | 29.0 (9)        |
| No specific requirements                                                        | 19.4 (6)        |
| Proctored/trained                                                               | 12.9 (4)        |
| Unknown                                                                         | 6.5 (2)         |
| Legal or absolute requirements for where PD catheters placed                    |                 |
| None                                                                            | 67.7 (21)       |
| Operating theater                                                               | 16.1 (5)        |
| Unknown                                                                         | 9.7 (3)         |
| Yes                                                                             | 6.5 (2)         |
| Legal or absolute requirements for who places PD catheters                      |                 |
| None                                                                            | 77.4 (24)       |
| Surgeon                                                                         | 9.7 (3)         |
| Unknown                                                                         | 6.5 (2)         |
| MD                                                                              | 3.2 (1)         |
| Yes, multiple options                                                           | 3.2 (1)         |
| Patients started on PD/year                                                      |                 |
| > 20                                                                            | 45.2 (14)       |
| 10–19                                                                           | 32.3 (10)       |
| 5–9                                                                             | 16.1 (5)        |
| <5                                                                              | 6.5 (2)         |
| Who places PD catheters                                                         |                 |
| Surgeon                                                                         | 45.2 (14)       |
| Surgeon and/or nephrologist                                                     | 29.0 (9)        |
| Surgeon and/or radiologist                                                      | 9.7 (3)         |
| Nephrologist                                                                    | 6.5 (2)         |
| Surgeon and/or nephrologist and/or radiologist                                 | 6.5 (2)         |
| Radiologist                                                                     | 3.2 (1)         |
| Where are PD catheters placed in hospital                                        |                 |
| Operation room                                                                  | 51.6 (16)       |
| Operation room and/or bedside                                                   | 12.9 (4)        |
| Operation room and/or bedside and/or procedure room                            | 9.6 (3)         |
| Radiology suite                                                                 | 6.5 (2)         |
| Operation room and/or radiology suite                                           | 16.1 (5)        |
| Operation room and/or bedside and/or radiology suite                           | 3.2 (1)         |
| During COVID-19 pandemic, delay or barriers to placement of PD catheters        |                 |
| No                                                                              | 51.6 (16)       |
| Yes                                                                             | 48.4 (15)       |
| If yes, country-wide or country-specific barriers or delays?                    |                 |
| N/A                                                                             | 54.8 (17)       |
| Country specific                                                                | 35.5 (11)       |
| Hospital specific                                                               | 6.5 (2)         |
| Country wide                                                                    | 3.2 (1)         |
| Was the problem solved?                                                         |                 |
| Yes                                                                             | 51.6 (16)       |
| N/A                                                                             | 38.7 (12)       |
| No                                                                              | 9.7 (3)         |

Omitted questions: 1, 2, 10, 11, 14, 16 and 17 (open-ended essay questions that were impossible to quantify).

**Trends in PD catheter insertion, including E-survey**

To better understand the global trends in PD catheter insertion procedures and the impact of COVID-19, an electronic questionnaire was administered to 82 nephrologists from 17 countries (Appendix B). The target audience of this voluntary survey was clinicians involved in starting patients on home dialysis taken from the mailing lists from the International Home Dialysis Roundtable [65] (Table 2).

The completion rate for this survey was 38%. Forty-five percent (14/31) of the respondents indicated that surgeons place PD catheters. About 77% (24/31) noted that there were no rules to
govern who can place a PD catheter. Additionally, 52% (16/31) of respondents indicated that the procedure currently takes place exclusively in the operating room, although 67.7% (21/31) stated that there are no legal requirements about where the procedure is conducted.

Specifics about the types of barriers to conducting the procedure varied. However, 52% (16/31) respondents identified availability of physical space, time and practitioners as important impediments to optimizing PD catheter insertion. Survey respondents were split on the impact of COVID-19 on practitioners’ ability to continue the procedure, with 48% (15/31) saying the pandemic increased delays or barriers and 52% (16/31) indicating it did not—although the vast majority of those that did see barriers also noted that they were resolved during the course of the pandemic.

In many cases, the challenges around capacity and staff availability improved as COVID-19-related hospitalizations decreased, with the shift of policy to accommodate patients with COVID-19. According to one respondent from Sweden, hospital staff created regular planning meetings for better coordination and to prioritize access to resources. In the UK, a respondent noted that the facility reorganized operating theaters to be better equipped to optimize catheter insertion opportunities for patients with COVID-19. In one system in Lebanon, the key to continuing PD catheter placement was improving public health protocols and guidance for staff and patients regarding COVID-19 vaccines, testing and lockdowns. Similarly, in the Netherlands, protocols regarding percutaneous PD catheter insertion by fluoroscopic guidance and urgent-start PD were published [66]. Respondents from Canada and the USA indicated that decisions to make catheter insertion for dialysis an essential procedure were critical to continuing the practice through the pandemic.

In some cases, operations that were implemented prior to or immediately at the start of the pandemic helped facilitate greater PD catheter insertion access and capacity. In the USA before the pandemic began, one institution created a program for PD units to invite surgeons to ‘meet the PD nurses, tour the clinic, see patients in training, see dialysis equipment, and view a brief PowerPoint...regarding medical and economic benefits of PD as renal replacement therapy’, which helped improve engagement. Another facility in the USA noted that at the beginning of the pandemic, one key to increasing capacity and moving beyond surgeon placement was to also have interventional radiologists place catheters.

However, a majority of the responses were from Europe and North America, which limits the generalizability of the survey findings.

**PD CATHETERS: SUGGESTED ACTIONS FOR IMPROVEMENT**

Three factors should be addressed to increase the availability and quality of PD catheter insertion. As shown in Table 3, these are patient and healthcare awareness of PD feasibility, training of clinicians to insert PD catheters and funding to maximize personnel, pathways and physical facilities for PD catheter insertion.

### Awareness of PD feasibility

The steps needed to increase the uptake of PD at the patient and system levels have been discussed in depth by Blake et al. [67]. The need for shared decision making with patients and their caregivers at all stages of PD delivery has been reinforced by the recent ISPD prescribing recommendations [68]. The misconception that people with previous abdominal surgery, obesity, aortic aneurysms, or polycystic kidneys are not eligible for PD has been addressed by the 2019 ISPD PD access guideline [23]. With the use of advanced laparoscopic PD catheter insertion techniques, there are few situations where there is an absolute surgical contraindication to PD catheter insertion [69].

### PD catheter insertion training

The respective merits of different PD catheter insertion techniques have been discussed in depth in the 2019 ISPD PD access guideline [23]. Although advanced laparoscopic techniques were promoted as the gold standard, the guideline recognizes the many situations where percutaneous catheter insertion is preferred. Having access to more than one method of PD catheter insertion maximizes access to PD. As an example, if access to surgery is limited, as occurred during the COVID-19 pandemic, surgeons in many centers, PD centers with access to percutaneous insertion techniques could continue PD catheter insertions [70]. Therefore training clinicians in all insertion techniques needs to be prioritized to improve the rate-limiting step of PD catheter insertion to enable greater uptake of PD as a dialysis modality.

Enabling and training nurses to insert PD catheters percutaneously will increase access to PD catheters; this is already

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**Table 3. Factors to be addressed to increase PD catheter insertion**

| Factor to address                      | Suggested strategies                                                   |
|---------------------------------------|------------------------------------------------------------------------|
| Patient feasibility                   | Education about PD to healthcare teams                                 |
|                                       | Promotion of ISPD PD access guideline                                  |
|                                       | Predialysis education                                                  |
|                                       | Auditing patients starting PD after choosing PD                        |
| Multidisciplinary PD teams: PD catheter insertion training | Availability of digital learning of theory                             |
|                                       | Provision of hands-on training for percutaneous and advanced laparoscopic techniques |
|                                       | Ensure that learning materials and teaching are available locally and in appropriate languages |
| Healthcare practices                  | Awareness of advantages of PD to patients and the healthcare system    |
|                                       | Adequate reimbursement to individuals and hospitals for PD catheter insertion in private systems |
|                                       | Provision of finance to support an appropriate number of professionals and facilities |
Peritoneal catheter insertion has been shown in examples of successful programs worldwide. The value of a successful catheter insertion and functioning system is needed to enable the necessary pathways to be adequately financed and resourced.

PD catheter insertion pathways

As discussed by Blake et al. [67], PD catheter insertion is potentially a rate-limiting step for starting patients on PD. Along with trained ‘inserters’, access to operating theaters with appropriate equipment, availability of anesthetists and hospital facilities for pre- and postoperative care are all needed and need to be funded. Furthermore, PD catheter insertion needs to be prioritized so procedures are not cancelled because of other pressures on surgical resources. Provision should be made for urgent surgery, such as for urgent-start PD, repositioning non-functioning catheters and to replace catheters for infection reasons. Enabling PD catheter insertion is going to depend on healthcare systems [71]. In private systems, PD catheter insertion prioritization will depend on reimbursement to the hospital and the individual surgeon. In public healthcare systems, awareness of the advantages of PD both for the patient and the healthcare system is needed to enable the necessary pathways to be adequately financed and resourced.

CONCLUSIONS

The COVID-19 pandemic has reigned the interest in PD as a dialysis modality, both for those with chronic kidney failure (to protect them from COVID-19) and for managing the surge of cases with AKI due to COVID-19. Despite the long history of the technique, PD catheter insertion remains neglected and has been identified as a rate-limiting step for starting patients on PD. The challenges range from those related to policies regarding catheter insertion (who can perform, where it can be done and insufficient prioritization as essential care) to issues related to individuals and hospitals (insufficient training in catheter insertion in nephrology and surgical training programs, lack of availability of operating rooms, and reimbursement issues). The value of a successful catheter insertion and functioning for the patient is often not appreciated. These problems can be overcome and sustainable and scalable programs established, as has been shown in examples of successful programs worldwide. In recent years, leadership by the PD community in PD catheter insertion has allowed rapid scale-ups. A judicious mix of expertise coupled with a referral/collaboration mechanism with expert centers that can undertake catheter insertion in more complex cases will expand the pool of patients and improve choices for patients who need dialysis. There are several areas of improvement—including patient selection, appropriate technique, multidisciplinary teams, appropriate training and shared decision making. Several stakeholders, such as the ISPD and ISN, have developed resources and training tools on enhancing insertion techniques. Awareness of the advantages of PD both for the patient and health system is needed to enable the necessary pathways to be adequately financed and resourced, and prioritizing PD catheter insertion is foundational to the success of PD.

SUPPLEMENTARY DATA

Supplementary data are available at obj online.

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All authors contributed to the research and writing of the article. V.J. put together all sections and finalized the manuscript. All authors read and approved the final version.

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REFERENCES

1. Marshall MR. The benefit of early survival on PD versus HD–why this is (still) very important. Perit Dial Int 2020; 40: 405–418
2. Jung HY, Jeon Y, Park Y. et al. Better quality of life of peritoneal dialysis compared to hemodialysis over a two-year period after dialysis initiation. Sci Rep 2019; 9: 10266
3. Tonelli M, Nkunu V, Varghese C et al. Framework for establishing integrated kidney care programs in low- and middle-income countries. Kidney Int Suppl (2011) 2020; 10: e19–e23
4. Yadav AK, Sankarasubbiaiyan S, Bg MG et al. The high mortality and impact of vaccination on COVID-19 in hemodialysis
population in India during the second wave. Kidney Int Rep 2021; 6: 2731
5. Hsu CM, Weiner DE. COVID-19 in dialysis patients: outlasting and outsmarting a pandemic. Kidney Int 2020; 98: 1402–1404
6. Taji L, Thomas D, Oliver MJ et al. COVID-19 in patients undergoing long-term dialysis in Ontario. CMAJ 2021; 193: E278–E284
7. Jiang HJ, Tang H, Xiong F et al. COVID-19 in peritoneal dialysis patients. Clin J Am Soc Nephrol 2021; 16: 121–123
8. Boujelbane L, Fu N, Chapla K et al. Percutaneous versus surgical insertion of PD catheters in dialysis patients: a meta-analysis. J Vasc Access 2015; 16: 498–505
9. Wegner G. Chirurgische Bemerkungen über die Peritonealhöhle, mit besonderer Berücksichtigung der Ovariotomie. Arch Klin Chir 1877; 20: 51–145
10. Ganter G. The elimination of toxic substances from the blood by dialysis. Munch Med Wochsr 1923; 70: 1478–1480
11. Heusser H, Werder H. Studies on peritoneal dialysis. Beitr Klin Chir 1927; 141: 38–49
12. de Moraes TP, Campos RP, de Alcantara MT et al. Similar outcomes of catheters implanted by nephrologists and surgeons: analysis of the Brazilian peritoneal dialysis multicentric study. Semin Dial 2012; 25: 565–568
13. Voss D, Hawkins S, Poole G et al. Radiological versus surgical implantation of first catheter for peritoneal dialysis: a randomized non-inferiority trial. Nephrol Dial Transplant 2012; 27: 4196–4204
14. Bowes E, Ansari B, Cairns H. Nurse-performed local-catheter insertion by nephrologists using a trocar versus the Seldinger technique: the experience of two Brazilian centers. Int Urol Nephrol 2014; 46: 2029–2034
15. Ros-Ruiz S, Alonso-Esteve Á, Gutiérrez-Vílchez E et al. The impact of interventional nephrologists on the growth of a peritoneal dialysis program: long-term, single-center experience. Nefrología 2016; 36: 19–23
16. de Moraes TF, Campos RP, de Alcantara MT et al. Similar outcomes of catheters implanted by nephrologists and surgeons: analysis of the Brazilian peritoneal dialysis multicentric study. Semin Dial 2012; 25: 565–568
17. Bowes E, Ansari B, Cairns H. Nurse-performed local-anesthetic insertions of PD catheters: one unit’s experience. Perit Dial Int 2010; 30: 589–591
18. Varughese S, Sundaram M, Basu G et al. Percutaneous continuous ambulatory peritoneal dialysis (CAPD) catheter insertion—a preferred option for developing countries. Trop Doct 2010; 40: 104–105
19. Sivaramakrishnan R, Gupta S, Agarwal SK et al. Comparison of outcomes between surgically placed and percutaneously placed peritoneal dialysis catheters: a retrospective study. Indian J Nephrol 2016; 26: 268–274
20. Sampathkumar K, Mahalidar AR, Sooraj YS et al. Percutaneous CAPD catheter insertion by a nephrologist versus surgical placement: a comparative study. Indian J Nephrol 2008; 18: 5–8
21. Nkoy AB, Ndiyo YM, Matoka TT et al. A promising pediatric peritoneal dialysis experience in a resource-limited setting with the support of saving young lives program. Perit Dial Int 2020; 40: 504–508
22. Chow KM, Szeto CC, Leung CB et al. Tenckhoff catheter insertion by nephrologists: open dissection technique. Perit Dial Int 2010; 30: 524–527
23. Crabtree JH, Shrestha BM, Chow KM et al. Creating and maintaining optimal peritoneal dialysis access in the adult patient: 2019 update. Perit Dial Int 2019; 39: 414–436
24. Shrestha BM, Shrestha D, Kumar A et al. Advanced laparoscopic peritoneal dialysis catheter insertion: systematic review and meta-analysis. Perit Dial Int 2018; 38: 163–171
25. Fredlund M, Van Niekerk H, Cullis B. Experience with placing peritoneal dialysis catheters in the iliac fossa in cases of frozen pelvis. Perit Dial Int 2021; 41: 578–580
26. Crabtree JH, Chow KM. Peritoneal dialysis catheter insertion. Semin Nephrol 2017; 37: 17–29
27. Voss D, Hawkins S, Poole G et al. Radiological versus surgical implantation of first catheter for peritoneal dialysis: a randomized non-inferiority trial. Nephrol Dial Transplant 2012; 27: 4196–4204
28. Shanmugalingam R, Makris A, Hassan HC et al. The utility of sonographic assessment in selecting patients for percutaneous insertion of peritoneal dialysis catheter. Perit Dial Int 2017; 37: 434–442
29. Abdel-Aal AK, Dybbro P, Hathaway P et al. Best practices consensus protocol for peritoneal dialysis catheter placement by interventional radiologists. Perit Dial Int 2014; 34: 481–493
30. Hagen SM, Lafranca JA, Steyerberg EW et al. Laparoscopic versus open peritoneal dialysis catheter insertion: a meta-analysis. PLoS One 2013; 8: e56351
31. Al Azzi Y, Zeldis E, Nadkarni GN et al. Outcomes of dialysis catheters placed by the Y-TEC peritoneoscopic technique: a single-center surgical experience. Clin Kidney J 2016; 9: 158–161
32. Sun TY, Voss D, Beechey D et al. Comparison of peritoneal dialysis catheter insertion techniques: peritoneoscopic, radiological and laparoscopic: a single-centre study. Nephrology (Carlton) 2016; 21: 416–422
33. Kelly J, McNamara K, May S. Peritoneoscopic peritoneal dialysis catheter insertion. Nephrology (Carlton) 2003; 8: 315–317
34. Wilkie M, Zhao J, Bieber B et al. International variation in peritoneal dialysis (PD) catheter practices: preliminary results from the Peritoneal Dialysis Outcomes and Practice Patterns Study (PDOPPS). Nephrol Dial Transplant 2017; 32: iii297–iii299
35. Wong LP, Yamamoto KT, Reddy V et al. Patient education and care for peritoneal dialysis catheter placement: a quality improvement study. Perit Dial Int 2014; 34: 12–23
36. Xie H, Zhang W, Cheng J et al. Laparoscopic versus open catheter placement in peritoneal dialysis patients: a systematic review and meta-analysis. BMC Nephrol 2012; 13: 69
37. Hagen SM, Lafranca JA, Steyerberg EW et al. Laparoscopic versus open peritoneal dialysis insertion: a meta-analysis. PLoS One 2013; 8: e56351
38. Wong LP, Liebman SE, Wakefield KA et al. Training of surgeons in peritoneal dialysis catheter placement in the United States: a national survey. Clin J Am Soc Nephrol 2010; 5: 1439–1446
39. Asif A, Pfederer TA, Vieira CF et al. Does catheter insertion by nephrologists improve peritoneal dialysis utilization? A multicenter analysis. Semin Dial 2005; 18: 157–160
40. Goh BL, Ganeshadeva YM, Chew SE et al. Does peritoneal dialysis catheter insertion by interventional nephrologists enhance peritoneal dialysis penetration? Semin Dial 2008; 21: 561–566
41. Gadallah MF, Ramdeen G, Torres-Rivera C et al. Changing the trend: a prospective study on factors contributing to the growth rate of peritoneal dialysis programs. Adv Perit Dial 2001; 17: 122–126
42. Perl J, Pierratos A, Kandasamy G et al. Peritoneal dialysis catheter implantation by nephrologists is associated with
higher rates of peritoneal dialysis utilization: a population-based study. Nephrol Dial Transplant 2015; 30: 301–309
43. Wilkie M. The North American PD Catheter Registry. Perit Dial Int 2020; 40: 111
44. Crabtree JH, Chow KM. Peritoneal catheter insertion. Semin Nephrol 2017; 37: 17–29
45. Ash SR. Chronic peritoneal dialysis catheters: overview of design, placement, and removal procedures. Semin Dial 2003; 16: 323–334
46. Crabtree JH, Fishman A. A laparoscopic method for optimal peritoneal dialysis access. Am Surg 2005; 71: 135–143
47. Crabtree JH, Burchette RJ. Effective use of laparoscopy for long-term peritoneal dialysis access. Am J Surg 2009; 198: 135–141
48. Haskins IN, Schreiber M Jr, Prabhu AS et al. Peritoneal dialysis catheter placement as a mode of renal replacement therapy: long-term results from a tertiary academic institution. Surgery 2017; 162: 1112–1120
49. Ilabaca-Avendano MB, Yarza-Solano G, Rodriguez-Valenzuela J et al. Automated peritoneal dialysis as a lifesaving therapy in an emergency room: report of four cases. Kidney Int 2008; 73(Suppl 108): S173–S176
50. Ghaffari A, Kumar V, Guest S. Infrastructure requirements for an urgent-start peritoneal dialysis program. Perit Dial Int 2013; 33: 611–617
51. Alkatheeri AMA, Blake PG, Gray D et al. Success of urgent-start peritoneal dialysis in a large Canadian renal program. Perit Dial Int 2016; 36: 171–176
52. Al-Hwiesh AK, Abdul-Rahman IS, Al-Audah N et al. Success of instant-start life-saving peritoneal dialysis in patients with end-stage vascular access failure: time to rescue patients. Int J Nephrol Kidney Fail 2019; 5: dx.doi.org/10.16966/2380-5498.182
53. Smoyer WE, Finkelstein FO, McCulloch MI et al. ‘Saving Young Lives’ with acute kidney injury: the challenge of acute dialysis in low-resource settings. Kidney Int 2016; 89: 254–256
54. Polanco E, Aquey M, Collado J et al. A COVID-19 pandemic specific, structured care process for peritoneal dialysis patients facilitated by telemedicine: therapy continuity, prevention and complications management. Ther Apher Dial 2021; 25: 970–978
55. Al-Hwiesh AK, Saeed I, Al-Muhann FA et al. Safety and efficacy of applying strict protocols during COVID 19 pandemic at Saudi dialysis center: single center experience. Arch Nephrol Urol 2021; 4: 1–8
56. Al-Hwiesh AK, Mohammed AM, Elnokeety M et al. Successfully treating three patients with acute kidney injury secondary to COVID-19 by peritoneal dialysis: case report and literature review. Perit Dial Int 2020; 40: 496–498
57. Gabriel DP, Nascimento GV, Caramori JT et al. High volume peritoneal dialysis vs daily hemodialysis: a random-ized, controlled trial in patients with acute kidney injury. Kidney Int 2008; 73(Suppl 108): S87–S93
58. Ponce D, Berbel MN, Abrão JM et al. A randomized clinical trial of high volume peritoneal dialysis versus extended daily hemodialysis for acute kidney injury patients. Int Urol Nephrol 2013; 45: 869–878
59. Al-Hwiesh A, Finkelstein FO, Abdul-Rahman IS et al. Acute kidney injury in critically ill patients: a prospective randomized study of tidal peritoneal dialysis vs. continuous renal replacement therapy. Ther Apher Dial 2018; 22: 371–379
60. Pedersen KR, Hjortdal VE, Christensen S et al. Clinical outcome in children with acute renal failure treated with peritoneal dialysis after surgery for congenital heart disease. Kidney Int 2008; 73 (Suppl 108): S81–S86
61. Vinsnouneau C, Camus C, Combes A et al. Continuous venovenous hemodiafiltration versus intermittent hemodialysis for acute renal failure in patients with multiple organ dysfunction syndrome: a multicenter randomized trial. Lancet 2006; 368: 379–385
62. Chionh CY, Soni SS, Finkelstein FO et al. Use of peritoneal dialysis in AKI: a systematic review. Clin J Am Soc Nephrol 2013; 8: 1649–1660
63. Divya Shankaranarayanan D, Neupane SP, Varma E et al. Peritoneal dialysis for acute kidney injury during the COVID-19 pandemic in New York City. Kidney Int Rep 2020; 5: 1532–1534
64. Oliver MJ, Crabtree JH. Prioritizing peritoneal catheter placement during the COVID-19 pandemic. Clin J Am Soc Nephrol 2021; 16: 1281–1283
65. Mendu M, Divino J, Vanholder R et al. Expanding utilization of home dialysis: an action agenda from the First International Home Dialysis Roundtable. Kidney Med 2021; 3: 635–643
66. Nederlaardse Federatie voor Nefrologie. Urgente start PD en bijbehorende protocollen. https://www.nefro.nl/pd-surgery-techniques-percutaneous-laparoscopic/. (29 March 2022, date last accessed)
67. Blake PG, Quinn RR, Oliver MJ. Peritoneal dialysis and the pandemic during the COVID-19 pandemic: will it go viral? Perit Dial Int 2020; 40: 302–309
68. Renal Interventions. Newer techniques for PD surgery: Time due advance or tempest in a tribal teapot? https://renalinterventions.net/pd-surgery-techniques-percutaneous-laparoscopic/. (29 March 2022, date last accessed)
69. Brown EA, Perl J. Increasing peritoneal dialysis use in response to the COVID-19 pandemic: will it go viral? J Am Soc Nephrol 2020; 31: 1928–1930
70. Brown EA. Influence of reimbursement policies on dialysis modality distribution around the world. Clin J Am Soc Nephrol 2019; 14: 10–12