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Special Article

Peritoneal Dialysis or Bloodless Dialysis: Basic Understanding for Internists

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Patients with kidney disease progressing to CKD-5 and further down End stage Kidney Disease (ESKD), is ultimately need kidney replacement therapy in terms of Kidney Transplant, Hemodialysis (HD) or Peritoneal Dialysis (PD). Patients who do not have a suitable donor need lifelong dialysis. Majority of the patients undergo hemodialysis and other opt for PD. There are approximately 500,000 patients with ESKD in USA and among them only 20% are on PD.[1]

The interest in PD has increased significantly in recent years and countries are implementing PD first policy for ESKD patients, where patient is offered HD only if there is a contraindication to PD. Mexico, Thailand and Hong Kong more than 50% ESKD patients now on PD. This interest is due to the fact that hidden costs in a HD session make it much costlier than PD, and the latter provides the liberty of home based therapy.

Pakistan where in an estimate although about 300,000 patients join the group of ESKD every year, yet only a fraction is able to find a place for dialysis. Long waiting list in dialysis centers and some areas patients have to travel long distances on their own expense to get HD sessions. Certain conditions such as HBsAg and HIV and not recently COVID has highlighted the importance of PD where patients can be dialyzed in there hospital isolation rooms or at homes.

This guideline is compiled to create awareness about PD in the local Pakistan healthcare system. It is not extensive on one hand yet gives a clear overview about Pd[1].

Indications for Dialysis

Dialysis is indicated in various clinical scenarios where the kidneys are unable to maintain adequate fluid, electrolyte, and waste product balance. The following are the primary indications:

1. Chronic Kidney Disease (CKD)

- o ESKD with a glomerular filtration rate (GFR) <15 mL/min/1.73 m².
- o Uremic symptoms, such as fatigue, confusion, anorexia, nausea, and pericarditis.

2. Acute Kidney Injury (AKI)

- o Severe metabolic acidosis (pH <7.1) not responsive to medical therapy.
- o Refractory hyperkalemia (potassium >6.5 mmol/L) despite medical management.
- o Fluid overload leading to pulmonary edema and unresponsive to diuretics.
- o Uremic complications, including encephalopathy or seizures.

3. Severe Electrolyte Imbalances

- o Life-threatening hyperkalemia.
- o Severe hyperphosphatemia or hypercalcemia.

4. Poisoning and Drug Overdose

- o Removal of dialyzable toxins (e.g., methanol, ethylene glycol, lithium, salicylates).

5. Refractory Fluid Overload

Conditions like heart failure or pulmonary edema where conservative measures are ineffective.

Renal Replacement Therapy (RRT)

ESKD patients in CKD -5 ie. eGFR <15 ml/min requires RRT or its preparation till clinical indication exists. Kidney transplantation is the most favored therapy as patient survival and quality of life is best compared to HD or PD[2].

When comparing HD with PD, PD has better survival

in the initial years and later comparable to HD. Overall PD has significant cost advantage, liberty for the patients and better quality of life. Table 1.

Indications for Peritoneal Dialysis

There are certain indications where PD is the only choice for RRT and

Inadequate Vascular Access for Hemodialysis

PD is often the only choice when vascular access for HD cannot be established. Patients with poor vascular health or limited viable veins face challenges in maintaining stable access, essential for HD and may need PD as only alternative at initiation or after HD initiation.

Severe Hemodynamic Instability (e.g., Cardiovascular Disease)

Severe cardiovascular diseases like heart failure and coronary artery disease can complicate HD due to rapid fluid shifts and hemodynamic changes for ultrafiltration during each 4 hours sessions. PD invovlves multiple sessions that avoids this hemodynamic instability and offers an excellent option for such patients including cardiorenal syndrome.

Preference for Home-Based Treatment

Many patients prefer home-based treatments like PD for greater flexibility, independence, and convenience over in-center hemodialysis. Studies show home therapies reduce hospital visits, improve quality of life, and encourage family involvement. Patient education is important to empower them to make decisions as the best therapy suited for them.

Pediatric Patients (Benefits of Home-Based Therapy)

PD is especially beneficial for pediatric patients, offering a home-based therapy manageable by parents or caregivers. It supports better growth, development outcomes, fewer hospitalizations, and preservation of residual renal function compared to hemodialysis. HD is anyhow not easily available for pediatric patients both for acute kidney disease and CKD. Home-based dialysis is crucial for younger patients' psychosocial and developmental needs.

Patients with Residual Renal Function

PD preserve urine output better than HD patients. In general patients on HD lose their urine output within 6-12 months and even a urine output of upto 200 ml is significant amount to improve the patient survival. This is probably the main reason that patients initiated on PD have better survival in the early years.

Older Adults

Older adults with ESRD may face challenges in managing dialysis due to frailty, comorbidities, and limited vascular access. PD is advantageous in these situations due to its gentler fluid removal process, reduced cardiovascular strain thus providing better of quality of life.

Short-Term Dialysis Needs

PD is recently being considered for acute kidney injury patientsoften utilized for short-term dialysis in patients with acute kidney injury (AKI) or as a bridge to a kidney transplant. The continuous nature of PD allows for controlled fluid and electrolyte balance, making it an ideal choice for temporary renal support. Unlike hemodialysis, which requires more invasive procedures, PD can be initiated quickly and with fewer complications (Harvard Medical School, 2018)[3].

Mental Health and Quality of Life

PD, especially when performed at home, is associated with better mental health outcomes compared to in-center hemodialysis. Home-based PD provides patients with greater autonomy, leading to improvements in their emotional well-being and quality of life. Studies consistently show that patients with PD report better overall satisfaction and fewer symptoms of depression.

Non-compliance and Convenience

PD offers a more flexible option for patients who have difficulty adhering to the strict schedules of in-center hemodialysis. Patients can manage their therapy at home, reducing the need for frequent hospital visits. This increased autonomy can improve overall adherence to dialysis protocols, especially in those with chaotic lifestyles such as shift changes and school or college assignments or job related time schedule issues.

Contraindication:

It is said that any patient can undergo PD and there are not many contraindications to PD. Some absolute contraindications including repeat abdominal surgeries or trauma causing adhesions, active abdominal infections or carcinomatosis, significant abdominal or inguinal hernias, severe pulmonary disease, mental illness with inability to cooperate, lack of proper home environment to perform exchange and finally compliance issues or no assistance available for PD. Some of these contraindications can still be a relative contraindication, such as hernias can be managed with Automated peritoneal dialysis (APD) in a supine position, adhesions can be lysed by an expert surgeon

and assisted PD for a patient who is unable to perform[4].

Some other relative contraindications include obesity, manual dexterity and repeated peritonitis.

Table 1: *Comparison of PD with HD*

Feature	Peritoneal Dialysis (PD)	Hemodialysis (HD)
Method	Uses the peritoneum as a membrane for filtration	Uses a dialyzer (artificial kidney) for filtration
Access	Requires a catheter inserted into the abdominal cavity	Requires vascular access (AVF, AVG, or CVC)
Frequency	Daily or few days of the week exchanges	Typically 3 times a week for 3-5 hours per session
Location	Can be performed at home	Usually performed in a dialysis clinic or center
Technical advantage	Only 30-70 liters of water/ week/ patient for dialysis	900 liters of water/ patient for dialysis
Flexibility	More flexible; patients can manage at home	Less flexible; dependent on scheduled clinic visits
Dietary Restrictions	Generally fewer restrictions	More stringent dietary restrictions (e.g., fluid, potassium, and phosphorus)
Complications	Risk of peritonitis and catheter-related issues (generally easily manageable with antibiotics)	Risk of infection, clotting, and cardiovascular issues
Quality of Life	Often better due to home management	May be impacted by treatment schedule and travel to clinic
Patient Training	Requires training for self-care and exchanges	Requires training for access care and machine use

What is the Pathway for Initiating PD?

As a primary care giver of a patient, the internist should understand the process of PD to provide a basic knowledge to the patient. This will help the patient in comprehending the procedure and make educated decision for their dialysis preference. Here we will outline the PD types and how it is performed.

What is Peritoneal Dialysis?

Peritoneal dialysis is a type of dialysis therapy that uses the patient's peritoneum, a natural membrane lining the abdominal cavity, as a filter to remove waste products, excess fluids, and toxins from the blood. Unlike hemodialysis, which requires a machine and vascular access, PD infuses a sterile dialysis solution (dialysate) into the peritoneal cavity through an abdominal catheter. The peritoneal membrane acts as a semi-permeable barrier, allowing the exchange of solutes and water between the blood and the dialysate[5].

Brief Anatomy and Physiology of the Peritoneal Membrane

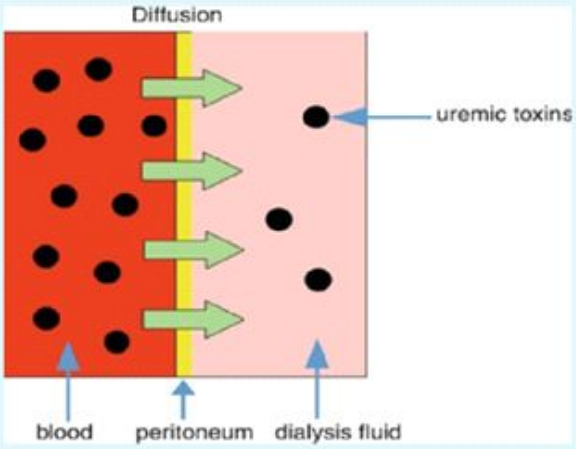
The Peritoneum: A highly vascular, semi-permeable membrane consisting of:

a) The visceral peritoneum: Plays a vital role in the effectiveness of peritoneal dialysis, as it covers the abdominal organs, including the intestines, liver, and stomach forming a smooth, semi-permeable barrier that facilitates the functional exchange of solutes and water during dialysis with the help of dense capillary network surrounding the abdominal organs.

b) The Parietal Peritoneum: Lining the abdominal wall, the parietal peritoneum provides similarly structural integrity to the peritoneal cavity, serving as an anchor for the abdominal organs as well as the exchange of solutes and water during dialysis[6].

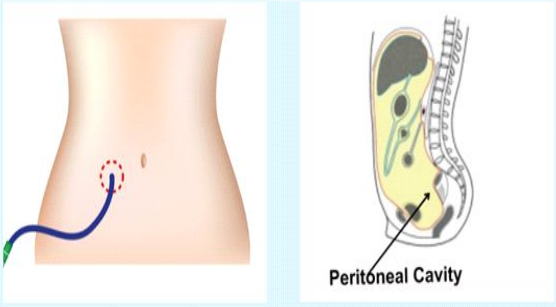
The process of exchange across the peritoneal membrane happens due the diffusion and convection through the pores of variable sizes allowing water only or solutes of different sizes to pass through the capillary membrane and into the peritoneal cavity. Figure 1.

Figure 1: *Movement of Water and Solutes Across the Peritoneal Membrane with Diffusion.*



Peritoneal Dialysis Catheter:

Figure 2: *Peritoneal dialysis catherter and the peritoneal cavity.*



PD catheter is placed into the abdominal cavity blindly or with the help of ultrasound or fluoroscopy guidance, minilaparotomy with local anesthesia or

under laproscopic guidance. The success of the catheter placement depends on the expertise of the person performing the procedure.

Types of Peritoneal Dialysis

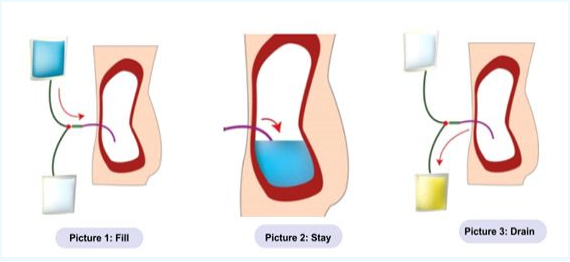
Continuous Ambulatory Peritoneal Dialysis (CAPD)

Automated Peritoneal Dialysis (APD)

CAPD is a type of PD that uses gravity and the whole exchange produre is done manually by the patient or their caregivers.

A bag of dialysis solution is connected to the PD catheter and the exchange starts by placing the drain

Figure 3: *The Process of Peritoneal Dialysis Exchange done Manually with Fluid filling into the Peritoneal Cavity, stay time of 4-6 hours and then Draining into the Drain Bag.*



bag portion of the system on the floor and hanging the fluid or dialysate bag on a pole. The gravity is used to push the fresh solution into the abdomen. Once this is completed, the system is disconnected from the catheter, and patient is free to move about until the next exchange. The dialysate bag and the drain bag are connected and the the fluid present in the abdominal cavity is drained by gravity into the drain bag before filling again. Figure III. Each of these exchanges lasts about 10-20 minutes[7].

APD is a form of PD that uses a machine called a cycler to perform dialysis exchanges. The APD cycler pumps in fluid into the peritoneal cavity and then pumps out the fluid automatically after a certin period of stay time in the peritoneal cavity. During each thearpy the cycler does multiple exchanges as prescribed by the nephrologist for clearance. APD is done at night during sleep and the patient wakes up in th emorning disconnecting themselves from the machine and are free to continue their daily chores in the morning.

Before each treatment, the APD cycler is set up with dialysate bags connected to the machinethen the PD catherter is connected to the cycler tubing. As per the prescription programmed it fills and drains the dialysis solution from your peritoneal cavity at regular intervals throughout the therapy. Typically, an APD treatment lasts between 8 and 12 hours during sleep. Figure IV.

APD is the most commonly used form of PD for children with kidney disease, as it enables the child to attend school each day, and the parent / caregiver to work during the day, without the need for any dialysis interventions during daytime hours. 80% of patients in USA undergiong PD opt for APD due to its convenience and better quality of life[8].

Figure 4: *Patient attached to the APD machine ready to sleep and working during an APD session. Byonyks APD cycler.*

How do we know the PD is working fine?

There are certain lab tests to measure the transfer of solute across the peritoneal membrane, this test is called Peritoneal Equilibration Test (PET) and Kt/V. PET test is performed at 6 weeks of initiating of PD and checks how fast a solute moves across the membrane allowing the nephrologist to decide about the stay time of the fluid inside the peritoneal cavity. Kt/V test is a measure of clearance of urea for the adequacy of the procedure and helps the nephrologist to modify the therapy dose.

Are there any Complications of Peritoneal Dialysis?

Any procedure is associated with some sort of adverse events. Similarly, PD patients are at risk of infectious complications that can affect the efficacy of therapy and patient outcomes. These complications are generally classified based on the site and type of infection. Infectious Complications are classified into.

1. Exit site infection
2. Peritonitis

Exit site infection; is the infection of the catheter insertion site that can include the tunnel of the catheter. In general the exit site is easily treatable as it is due to the skin flora, however persistent infection can lead to intraperitoneal contamination and peritonitis.

Peritonitis; is generallly easily treatable and does not

lead to discontinuation of PD as the common notion may be. With current practices of hand sanitization aand good training and retraining peritonitis should not happen for more than 2 years. Most of the time peritonitis results from mishandling of the catheter connection during the procedure and occsaionally from the transmigration of gut bacteria due to constipation, divericulitis or others conditions involving the gut.

At times the infection may require removal of the catheter and temporary shifting the patient to HD and then reinsertion of the PD catheter after about 4 weeks for reinitiation of PD. Non Infectious complications related to peritoneal dialysis include catheter related issues that are solved by repositioning or reinsertion of the PD catheter, patient related due to the inherent peritoneal membrane characteristics.

In conclusion PD is an option for RRT, that should be offered to the pediatric patients, patients who want liberty to perform their jobs or education and a good quality of life. It is an easy procedure that can be learnt quiclky by the patient or their caregivers providing the liberty of home based therapy and improved wellbeing.

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Authors' Contribution

AA: Conception
AA, MI, AS: Design of the work
AA, NT: Review critically for important intellectual content
AA, MI, AS, AS, NT: Approve the version to be published
AA, MI, AS, AS, NT: Agree to be accountable for all aspects of the work.

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