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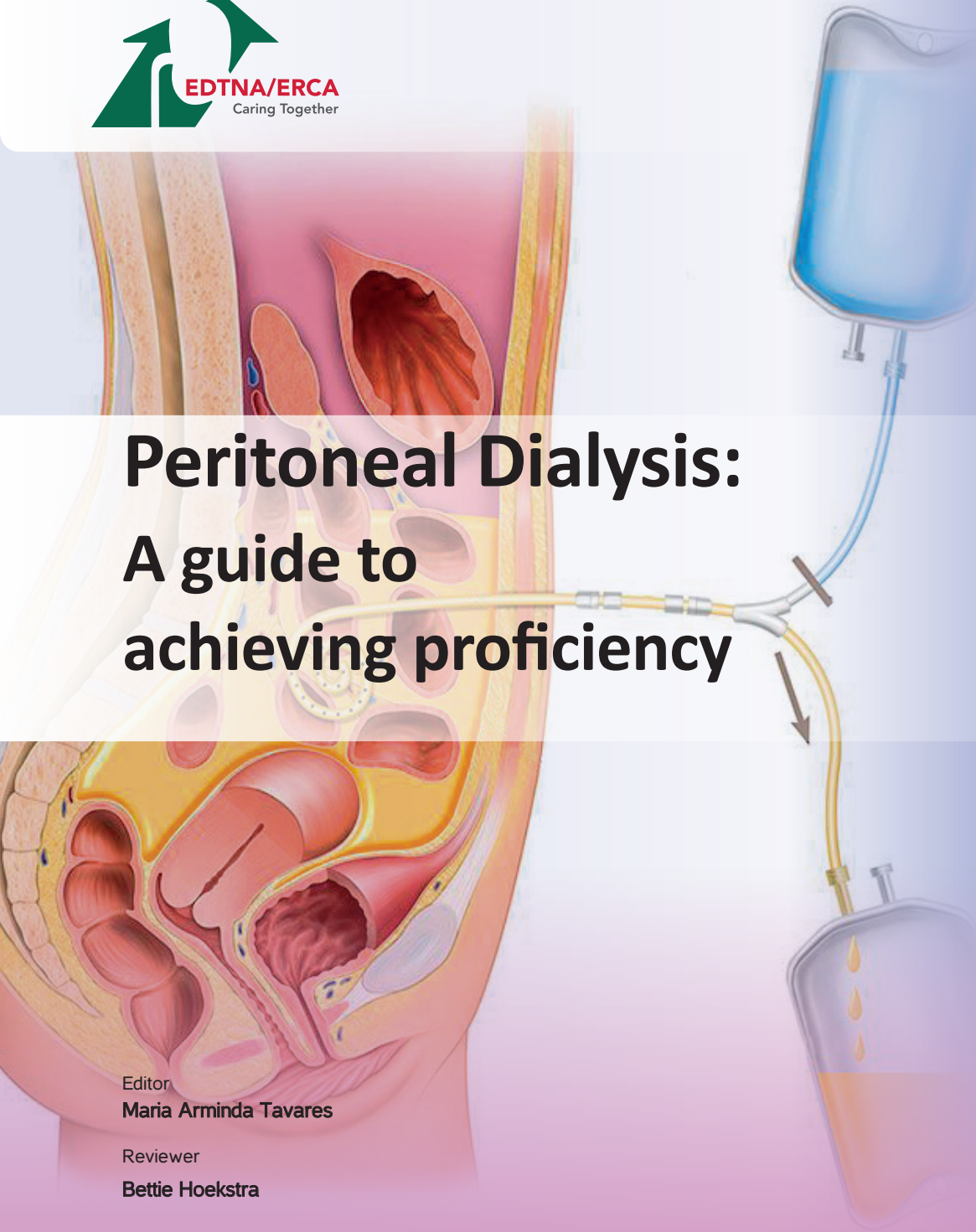

Peritoneal Dialysis:
A guide to achieving proficiency

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Maria Arminda Tavares

Reviewer
Bettie Hoekstra

Peritoneal Dialysis:
A guide to achieving proficiency

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Peritoneal Dialysis: A Guide to achieving proficiency

Foreword

This book is the third publication in an EDTNA/ERCA series about Peritoneal Dialysis (PD). After two different publications in 2009 and 2016 respectively, “PD, A guide to Clinical Practice” (2009) and “500 Questions and Answers about Peritoneal Dialysis”, it is time for a new book that will enable nephrology professionals to be proficient in their care for patients on peritoneal dialysis.

The aim of the book is to provide a document which a multidisciplinary PD-team can use to improve their practice: to provide up-to-date clinical guidelines of best practice in PD evidence-based clinical practice in caring for the people on PD, and to provide a quality reference text for professionals who care for patients receiving PD. Chapters are written by PD-experts working and living in different countries.

PD is, next to home haemodialysis (HD), a great option for those patients who prefer to do dialysis treatments in the comfort and privacy of their own home. Advantages of PD include the preservation of residual kidney function and an improved patient survival in the first few years of dialysis. Cost-effectiveness can be a reason for some countries to choose PD as the first dialysis option.

Nurses Competencies

Training, educating and supporting patients on PD is the key to successful treatment, always in an integrated team of doctors, nurses, social workers and dieticians. Nurses are the main professionals on the PD-team who teach patients how to manage their treatment at home.

Apart from a profound knowledge of the medical aspects of dialysis and educating and supporting patients, often by telephone or by house calls and/or Skype, nurses also require great expertise in communication. As the patients are mainly receiving their treatment at home, (when all goes well, the patient may only be seen once every six to eight weeks in the outpatient clinic), then nurses who are responsible for the care of those patients need to have good coordinating, planning and reporting skills. Advising on the phone an

acutely ill patient at home demands independent assessment skills and the ability to act on information gathered in the assessment.

The future of PD

We expect there will be interesting challenges and developments in the future of PD: more percutaneous implantations, need for better monitoring of catheter survival and infections, developing improved guidelines for the training and supporting of patients who are often elderly, and working together with family and district nurses. The use of digital technology and e-health, such simulation training programmes or the ability to use webcams for consultations, for clarifying problems, these are all very promising developments in PD care.

Shared Decision Making

The use of PD varies between countries and between dialysis centres. Reasons for this are diverse and still give cause for discussion. Despite these debates, patients should be able to make a well-informed choice about a dialysis treatment that suits them.

Aase Riemann

EDTNA/ERCA Brand Ambassador, The Netherlands.

CHAPTER 1: Concepts in Peritoneal Dialysis

Learning objectives:

1. To recognize basic anatomy and physiology of peritoneal dialysis.
2. To understand solute and fluid transport mechanisms.
3. To acknowledge the importance of peritoneal equilibration test, residual kidney function and peritoneal dialysis adequacy.

Basic Anatomy and Physiology of Peritoneal Dialysis

PD is carried out by taking advantage of a potential space in the peritoneal cavity, to store the PD solution for a few hours. During these hours the dialysis solution is in close contact with the peritoneal membrane, through which the exchange of solutes and fluid takes place. This membrane works as a natural dialytic filter and is composed of a visceral layer, which covers most internal abdominal organs, and a parietal layer which forms the inner layer of the abdominal wall. Both layers cover the intra -peritoneal space. As shown in figure 1, each layer of the peritoneum is composed of mesothelium, interstitial tissue and blood capillaries.[1] Transport of solutes and fluids occur through these capillaries.

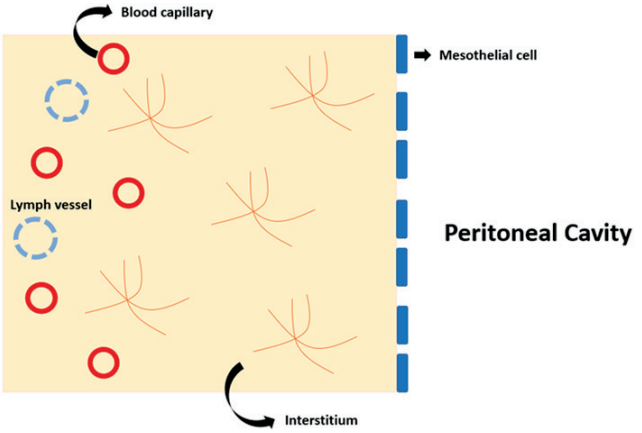

Figure 1 - Peritoneal membrane simplified histologic anatomy. Note that there is a certain interstitial thickness separating the blood capillaries from the peritoneal cavity. (Adapted from Nessim S, Perl J, Bargman J. The renin–angiotensin–aldosterone system in peritoneal dialysis: is what is good for the kidney also good for the peritoneum?. Kidney Int. 2010;78(1):23-28

Solutes and Fluid Transport

The three-pore model (figure 2) remains the most accepted explanation for how solute and fluid transport occurs across the semi-permeable peritoneal membrane. It is based on the proposed existence of three sets of pores: large pores, small pores and ultra-small pores. These pores are thought to be present on the capillary membranes.[2,3] Accordingly, the capillary membrane's effective surface area is as relevant as the existence of these pores. Therefore, it is thought that in clinical situations where there is increased vascular surface area (ex.: peritonitis), there will be more pores available for solute transport.[2]

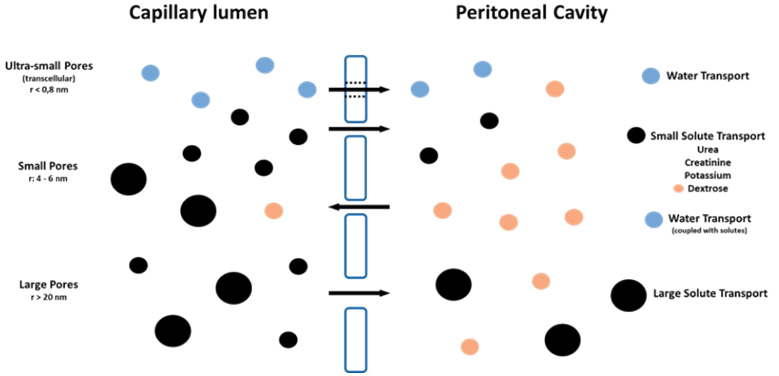

Figure 2 - Representation of the three-pore model for peritoneal transport. (Adapted from Daurgidas J, Blake P, Ing T. Handbook of Dialysis. 5th ed. Philadelphia, Wolters Kluwer Health; 2015)

Solute Transport

Transport of both macromolecules and small solutes occurs during peritoneal dialysis. Convective transport of proteins and other macromolecules takes place across large pores, which exist in a relatively small number in the capillary membranes. Small pores are responsible for the diffusion of some uremic toxins (urea, creatinine and potassium) from the patient's plasma to the dialysate, depending on the concentration gradient, as the dialysis fluid is free from these molecules. Glucose diffusion, in the opposite direction (dialysate to plasma), is also carried out through these pores. Solutes with low molecular weight (urea and potassium) will diffuse more rapidly than those with high molecular weight (creatinine).[2,3] Effective

peritoneal surface area has a positive impact in solute diffusion. It can be increased by infusing larger dialysate volumes, involving more peritoneal capillaries in the solute transport by bringing them into contact with the dialysis fluid.[2]

Fluid Transport

Free water clearance is carried out through the ultra-small pores, across the osmotic gradient into the peritoneal cavity, accounting for most of the ultrafiltration that occurs during peritoneal dialysis. The osmotic gradient is created by the by the concentration of dextrose in the dialysis fluid' (the most commonly used dialysate osmotic agent) which is highest at the beginning of the dialysis solution dwell. Water transport, coupled to solute diffusion, also occurs through small pores, being responsible for only a small fraction of the ultrafiltration.[2,3] Besides, In addition to transport of water into the dialysate from systemic circulation, there is also some water reabsorption as dialysate dextrose is absorbed through these small pores.[3]

Ultrafiltration is driven by three main gradients: hydrostatic pressure gradient, osmotic pressure gradient and oncotic pressure gradient. The oncotic pressure gradient is created by the plasma protein content and it opposes ultrafiltration by keeping fluid inside the capillaries. The hydrostatic pressure gradient is determined by the difference between the pressure inside capillary lumina and the inside of the peritoneal cavity. The intraperitoneal pressure may vary with postural changes (the intraperitoneal pressure is higher in seated position than in supine position) and with the volume of instilled dialysate.[2,3] 'It is important to be mindful of the role of different gradients in the provision of PD as the increase of the volume of infused dialysate may increase the effective capillary surface area involved in fluid transport. Also, the intraperitoneal pressure is increased, thus reducing the hydrostatic pressure gradient which in turn reduces ultrafiltration. The osmotic pressure gradient is determined by the concentration of the dialysate osmotic agent as higher concentrations favour ultrafiltration. The most commonly used osmotic agent is dextrose, whose concentration decreases with dwell time as it diffuses from the dialysate in the peritoneal cavity (higher concentration) to plasma in the systemic circulation (lower concentration) through the small pores in the capillaries. As with the

diffusion of solutes, increasing the effective peritoneal surface area also impacts positively ultrafiltration.[2]

Overall, there are two mechanisms responsible for the decrease of ultrafiltration rate with dialysate dwell time. On one hand, the continuous dextrose diffusion from dialysis fluid to plasma decreases its concentration in the peritoneal cavity, resulting in a decreased osmotic pressure gradient. On the other hand, as the ultrafiltrate volume adds to the original dialysate infused volume, the total fluid volume inside the peritoneal cavity will increase with the dwell time, increasing the intraperitoneal pressure, which in turn reduces the hydrostatic pressure gradient and limits further ultrafiltration.

The osmotic efficacy of a given solute is determined by its reflective coefficient (RC). The reflective coefficient measures the membrane resistance to the solute transport and ranges from 0 to 1. The higher the RC the better the solute works as an osmotic agent. Dextrose has a low RC (0,02-0,05) in large and small pores but it increases to 1.0 in ultra-small pores, explaining why it works well as an osmotic agent.2,3 Icodextrin, on the other hand, has a global RC close to 1.0 because it is only slowly absorbed through the lymphatics.[2]

A final word should be given to the peritoneal fluid absorption, which is carried out by the lymphatic vessels. It antagonizes ultrafiltration and varies considerably from person to person. It increases in response to intraperitoneal pressure.[2]

Measurement of Peritoneal Transport

Solute and fluid transport across the peritoneal membrane varies from patient to patient, according to membrane characteristics. To evaluate peritoneal membrane properties, a peritoneal equilibration test (PET) should be done 8 to 12 weeks after commencement of peritoneal dialysis.[2-4] This is typically done by infusing 2 litres of a standard 2,5% dextrose solution and letting it dwell for 4 hours. A single blood sample is drawn at 2 hours and dialysate samples are collected at 0, 2 and 4 hours. Results are presented as dialysate to plasma (D/P) ratios plotted against time for creatinine, urea and sodium, as well as dialysate glucose concentration throughout time (D/DO). Patients are then classified as high, high-average, slow-average and slow transporters, according to their creatinine D/P and glucose D/DO ratios (figure 3).[2,5]

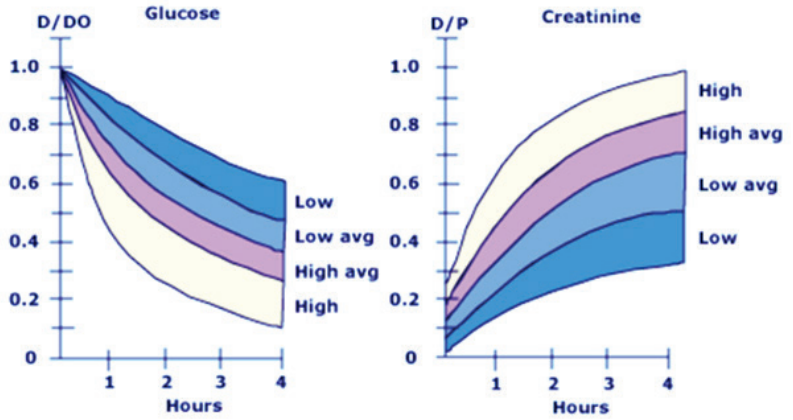

Figure 3 - Categorization of transport types according to standard PET curves for creatinine and glucose. D - dialysate concentration, DO – original dialysate glucose concentration, P – plasma concentration. (Adapted from Twardowski et al. Peritoneal equilibration test. Perit Dial Bull. 1987; 7:138)

This classification is important for tailoring dialysis therapy, as a person who is a high transporter will lose the osmotic pressure gradient more rapidly due to faster dextrose absorption through small pores. In this situation, as short dwell times are more appropriate, preference should be given to automated PD with multiple short cycles during the night while leaving the peritoneal cavity empty during the day.[2,4]

The International Society of Peritoneal Dialysis has advised the use of 4,5% dextrose solution to perform the PET, to anticipate ultrafiltration insufficiency by estimating sodium sieving (sometimes referred to as sodium dip). Sodium sieving refers to the decrease in dialysate sodium concentration that occurs in the first hour of the dwell as a result of free water transport by the ultra-small pores, through the osmotic gradient created by the higher initial dialysate dextrose concentration. A sodium dip ≤5 mmol/L and/or a sodium sieving ratio ≤0.03 at 1 h suggests UF insufficiency. UF insufficiency has also been defined as a UF ≤400ml during a 4 h PET with a 4,5% dextrose solution.[3,4]

Residual Kidney Function

Residual kidney function (RKF) is strongly associated with mortality on peritoneal dialysis.[6] There are several mechanisms which could contribute to this association, such as preserved kidney salt and water elimination (limiting volume overload and cardiac remodelling), as well as increased elimination of non-measured uremic toxins with inflammatory potential.[6-7] Measures to preserve RKF include avoidance of nephrotoxins, use of ACE inhibitors and angiotensin receptor blockers and avoidance of extracellular volume depletion.[1,6,7]

PD Adequacy

Dialysis adequacy should be evaluated based on the uremic toxins' removal (indirectly measured by urea clearance) as well as fluid removal. Urea clearance is measured by collecting 24h urine and 24h PD effluent. Ratios of pooled urea concentration from both urine and effluent, and patient's plasma are calculated (Kt) and normalized to their urea volume distribution (V). This ratio is expressed as Kt/V, and the minimal delivered dialysis dose is defined as a total (kidney + dialysis) weekly Kt/V ≥1.7. These measurements should only be taken from 4 weeks after the commencement of PD to ascertain some degree of stability, as the calculated delivered Kt/V is supposed to represent a dose of dialysis that has been consistently given to the patient.[2,8,9] In patients without RKF, a net ultrafiltration ≥1L/day is recommended.[9]

PD Solutions

There are two types of PD solutions: glucose and non-glucose solutions. Glucose solutions are available in three different concentrations (1,5%, 2,5% and 4,5%) with increasing osmotic pressure. Non-glucose solutions include amino acid-based solutions, used for nutritional supplementation or lowering dextrose exposure, and icodextrin-based solution which is another osmotic agent used in peritoneal dialysis. As mentioned before, icodextrin absorption is carried out only by lymphatic vessels, which makes transportation much slower than that of dextrose, resulting in a reflection coefficient close to 1.0.[2]

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Suggestion for further reading

Morelle J, Stachowska-Pietka J, Öberg C, Gadola L, La Milia V, Zanzhe Yu et al, 2021. ISPD recommendations for the evaluation of peritoneal membrane dysfunction in adults: Classification, measurement, interpretation and rationale for intervention. Peritoneal Dialysis International 2021, Vol. 41(4) 352–372

CHAPTER 2: Different modalities in Peritoneal Dialysis

Learning objectives:

1. To understand the importance of a person-centred choice of PD modality.
2. To recognize the difference between manual and automated PD.
3. To distinguish between different treatments of the cycler.

Introduction

PD is a well-established renal replacement therapy (RRT) for patients with End Stage Kidney Disease (ESKD). It is an effective treatment and is relatively simple to perform. That is why PD is the first choice when we talk about a home treatment modality and the preferred treatment for paediatric patients.[1]

Across the world, the distribution of patients receiving PD does not reflect the health professional's recommendation or the choice of the patients and caregivers.[2] PD may be underutilized[2,3], although patients who switch treatment from HD to PD may have a higher mortality risk, when compared to patients assigned to PD as first treatment.[2,4] To overcome this issue, several countries have adopted a PD-first policy (PD is used as the first treatment modality for patients with ESKD or a PD-favoured policy (PD is highly recommended as the preferred treatment for patients with ESKD and the barriers to its use are removed). Other countries have adopted home dialysis first (HD and PD) policies, which are a helpful alternative in developing countries, especially when they have limited resources which need to be optimized.[2]

PD is a flexible therapy that allows an individualized prescription by combining different types of dialysis solutions, different numbers and durations of exchanges and different techniques: manual versus automated.[1,5] Currently it is recommended that treatment modality choices should be more individualized and include a patients' goals and preferences while still maintaining evidence-based practice. The ISPD(ISPD) recommends PD should be prescribed following a shared decision-making process between the person receiving PD, their caregivers, and the healthcare team, with the objective

of establishing realistic care goals that promote quality of life while minimizing symptoms and ensuring high-quality care is provided.[6,7]

The effectiveness of PD in removing uremic toxins is variable and depends on multiple factors such as the individual's peritoneal membrane characteristics and the specific dialysis prescription, for example the type of solution, number of exchanges, total daily volume, fill volume and dwell-time of PD exchanges.[8] Research indicates that there is no significant difference between PD modalities in relation to mortality, residual kidney function, health, quality of life, technique failure, adverse events, risk of peritonitis, adequacy outcomes, nutritional status, and anaemia.[9] There are essentially two ways of performing PD: Continuous Ambulatory Peritoneal Dialysis (CAPD) and Automated Peritoneal Dialysis (APD).

Continuous Ambulatory Peritoneal Dialysis (CAPD)

Continuous Ambulatory Peritoneal Dialysis (CAPD) was first introduced by Popovich and Moncrief in 1976.[10] CAPD is performed continuously throughout the day while the person goes through their daily activities. It is done manually by the patient themselves, or by a care provider, so it requires training prior to commencement.[1] During the procedure, 1,5 to 2,5 L of PD dialysis fluid is infused through a peritoneal catheter, using gravity, into the peritoneal cavity, where it remains for at least 3 hours. This procedure is repeated three to five times a day, and then the dialysis fluid is removed. This typically means three or four short dwells during the day, for a period of 4 to 6 hours each, and a long dwell overnight, for a period of 8 to 10 hours.[10,11,12,13] During the dwell-time solute and fluid exchange occurs across the peritoneal membrane, between the peritoneal capillary blood and the dialysis solution, which results in the removal of excess fluid, toxins and the correction of electrolyte imbalances.[13]

Nowadays, double-bag systems are most commonly used. This system contains the unused dialysis solution, which is connected to an empty sterile drain bag through a Y-set tubing system. The procedure is easy to carry out, and is illustrated in figure 1. First, the patient connects the double-bag system to the peritoneal catheter and drains the dialysis solution in the peritoneal cavity into the drain bag. After the drainage process is complete the peritoneal cavity is fill with a new dialysis solution.[1-14] Each exchange (drainage and infusion) typically takes 20–30 minutes to be complete.[1]

The specifics of the prescription, such as type of dialysis solution, volume to be infused, dwell time and number of exchanges, may change according to patient size, peritoneal membrane characteristics and residual kidney function.[13] During the day, a dry period may be allowed for patient comfort, or it may even be clinically necessary in some conditions (high transporters, high intraperitoneal pressure).[11]

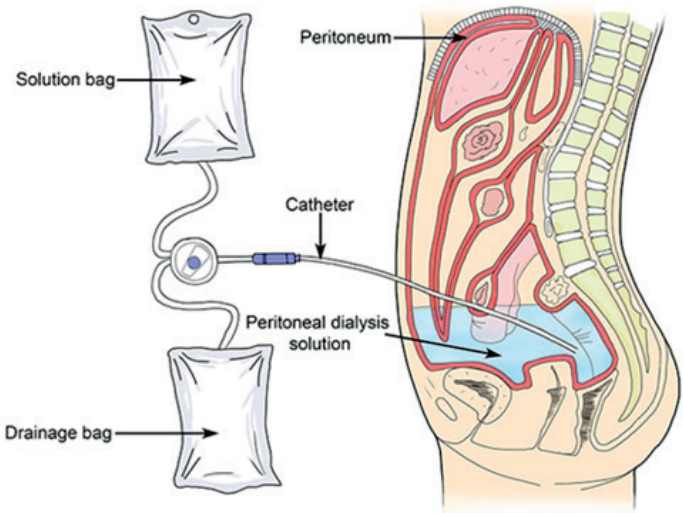

Figure 1 – CAPD scheme, adapted by https://mammothmemory.net.

Automatic Peritoneal Dialysis (APD)

Automated Peritoneal Dialysis (APD) uses a machine, called a cycler, to perform the exchanges. This treatment usually occurs overnight, for 8 to 10 hours, while the patient sleeps.[1,14] The cycler makes infuses the dialysis solution into the peritoneal cavity and keeps the dialysis solution in the peritoneal cavity for a long enough period to enable the solute and fluid exchange. After dwell-time, the waste fluid is drained, and the cycle starts all over again (infusion – dwell time – drainage).[15] The dialysis solution is usually pre-warmed by the cycler before inflow. Modern APD machines have safety alarms that alert the user to situations such as infusion failure, drainage failure and low ultrafiltration. To obtain a more efficient exchange some cyclers interrupt drainage at the breakpoint, between the fast and

slow phases.[14] Remote patient management systems or the use of a memory card in the cycler allows clinicians to monitor home therapy, including problems that patients may experience during treatment, and adherence to prescriptions.[1-14] Cyclers can be programmed according to the composition of the dialysis solution, intraperitoneal fill volume at each cycle, total or fractional (Tidal) exchange, dwell duration, number of night cycles, extra day exchanges, last infusion volume and total treatment time.[16]

APD is the PD modality of first choice in children and students, full time workers, patients with a highly permeable peritoneal membrane (high transporters), patients with hernias and leaks, older aged or dependent people who rely on a caregiver, patients who require high dialysis clearance and patients who prefer this modality for personal reasons.[1,15] In some countries APD is the preferred PD modality for lifestyle reasons, however this success has only been possible thanks to the technological progress of the cyclers.[16]

These technology advances make it possible to adjust the treatment according to the individual characteristics of the patient and the clinical and biochemical data.

According to these different characteristics APD can include[1]:

- Continuous Cycling Peritoneal Dialysis (CCPD)
- Intermittent Peritoneal Dialysis (IPD)
- Optimized Continuous Peritoneal Dialysis (OCPD) or PD-Plus
- Tidal Peritoneal Dialysis (Tidal PD)
- Adapted Automated Peritoneal Dialysis (adapted APD)

Continuous Cycling Peritoneal Dialysis (CCPD)

This type of APD was introduced to obtain higher solute and fluid removal compared to CAPD, using an automated procedure with a cycler during the night while the patient sleeps. It's called continuous because the dialysis solution is in constant contact with the peritoneal membrane, 24 hours a day.[1,17] An example of a CCPD prescription might be of four or five exchanges during the night, with volumes between 2 and 3 L of dialysis solution and dwell time of 60 to 120

minutes. During the day, the peritoneal cavity is filled with 1.5 to 2 L of a dialysis solution, and a long day dwell occurs. A graphic representation of this process is shown in figure 2.

CCPD allows greater flexibility in the number and volume of exchanges overnight and makes it possible to use higher volumes of dialysis solution because they are better tolerated in the supine position.[1]

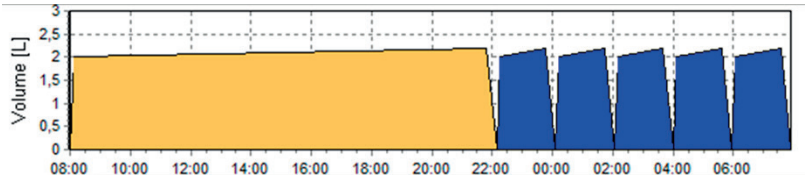

Figure 2 – CCDP graphic representation, adapted by Fresenius Medical Care (FMC) Patient OnLine Programme (POL).

Intermittent Peritoneal Dialysis (IPD)

IPD prescription is similar to CCPD, but without the day dwell time. It is called 'intermittent' because the treatment only occurs during the night and the peritoneal cavity remains empty during the day.[1,11,18]

This modality may be a good alternative for people who have clinical conditions that affect their abdomen, like hernias and leaks (the migration of peritoneal fluid into adjacent body structures). When this form of APD is used it can be difficult to achieve an adequate dialysis dose if the patient has little or no residual kidney function. However, it can be an appropriate method when needed .[1] A graphic representation of this treatment is shown in figure 3.

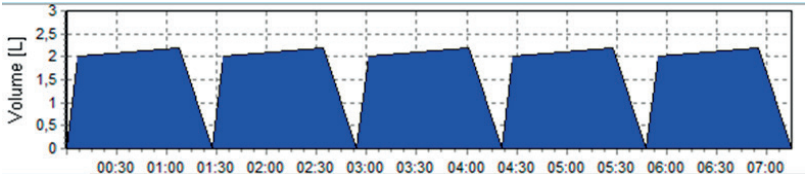

Figure 3 – IPD graphic representation, adapted by FMC POL.

Optimized Continuous Peritoneal Dialysis (OCPD) or PD-Plus

When we talk about an Optimized treatment or a Plus treatment, we are talking about the necessity to perform at least one additional exchange during daytime hours.

Sometimes the dialysis dose needs to be increased without increasing the duration of the night treatment. In these cases, it may be useful for an exchange to be performed in the cycle, commonly on late afternoon, with 3 or 4 hours of dwell time. After the drainage and the infusion of the dialysis solution the person disconnects from the cycler and only restarts treatment when going to sleep. This treatment scheme is represented on figure 4.

We can also vary this treatment and have it in an intermittent way – Optimized Intermittent Peritoneal Dialysis.[1,11]

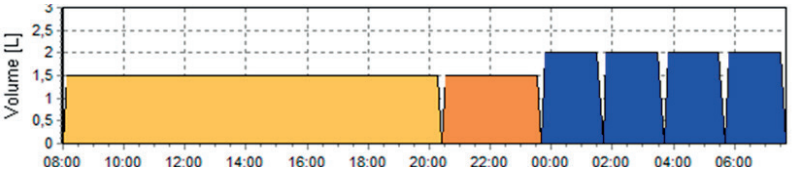

Figure 4 – OCPD graphic representation, adapted by FMC POL.

Tidal Peritoneal Dialysis (Tidal PD)

Sometimes, drainage time needs to be accelerated during APD to optimize the duration of the treatment and increase efficiency by reducing the drainage alarms on the cycler. Other times, a peritoneal catheter may have slow drainage problems or a person may experience pain when the inflow/outflow process occurs.[19] In these cases, it may be useful to allow a residual volume in the peritoneal cavity by not letting all the fluid drain during the night. Subsequent inflow volumes are proportionally reduced to prevent overfill of peritoneal cavity, and after a programmed number of cycles, complete drainage may occur. This technique is called Tidal and is represented in figure 5. At the end of the treatment a complete drainage usually takes place.[1]

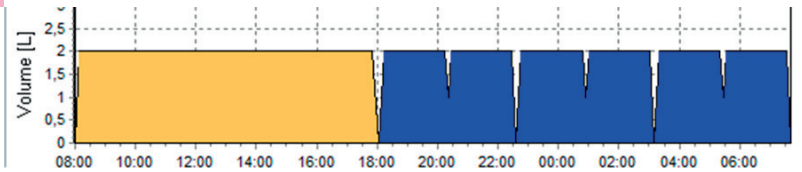

Figure 5 – Tidal PD graphic representation, adapted by FMC POL.

Adapted Automated Peritoneal Dialysis (adapted APD)

Conventional APD usually has a repeated prescription for all night exchanges, relating to the fill volume and dwell-time. However, an APD programme with a short dwell-time and lower fill volume helps with ultrafiltration (fluid removal), while a programme with a long dwell-time and higher fill volume helps with removal of uremic toxins.[20] Adapted APD allows the use of varied dwell time and fill volume to optimize the PD prescription. This programme usually starts with two or three short dwell-times with a small fill volume to promote ultrafiltration, followed by two or three long dwell-times with a high fill volume to remove uremic toxins from the blood.[20-21] This treatment scheme is represented in figure 6.

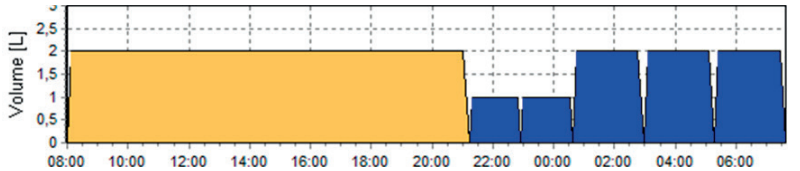

Figure 6 – Adapted PD graphic representation, adapted by FMC POL.

Assisted Peritoneal Dialysis (aPD)

Some patients with ESKD requiring RRT may be unable to perform PD by themselves, due to physical or psychosocial conditions that act as a barrier to selfcare.[22] In these cases, it may be necessary to have an informal caregiver perform the treatment. According to ISPD guidelines, when prescribing PD one should consider patients' priorities and lifestyle including those of their families/caregivers', especially if aiding in their care.[6]

Patients with ESKD undergoing PD can be assisted by a family member or a healthcare professional, such as a nurse, to perform

either CAPD or APD.[22] France, Sweden, Belgium, Australia, and Canada are some of the countries with successful experience in assisted PD (aPD) programmes. All countries with PD units should have methods of providing aPD, to ensure that all patients have equal access and can benefit the different advantages of this treatment.[23]

When performing aCAPD the healthcare professional visits the patient at home three or four times a day to perform the manual exchanges. At aAPD modality it may only be necessary to visit twice a day for the preparation of the cycler for overnight treatment and connection of the patient, and at the end of the treatment to disconnect the patient.[15,24] Despite starting with total aPD, the goal is to promote as much independence as possible, helping the patient or a family member to perform parts of the treatment like connecting and disconnecting the cycler and resolving the most frequent alarms, allowing a greater flexibility and independence in their daily routine.[15]

Special situation: PD modality in Children

In children, the unique aspects of growth, nutrition, cognitive and emotional maturation increases the complexity and makes the dialysis treatment more challenging.[7] According to the 2020 ISPD guidelines, the selection of dialysis modality in children should be based upon the child's age and size, presence of co-morbidities and contraindications, family support, the relative professional experience of the healthcare team and the individual preference of the child and/or caregiver.[6]

PD may be a good alternative for children as it could preserve dialysis access and interfere less with the child's and family's lifestyle. Children should be supported to participate in school, in their hobbies and other activities, and to spend time with family and friends.[6,15] APD appears to have some advantages over CAPD because it allows the patient to have more free time during the day. In some cases, it may be useful to perform APD overnight and leave an empty peritoneal cavity during the day, preventing complications of high-volume intraperitoneal pressure.

Conclusion

PD is a well-tolerated and efficient dialysis modality option in the treatment of ESKD.

It may be applied as an intermittent or continuous treatment, manually performed by the person or a caregiver during the day, or it can be automated and performed by a machine, usually overnight.[1]

We need to move away from a “one-size-fits-all” approach to dialysis and provide more individualized care. Identifying and achieving patient goals is an important component of dialysis care which requires joint efforts among all people involved including HCP, the patient and the family members.[6-7] Patients should be trained about their treatment options so they can make an informed decision regarding their preferences. The different options for PD make it possible to adapt treatment to the specific needs of the patient.

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CHAPTER 3: Prescriptions and Peritoneal Dialysis adequacy

Learning objectives:

1. To identify the different methods to measure adequacy of dialysis
2. To understand how to provide adequate dialysis and the clinical consequences
3. To understand the definition of “Goal- directed” dialysis

Introduction

The availability of life-saving dialysis therapy has been one of the great successes of medicine in the past four decades. PD(PD) is the first choice of dialysis modality and is currently used to treat about 11% of dialysis patients worldwide[1]. In the early days of PD, interest focused mainly on its technical aspects, because of the very high rate of complications (mechanical or infectious) and failure of the method, which led to a 3-year survival rate of 35% and a high transfer rate to HD. Technological advances progressively improved some of these problems, allowing an increase in the number of patients receiving PD. Once PD was established as a viable therapy, attention shifted to the identification of appropriate indicators for dialysis prescription, ameliorating clinical outcomes of these patients.

Despite treatment of hundreds of thousands of patients, the overall quality of life for patients with ESKD has not substantially improved. A narrow focus by clinicians and regulators on basic indicators of care, like dialysis adequacy and anaemia, consumed time and resources but did not result in significantly improved survival; also, frequent hospitalizations and dissatisfaction with the care experience continue to be seen.[1]

Adequate dialysis and clinical Correlations

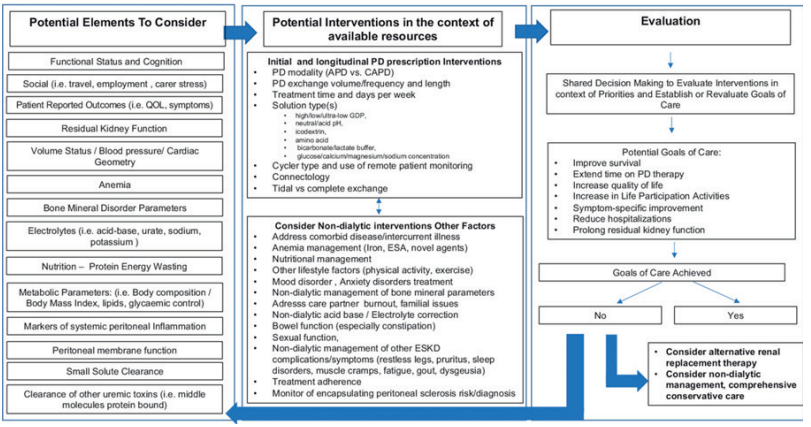
For a long time, in HD and PD, “dialysis adequacy” was defined solely on the basis of the clearance of solutes by the technique itself. One method of quantifying dialysis adequacy is the kinetic model of urea. Urea was chosen as the solute marker because its concentration increases in kidney failure, it has a low molecular weight (60 kDa), It rapidly diffuses between compartments of the peritoneal cavity and its volume of distribution is in total body water and it crosses

the peritoneal membrane easily. As it constitutes the final product of protein metabolism, the model can be correlated with dietary protein intake.[2] The Kt/V of urea is the most used adequacy index in clinical practice. On PD, Kt/V of urea can be expressed as kidney clearance and peritoneal urea, or expressed as each of its kidney and peritoneal fractions independently. The determination of peritoneal Creatinine Clearance (CCr) has little value since it is a reflection of residual kidney function. Therefore, it is recommended that only urea kinetics should be used as an index of adequacy.[3]

Several clinical studies failed to demonstrate a relationship between dialysis dose, measured as urea or creatinine clearance, and clinical benefit for PD patients. Chronic end-stage kidney failure impacts more than just protein catabolite excretion, it also impacts the removal of fluid, control of systemic blood pressure, acid-base balance, mineral metabolism, anaemia, nutrition, among other functions.

Adequate dialysis, therefore, has to be defined in a broader way than the simple measure of the clearance of small solutes. It is important to clearly establish "adequate ranges" of clinical and laboratory indicators that correlate with a better prognosis for PD patients. Adequate dialysis should be defined as the effective dose able to control symptoms, preserve patient's activity, and maintain sufficient metabolic and homeostatic balance.

Figure 1- Prescribing Peritoneal Dialysis For High Quality Care[4]



Brown, Edwina & Blake, Peter & Boudville, Neil & Davies, Simon & de arteaga, Javier & Dong, Jie & Finkelstein, Fred & Foo, Marjorie & Hurst, Helen & Johnson, David & Johnson, Mark & Liew, Adrian & Moraes, Thyago &

Perl, Jeff & Shroff, Rukshana & Teitelbaum, Isaac & Wang, Angela & Warady, Bradley (2020). ISPD practice recommendations: Prescribing high-quality goal-directed peritoneal dialysis. Peritoneal Dialysis International: Journal of the International Society for Peritoneal Dialysis. 40. 089686081989536. 10.1177/0896860819895364.

Undoubtedly, this definition requires different therapeutic approaches that rely on individualized prescriptions, based on patient-centred decision-making, after discussion with the clinical team. The aim is to set realistic goals of care that (1) maintain the person's quality of life as much as possible, allowing them to achieve their goals including cultural and spiritual needs of patients and their families, (2) minimize symptoms and the impact of the dialysis regimen on mental health and social circumstances, and (3) ensure a high quality of care is provided. In 2018 it was proposed that there should be a change in terminology from “adequate” dialysis to “goal-directed” dialysis.[4]

Objectives of dialysis adequacy

- Prevent the appearance of uremic symptoms
- Optimize quality of life
- Maintain one's own lifestyle
- Avoid morbidity associated with kidney disease
- Avoid morbidity associated with the PD
- Reduce hospitalizations
- Improve survival
- Maintain a positive nitrogen balance
- Maintain adequate caloric intake
- Prolong residual kidney function

A retrospective analysis of an administrative database of anuric PD patients demonstrated increased mortality in patients with Kt/V<1.7. The evidence does not demonstrate a clear relationship between clearance of small solutes in PD and survival, but it demonstrates that a minimal of small molecule clearance is necessary in order to avoid unacceptable levels of morbidity and mortality.[5]

Potassium

There is a U-shaped association between serum potassium concentration and the risk of sudden cardiac death in PD. Risk is lowest at 5 mEq/L and increases for values above or below.[6]

Quality of life and Reported Outcomes and Measurement of Dialysis Dose

Patient-reported outcomes (PROs) measure symptoms, health-related quality of life (HRQoL), and experiences of care. PROs, alongside the consideration of patient preferences are essential in patient-centred care, can provide important diagnostic information, and can influence patient behaviour, thereby affecting morbidity, resource utilization, and survival.[8] Furthermore, depression is independently associated with survival, and those suffering from acute or chronic pain can experience changes in HRQoL.[9] Future research is needed to find patient-centred outcome metrics.[10]

Nutrition and BCM

Sarcopenia is defined as progressive generalized loss of muscle mass and functional strength. Identifying patients with sarcopenia and malnutrition is important as both are poor prognostic indicators for patients on peritoneal dialysis.[11]

Optimization of Cardiovascular Health by Dialysis Dosing

Clinical examination, including blood pressure measurements, should be part of routine care of fluid status. Volume assessment instruments such as bioimpedance exist, but lack regulatory approval.[12] Chronic expansion of extracellular volume contributes to increased morbidity and mortality.[13] This home-based therapy can efficiently extract sodium-rich fluid resulting in decongestion which provides a better functional status and quality of life, resulting in significant savings in health-care expenditure.[14] Methods use to evaluate dialysis adequacy that incorporate fluid management should consider not only extracellular volume status, but also fluid removal strategies. Patients with PD continuously remove solutes, and it is the continuous nature of this dialysis that has led many to suggest that this may be one reason why PD patients are clinically well, despite maintaining higher serum levels of small uremic solutes.[6]

Kidney function

Any residual kidney function that continues to remove waste products and the remaining fluid volume through urine should be known. Management should focus on preserving this residual function for as long as possible. Residual kidney function impacts on patient survival and quality of life. Longer preservation of residual function is a major advantage of PD and should also be an adequacy treatment target. This goal can be successfully achieved by using automated PD, icodextrine, low-glucose degradation products, individualized PD profiles and angiotensin-converting enzyme inhibitors or angiotensin-II receptor blockers .[17]

PD Strategies

The initial prescription of PD is empirical. Body surface area is estimated from anthropometrics formulas and is used to calculate the creatinine clearance per 1.73 m2.
The diuresis and residual kidney function must be evaluated periodically because PD treatment will need to increase peritoneal clearance of solutes and water, in order to compensate for progressive loss of residual kidney function. The modifiable factors of dialysis are the frequency of turnover, the volume of the exchanges and the osmolarity of the solutions.

Knowledge of the characteristics of the transport of solutes and water across the peritoneal membrane is also of great importance in the prescription of peritoneal dialysis. Solute clearance occurs early and with greater magnitude in patients with high peritoneal transport. Those patients therefore need to use a rapid turnover with multiple short stay like automated nocturnal peritoneal dialysis. In contrast, this solute clearance is of smaller magnitude and is delayed in patients with low peritoneal transport. The length of dialysis time is a point of importance for adequate clearance of solutes in patients with low peritoneal transport, meaning for these patients a regimen of very long exchanges such as CAPD or CCPD (continuous cyclic peritoneal dialysis) may be preferred.[2]

Some patients with significant residual kidney function can begin PD with three exchanges or less per day, an approach called PD incremental. An increase in the volume of exchanges achieves greater clearance of solutes, compared to an increase in their frequency.

However, the volume of the exchanges is limited by the capacity of the peritoneal cavity, body surface, tolerance of the patient and the risk of leaks and hernias.[2]

Increasing the tonicity of the dialysis fluid is a method' that results in an increase in the volume of ultrafiltration and can be useful for the control of hypervolemia. However, the use of glucose-based dialysis solutions as an osmotic agent leads to a series of metabolic complications such as hyperglycaemia, dyslipidaemia, obesity, and other local complications such as long-term damage to the peritoneal membrane. The use of icodextrin, an osmotic agent, increases the ultrafiltration capacity and clearance, without the metabolic complications.[2] PD programmes should monitor the outcomes of these clinical interventions, focusing on inexpensive clinical indicators, to determine efficacy, trends and progression and for international comparison.[4]

Conclusion

In order to improve patients' quality of life, in addition to using technically complex and costly therapies, regulators, clinicians and providers need to follow new quality paradigms and guidelines.

These new models of clinical practice have basic indicators (infection rate and small molecule clearance) to gauge adequate management/treatment, but outstanding performance at those levels would be necessary but not sufficient to achieve the proposed objectives. Achievement of these intermediate outcomes will allow improvements in survival, hospitalization rates, patient experience and quality of life.[15]

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CHAPTER 4: Peritoneal Dialysis catheter implantation

Learning objectives:

1. To Identify the different types of pd catheters
2. To Illustrate the different methods of pd catheter implementation

Introduction

In PD, a well-functioning catheter is of great importance. A dysfunctional catheter may result in peritonitis and impact the efficiency of dialysis as well as the overall quality of treatment. Therefore, dysfunctional catheters represent one of the main barriers for optimal use of PD.[1] About 30 per cent of people who change from PD to HD do so due to catheter failure.[2]

Good catheter function can be related to health personnel dependent factors, such as catheter care and implantation technique, and also to features of the catheter itself.[3] Literature shows that variability of implantation technique´s is more closely related with the surgeon experience and the centre characteristics rather than with the catheter design. Catheter placement techniques can also influence outcomes.[4] Other factors such as age, gender, race, body mass index (BMI), diabetic status, comorbidities, previous abdominal surgeries, peritoneal infections, or exit site/tunnel infections do not affect the PD catheter survival.

When considering the relationship between PD catheter type and outcomes, we should keep in mind there are different types of available PD catheters.[3] The main differences in PD catheter design include the number of cuffs, the shape of subcutaneous tract (straight vs. swan neck), and the shape of intra-peritoneal tract (straight vs. coiled).

The availability of the best catheter design and materials, along with a skilful management of PD access, may have the greatest impact on long-term patient outcome on PD. Peritoneal catheter dysfunction is still considered responsible for a significant proportion of the high technique failure rates[5], because PD access complications, along with patients' improved survival, determine increased patient dropout to HD. It is now established that the use of straight catheters may

improve outcomes and technique survival, but further advances in PD catheter technology can potentially improve technique survival.

Catheters for chronic PD

Currently, most chronic catheters are constructed of silicone rubber, whereas some are fabricated from polyurethane rubber. A polyurethane catheter that ceased production in 2010 was made of a particular polymer extremely susceptible to oxidative stress fractures, softening, and rupture due to chronic exposure to polyethylene glycol present in mupirocin ointment used for long-term catheter exit-site prophylaxis.[6] A polyurethane catheter continues to be marketed that it is constructed from a higher-grade polymer that may be more resistant to oxidative degradation or softening plasticizers; however, published clinical experiences with this device are required. Erosion of silicone catheters due to the use of gentamicin cream at the exit site has been reported but appears to be a rare complication.[7]

Used PD catheter types are illustrated in Figure 1. The standard double Dacron (polyester) cuff, straight- and coiled-tip catheters with straight or preformed arc bend intracuff segments constitute the most commonly used PD access around the world (Figure 1). No difference in functionality has been convincingly demonstrated between straight- and coiled-tip catheters with or without a preformed arc bend. Although standard catheters are available with single Dacron cuffs, it has been hypothesized that double-cuff catheters may be superior to single-cuff catheters in preventing peritonitis caused by periluminal entry of organisms.

Extended 2-piece catheters were originally designed to provide presential exit site (Figure 1). The extended catheter consists of a 1-cuff abdominal catheter segment that attaches to a 1- or 2-cuff subcutaneous extension segment using a double barbed titanium connector to permit remote location of the exit site to de upper chest. Extended catheters are also used to provide remote exit- location to the upper abdominal and back regions.[8,9] The abdominal catheter can be placed by any insertion method. The subcutaneous extension catheter is implanted using a vascular tunnelling rod or similar device supplied by the catheter manufacturer (Figure 2).

Most currently manufactured chronic catheters possess a white radiopaque stripe along the longitudinal axis of the tubing that enables

radiographic visualization. The stripe can also serve as a guide during implantation of the catheter to prevent accidental twisting or kinking of the catheter tubing. The majority of adult catheters have a 2.6mm internal diameter. One catheter brand possesses a 3.5mm internal diameter and can be identified by its blue radiopaque stripe. While the in vitro flow rate of the larger bore catheter is higher, any therapeutic advantage of this device has yet to be demonstrated in the in vivo state. The importance of recognizing the catheter bore size is to prevent accidental interchange of repair kits and replacement catheter adapters that can result in a loose fit and separation.

Various modifications of the standard catheter designs have been made in an attempt to address the common mechanical problems of tissue attachment, tip migration, and peri catheter leaks. However, none of these alternative configurations has persuasively shown to provide any benefit over the standard catheter designs shown in Figure 1, but they do increase device costs, add difficulty to insertion and removal, and they are not universally available. Concerns for common mechanical problems are more reliably addressed by proper implantation technique than by a catheter design.

Figure 1- Commonly used peritoneal catheters. A) Catheter with straight intercuff segment, 2 cuffs, and straight or coiled tips. B) Catheter with preformed intercuff arc bend, 2 cuffs, and straight or coiled or tips. C) Extended catheter with 1-cuff, coiled-tip abdominal catheter, 2-cuff extension catheter with preformed intercuff arc bend, and titanium double-barbed connector.

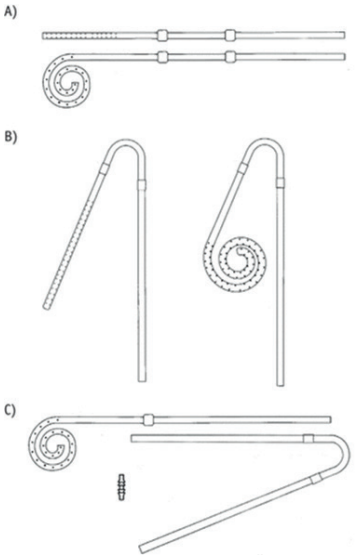
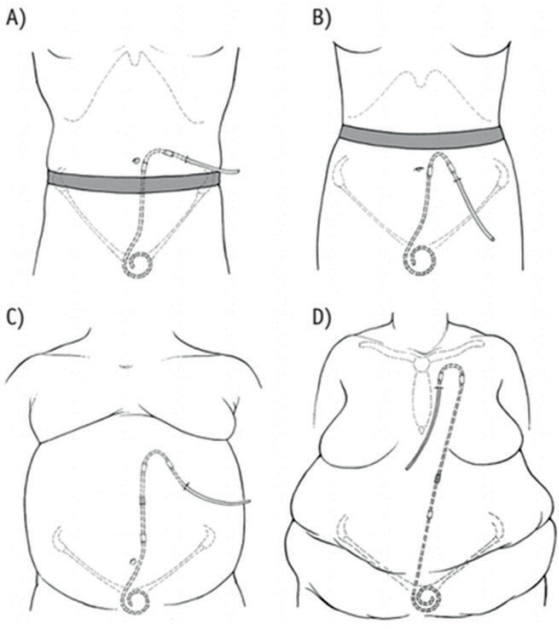


Figure 2 - Practical applications of a basic catheter inventory. A) Straight intercuff segment catheter with laterally directed exit site emerging above a low-lying belt line. B) Preformed swan neck intercuff arc bend catheter with downwardly directed exit site emerging below a high-lying belt line. C) Extended catheter with upper abdominal exit site for an obese rotund abdomen, lower abdominal skin folds, or incontinence. D) Extended catheter with presternal exit site for severe obesity, multiple abdominal skin folds, intestinal stomas, or incontinence. Reprinted from Crabtree JH, Chow KM, PD catheter insertion. Seminars in Nephrology 2017; 37:17–29, with permission from Elsevier.



Catheter implantation

Research has not yet shown the best way to implant a peritoneal dialyses (PD) catheter. A well-positioned catheter is important for optimal PD treatment. The catheter functions most effectively when its tip is located in the lowest part of peritoneal cavity.[10] The rate of complications varies with the placement technique and can cause primary catheter failure and mortality however there is no consensus about the optimal placement technique.[11]

Patient comorbidities, expertise of the healthcare provider, resource availability and urgency for PD start are factors that influence the choice of implantation techniques.

Preference is given to a surgical or laparoscopic technique, but especially the experience of the specialist influences a well-usable PD catheter.[12,13]

Traditional technique is open surgery but most of PD catheters are nowadays placed with a laparoscopic method, performed by a dedicated surgeon, which is less invasive than an open technique.[14]

It is also an option to use ultrasound or radiographic imaging for percutaneous image-guided PD catheter insertion by an intervention radiologist or a trained nephrologist. This technique has advantages like short procedure times, no need for general anaesthesia and imaging and documentation of the position of the catheter tip.[15]

The most common contraindications for using image-guided PD catheter insertion include ongoing infections, uncorrected coagulopathy, active diverticulitis and recent placed gastrostomy tubes. In case off adjunctive procedures such as omentopexy or adhesiolysis an open procedure is also recommended.[16]

Preoperative evaluation and determination of an optimal PD catheter exit-site is necessary by a dedicated PD-team and essential for long-term success. Evaluation of patient`s medical and surgical history is part of pre-operative care. It is important to evaluate the patient for hernias and scars. The skin marks for exit-site location should be applied with the patient in supine position and checked with the patient in upright position. Manual access to the exit-site location is essential for proper catheter care. The PD catheter must not be constrained by beltline or skin folds. It is recommended to start with laxatives one to several days before placing the PD catheter to facilitate placement and maintain good catheter function at the start of treatment.[17] Preprocedural antibiotics such as intravenous cefazolin or vancomycin should be administered one hour before placement.[18] The urinary bladder should be emptied.

At the end of the PD catheter insertion procedure a titanium adapter and extension catheter are connected and the PD catheter is filled with heparinized saline or dialysate and sealed with a cap. It is possible to place an embedded catheter under the skin far in advance of anticipated need. When kidney function declines to initiate dialysis, the external limb is brought to the outside through a small skin incision. Because the catheter has been afforded extended healing time the patient is able to proceed directly to full volume PD.[17]

After the procedure the exit site is covered with sterile dry gauze and tape for at least a week. It is important to keep it dry, which precludes shower or tub baths. Routine exit-site care by the patient starts when

the exit-site is well healed. The catheter should always be anchored to the patients' skin to avoid torque movements at the exit-site. This has been shown to reduce the risk of exit-site infection.

A catheter should be placed 2-6 weeks prior to use to ensure anchoring of the internal cuffs an healing of the exit site. It is recommended to wait 2 weeks before starting treatment to allow the cuff to heal into place.[19] Urgent PD start is possible with low fluid volumes, bed rest and minimal intraperitoneal pressure to minimize the risk of leakage.[20]

It is recommended to do an audit of catheter insertion outcomes on at least an annual basis to evaluate long-term catheter patency and occurrence of procedure-related complications, peri catheter leakage, infections, visceral injury, and haemorrhage.[17]

Conclusion

The availability of the best catheter materials, along with a skilful evaluation of the patient and the experience of the specialist who places the peritoneal catheter may have the greatest impact on long-term patient outcome on PD.

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CHAPTER 5: Managing peritoneal dialysis complications

Learning objectives:

1. To identify PD complications
2. To be able to manage most common PD complications

Introduction

Performing PD technique and caring of a peritoneal catheter poses unique challenges to patients, caregivers and health care providers. Associated complications can be grossly divided into non-infectious and infectious complications.[1] Nonetheless, there are further complications associated with ESKD and dialysis, namely cardiovascular or mineral bone diseases, among others, that are beyond the scope of this chapter.

Non-infectious complications

1. Abdominal pain during infusion or drainage

Some patients complain of discomfort or pain during dialysate inflow, which can be related to solution temperature or pH, and usually resolves over the following days or after filling is complete.

Key points[1,2]:

- exclude peritonitis;
- change position during infusion;
- check dialysis solution temperature (warm to body temperature);
- Check dialysis solution expiration date ;
- avoid constipation;
- slow the rate of fluid inflow;
- use bicarbonate-lactate buffered solutions;
- check PD catheter position (abdominal X-Ray) – surgical reposition if necessary.

Abdominal pain during outflow could mean peritoneal inflammation or pelvic irritation related to the tip of the catheter. It can be prolonged in time.

Key points[1,2]:

- exclude peritonitis;
- on CAPD - leave a small residual volume of fluid in the peritoneal cavity at the end of the drain;
- on APD – program the cycler to tidal PD.

2. Bloody dialysate

As little as a few drops of blood can produce pinkish, red coloured or grossly bloody dialysate. It is more common in pre-menopausal women (during ovulation and menstruation) as a benign event. On the other hand, it could occur after catheter placement or in the presence of retroperitoneal pathology.

Key points[3]:

- evaluate bleeding gravity (check for haemodynamic stability, with blood pressure and pulse) and quantity (auto limited, continuous or recurrent);
- exclude peritonitis;
- assess patient background, for potential causes, including: menstrual cycle, date of catheter placement, abdominal trauma or exaggerated physical activity, recent procedures (colonoscopy, sigmoidoscopy), surgical causes (cholecystitis, rupture of the spleen, pancreatitis), medical causes (anticoagulants or coagulation disorders, recent administration of recombinant tissue plasminogen activator (tPA), polycystic kidney disease, encapsulating peritoneal sclerosis, carcinomatosis);
- if the haematocrit of the liquid is superior to 2% and abdominal pain with defence is present, surgical consultation is mandatory;

- treatment consists on flushing the abdomen with a few cycles of 500 - 1000 mL room temperature heparinized (500 U/L) dialysis fluid;
- monitor progression and maintain heparinized dialysis fluid while the effluent has visible signs of blood.

3. Catheter malfunction

Failure in the inflow (more than 15 minutes to instil a 2L-bag) or outflow (incomplete drainage or more than 25 minutes to drain a 2L-bag) flux can be due to mechanical obstacle, such as kinks or closed clamps, migration of the catheter tip, constipation, adhesions, fibrin or blood clots. Outflow obstruction can be present in catheter entrapment by omental wrap, allowing inflow, but with a sudden end of the drainage on the early phase of outflow.

Key points[4]:

- exclude mechanical blockage (check clamps, connections, transfer set and catheter for kinking);
- change body position;
- exclude peritonitis;
- perform abdominal X-Ray, to check for PD catheter tip position and constipation signs;
- treat constipation, with laxatives or enema, keep regular bowel movements;
- if malfunction persists, perform a forceful catheter flush (with a syringe infuse normal saline with pressure; discontinue if the patient experiences pain or cramping)[5];
- if catheter tip has migrated, refractory to previous measures, interventional relocation might be needed;
- if catheter tip is well positioned and refractory to previous measures, instil recombinant tissue plasminogen (tPA), in the concentration of 1 mg/mL;
- in case of fibrin-related obstruction, heparin (500 U/L) should be added to each exchange.

4. Catheter fracture or accidental contamination

Damage to the external catheter tubing may result from sharp instruments cuts or punctures, fracture from crushing clamps, catheter adapter tears or chemical destruction of the catheter from antibiotic ointments or organic solvents.

Key points[4]:

- determine the exact location of the dialysis fluid leak in the catheter or transfer set;
- catheter damage with leak is considered a contaminating event - exclude peritonitis, prophylactic antibiotics are indicated;
- if at least 2 cm of tubing is present beyond the exit site, the catheter can be shortened, use commercially available repair kits;
- if the catheter tubing is too short, internal splicing repair, to the intercuff segment can be considered, or otherwise replacement of the pre-existing catheter;
- the patient should be instructed to clamp catheter between the exit site and the catheter tear, cover with sterile dressing, and go to clinic or emergency room as soon as possible.
- Accidental contamination, like disconnection between the transfer set and the catheter at the connector, not closed twist clamp on the transfer set allowing fluid escapes, leak in the dialysate solution bags or tubing resulting in the possibility of contaminated fluid instilled into the patient, may require a transfer set change, exclusion of peritonitis and prophylactic intraperitoneal antibiotics.

5. Dialysate leaks

Peritoneal leaks are defined as any dialysate loss from the peritoneal cavity other than through the lumen of the catheter. The time period following catheter implantation and the start of PD may suggest its cause.[4] Risk factors for leakage may be related to catheter insertion technique, time between catheter insertion and initiation of PD, increased intra-abdominal pressure (volume of dialysate instilled,

body mass index, polycystic kidney disease) and patients' condition (elderly, malnourished, diabetic or on high dosage of corticosteroids).[5]

Key points[4]:

- delay starting dialysis for 2 weeks following catheter placement;
- early pericatheter leaks manifests as fluid appearing through the incision or at the exit site;
- dialysate leak can be verified by a positive test strip of the seeping fluid;
- try supine low volumes exchanges and dry day, or discontinue dialysis temporarily for 1 to 3 weeks;
- consider prophylactic antibiotics, due to higher risk of peritonitis;
- subcutaneous leakage may evolve as genital region or abdominal wall oedema, reduced exchange outflow volume, weight gain;
- monitor girth, flank and back for subcutaneous fluid, scrotal or labial swelling;
- try supine low volumes exchanges and dry day, or discontinue dialysis temporarily for 1 to 3 weeks;
- consider prophylactic antibiotics, due to higher risk of peritonitis;
- if persistent, requires evaluation for an anatomical defect;
- persistent leaks may require surgical repair or catheter replacement;
- hydrothorax presents as dyspnoea, pleuritic pain or a decrease in ultrafiltration;
- may be acquired after heavy exertion or congenital due to innate diaphragmatic defects;
- chest X-Ray shows right pleural effusion and diagnosis is confirmed by thoracocentesis, with recovery of fluid low in protein and high in glucose concentration;

- alternatively, the diagnosis of pleuroperitoneal fistula can be made with peritoneal scintigraphy showing radioisotope in the thoracic cavity or MRI;
- conservative treatment (with temporarily PD discontinuation) is rarely successful, thoracoscopic pleurodesis has high success rate.

6. Hernia

Abdominal wall hernia is a common mechanical complication, which is often associated with discontinuation of PD. Infusing dialysis fluid into the abdomen on a regular basis causes an elevation of the intraabdominal pressure, which is a risk factor for the development of hernias.[6] In this sense, abdominal wall hernias should be repaired prior to the initiation of PD, at the time of the catheter implantation or staged as a separate procedure. Hernias in PD population are commonly incisional, umbilical, inguinal or pericatheter. The latter occurs more often when the catheter is placed through the midline instead of the paramedian approach through the rectus muscle.[5]

Key points[4,5]:

- examine suspect sites (protusion at umbilicus, inguinal area, genitalia, previous surgical scars, or catheter insertion site);
- determine reducibility, pain, size, and evaluate for inflammation;
- refer to surgeon to determine intervention;
- extraperitoneal hernia repair technique with prosthetic mesh is advised to reduce the risk of recurrence;
- minimize intra-abdominal pressure;
- avoid coughing, straining, constipation and stair climbing;
- use of velcro abdominal binder during ambulatory periods following repair of umbilical and midline hernias;
- use of alternative perioperative dialysis regimen, avoiding the need for temporary HD;
- supine low volume frequent exchanges and dry day;

- volume graduated incrementally over 2 weeks to usual regimen;
- considerer HD backup in patients with no residual renal function presenting azotaemia despite small volume frequent exchanges.

7. Encapsulating Peritoneal Sclerosis (EPS)

EPS is a rare complication of long-term PD, associated with considerable morbidity and mortality. The diagnosis is clinical and confirmed radiographically or by laparotomy, based on a combination of bowel obstruction and features of encapsulation due to peritoneal fibrosis.[7]

Key points[7,8]:

- occur in patients performing PD more than 5 years, presenting after withdrawal in the majority
- there are no specific predictors for the development of EPS;
- clinical suspicion should arise when symptoms such as anorexia, nausea, vomiting and weight loss are present or clinical signs of bowel obstruction;
- no gold standard exists for diagnosis, only a coccon wrapped around the bowel is radiologically diagnostic;
- PD should be discontinued and the patient transferred to HD, but EPS may worsen after stopping PD occasionally;
- EPS-specific treatment depends on the disease stage;
- nutritional support (often by parenteral nutrition) is essential;
- some drug therapies have been reported to have beneficial effects (i.e., corticosteroids, tamoxifen and immunosuppression);
- surgical intervention when there was no improvement of bowel obstruction with conservative medical therapy.

Infectious complications

1. Catheter related infections: Exit-site infection (ESI) and tunnel infection (TI)

Catheter related infections are major predisposing factors to PD-related peritonitis. An ESI is defined by the presence of purulent drainage with or without erythema of the skin at the catheter-epidermal interface. A TI is defined as the presence of clinical inflammation or ultrasonic evidence of fluid collection along the catheter tunnel (more than 2cm proximally to the exit site). TI usually occurs in the presence of an ESI, as it rarely occurs alone.[9,10]

Key points[5,9]:

- check for erythema, induration, or tenderness at exit-site or over the tunnel;
- peri-catheter erythema without purulent drainage can be an early indication of infection, an allergic skin reaction or occur after trauma to the catheter;
- obtain a sample for culture and Gram stain of purulent exudate and/or drainage;
- if necessary express fluid by pressing on the superficial cuff or with a gentle downward pull of catheter;
- S. Aureus and P. aeruginosa are the most serious and common exit-site pathogens, often associated with tunnel involvement;
- ultrasound of subcutaneous pathway might be performed in:
- initial evaluation of suspected TI (especially if caused by S. Aureus);
- follow-up of ESI and TI;
- relapsing peritonitis (may be due to an occult tunnel infection);
- initiate empiric oral antibiotic therapy as indicated by clinical appearance;

- cover S. Aureus (i.e., penicillinase-resistant penicillin or first-generation cephalosporin);
- in patients with history of pseudomonas ESI, empiric therapy should include targeted antibiotic therapy;
- intensify exit-site care: clean at least daily during ESI and change cleansing agent if required;
- apply new sterile dressing with each cleaning procedure until infection resolved;
- in the case of severe ESI, saline soaks in addition to antibiotics may be used;
- add 1 tablespoon of salt to 1 pint (500ml) sterile water and apply to gauze and wrap around the exit-site for 15 minutes, 1 to 2 times a day;
- look for precipitating or contributing factors:
- a break in PD technique, mask use, compliance of hand washing, use of exit-site prophylaxis;
- S. Aureus carrier status;
- adjust to narrow-spectrum agents once culture results and sensitivities are known;
- ESI should be treated with at least 2 weeks of effective antibiotics, except for Pseudomonas species;
- ESI caused by Pseudomonas species and any TI should be treated with at least 3 weeks of effective antibiotics;
- considerer external cuff-shaving for persistent TI;
- indications for catheter removal include:
- catheter related infections that occur with peritonitis episodes;
- refractory catheter infections (defined as failure to respond after 3 weeks of effective antibiotic therapy);
- retrain patient on appropriate exit-site care;
- daily topical application of mupirocin cream or, as an alternative, topical gentamicin;
- clean exit-site at least twice weekly and every time after a shower.

2. Peritonitis

Peritonitis is a common and serious complication of PD, contributing significantly to hospital admissions, technique failure, and associated with an increased risk of all-cause mortality.[11] Therefore, a prompt diagnosis and treatment of this infection is essential for long term success of PD.[10] Peritonitis is diagnosed when at least 2 of following are present:

(1) clinical features consistent with peritonitis (i.e., abdominal pain and/or cloudy effluent);

(2) dialysis effluent white cell count > 100/µl or > 0.1 x 109/L (after a dwell time of at least 2 hours), with > 50% polymorphonuclear;

(3) positive dialysis effluent culture.[12]

Key points[7,8]:

- perform physical exam including abdominal palpation, exit-site and tunnel assessment;
- disconnect drained bag and send sample to laboratory for cell count with differential, Gram stain and culture;
- dwell time should be at least 1-2 hours (if patient is dry, instil 1L of dialysate);
- in APD use % PMN vs absolute WBC count to diagnosis peritonitis;
- inoculate 2 (aerobic and anaerobic) blood culture bottles with 5-10mL of effluent or centrifuge 50mL PD effluent at 3000gr for 15 minutes followed by resuspension of the sediment for inoculation into blood culture bottles;
- in presence of cloudy effluent:
- initiate empiric antibiotic therapy immediately, while waiting for test results;
- add heparin 500 U/L to each bag until effluent clears (usually 48 to 72 hours);
- there are infectious and non-infectious causes to be considered in the differential diagnosis, including culture-positive infectious peritonitis, infectious peritonitis with sterile cultures, chemical peritonitis, calcium channel

blockers, eosinophilia of the effluent, hemoperitoneum, chylous effluent, malignancy and specimen taken from “dry” abdomen;

- initiate adequate pain management intervention;
- empirical antibiotic regimens should be centre-specific, covering both gram-positive and gram-negative organisms;
- intraperitoneal administration is the preferred route, unless features of systemic sepsis;
- allow to dwell for at least 6 hours (in intermittent dosing);
- perform cell counts and repeat cultures if there is no improvement after 48h;
- assess the need for hospitalization;
- look for precipitating or contributing factors:
- exit-site infections and/or tunnel infections;
- a break in PD technique, mask use, compliance of hand washing, use of exit-site prophylaxis;
- recent procedures, constipation or diarrhoea, and antibiotic use;
- adjust to narrow-spectrum agents once culture results and sensitivities are known;
- length of treatment regime is usually 14 days for Gram positive organisms, except for S. Aureus and Enterococcus, and 21 days for Gram-negative peritonitis;
- indications for catheter removal include:
- refractory peritonitis (failure of effluent to clear up after 5 days of appropriate antibiotics), relapsing peritonitis (an episode that occurs within 4 weeks of completion of therapy of a prior episode with the same organism or one sterile episode), or fungal peritonitis;
- may also be considered for repeat peritonitis (an episode that occurs more than 4 weeks after completion of therapy of a prior episode with the same organism), mycobacterial peritonitis and infection caused by multiple enteric organisms;
- schedule re-education/training for technique issues.

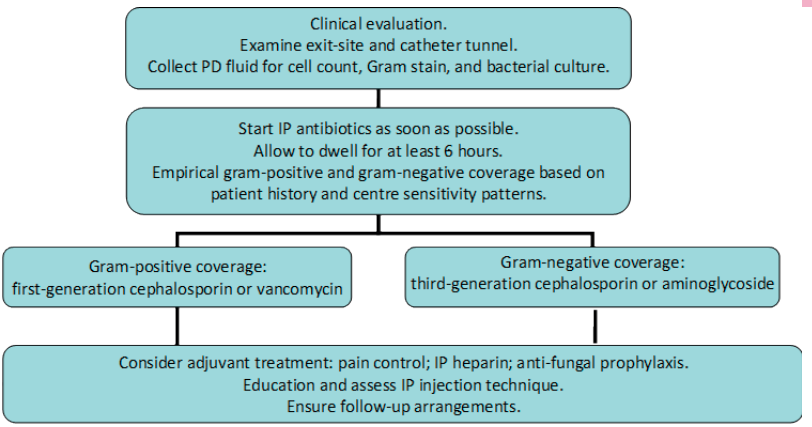

Figure 1 – Initial management of peritonitis, adapted from "Li PK, Szeto CC, Piraino B, Arteaga J, Fan S, et al. ISPD peritonitis recommendations: 2016 update on prevention and treatment. Perit Dial Int 2016;36:481-508."

Conclusion

Infectious and mechanical complications of the peritoneal catheter are common reasons for PD failure.[4] Careful training of patients with periodic retraining is crucial to minimize these complications and provide higher quality patient outcomes.

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CHAPTER 6: Best evidence clinical practice to educate and training peritoneal dialysis patients

Learning objectives:

1. To review the evidence for education and training of patients on PD
2. To describe the current recommendations for patients with PD

Introduction

Various (inter)national guidelines provide recommendations regarding dialysis education and treatment, which should suffice that these are uniformly used by kidney/dialysis centres.[1] Nonetheless, there is a huge practice variation that could be explained by good practices or best practices. One of many definitions for best practice in health care is “to identify, collect, evaluate, disseminate and implement the information in the best way possible, as well as to monitor the outcomes” or a practice that has been proven to work well and produce good results and is therefore recommended as a model.[2]
Unfortunately, there are also many “best ways” to educate and train a patient, however, the best practices are not always publicized and available to all nephrology nurse’s communities to consider and convert these in guidelines. Nevertheless, research in this important area has been remarkably scant to date.

Training

Patient training programmes should focus on basic and essential information patients need to master to dialyze successfully and safely at home. Patient training has widely been one of the most critical factors for achieving optimal PD clinical outcomes, including avoidance of peritonitis.[3-6] Training can be defined as any interaction between the patient and the healthcare professional, which intentionally recognizes the patient as a healthcare provider, allowing them to have a greater understanding of their condition and health needs.[7] Therefore this concept is perfect when discussing PD training, as it is a crucial component of preparing for PD, as patients and/or caregivers perform PD in their homes without direct assistance or supervision from a healthcare provider. The ISPD(ISPD) has

published recommendations and guidelines since 1994.[8] The 2006 Guidelines tried to answer some questions that arise when talking about PD training: Who should be the trainer? Who is the learner? What should be taught? Where should the training occur? What should be the duration of the training? How should the patient be taught? However, many of these questions remain unanswered.[9] Almost 10 years later Zhang et al, revisit the same questions and found no consensus regarding training and lack of hard evidence.[10]

Aware of controversies and lack of sufficient evidence in PD training, the Nursing Liaison Committee of the ISPD(ISPD) has undertaken a review of PD training programmes around the world to develop a syllabus for optimal training. The syllabus for teaching PD to patients and caregivers aimed to help nurses train patients, it is designed as a 5-day programme of about 3 hours per day, but both duration and content may be adjusted based on the learner.

The structure of the course is Day 1: Establish a report, describe goals and plan of the course, demonstrate steps of different procedures, assess patient learning styles/barriers, explain how learning will occur, introduce concepts of PD. Day 2: Review goals, provide repeated supervised practice sessions of PD exchange and exit-site care with feedback from the previous day, review concepts of asepsis, peritonitis, residual kidney function, fluid balance, documentation, move from simple to more complex learning. Day 3: Continue supervised procedure practice with feedback, review concepts through discussion and questions, introduce problem-solving. Day 4: Continue supervised procedure practice with feedback, including acknowledgement of skills mastered, review concepts through discussion and questions, continue to problem solve through “what if” scenarios. Day 5: Review all previously presented concepts and practice all procedures until proficiency is demonstrated. After completion of the proposed PD training syllabus, the PD nurse will have provided an education to a patient and/or caregiver such that the patient/caregiver has the required knowledge, skills, and abilities to perform PD at home safely and effectively. In summary the ISPD recommendations are training performed by experienced PD nurse, tailored for an individual learner and using adult education. The committee believes that, while the recommendations are still relevant and following current teaching practices in PD clinics, there is a need for a more comprehensive course to guide PD nurses.[11]

The Targeted Education ApproaCH to improve Peritoneal Dialysis Outcomes (TEACH-PD Trial), is a Randomized Clinical Trial, recruiting patients in Australia and New Zealand, that uses a comprehensive PD training curriculum which includes modules for training PD nurses (trainers) and patient training manuals. The package comprises 2 introductory modules and 2 clinical case modules.[12] The curriculum is designed for both interactive digital media (trainers) and traditional paper-based teaching with practical demonstrations (patients). Assessment is also addressed. The trial is aimed to develop a standardized, evidence-based curriculum for PD trainers and patients aligned with guidelines from the ISPD(ISPD), using best practice pedagogy.[13]

Training practices have been reported as highly different in PD units. A survey of 137 nurses from the USA, Canada, South America Hong Kong and the Netherlands found a variation time between 6 and 96 hours.[14] Similarly a survey done in Australia PD units reported a variation in average training duration from <2hours to >6hours/day, the same was shown for the number of training days 14% did 2-3 days and 14% more than 7 days.[15]

A study aimed to identify characteristics influencing PD training durations, its relationships with the first episode and permanence on PD, found that the number of PD training sessions depends on the patient's age and comorbidities, but is not related to social, educational or employment status. Prolonged training duration (more than 13 sessions of 2-3 hours) was a statistically significant predictor of higher peritonitis risk, but it was not related to shorter permanence in PD in this series.[16] Different results were found in the Brazilian Peritoneal Dialysis Multicentre Study (BRAZPD II) where 15 hours of training was associated with lower peritonitis rates.[17]

A Dutch study aimed to revisit the manual for training and education of PD patients and caregivers after a decade, however several topics did not change. Improvement is seen in house visits, retraining and paving paths for more home dialysis. Didactic trained nurses are still rare, but experienced nurses are available.[18]

A recent study looking at the Peritoneal Dialysis Outcome and Practices Pattern study (PDOPPS), including 120 participating facilities across 7 countries, has shown the difference between peritonitis rates amongst countries participating in the study as well as the variation in training programmes. Interesting to show

that the difference in training duration (defined as training days) has persisted, it was shorter in the UK (2-3 days) and the longest in Japan (>7days).[19] Further analysis of PDOPPS data looking into training hours per day found that it remained variable. The study has found that there was no evidence that peritonitis risk was associated with when, where, how or how long PD patients should be trained.[20]

As educators/trainers, we must continually rethink and re-evaluate our education practices, particularly with adult learners, we do know a great deal that we can apply to our teaching to improve the outcomes of our learners.

Conclusion

High-level evidence guiding how, where, when and by whom PD training should be performed is still deficient. Until high-quality evidence is generated, the ISPD PD training guidelines should be followed and evaluated against peritonitis outcomes.

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CHAPTER 7: Home visits and patient reported outcomes

Learning objectives:

1. to understand the purpose of home visit
2. to learn what factors might affect home visits
3. to explain what to consider about patient reported outcomes for PD

Home visits

Home visits are important in caring for patients undertaking PD treatment at home for both CAPD and APD. They are also important for supporting any caregivers in the home environment. Home visits can be important prior to commencing therapy and during the early stages. Prior to starting therapy, it can be useful to assess the patient's home situation including family dynamics and logistic of the delivery of consumables and suitability of space in the rooms where PD will be undertaken, for example space in the bedroom for APD machines.

Whilst we acknowledge that home visits are paramount for home-based therapy, we recognise that this is not always possible. As part of the training and retraining, it is common to carry out a home visit, but not possible in all centres, because it is time consuming and costly to perform visits.1 The periodicity of home visits is not consistent across countries but it is widely recognised that a visit before and after the patient starts PD and then regular visits thereafter is good practice.

Usually, a nurse will go to the patient's home, however other members of the multidisciplinary team e.g., physician, social worker or technician can also carry out a home visit.[2] Any individual involved in home visits should be competent to undertake the activity required.

In spite of the fact that there is little evidence in literature for the need of home visits, both "the ISPD Nursing Liaison Committee" and "the ad hoc European committee for elective chronic PD in paediatric patients" recommend the use of home visits as part of the overall care of PD patients.

The purpose of home visits may vary but the list below shows the most common, although not limited to the following:

- Training
- Retraining
- Reducing complications e.g. Peritonitis
- Compliance
- Evaluation of the therapy in the patient's own environment
- Support of the patient, their family and or caregiver
- Creating communication pathways between the patient at home and the staff at the PD centre.
- Educating and creating communication pathways between the district nurses and the staff in the PD centre.
- Opportunity to assess mental health and have "difficult" discussions in privacy.
- Physical assessment of the patient and wellbeing. E.g., assessing for fluid overload etc.
- Potentially can reduce hospitalisations by trouble shooting, solving problems before patients become unwell.

There are many advantages to undertaking a home visit, but it can be difficult to perform if the patient lives far from the clinic.

Patients undertaking PD at home may have access to their own electronic personal health records, and the ability in some cases to communicate to the team in the clinic by email/phone text messages and pictures.[3] This could potentially lead to improved preparation for home visits but also in some cases if home visits are not possible may replace the need, and prompt early interventions/problem solving.

Home visits are a recognised part of most PD programmes but they may carry potential associated risks. It is often a lone worker visiting a family at home and the circumstances might not always be ideal, there can be some conflict or situations that are uncomfortable. We would therefore recommend that an assessment is undertaken prior to a visit and that there is some way of tracking where the health care worker is during a shift.

Patient Reported Outcomes

Patient reported outcomes can be described as a patient's perception of their experience of life and feelings of well-being. It describes the patient's individual opinion of their symptoms, impact of the burden of the treatment holistically including mental health and social setting.[4]

It is important that patient reported outcomes be taken into consideration when planning care and when monitoring the quality and effectiveness of kidney care including PD treatment.[5]

There does not appear to be a consistency across all reported outcomes in PD. We will mention/discuss in this section some key outcome measures.

Quality of life for chronic dialysis patients is often overlooked but in order to improve patient's quality of life it is important to include measurement of this along with patient empowerment, health literacy, shared decision making and patient education.

There are not many published articles that concentrate on patient outcomes related to PD but those all highlighted the importance of measurement.[5,6,7] Health Related Quality Of Life (HRQOL) is not as common as it could be and it is suggested that it should be a standard measure of patient-centred and reported outcomes.[5]

There are a number of ways of measuring quality of life but the most commonly used in Chronic Kidney Disease (CKD) is the HRQOL 36 questionnaire.

Most patient related outcomes within the CKD field have concentrated on HD. However, these results should not be necessarily associated with PD as it is very different from HD in part because the treatment occurs at home, but also due to its self-care nature. "PD catheter may affect body image, self.esteem, and sexual functioning, it is important to acknowledge the impact of these factors on the PD patient's life".6 There are many factors that can influence patient outcomes in PD. Some of the factors that influence HRQOL in patients undergoing PD are summarised in Figure 1.[5]

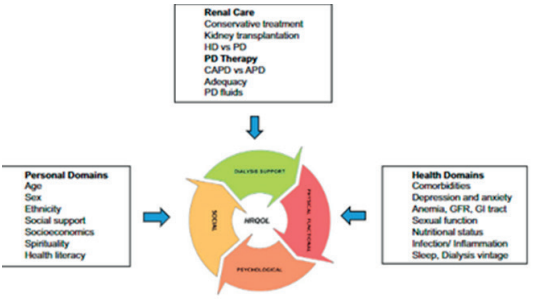

FIGURE 1 The health related quality of life (HRQOL) in patients undergoing peritoneal dialysis is a product of many factors related to personal and health domains of patients that together with renal care and dialysis support they receive are influencing the physical-functional, psychological and social dimensions of the patients´ HRQOL [Color figure can be viewed at wileyonlinelibrary.com]

Figure 1 - *Health related quality of life in patients undergoing PD is a product of many factors related to personal and health domains of patients that together with the kidney care and dialysis support they receive are influencing the physical, functional, psychological and social dimensions of the patients' HRQOL. Source Aguiar R, Pei M, Qureshi AR, Lindholm B. Health-related quality of life in PD patients: A narrative review. Semin Dial. 2019 Sep;32(5):452-462.*

Measuring quality of life of the patient is only the first step, once this has occurred feedback to the patient and review and care planning is necessary to try and help improve those areas identified. This may include changes to PD regimes, medication, and referrals to other agencies. It is important to recognise what is important to the patient may be different to that of the healthcare worker. Improving quality of life of patients in HD is demonstrated to reduce hospitalisation and mortality[8,9,10] rates and it may be acceptable to assume the same for PD, but more information, and research is required into this area for PD patients.

Life participation is also found in the literature as a method of assessment which can have 2 components, obligatory and non-obligatory activities. However, it is not clear that there is consistency using this tool.[7]

Conclusion

Anecdotally there may be a link between home visits and patient related outcomes; in this chapter, we have given an overview of both these areas.

Home visits can be difficult to arrange but are invaluable for patient wellbeing, furthermore measuring/reviewing patient outcomes can also improve wellbeing, leading to patients potentially staying on PD longer and with better outcomes.

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Further Reading

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CHAPTER 8: Peritoneal dialysis in chronic complex patients with End stage Kidney Disease

Learning objectives:

1. To identify complex patients, beyond multimorbidity
2. To individualize therapy goals in complex patients
3. To implement quality processes of patient career management, including diseases, peritoneal access and transitions

To begin with, the reader is invited to ask the question: which are "complex patients" in PD?

It is expected that a much broader concept of complex patients will be acknowledged at the end of this chapter. Complexity in patient management is related with either:

1. accumulated diseases that affect the patient status and its quality of life
2. individual psycho-social context
3. peritoneal access rescue
4. critical transitions in the patient course
5. unmatching between patient, clinicians and dialysis system perspectives and focus

Some clinical issues or complications in patients with CKD are predictable and stratifying risk scores should be applied to allocate resources and adjust objectives. However, "putting the patient in the driving seat", or supporting patient options towards his global life rehabilitation is what brings complexity to the patient (person) management, on the top of strictly medical scientific interventions.

Multimorbidity

Aging is often pointed as a complex patient condition. Aging per se is a limiting process that lacks preventive medicine in all aspects of the health dimensions. In PD, aged patients oblige to tailor the information/education/ induction PD processes to functional and cognitive characteristics. However, assuming an aged patient as a complex PD patient may often reside solely due to the lack of

structure from the health system to offer adequate resources and assisted peritoneal dialysis.[1]

Assisted PD would give to the patient and family the chance of better experience of PD in those with higher training difficulties, or transitory limited self -dialysis capability. Assisted PD is also an opportunity to scale digital health tools to support patients and family at home. On the other hand, it is hardly acceptable in a quality improvement system to accommodate the fact that many patients who chose PD are allocated to centre HD due to the lack of available assistance.[2]

In fact, patient adherence and satisfaction with life are generally better with PD in aged patients. Besides, incremental PD regimens are feasible with preservation of residual renal function, avoiding intermittent fluid shifts and related organ damage. PD also allows maintenance of social and family routines without disruptive treatment sessions or vascular accesses procedures, all this making PD modality far from complex, and quite on the contrary, a gratifying patient -clinician´ cruise.

On the other hand, multimorbidity is a frequent challenge, indeed complex, in the treatment of CKD patients. The Charlson comorbidity index for dialysis patients is used for calculation of comorbidity (Charlson Comorbidity Index (CCI) - MDCalc)[19] although other multidimensional scores can be applied for frailty screening . This condition involves many situations that go beyond associated diseases such as heart failure, diabetes, chronic pulmonary disease, immunosuppression or malignancy. In fact, the concept of multimorbidity includes frequent conditions that go along with the current epidemiology of the patients admitted in dialysis programmes: difficulty in managing their treatments or day-to-day activities, care and support need from multiple services such as for meals, mobility and transportation, long-term physical and/or mental health disability, frailty and risk of falls, frequent unplanned or emergency care needs, multiple regular pharmacy and risk of its iatrogenic effects.[3]

In this context a tailored plan of treatment and shared decisions with the patient and family / career is mandatory. Many of these patients may chose conservative treatment levelling the burden of the disease and the adverse effects of care. In the absence of a qualitative care offer and structure of supportive non dialytic care, many of these patients end in HD, with a questionable process of treatment choice.

In fact, these patients do not match the optimal profile of autonomous patients pointed as those who can benefit more from automated dialysis. However also in these frail patients, should dialysis be prescribed. Assisted PD would combine the gains of quality of life apported by home care with the benefits of gentle sustained daily ultrafiltration and clearances. Unfortunately, dialysis system is still focussing on in centre HD, neglecting the opportunity of investing in home treatments. But hopefully a changing paradigm is to come. Clinical and costs burden of transportation and vascular accesses can be spared with assisted PD. In many cases assisted PD is temporary, avoiding prolonged hospital stays and admissions.

Prescribing high-quality goal-directed PD should be the aim, adjusting the regimens in order to mitigate the burden of care.[4] Main focus on patient reported outcome measures, fluid status, nutrition and minimal targets of small solute removal are mandatory. The dialysis Units often lack the resources to assure adequate evaluation of functionality, pain scores, mental health, frailty, or body composition (fluid overload, lean mass). However, those tools should be a standard of quality in whichever the modality of dialysis, mostly in complex patients.

Skilled volume evaluation and control can be attained combining careful diuresis maintenance (preventing nephrotoxicity and dehydration) and advocated tools:

1. Panel of clinical evaluation (blood pressure, weight, oedema), biomarker (pro BNP) and multifrequency BIA (longitudinal trends of body composition)
2. Water and sodium balance with dietetic restriction and high-dose furosemide to manage fluid and sodium retention
3. Elective use of icodextrine and APD in fast transporters
4. Use of neutral pH, low GDP PD solutions to improve preservation of residual kidney function and urine output.

Specific tasks and tips can be suggested in complex patients according to their burden of cardiovascular disease5 and diabetes6 as mentioned in table 1.

Table 1: Key specific therapy tasks and tips to manage PD patients with heart failure and or diabetes mellitus (adapted from references).[5,6,20]

Heart failure
• patient with congestive heart failure be prescribed incremental dialysis with icodextrine to optimize fluid balance, decrease congestive symptoms, decrease hospital admissions and central venous catheters in acute settings
• patients with ischemic heart disease be treated with antiplatelet agents
• patients with left ventricular hypertrophy or heart failure be considered for treatment with an angiotensin converting enzyme inhibitor or angiotensin receptor blocker
• patients with left ventricular hypertrophy, dilated cardiomyopathy, or systolic heart failure be considered for treatment with a beta-blocker
• patients already receiving an angiotensin converting enzyme inhibitor or angiotensin receptor blocker be considered for treatment with a mineralocorticoid receptor antagonist
• patients with heart failure and anaemia receive treatment for anaemia and have target haemoglobin no different from PD patients without heart failure
• patients with low ejection fraction, high troponin and N-terminal pro-brain natriuretic peptide levels and those who survive a previous tachyarrhythmic cardiac arrest be considered at high risk for sudden cardiac death.
• beta blockers be considered for primary prevention of sudden cardiac death in high-risk PD patients
• implantable cardioverter-defibrillator be considered for secondary prevention of sudden cardiac death in PD patients who survive an episode of cardiac arrest confirmed as being the result of malignant ventricular arrhythmia (except those occurring within first 48 hours post-acute myocardial infarction)
• the risk-to-benefit ratio of warfarin for stroke prevention in dialysis patients, including patients on PD, with atrial fibrillation is uncertain
• use of novel oral anticoagulants to prevent stroke in atrial fibrillation not recommended yet
• Diabetes Mellitus
• Glycaemic control is mandatory but the target of glycated haemoglobin in PD is uncertain. Glycated albumin better predicts outcome on PD 7,8,9
• Glucose sparing regimens are advocated taking into account ultrafiltration efficiency
• Icodextrine optimizes fluid balance in PD regimens
• Use of amino-acids-based solution in short dwells may be considered10

• Sodium–glucose cotransporter-2 (SGLT2) inhibitors showed consistent renal benefits across different levels of eGFR but evidence still lacking in dialysis11,12,13
• patients with peripheral arterial disease, particularly those with diabetes mellitus, to receive multidisciplinary foot care
• patients with peripheral arterial disease be considered for antiplatelet therapy
• patients with non-critical peripheral arterial disease receive supervised exercise therapy

Other systemic diseases may add complexity in managing patients with the need of multidisciplinary approaches. All medical tasks must be complemented by nurse-led interventions, promoting medical literacy, prioritizing therapy goals and promoting therapy adhesion. Assessing and identifying the patient who is not copping or "not doing well" under PD is recommended as expressed in ISPD best practice guidelines.[14]Taking into account dialysis issues, hospitalization rate, possible burn-out of patient/ carrier, including the need of an end-of-life plan, will support the decision to adjust PD regimen, to transfer to HD, to offer PD within a palliative care or even to suspend dialysis.

Peritoneal access

Besides these medical tasks also maintenance of a viable and safe peritoneal access may be part of the complexity of specific PD patients.

Laparoscopic implantation of peritoneal catheter is recommended in patients with previous major abdominal surgery or suspected adhesions, and access to laparoscopic catheter revision is critical to timely solve catheter dysfunction. Special peritoneal access implantation methods and technique complications are viable depending on the team experience but consider that according to ISPD guidelines[15]:

- In case of abdominal hernia, extraperitoneal mesh repairs are suggested, since the safety of intraperitoneal mesh in PD patients has not yet been established
- Patients with symptomatic biliary tract disease without signs of active infection can safely undergo cholecystectomy at the time of catheter placement

- Considering abdominal vascular prostheses, allow at minimum, a 2-week period of retroperitoneal epithelialization following an intraabdominal graft placement before starting PD, but this interval may optimally be extended to 4 months as mentioned in Kidney Disease Outcomes Quality Initiative (K/DOQI) guidelines; on the other hand, the use of endovascular aortic and iliac artery stent grafting allow to maintain PD therapy uninterrupted.
- As for autosomal dominant polycystic kidney disease (PKD) there is higher risk of abdominal hernias and in extreme cases some conflict of space may occur due to enlarged kidneys but there is no significant difference between PKD patients and non-PKD patients for dialysis adequacy and patient and technique survival
- Asymptomatic diverticulosis or a remote history of resolved diverticulitis is not a contraindication for PD
- Laparoscopic bariatric surgery such as gastric sleeve resection and Roux-en-Y gastric bypass do not necessarily imply to stop PD; ISPD guidelines signalises that with watertight closure of laparoscopic port sites, PD can be resumed immediately utilizing a recumbent low-volume intermittent PD protocol for the first 2 postoperative weeks.
- To manage access dysfunction use of rescue laparoscopy is recommended

Transitions

Transition management is also a key process insufficiently addressed in Dialysis Units, pointing to other dimension of complex patients under PD.[16]

Change of therapy usually involves a crisis that aggregates patient and family perspectives, social context and psychological challenges. System resources often fail to adequately support these transitions. Specifically address the following conditions:

- Transition from paediatric to adult care with non -adherence to treatment adds complexity to the management of PD in such “late adult” patients
- A mismatch or unrealistic expectations towards PD in young, labour active and self-determined and image-focused

patients reinforces the need for a more careful process of information, evaluation and patient centred therapy plan before allocation to the modality. In fact, these presumed optimal candidates to PD often menace PD maintenance earlier than expected.

- Resuming dialysis after graft failure adds a psychological burden to self-dialysis, facing the internal crisis process with resistance to transition to dialytic therapy decreased quality of life and increased levels of depression. Such complex transition calls for team support, domiciliary reinforced communication and proactive tools of coping. Additionally tapering of immunosuppression, earlier adjustment of PD regimen to loss of graft function or chronic inflammatory state by the presence of dysfunctional graft challenges PD management.
- Unplanned urgent transitions to HD after a catheter related complication usually does not affect patient survival but generates a crisis that is amplified by interruption of care management, different treatment teams and focus, worse patient experience that feels suddenly “out and insecure” urges for a better integration of dialysis modalities
- In the absence of refractory fluid overload, acquired membrane changes documented in a PET test, particularly addressing the rare risk of peritoneal encapsulating peritoneal sclerosis, are not an absolute indication to stop PD since this can even aggravate the prognosis. There is still no definite answer to the best strategy. Shared decision-making levelling risk-benefits of transfer to HD under prophylactic use of tamoxifen should be considered[17,18]
- Unawareness of the patient who is “failing to drive” and lack of assisted PD often implies late transition, with consequences on patient survival and use of precarious vascular access (CVC) in the transfer to HD. It deserves to be mentioned that transition management should favour the “home -integrated dialysis” model and the PD to home HD transition, whenever possible, although system resources often frustrate such quality process.

Conclusions

Health services must adjust to complexity and uncertainty. Health economic conditions substantially health offer which remains insufficient, particularly due to lack of assisted peritoneal programmes. In many aspects there is room for improving quality of assistance to mitigate the present default of individualized patient care. Each patient brings its complexity in its own individual life course. Pure technique skills in a dialysis modality prescription is no longer enough. It is not solely awareness /education/ scientific updating that is needed at the level of patients, clinicians and policy makers; it is commitment of all stake-holders in a change towards higher quality.

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CHAPTER 9: Nutritional and pharmacological support in peritoneal dialysis patients

Learning objectives:

1. To recommend nutritional assessment tools for patients treated with PD
2. To identify the factors that contribute to protein-energy wasting (PEW) and PEW manifestations for patients treated with PD.

Introduction

Chronic diseases including chronic kidney disease (CKD) inevitably require changes in the patient's life. An important part of necessary adjustment is nutrition. To achieve change, it is necessary to have an in-centre multidisciplinary approach with patients and to consider cultural, economic and medical issues. A renal dietitian should be a part of the multidisciplinary team, but in practice, it is also important that all health care workers involved in daily practice with patients on PD(PD), gain knowledge about nutritional recommendations. It is estimated that 11 % of patients on renal replacement therapy (RRT) are treated with PD 2 and in many countries the percentage of PD patients is growing. Dietary recommendations are not universal and we need to address patients' individual needs influenced by comorbidity, social status, religion, and cultural habits. KDOQI Guidelines are focused on 6 primary areas: nutritional assessment, medical nutrition therapy, protein and energy intake, micronutrients, electrolytes and nutritional supplements

Nutritional Assessment

Nutritional management is challenging and no method is 100 % effective.[1]

- Anthropometry parameters such as body weight and body mass index-BMI: should be done monthly or at least every 2 months in patients treated with PD. Handgrip strength is also advised as all these methods are easy to perform and also inexpensive.[1,3]
- Evaluation of patients' appetite, dietary intake, 3 day food record: necessary if we want to address patients individual needs.

- Subjective Global Assessment (SGA): a simple, widely used and reliable method of assessment in PD, even if it is subjective and dependant on observer variability.[1]
- Malnutrition Inflammation Score (MIS): with additional parameters in this tool (SGA, serum albumin, iron and BMI) it is possible to detect the association between inflammation and malnutrition. MIS is an independent predictor of death and a tool to asses PEW in PD patients[4,5] and it is recommended by KDOQI.[3]
- Laboratory markers (albumin, pre-albumin, potassium, phosphate, bicarbonate) are commonly used markers. The impact of albumin loss in PD fluid and urine must be taken into consideration.
- Protein Equivalent of Total Nitrogen Appearance (nPNA): a simple method that approximates the daily protein intake, but only if the patient is not in an anabolic or catabolic state.[1]
- Body Composition Measurement (BCM): this is highly influenced by hydration status[1] and there is insufficient evidence to recommend using this tool to assess status in PD.[3]

Malnutrition and Protein-energy wasting (PEW)

Protein-energy wasting (PEW), is defined by the Society of Renal Nutrition and Metabolism as reduced somatic and/or circulating body protein mass, decreased fat mass, and usually reduced protein and energy intake.[5] It has a prevalence that is variously estimated to be 18 % to 75 % in HD and PD patients. A retrospective cohort study from 2012-2020 on 555 participants showed a 27,3 % prevalence of PEW, but did not find that PEW is a better mortality predictor than albumin or low muscle mass. In PD loss of albumin in PD fluid may range from 6g to as much as 15 g/day.[6]

Protein-energy wasting (PEW) is a pathological condition which occurs when malnourishment is combined with hyper catabolism. It is very common in patients with CKD and especially in patients with end-stage kidney disease (ESKD) and has been associated with increased hospitalization. PEW can occur in early stages because of depression and subsequent loss of appetite, anorexia, and dialysis treatment. High risk factors for developing PEW are patients with

diabetes mellitus, hyperparathyroidism, metabolic acidosis, cardiac cachexia, vomiting and maintenance HD patients (MHD) with insulin resistance.[7]

Special factors contributing to the development of PEW among patients on PD are:[8]

- protein loss into urine and peritoneal dialysate
- inadequate dialysis
- slow gastric emptying and fluid in abdominal cavity
- possible hyperglycaemia and suppressed appetite

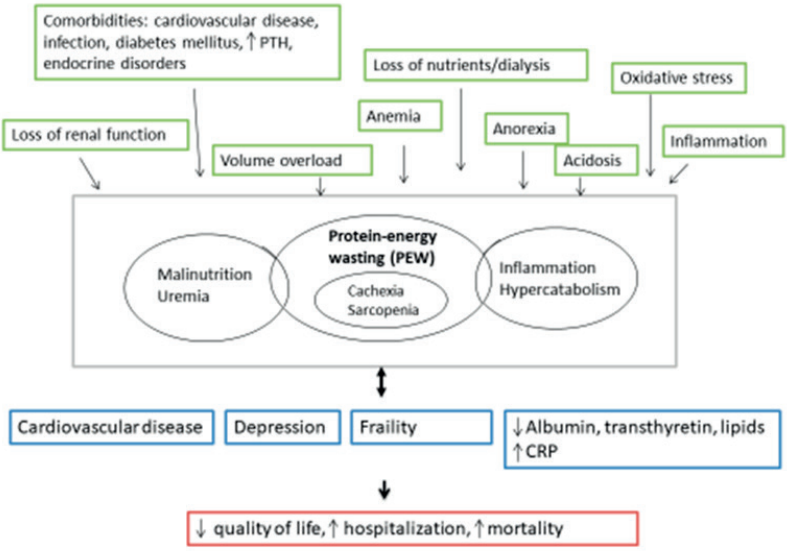

Figure 1 - *Factors that contribute to PEW and manifestations of PEW in CKD. (Adapted from references).*[5,9]

Several guidelines for nutritional management for patients with kidney disease have been published, however study findings determined that only 3 are of moderate quality: KDOQI, ESPEN (European Society for Clinical Nutrition and Metabolism) and DAA (Dietitians Association of Australia).[10]

Experts suggest there are 4 main categories for diagnosing PEW:[5,9]

- biochemical criteria (serum albumin <3,8 g/dl; pre-albumin <30 mg/dl)
- low body weight, reduced total body fat or weight loss (<23 kg/m2; 5 % weight loss in 3 months or 10 % weight loss in 6 months; <10 % of total body fat)
- a decrease in muscle mass (5 % reduction of muscle mass in 3 months or more than 10 % reduction in 6 months)
- low protein / dietary intake (<0,8 g protein/kg/per day for 2 months; <25 kcal/kg/day for a 2-month period)

For patients treated with PD it is not recommended to rely on biochemical parameters only, as some patients can have low serum albumin but no evidence of malnutrition. Chronic inflammation also decreases albumin synthesis and fluid overload has an impact as well. To prevent PEW, standard preventative measures should be taken – early detection of depression, weight loss, nutrient intake measurements, and exercise.

PEW could be prevented by individual dietary instructions and prescribing an adequate dialysis regimen with an evaluation of compliance.[5,9] Monitoring should be done monthly and as patients on PD often have lower serum albumin values, it is important to observe trends.[2,8] In order to preserve the appropriate nutritional status, an energy intake of 30-35 kcal/kg of ideal body weight per day must be achieved. Protein intake for patients treated with PD must be up to 1,2 g of protein/kg of ideal body weight per day, and in cases of acute illness or peritonitis even higher.[7] Rapid peritoneal transporters also need a higher protein intake.

Clinical recommendations are as follows:[11,12] optimizing nutritional intake, correcting metabolic acidosis, eliminating inflammatory factors, minimizing hormonal alterations, correcting hypovitaminosis and increasing physical activity. Some new treatments will be available in the near future including appetite stimulants, anti-inflammatory and anti-oxidant medications, and probiotics.[12] For patients requiring a higher protein intake, we should pay attention to possible hyperphosphatemia.

Use of icodextrine for a daytime dwell and solutions with amino acids are recommended as they can improve appetite, minimize glucose absorption and improve albumin levels.[6,8] If preventative measures are not sufficient, nutrient supplementation is recommended. Oral

supplement 2-3 times/day can provide additional 7-10 kcal/kg per day; these supplements should be taken 1 hour after a big meal. Supplements should be paired with exercise to increase muscle mass which improves nutrient status and quality of life.[13]

Nutritional screening (weight, BMI, serum albumin, dietary energy intake, and malnutrition-inflammation score-MIS) is required every 3 months. Recently a new marker has been introduced – sCr/BSA (serum creatinine adjusted for body surface area) that is easy to measure and identifies more PEW patients than with standard muscle loss observation.[13]

Recommendations for patients

- Set daily goals for liquid intake, potassium, phosphorous, high quality protein intake, sodium limit and calorie goal.[14]

Some important nutrition messages for patients:[15]

- daily food intake should contain all vital nutrients and food should be versatile (try to avoid processed food)
- regular weight control
- prevent constipation with enough fluid and fibre intake and exercise
- include high protein food (best sources are meat, fish, eggs, milk)
- avoid food rich in potassium and phosphate
- control daily fluid intake and be aware that some food can contain a lot of fluid
- divide your food intake into more frequent smaller meals

Conclusion

Nutrition is an important part of treatment. It is specially challenging for patients on PD. Ideally, renal dieticians should be involved in a multidisciplinary team. Close regular monitoring of nutritional status is vital and contributes to patients' long-term survival and quality of life. Patients treated with PD are at a great risk for PEW. Proper nutritional assessment is vital – and beside laboratory parameters and clinical examination, MIS is recommended.

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CHAPTER 10: Peritoneal Dialysis patients and transplantation

Learning objectives:

1. To understand some potential benefits of PD before kidney transplantation
2. To be able to recognize the ability to use PD in the posttransplant period
3. To recognize PD as an option in patients returning to dialysis after kidney graft failure

Introduction

Kidney transplantation offers the best potential option for full rehabilitation of patients with end-stage renal disease. Pre-emptive transplantation improves patient survival compared with transplantation after initiation of dialysis.[1] However, as the global burden of CKD continues to increase1, the need for kidney replacement therapy is rising. Due to organ shortage, most of the patients require to be maintained on dialysis before kidney transplantation.

Patients who are already on dialysis and are suitable for transplantation should be considered as soon as possible because the adverse effects of dialysis therapy on post-transplant outcomes are duration dependent.[2] Analysis of the United States Renal Data Systems (USRDS) database have shown that a pretransplant dialysis duration of six months or more, significantly decreases graft survival.[3] The risk of death with a functioning allograft and all-cause mortality is also higher among patients who perform dialysis more than six months before transplantation.[2,3] There is not yet a consensus whether there is a preferred pretransplant dialysis modality, i.e. HD versus PD.[4,5]

This chapter will review the potential advantages of PD before kidney transplantation, particularly in the incidence of delayed graft function, acute rejection, and patient and graft survival. A brief analysis of PD-related issues on returning to dialysis after kidney transplantation will also be presented.

Dialysis modality and likelihood of receiving a kidney graft

A large study using the USRDS database found that, even after adjusting for patient demographics, dialysis duration, body mass index, baseline glomerular filtration rate at the time of dialysis initiation, ability to work, and other comorbidities like cardiovascular disease, peripheral vascular disease, and hypertension, patients on PD were approximately 40% more likely to undergo kidney transplantation.[6] PD patients also have a higher likelihood of being listed for kidney transplantation, because they usually are younger and have less comorbidities.[7]

PD or HD before kidney transplantation? - comparing outcomes

Most studies that have compared pretransplant dialysis modalities on post-transplant outcomes have demonstrated no clear benefit of one modality over the other on graft or overall patient survival.[6,8] However, other studies have indicated an increased survival for patients and graft for those treated by PD or, on the contrary, increased graft survival in HD.[9,12]

Studies have shown that CKD leads to a micro-inflammation condition through accumulation of inflammasomes and metabolites, and those artificial membranes used in HD could increase free radical production by activating complement factors and phagocytic leukocytes. This increased oxidative stress could explain the increased delayed graft function in HD patients.[13,14] On the other hand, PD patients had better cell-mediated immune states and less oxidative stress.[15] Additionally, PD modality has a protective effect on kidney functional recovery after transplantation due to more optimized fluid status and better-preserved residual native kidney function.[16]

Otherwise, Snyder et al. in a study including 22,776 patients suggested that PD patients had a higher risk of graft failure than HD patients in the first 3 months after transplantation.[6] These results could be explained by a higher incidence of infections and early graft thrombosis in PD patients.[17] Generally, PD patients have a better immunologic state, which could be associated with more early acute rejections and therefore an adverse effect on graft survival.[18]

A recent meta-analysis on this topic has been shown that pretransplant PD patients had a significantly lower incidence of delayed graft function than HD patients. In contrast, there was no significant difference in

the incidence of acute rejection. Pretransplant PD patients had a better 5-year patient survival rate compared with HD patients, which was associated with a better quality of life, better nutritional status, and fewer blood transfusions in PD patients. However, there was no significant differences in the graft survival rate.[9]

Using PDin the post-transplant period

Some nephrologists have some apprehension in using PD in early post-transplant period in case of delayed graft function because of some concern that the peritoneal membrane has been disrupted during transplant surgery, with the potential leakage of glucose-containing peritoneal dialysate fluid and infection.[19] However, PD has been used successfully in many patients with delayed graft function.[20]

The optimal timing of PD catheter removal after kidney transplantation is still unclear. Some authors suggest removing the Tenckhoff catheter at the time of transplant surgery to avoid the (approximately) 5 percent risk of post-transplant peritonitis even in patients who do not perform PD after kidney transplant.[19] A higher incidence of peritonitis has been shown to be associated with an increased number of peritonitis episodes prior to transplant surgery (average of three), previous peritonitis episodes due to Staphylococcus aureus, male gender, technical problems at surgery, presence of rejection episodes, permanent graft non-function and urinary leak.[21]

There is however some consensus that the PD catheter should be removed within one month after surgery unless there is a strong likelihood that dialysis will be needed in the near future.[19,20]

PD after kidney transplant failure

The growing number of kidney transplants performed in Western countries, along with the higher rate of patient survival and the improvement of short- and long-term graft survival, are generally contributing to an increasing number of patients returning to dialysis after graft loss.[22] Kidney allograft failure represents 2-3% of the causes of PD initiation annually.[23] Based on available data survival of these patients appears to be similar to PD transplant-naïve patients and PD outcomes are not poorer to HD after kidney transplant failure.[24]

The evidence is more conflicting in the effect of PD in preserving residual graft function as in the native kidney, and different approaches to transplant nephrectomy and immunosuppression maintenance strongly determine this outcome. There is no standard way of managing immunosuppressive medication after graft loss. However, withdrawal of anti-proliferatives, progressive tapering of calcineurin inhibitors according to immunological risk and slow tapering of steroids, is the most consensual approach.[24]

Failed transplant patients may undergo a transplantectomy, which in addition to reducing residual function, may induce surgical complications and jeopardize the technique's survival.[25] Maintenance of immunosuppression after transplantation failure is associated with a higher risk of peritonitis in PD patients.[25] Conversley, it has been suggested that continued immunosuppression after graft failure could prolong patient survival on PD.[24]

Conclusion

PD seems to be a suitable choice for selected patients awaiting kidney transplantation. The results of transplantation are not significantly associated with pretransplant dialysis modality. PD can also be used successfully after kidney allograft failure, where specific issues like the need for transplantectomy and immunosuppressive therapy should be considered.

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CHAPTER 11: Peritoneal Dialysis Nurses Trainers

Learning outcomes:

1. To understand the importance of patients' engagement in their PD health care.
2. To recognize what factors are influencing patient and family engagement in their health care.
3. To inform about the PD Nurse Trainer skills required and methods for delivering training sessions.
4. To learn how to evaluate patients learning needs after each session.

Introduction

The main goal for PD(PD) Nurses as health professionals in care, is to train people with End Stage Kidney Disease (ESKD), their carers and families, and to engage in their PD Home Treatment. The training can be carried out either in the PD Nurses place of work or in the patients home. This approach to training for people undergoing PD treatment is currently considered necessary and supportive, to both the patients and the Health Care Organization.

There are two points that researchers of people with chronic diseases take into consideration. The first one concerns sociological issues and the second one is about public health. There are many theories concerning these issues and there are several different kinds of theories found in scientific literature and in working practice models, which help HCP understand how patients can be involved in their own health and care management. In their study, Graffigna Guendalina and Barello Serena (2018) present a very informative table about the latest theories related to patients' engagement in their health care (table 1).[1,6,8,9,14,15,18,24,25]

Latest theories related to patients' engagement in their health care	
Gruman et al, 2010 (p.353)	Set of behaviours including two overarching domains: 1) "managing health" behaviours, which is both the self-management of chronic disease and the adoption of healthy behaviours and 2) "managing health care" behaviours, which can be both patient and "consumeristic" behaviours
Carman et al, 2013 (p.224)	Set of behaviours by patients, family members, and health professionals and a set of organizational policies and procedures that foster both the inclusion of patients and family members as active members of the health care team and collaborative partnerships with providers and provider organizations, so that the desired goals of patient and family engagement include improving the quality and safety of health care
Hibbard et al, 2010 (p.1918)	Patients' motivation, knowledge, skills, and confidence to make effective decisions to manage their health
Graffigna et al, 2015 (p.2)	Process-like and multidimensional experience resulting from the conjoint cognitive (think), emotional (feel), and conative (act) enactment of individuals toward their health management. In this process, patients go through four experiential positions (disengagement, arousal, adhesion, and eudemonic project). The unachieved synergy among the different subjective dimensions (think, feel, act) at each stage of the process may inhibit patients' ability to engage in their care
Légaré et al, 2013 (p.277)	["engagement" is] the process of individuals' responsibilization that ensures that clear information leads to the best decision for the person who is seeking the care, thus improving self-management

Mittler et al, 2013 (p.37)	Engaging consumers refers to the performance of specific behaviours ("engaged behaviours") and/or an individual's capacity and motivation to perform these behaviours ("activation") aimed at gaining health
Forbat et al, 2009 (p.84)	A range of ways to conceptualize involvement are used interchangeably in policy and practice without due recognition of the very different meanings of public consultation, patient/carer involvement in treatment decision making, and patient/carer involvement in service design and development

Table 1: Definitions for patients' engagement in their Health Care (Graffigna Guendalina, Barello Serena 2018)[14]

The implementation of training people suffering with Chronic Diseases during their treatment was noted in 1998 by the World Health Organization (WHO) as an urgent issue. WHO recommended that HCP educate their patients and it also defined this process as 'Therapeutic Patient Education (TPE). The scope was to orientate HCP to "enable people with chronic diseases to manage their illness'' for the benefits of health and financial terms. But the issue that arose from this, according to WHO (1998) was that 'health care providers do not have the skills necessary to educate or train'. Also, according to Graffigna G, et al. (2017), HCP trainers' mission, is not only to "put patients at the centre of the medical and nursing action" according to their care needs, but also to succeed on behalf of their health care organization.[10,11,33]

This has to be a partnership between the health care trainer, patient and patient's family or anyone dealing with the patients care (the carer). All decisions about patient's care, must involve and respect their own beliefs, wishes, preferences and needs. The main goal for the health care trainer is to support patients and inspire them to participate in their own care. As Benjamin Franklin quoted once, "Tell me and I forget, teach me and I may remember, involve me and I learn."

Factors influencing patients and families' engagement with Health Care

As trainers, PD nurses need to consider all factors that contribute to their patient's and families' implications for health care. There are mainly three factors to consider (figure 1):

- patients themselves,
- organizations
- society[6]

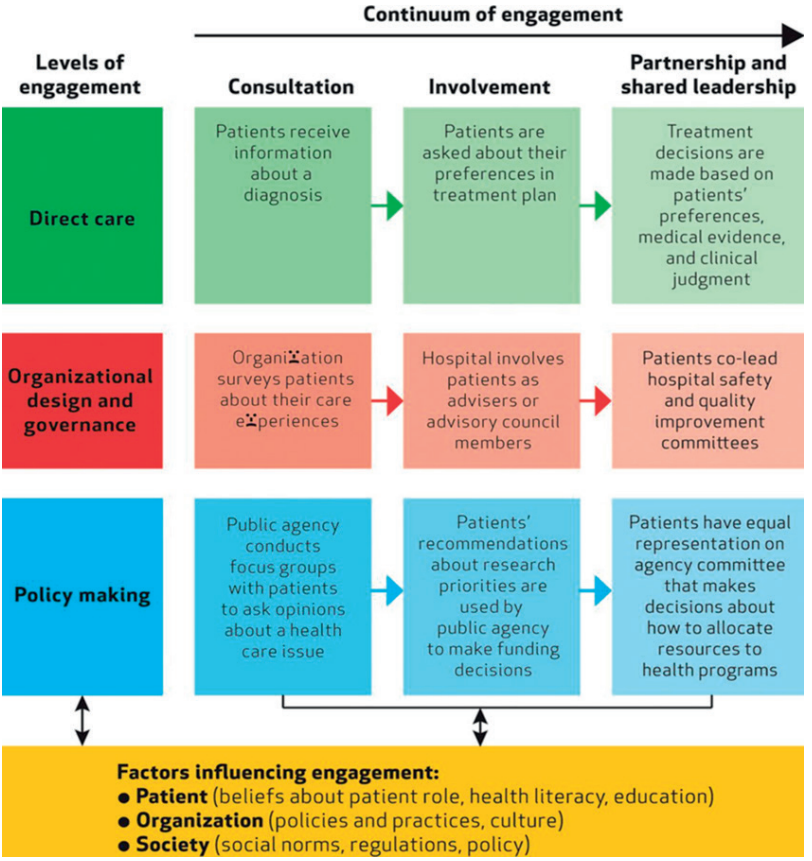

Table 2: Factors influencing patients and families' engagement with their health care.[6]

Patient's individual factors are very important for the Health Care educator to take into consideration. They affect their impact on their willingness, motivation, and also their attitudes, knowledge, beliefs, self-effectiveness and functionality.[27,30]

The psychological factor has also a role in how patients can or can't manage their illness and their health care engagement. The

complex process is based upon increased patient understanding and subsequent growth in self-confidence, which is primarily emotional and psychodynamic. Adoption of a psychosocial approach for defining and measuring patient engagement promises to greatly enhance our understanding of how people can decide to change their role in the health care journey in favour of engagement.[12,13,14]

According to the Patient Health Engagement (PHE) model, four phases of patients' commitment to prescriptions and self-management in care (figure 2) can be defined.

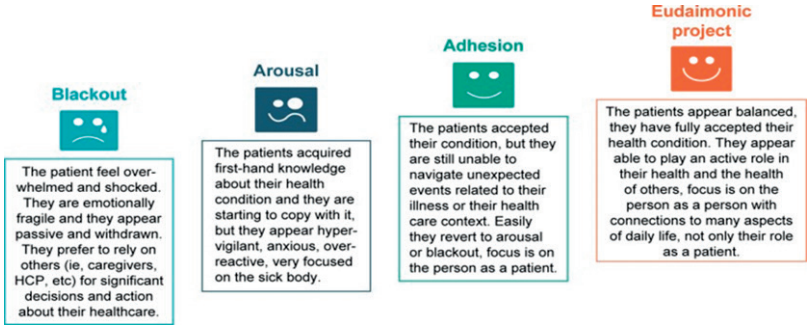

Table 3: Description for featuring the PHE model. Abbreviation: PHE, Patient Health Engagement[12,13,14].

PD nurses' skills and learning models

As qualified nurses, PD nurses during their basic training, do not get professional knowledge and skills for trainers. They might have the knowledge, skills and experience of PD and the willingness to impart their knowledge, but they do not have the special educational skills for this. Usually, nurses as with all HCP, teach with the training method of "seeing one, doing one, teaching one". Their trainees are either patients and family members and carers, or colleagues, students and collaborators. This is another factor influencing patients', carers' and families' engagement in treatment. Special skills are needed in PD nurses to train people and particularly as the issue concerns health care, wellbeing and quality of life. It is important to bear in mind that all trainees are different, have different educational backgrounds, differences in cultures, educational levels, ages and needs, different goals, and previous experiences, and also what they feel and what emotions they have. This is difficult work for the PD Nurse Trainer who will need to consider many aspects before undertaking the task.

There are many learning models about teaching that a PD Nurse trainer can use, to understand adults' earning process. Malcolm Shepherd Knowles (1913–1997) who dedicated his whole career to adult learning research, describes adult teaching as an art and emphasizes that adult trainees' ability to learn has to do with self-motivation, learning experience, readiness to learn and also be open to it'' (figure 3).[26]

Table 4: Five assumptions. Theory of Andragogy. Source for chart: Google Image

Trainers must include and put these assumptions into practice when dealing with adults. According to Malcolm S. Knowles (1913 - 1997), the trainer has 6 ways to do this:

1. Promote a positive training environment based on cooperative learning;
2.Research into adult trainee's needs and interests.
3.Create Learning objectives based on the trainees' needs and interests.
4.Design any activity which is needed for achieving learning objectives.
5.Make strategies and find methods and resources for instructions.
6.Review any activity and modify it when necessary.

Note that adults are assimilating information when it is useful and relevant. The trainer has to explain the reason that the trainee has to learn this specific skill. A way for a trainer to manage this is by

creating solutions similar to their own life experiences as this creates an easier way for the trainee to memorise information. It is also important to be alert in solving any problems, to be able to apply this immediately, and also to perform any relevant basic tasks.

The PD Nurse trainer who takes over the responsibility to train a patient or a family member, a student or another nurse, has to provide the training with efficiency and knowledge and must be effective from the point of how they can learn and also what motivates them to learn. The next step is to proceed to the design of the session or lesson and consider the way that it is going to be delivered. They must be able to communicate with the trainee and if there are several trainees, need to be able to manage the differences among them. Usually, soft skills are needed for Trainers.[30]

There are many soft skills that a trainer can acquire. For instance:

- Communication skills – including competence in speaking, listening, writing and presenting.
- Politeness– manners, acceptable behaviour, saying please and thank you, business etiquette, respectfulness, and courteousness.
- Flexibility skills– teachable, a lifelong learner can adjust, adaptable, consents to change, accept new ideas.
- Integrity – ethical, honest, has personal values, high morals, does what's right.
- Interpersonal –personable, empathetic, friendly, nice, warm, sense of humour, civility, self-control, patient, sociable.
- Positive Attitude –enthusiastic, optimistic, pleasant, encouraging, confident.
- Professionalism – likes what they do, appropriately -dressed, poised.
- Responsibility –reliable, accountable, resourceful, self-disciplined, conscientious, wants to do well, common sense, gets the job done.
- Teamwork –agreeable, gets along with others, supportive, collaborative, cooperative and helpful.
- Work Ethic – loyal, willing to work, hardworking, self-motivated, shows initiative, good attendance, punctual.30,31

In order to deliver a lesson, a trainer should also have the following skills:

- Skills of training design, meaning how to compose and deliver sessions, training technique practices, adequate and valuable feedback of the session and powerful communication skills.
- Attendance Communication skills, which concern the ability of the trainer to clarify the communication activity, to put into words the communication skills and embrace communication techniques.
- Attendance Management skills to help the trainer to build up effective participation throughout all the sessions.
- Skills to avoid or manage possible trainee discomfort.
- Ability to encourage feedback.
- Skills to build the training framework through the trainee's characteristics, training content plan, clarification of training aims, embracing training tools and techniques, and the ability to evaluate the training presentation.

PD Nurse Trainer's consideration for lesson preparation need to bear in mind:

- the patient's ability to learn
- the evaluation of patient's motivation to learn
- how to implement patient feedback as trainees
- how to design the sessions
- according to what the trainer is planning to train, what learning outcomes will be expected after each session
- prepare all sessions
- the way they will deliver the session
- what training techniques will be implemented?
- how to communicate effectively
- trainees' differences if there is more than one trainee
- ability for reflection to improve training.

The ISPD(ISPD) promotes worldwide the quality of practice, and achievement of the best outcomes of peritoneal dialysis, through research, education, and advocacy, proposes a whole training programme for professional PD e trainers. This programme shows step by step how a PD Nurse can design each lesson. It explains how a PD trainer can plan an advanced lesson and how to teach it. For more detailed information go to: https://ispd.org/teaching-nurses/.

Patient's learning needs – how to meet them

According to ISPD, the best way to train a patient is to use techniques such as practice feedback or instructions. When a trainer is assessing the patient's understanding during a practical example, there is the opportunity to evaluate the level of the patient's learning outcome, and if needed to proceed to any repeated or additional information.

Practice has to be connected with activities related to the patient's learning outcome and if this subject is too long, the trainer can separate it into shorter parts (table 2).

Learning Outcome	Practice Activity Directions
To inspect the solution fluid prior to using it.	"Here's a bag of solution. Show me what you would do before you would use this bag, and tell me the steps as you go through them."
To identify and describe the role of the peritoneum.	"Here's a picture of the body. Can you show me where? the peritoneum is and describe how the fluid replacement works?"
To differentiate cloudy and clear solution bags	"Here are two different bags of fluid; can you tell me which one of them is clear? Here is another example a bit more difficult – can you point out the difference now?"

To solve a potential problem.	(Pose problems that might occur). "What would you do if you accidentally dropped the cap onto the floor?"
To connect tubing.	"Now that I've shown you how to do this, try reading the directions aloud as you connect the tubing to the machine."

Table 2: ISPD table for learning outcome and practice activity

When the PD Nurse trainer is planning a session, they should also include an evaluation of practical activities, correction of patient's mistakes, evaluation of their learning level and information follow-up.[19,35,36]

The Teach-Back Method is a learning evaluation method and helps the PD Nurse Trainer to gauge trainees' learning and practical skills. It can lead to the improvement of patient safety, through effective communication with the trainer, and helps trainees to understand what the trainer needs them to know concerning their PD care.

Generally, the Teach-Back Method endorses that the trainer should be able to:

- Separate topics into smaller themes and help impart this information.
- Request the patient to teach back with their own words. Notice the words they are using.
- Allows patients to study material.
- Introduce the next topic with new information when the patient can teach back with no mistakes.
- Change the word choice if a patient cannot teach back without mistakes. Sometimes it is easiest to consider using their own words.

The PD nurse can use this method not only regarding PD therapy training but also in other areas such as medication, diagnosis, new treatment plan, new device etc. (figure 4).

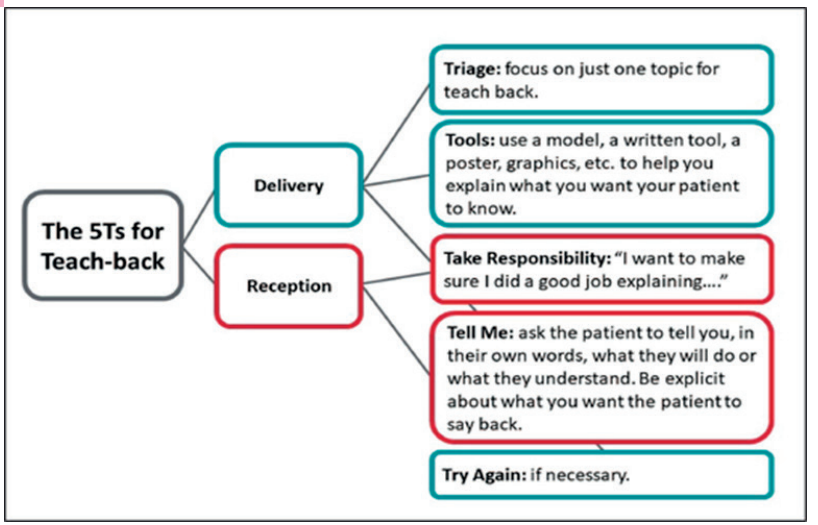

Figure 4: The 5Ts for Teach-Back. Teach Back is about delivery and reception.[21]

Important points for PD trainers of the Teach-Back Method:

- Make use of verbal communication.
- Focus only on two - four important topics at each visit.
- Begin with the most important.
- Use plain language – avoid medical definitions.
- Give educational materials. Highlight essential information.
- Use pictures or drawings.
- Give them the chance to ask any questions.
- Smile, have eye contact with the trainee, give reassuring encouragement and last but not least, remove any physical barriers between the trainer and the trainee, e.g., crossed arms, desk, computer, etc).
- Bear in mind possible patients' difficulties with their level of understanding, sickness burden, tiredness, hearing problems, language diversity and worries about the new diagnosis or treatment.[1,2,4,5,7,16,17,18,21,22,23,24,35]

For more detailed information, please go to:

https://www.ahrq.gov/patient-safety/reports/engage/interventions/teachback.html

Conclusion

PD Nurses HCP can train people with ESKD to manage their PD treatment at home. Many people find this to be a huge challenge, but it is manageable for professional PD Nurse Trainers. It can be achieved by using different techniques, methods, models and professionalism. PD Nurses as Trainers can manage to cope with factors influencing the Patients', Carers' and Families' engagement in their health care. They are using their unique educational Health and Training knowledge, pedagogically and effectively, to enhance learning methods and motivate trainees to manage their goals. These goals are to ensure the success of the trainee's PD treatment management. All this effort can lead to patients' satisfaction and enrich their quality of life and lead to the Health Organization's quality of care recommendations.

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