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Review Article

End-Stage Renal Failure: Which Therapeutic Option to Choose?

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Abstract: Managing end-stage renal failure poses a significant challenge for healthcare professionals, requiring a comprehensive approach to ensure the best outcomes for patients. The main therapeutic options include hemodialysis, peritoneal dialysis, and kidney transplantation, each with its own advantages and disadvantages. It is crucial to recognize that these methods are not mutually exclusive but rather complementary, and can be used sequentially or in combination according to individual needs. Hemodialysis involves using a machine to filter blood through an artificial kidney and remove waste and excess fluid from the body. This procedure is typically performed in a dialysis center several times a week and can be burdensome for patients due to the need for regular clinic visits. Peritoneal dialysis is another treatment option in which the peritoneum, a membrane inside the abdomen, is used as a semi-permeable membrane to filter blood. This method can be performed at home, offering more flexibility and comfort for patients. However, it requires increased patient commitment and may pose a higher risk of infections. Kidney transplantation is often considered the optimal treatment for end-stage renal failure, offering better quality of life and longer survival compared to dialysis. However, the limited number of donors and strict compatibility criteria make this option inaccessible for many patients. Therefore, it is essential for nephrology centers to offer these three therapeutic options to meet the varied needs of patients. By customizing treatment plans based on individual preferences and providing continuous support, we can improve the management of end-stage renal failure and outcomes for patients and their families. By adopting a collaborative approach, we can better address the growing demand for care for this population.

Keywords: Renal failure, hemodialysis, peritoneal dialysis, kidney transplantation.

INTRODUCTION

Chronic kidney disease (CKD) is a serious medical condition characterized by an irreversible decrease in glomerular filtration rate (GFR), which is the primary indicator of renal function. This reduction in GFR can result from the progression of chronic kidney disease over an extended period or from the non-recovery after acute kidney failure.

Chronic kidney diseases are defined by an international consensus, which states that they must present at least one of the following criteria persisting for more than 3 months:

- A glomerular filtration rate lower than 60 ml/min/1.73 m^2 [1], indicating that the kidneys are not filtering the blood as efficiently as they should.
- Clinically significant renal morphological or histological abnormality, meaning alterations in the structure or functioning of the kidneys that are clinically important.
- Abnormalities in blood or urine composition resulting from renal impairment [1].

Chronic kidney diseases can progress over time and eventually lead to end-stage renal failure, also known as end-stage renal disease (ESRD). At this stage, the kidneys lose their ability to maintain the chemical balance and filtration necessary to sustain the body's health. Without appropriate treatment such as dialysis

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or kidney transplantation, end-stage renal failure can be fatal.

The measurement of estimated glomerular filtration rate allows for the classification of chronic kidney diseases into five stages, ranging from normal renal function (stage 1) to end-stage renal failure (stage 5). This classification is crucial for assessing the severity of the disease, planning treatment, and predicting prognosis. Patients in advanced stages of CKD require close monitoring and appropriate medical management to slow disease progression and prevent serious complications.

Table 1 : Stages of chronic kidney disease. [2]

Stade	Description	GFR (ml/min/1.73 m2)
1	Chronic Kidney Disease* with normal renal function	≥ 90
2	Chronic Kidney Disease* with mild renal insufficiency**	60-89
3A	Mild to moderate renal insufficiency	45-59
3B	Moderate to severe renal insufficiency	30-44
4	Severe renal insufficiency	15-29
5	End-stage renal failure	< 15
* With markers of renal impairment: clinical proteinuria, hematuria, leukocyturia, or morphological or histological abnormalities, or markers of tubular dysfunction, persisting for more than 3 months. ** A GFR between 60 and 89 ml/min may be normal in an elderly individual [1].		

Renal Replacement Therapies :

Renal replacement therapies, including kidney transplantation, peritoneal dialysis, and hemodialysis, are considered complementary approaches rather than competitive ones. None of these methods alone can guarantee a satisfactory and definitive therapeutic response for chronic renal failure.

Contemporary management of end-stage renal disease today requires an integrated approach combining these different treatment modalities. It is crucial to inform patients, especially when they reach an advanced stage of chronic renal failure, about the various available options, taking into account their medical and social constraints to determine feasible methods.

Kidney transplantation is generally preferred due to its potential advantages in terms of quality of life and survival. However, when transplantation is not possible, dialysis becomes necessary. The choice between peritoneal dialysis and hemodialysis depends on several factors, including patient preferences, capabilities, available medical expertise, and regional resources. Dialysis is usually initiated when the glomerular filtration rate reaches a level between 5 and 10 ml/min/1.73 m^2 [3]. However, the decision to start dialysis is not based solely on the glomerular filtration rate but also on clinical and biological criteria. Clinical symptoms to consider include fatigue, deterioration in quality of life, muscle cramps, insomnia, fluid and sodium retention, poorly controlled hypertension, nausea, and weight loss due to malnutrition. From a biological perspective, it is important to consider indicators such as elevated levels of blood urea and creatinine, the rate of decline in glomerular filtration rate, hyperkalemia, acidosis, hyperphosphatemia, and hypocalcemia. These criteria help assess the need to initiate dialysis in patients with severe chronic renal failure.

Kidney Transplantation :

Kidney transplantation is considered the treatment of choice for end-stage chronic kidney disease due to its advantages in terms of survival and quality of life, while also offering significant financial savings. In Algeria, over 350 kidney transplantations were performed in 2016, demonstrating the importance of this therapeutic option in the country [4]. Kidney transplantation can be performed either before the onset of dialysis (preemptive transplantation) or afterward. Before proceeding with transplantation, patients undergo a thorough evaluation to identify any potential contraindications, such as the risk of disease recurrence, cardiovascular issues, latent infections, neoplasms, and abnormalities of the urinary tract.

Renal grafts are harvested from facilities accredited by the Ministry of Health and transplanted by specialized surgical teams. Donors can be living relatives or individuals in a state of brain death. The graft is typically implanted in the right iliac fossa of the recipient (Figure 1). To prevent graft rejection, patients must undergo immunosuppressive therapy. However, this can lead to complications, including infections, tumors, and cardiovascular problems, which may be exacerbated by inadequate immunosuppression [5]. The main challenge of kidney transplantation lies in the shortage of organs, given the high number of patients awaiting kidney transplantation. This reality underscores the importance of raising awareness about the need for organ donation and developing transplantation programs to meet the growing needs of the population with chronic kidney disease.

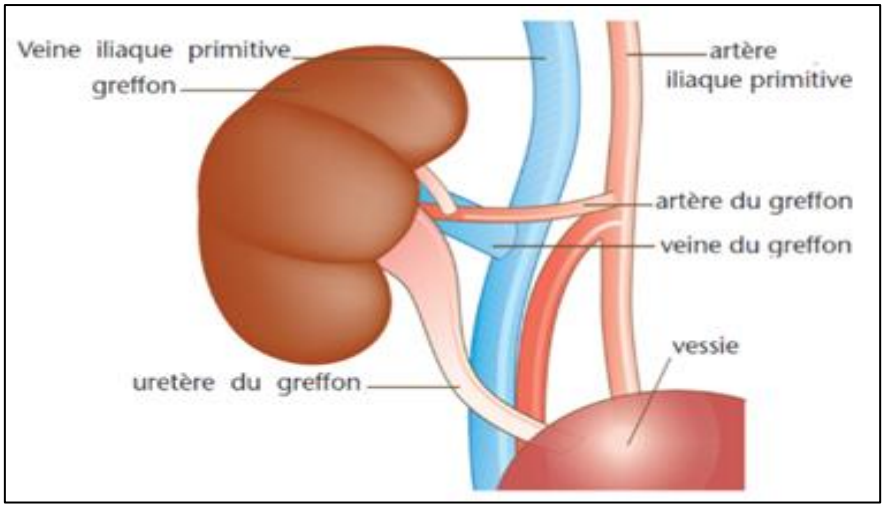

Figure 1: Appearance and vascularization of a transplanted kidney [3]

Peritoneal Dialysis :

Peritoneal dialysis is a renal replacement therapy method that offers an alternative to hemodialysis and kidney transplantation in the treatment of end-stage chronic kidney disease [6]. Peritoneal dialysis is less utilized than hemodialysis in Algeria, with approximately 2.5% of chronic kidney disease patients being treated with peritoneal dialysis [7], compared to 11% globally [8]. It is a technique that can be easily and quickly implemented, allowing for home-based treatment that is gentler and less aggressive on the cardiovascular system compared to hemodialysis [9]. The duration of peritoneal dialysis use in a patient is limited to a few years due to the progressive alteration of peritoneal properties. This method utilizes the peritoneal cavity as an exchange zone with the uremic patient, thus offering a method of intracorporeal clearance. To achieve this, peritoneal dialysis requires: a peritoneal dialysis catheter, surgically inserted approximately fifteen days before the start of peritoneal dialysis treatment (Fig. 2), a connection system that ensures exchanges are done aseptically, and sterile dialysate bags (Fig. 2). This technique helps eliminate nitrogenous waste, uremic toxins, and restore hydroelectrolytic and acid-base balance in chronic kidney disease patients. Peritoneal exchanges rely on two principles: diffusion and convection (ultrafiltration) [10]. Diffusion occurs based on transmembrane concentration gradients, and ultrafiltration is achieved using peritoneal dialysis solutions with high osmolarity, allowing for net fluid removal. Osmotic pressure is either of crystalloid (glucose, amino acids) or colloid (icodextrin) origin. There are two main modalities of peritoneal dialysis: continuous ambulatory peritoneal dialysis (Figure 2) and automated peritoneal dialysis, which utilizes a cycler device to perform overnight exchanges (Figure 3).

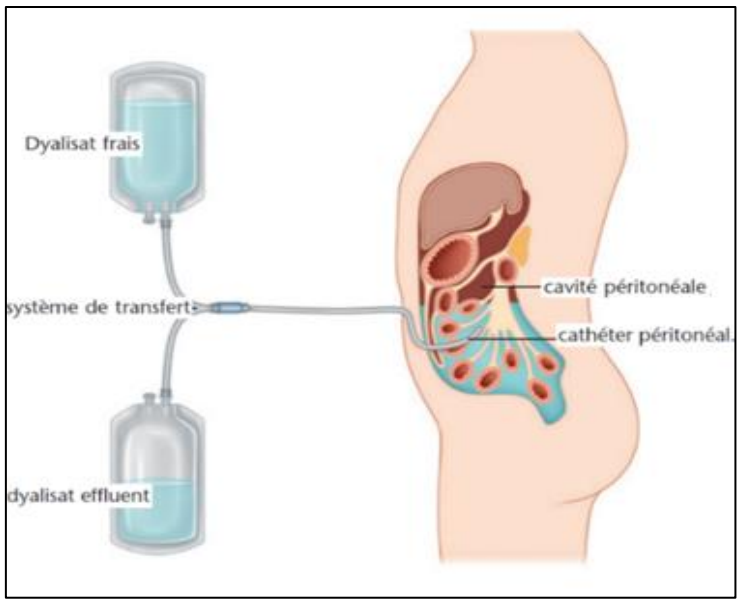

Figure 2: continuous ambulatory peritoneal dialysis [6]

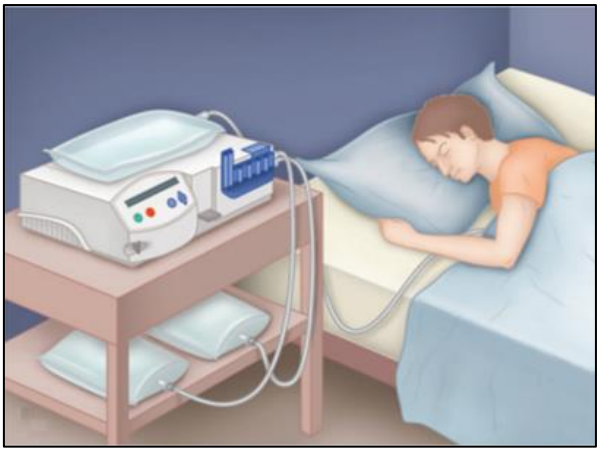

Figure 3: automated peritoneal dialysis [6]

There are multiple reasons for the underutilization of peritoneal dialysis, including the widespread availability of hemodialysis in all 48 provinces of the country, making it more accessible. The lack of reimbursement for peritoneal dialysis by social security in both public and private facilities, unlike hemodialysis, has also contributed to tilting the balance in favor of hemodialysis. Similarly, the inadequate development of peritoneal dialysis, which is only available in certain university hospital centers, has made it inaccessible to a wider audience. Additionally, other factors come into play, such as patient refusal to manage their illness, the burden of the technique, fear of abdominal surgical complications, and the patient's physical inability to self-manag

Hemodialysis :

Hemodialysis is a renal replacement technique for end-stage chronic kidney disease that provided survival for over 3 million patients worldwide in 2015 [11]. It remains the most frequently used modality worldwide, with nearly 90% of patients undergoing hemodialysis, while the remaining 10% opt for peritoneal dialysis [12]. In 2016, in Algeria, the number of patients with end-stage renal failure was 23,957, of whom 91.8% were treated with hemodialysis, only 2.5% received peritoneal dialysis, yet 5.6% of these patients were able to undergo kidney transplantation [7].

Hemodialysis meets an increasing healthcare need not covered by transplantation and peritoneal dialysis. Hemodialysis sessions are conducted three times a week, lasting approximately 4 hours, requiring vascular access through an arteriovenous fistula, arteriovenous graft, or hemodialysis catheter. Extracorporeal blood circulation is established using a hemodialysis generator (Fig. 4) and a dialyzer (Fig. 5), facilitating solute exchange by bringing the patient's blood into contact with dialysate. Two types of exchanges are used in hemodialysis treatment: diffusive transfers based on concentration gradients, allowing for the diffusion of dissolved molecules across a membrane in contact with blood and a dialysis bath, and convective transfers of dissolved molecules in the blood, achieved through ultrafiltration resulting from the application of positive hydrostatic pressure across the same semi-permeable membrane. This results in a net fluid removal, necessary for anuric patients.

Figure 4: Hemodialysis generator

Figure 5: Dialyzer

CONCLUSION

Treating end-stage renal failure poses a major challenge for healthcare professionals, and it is crucial to adopt a holistic approach to ensure the best outcomes

for patients. Hemodialysis, peritoneal dialysis, and kidney transplantation are the three main therapeutic options available, each with its own advantages and disadvantages. It is essential to understand that these methods are not mutually exclusive but rather complementary, and they can be used sequentially or in combination to meet the specific needs of each patient. Therefore, it is imperative for nephrology centers to develop and offer these three therapeutic options to adequately address the increasing demand for care for patients with end-stage renal failure. By developing expertise in each of these techniques, healthcare professionals can individualize treatment plans based on the needs and preferences of each patient while optimizing clinical outcomes and quality of life. Additionally, continuous education and support for patients and their families are essential to help them make informed decisions about their treatment and effectively manage their chronic illness. By adopting an integrated and collaborative approach, we can improve the management of end-stage renal failure and optimize outcomes for all affected patients.

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