Medical Practice Improvement Project

- Introduction to Dialysis
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Cutting Edge
Surgical Medical Group

Disclosures

None

Learning Objectives

- **Understand the Mechanism of Hemodialysis:**
- **Identify Indications for Hemodialysis:**
- **Analyze the Morbidity and Mortality Rates of Hemodialysis:**
- **Evaluate the Impact of Long-Term Hemodialysis on Patients:**

What is Hemodialysis?

- Hemodialysis is a medical treatment used to filter waste, excess fluid, and toxins from the blood in patients whose kidneys are not functioning properly. This process mimics the function of healthy kidneys, helping maintain essential chemical balances in the body. Hemodialysis is typically used when kidney function falls to a dangerously low level, such as in chronic kidney failure or acute kidney injury.

Indications for Hemodialysis

- Hemodialysis is prescribed when the kidneys are unable to perform their essential functions, including the removal of waste and excess fluids from the body. The main indications for hemodialysis include:

1. **Chronic Kidney Disease (CKD):**
    1. Stage 5 CKD, also known as end-stage renal disease (ESRD), when the kidneys are working at less than 15% of their capacity.
2. **Acute Kidney Injury (AKI):**
    1. Sudden kidney failure caused by injury, infection, or drug toxicity, requiring temporary dialysis.

Indications for Hemodialysis

3. Severe Electrolyte Imbalance:

- Conditions such as dangerously high potassium levels (hyperkalemia) that cannot be corrected through medication.

4. Fluid Overload:

- Conditions such as heart failure, where fluid accumulates in the body and cannot be removed effectively by the kidneys.

5. Poisoning:

- Ingesting certain toxins or drugs (e.g., alcohol poisoning, overdoses) that can be removed through dialysis.

How Hemodialysis Works

- Hemodialysis works by removing waste, excess fluid, and electrolytes from the blood using a dialysis machine and a special filter called a dialyzer (also known as an artificial kidney). The process involves the following steps:

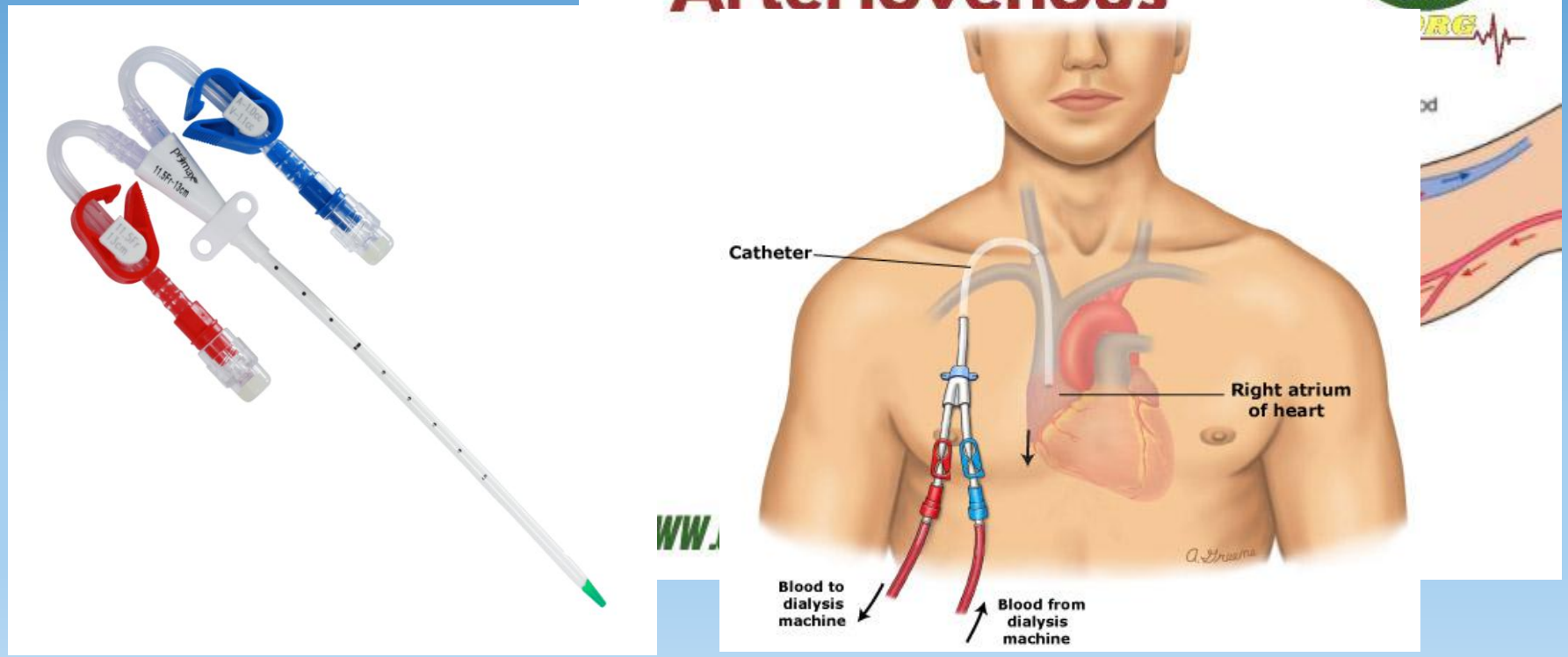
1.Access to the Bloodstream:

1. A vascular access point is created through surgery, typically in the arm, allowing the blood to flow in and out of the body.
2. The most common access points are:
    1. **Arteriovenous (AV) fistula:** A connection made between an artery and a vein.
    2. **AV graft:** A synthetic tube that connects an artery and a vein.
    3. **Central venous catheter:** A tube inserted into a large vein (temporary).

2.Blood Circulation:

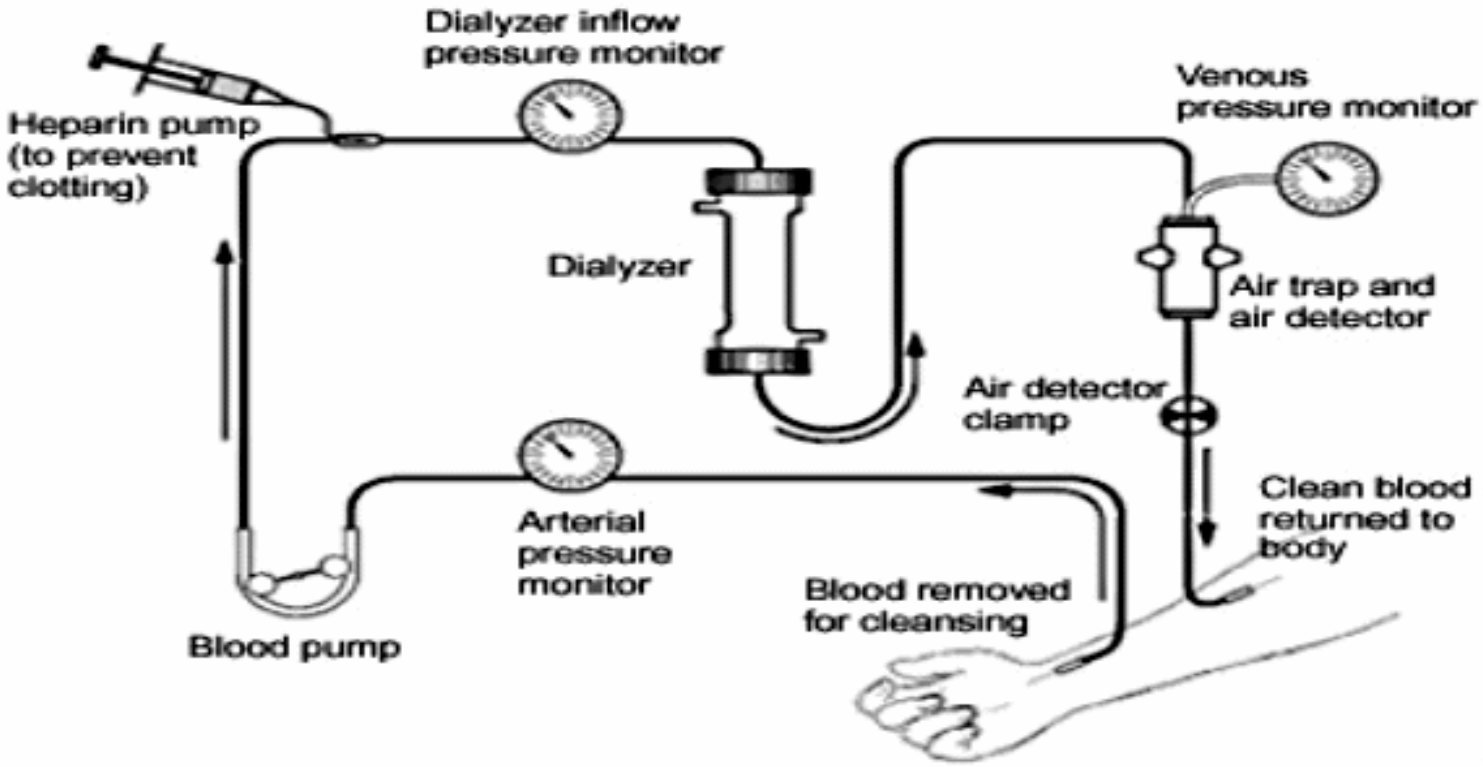
1. Blood is drawn from the body through the access point and enters the dialysis machine.
2. The blood flows through the **dialyzer**, which is a semi-permeable membrane that separates the blood from a special fluid called the **dialysate**.

AV Fistula Dialysis catheters



How does a Dialysis Machine work?

- Path which blood takes:



How Hemodialysis Works

3. Filtration:

- In the dialyzer, waste products and excess fluid in the blood pass through the membrane into the dialysate, which carries them away.
- The dialysate contains a balanced mixture of electrolytes and other substances that help to restore the correct chemical balance in the blood.

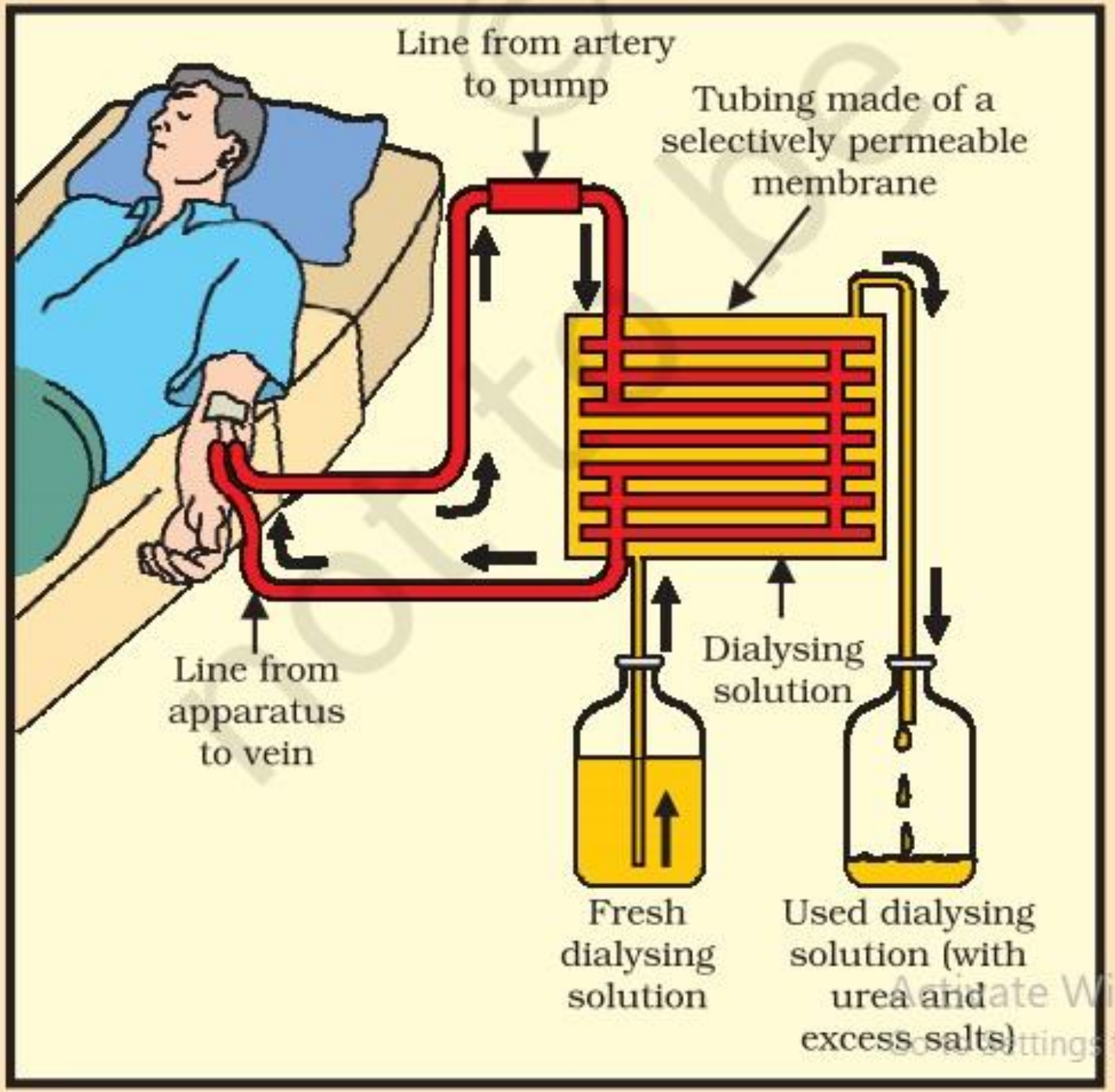
4. Return of Clean Blood:

- Once the blood is filtered, it is returned to the body via the same access point.

5. Duration and Frequency:

- Hemodialysis treatments typically last around 3 to 5 hours and are usually performed three times a week.

The Filter Process



Additional Uses of Hemodialysis

- **Uses of Hemodialysis**
- **Chronic Kidney Disease (CKD) Management:** Hemodialysis is often used as a long-term treatment for patients with ESRD, especially when a kidney transplant is not available or suitable.
- **Acute Kidney Injury (AKI):** Hemodialysis helps patients with temporary kidney failure recover until their kidneys regain function.
- **Fluid and Electrolyte Regulation:** Hemodialysis helps maintain balance by removing excess fluids and regulating levels of potassium, sodium, calcium, and bicarbonate in the blood.
- **Toxin Removal:** Hemodialysis can be used to remove harmful substances from the blood, such as drugs, toxins, or alcohol, when other treatments are ineffective.

Morbidity, Mortality, and Long-Term Dialysis

Morbidity and Mortality Rates: The morbidity and mortality rates for hemodialysis patients remain high. According to a study by the *National Institute of Diabetes and Digestive and Kidney Diseases* (NIDDK), the

1-year survival rate for dialysis patients is approximately 80%, with the

5-year survival rate dropping to about 50% (NIDDK, 2022).

Additionally, patients on hemodialysis experience a high incidence of cardiovascular complications, which are the leading cause of death in this group (USRDS, 2023).

Morbidity, Mortality, and Long-Term Dialysis

Mortality Rates: The mortality rate for patients undergoing hemodialysis has improved in recent decades, but it is still significantly higher than the general population.

The *United States Renal Data System* (USRDS) reported that the overall mortality rate for dialysis patients is approximately 20-25% annually, with cardiovascular disease accounting for nearly half of these deaths (USRDS, 2023).

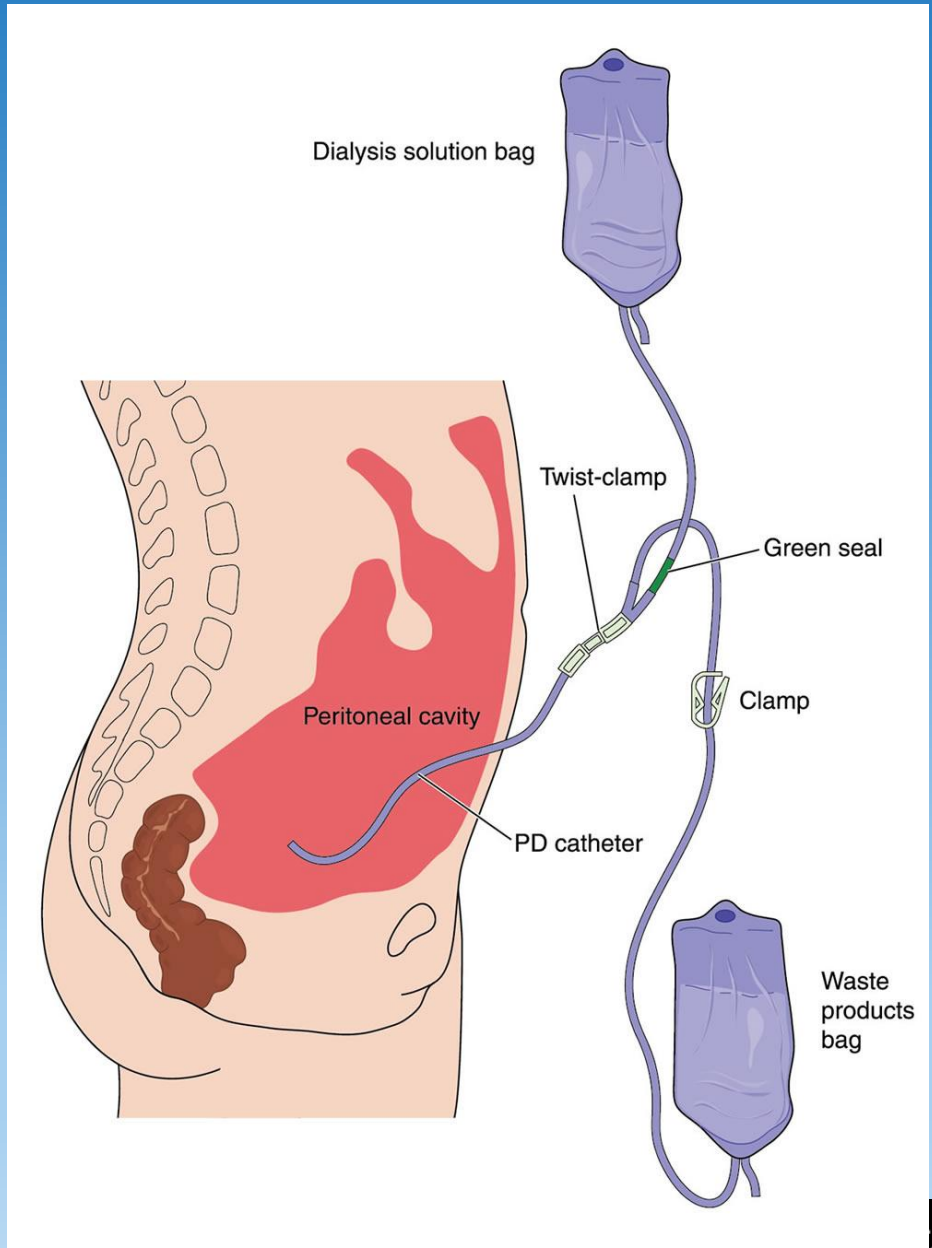
Morbidity, Mortality, and Long-Term Dialysis

- **Quality of Life and Long-Term Dialysis:** Long-term hemodialysis is associated with numerous challenges, including frequent hospitalizations, physical limitations, and a reduced quality of life. However, advancements in dialysis technology and treatment protocols have improved survival rates and quality of life for many patients (Brown et al., 2020).
- The burden of dialysis is particularly significant in older adults, who may experience greater frailty and comorbidities (Cairns et al., 2021)

Peritoneal Dialysis: An Overview

- Peritoneal dialysis (PD) is a form of dialysis that uses the peritoneum (the membrane lining the abdominal cavity) as a natural filter to remove waste and excess fluid from the body. Unlike hemodialysis, which filters the blood through a machine, peritoneal dialysis allows the patient to perform dialysis at home, using the peritoneal membrane as the filtration system.

Peritoneal Dialysis Catheter



How Peritoneal Dialysis Works

Access to the Peritoneal Cavity:	• A catheter is surgically inserted into the patient's abdomen to provide access to the peritoneal cavity.
Dialysis Fluid:	• Special dialysis fluid (dialysate) is introduced into the abdominal cavity through the catheter. The fluid contains a mixture of glucose and electrolytes, which create an osmotic gradient.
Diffusion and Osmosis:	• Waste products, toxins, and excess fluids pass from the blood vessels in the peritoneal lining into the dialysis fluid by the processes of **diffusion** (movement of solutes) and **osmosis** (movement of water).
Drainage and Replacement:	• After the exchange of waste materials occurs (typically in 4 to 6 hours), the used dialysis fluid is drained out of the abdomen and replaced with fresh fluid. This process is called an "exchange."
Treatment Frequency:	• The process is usually done multiple times a day, or it can be done overnight with automated peritoneal dialysis (APD), which uses a machine to perform exchanges while the patient sleeps

Advantages of Peritoneal Dialysis

1. **Greater Flexibility and Independence:**
    1. Peritoneal dialysis can be performed at home, offering greater flexibility and independence for patients.
    2. It can be done during the day or night, with automated machines allowing for continuous dialysis during sleep (APD).
2. **No Need for a Dialysis Machine:**
    1. Unlike hemodialysis, there is no need for a complex machine and regular visits to a dialysis center, making PD more convenient for some patients.
3. **Less Impact on Blood Pressure:**
    1. Peritoneal dialysis tends to be gentler on the cardiovascular system, resulting in fewer fluctuations in blood pressure compared to hemodialysis.
4. **Better Preservation of Residual Kidney Function:**
    1. Studies suggest that peritoneal dialysis may help preserve the remaining kidney function longer than hemodialysis, especially in the early stages of dialysis (Johnson et al., 2021).
5. **Better Lifestyle and Quality of Life:**
    1. Many patients report better overall quality of life with peritoneal dialysis, especially if they value the ability to continue daily activities and have more control over their treatment schedule.

How Long Does PD Take to DO?

- The duration of peritoneal dialysis (PD) varies depending on the type of PD treatment used and the specific needs of the patient. Here's a breakdown of the time it typically takes:
- **1. Continuous Ambulatory Peritoneal Dialysis (CAPD):**
- **Time per exchange**: Each exchange typically takes about **30–40 minutes**.
- **Number of exchanges per day**: 4 exchanges, spaced throughout the day (every 4–6 hours).
- **Total daily time**: About **2 to 2.5 hours** in total for the exchanges.
- In CAPD, the patient manually fills and drains the dialysis fluid from the abdomen at regular intervals. Each exchange includes filling the peritoneal cavity with fresh dialysate, allowing it to dwell for a few hours, and then draining the used fluid and replacing it with fresh fluid.

How Long Does PD Take to DO?

- **Automated Peritoneal Dialysis (APD):**
- **Time per night**: APD is typically done overnight, using a machine to perform the exchanges automatically while the patient sleeps.
- **Total daily time**: Since it is done during sleep, it usually takes around **8 to 10 hours** overnight for the machine to perform 3 to 5 exchanges.
- APD is more convenient for patients who prefer not to perform exchanges during the day. The automated machine handles the fluid exchanges while the patient rests, providing more flexibility during waking hours.

Disadvantages of Peritoneal Dialysis

Risk of Peritonitis:	• The main complication is peritonitis, an infection of the peritoneal cavity, which can occur due to improper catheter care or contamination of the dialysis fluid. This condition requires prompt medical attention and treatment with antibiotics.
Technique Sensitivity:	• The success of peritoneal dialysis heavily depends on the patient's ability to maintain a clean environment and handle the exchange process. This can be challenging for elderly or frail patients.
Limited Dialysis Efficiency:	• Peritoneal dialysis is generally less efficient at clearing waste and toxins compared to hemodialysis, especially in patients with advanced kidney disease (Cochran et al., 2019).
Weight Gain and Fluid Retention:	• The dialysate fluid contains glucose, which can lead to weight gain and increased risk of developing diabetes if not carefully managed.
Peritoneal Membrane Failure:	• Over time, the peritoneal membrane may lose its ability to effectively filter waste products, leading to the eventual need for switching to hemodialysis or a kidney transplant.

How Good is Dialysis?

Revised Chart: Creatinine Clearance and Kidney Function Comparisons

Dialysis Type / CKD Level	Creatinine Clearance (mL/min)	Notes
Normal Kidney Function (Stage 1)	100–120	Healthy kidneys with normal filtration.
Chronic Kidney Disease (Stage 2)	60–89	Mild kidney damage, slight decrease in clearance.
Chronic Kidney Disease (Stage 3)	30–59	Moderate decrease in kidney function.
Chronic Kidney Disease (Stage 4)	15–29	Severe kidney damage, preparation for dialysis needed.
Chronic Kidney Disease (Stage 5)	< 15	End-stage renal disease (ESRD); requires dialysis or transplant.
Hemodialysis	30–50	More efficient than peritoneal dialysis; typically performed 3 times a week.
Peritoneal Dialysis	15–30	Less efficient than hemodialysis but offers home-based treatment.

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References

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- dialysis machine diagram - Search Images
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