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**COMPARATIVE ANALYSIS OF HEMODIALYSIS AND RENAL
TRANSPLANTATION TREATMENTS OF END STAGE
RENAL DISEASE**

***Abstract.** As renal failure cases rise across the USA due to a variety of diseases there aren't many treatments available and the ones that are available have a great impact on the patient as well as the health care system, previous research has relied on statistics and focused on treatments available and its success rate but excludes the personal and socioeconomic burdens that presents with it. Using data provided by the CDC, KIDGO and USRDS in this paper I will be pointing out the advantages and disadvantages of the treatments in terms of safety, availability, efficacy and socioeconomic burden both personal and healthcare system.*

***Keywords:** kidney transplant, advantages, disadvantages, ESRD*

End stage renal disease is defined as an irreversible decline in renal function, included under stage 5 of The National Kidney Foundation, Kidney Disease Outcomes Quality Initiative Classification of Chronic Kidney Disease (CKD), where it refers to individuals with a Glomerular Filtration Rate (GFR) of less than 15ml/minute per 1.73m² body surface area or those requiring dialysis irrespective of their GFR.

The K/DOQI classifies kidney failure into 5 stages based on GFR, symptomatic decline in renal function, blood markers, and organ screening and biopsy.

GFR category	GFR (ml/min/1.73 m ²)	Terms
G1	≥90	Normal or high
G2	60-89	Mildly decreased*
G3a	45-59	Mildly to moderately decreased
G3b	30-44	Moderately to severely decreased
G4	15-29	Severely decreased
G5	<15	Kidney failure

[9]

In 2018 ESRD incidence was 131,636 around 785,883 people per year are affected[10] by ESRD in the United States and is disproportionately affecting minorities and low-income society when compared to Whites.

African American population are 3.5 times more likely to have ESRD, as for Native American's and the Latinx community are 1.5 times more likely to have ESRD compared to Whites.

In 2018 the number of patients ongoing in-center hemodialysis in the United States was 112,818 as well as 68,986 were on peritoneal dialysis and in-home hemodialysis, while kidney transplantation cases were at all time high of 22,393 only 3.6 per 100 patients were ESRD patients and 26,726 newly added patients to transplant waiting-list[11].

Causes. More commonly Diabetes mellitus, Hypertension and polycystic kidney disease are the precursors of ESRD in developed countries and less commonly due to Good Pasture's disease, autoimmune-lupus erythematosus, Alport's syndrome, Henoch-Schoenlein purpura and renal artery stenosis.

Symptoms: Fluid retention, Anemia, Hyperparathyroidism, Hyperphosphatemia, Hypo- or Hypercalcemia, Dyslipidemia, Protein and energy malnutrition, Hypertension, Ventricular dysfunction, Cardiovascular events.

Treatment. In the case of end stage renal disease there aren't many options available, in such organ failure the only viable solution is replacement therapy in which the original process is replaced either by a mechanical mechanism or an organic one, which leaves us with the 3 current available treatments: Hemodialysis, Kidney Transplant, Comprehensive conservative care.

Hemodialysis

Dialysis is defined as the diffusion of molecules in solution across a semipermeable membrane along an electrochemical concentration gradient.

The primary goal of hemodialysis to filter wastes and water from the blood, as the kidneys did when they were healthy. Hemodialysis helps control blood pressure and balance important minerals, such as potassium, sodium, and calcium, in the blood. This is accomplished by the transport of solutes such as urea from the blood

into the dialysate, and by the transport of solutes such as bicarbonate from the dialysate into the blood environment, which is a characteristic of normal kidney function.

Solute concentration and molecular weight are the primary determinants of diffusion rates. Small molecules, such as urea, diffuse quickly, whereas compartmentalized and larger molecules, such as phosphate and albumin diffuse much slower, the standard for calculating dialysate adequacy is to measure the clearance of solutes that accumulate in patients with uremia for calculating the dose of dialysate Kt/V is a measure of the dose of dialysis given in a single treatment where K is the dialyzer urea clearance, T is the total treatment time, and V is the total volume within the body that urea is distributed,[6] treatment time is calculated taking into consideration the removal of solutes and accumulated excess fluid safely, some countries prefer to shorten the treatment time for financial reasons but efficacy and outcomes of this shorter time can vary with results negatively, the frequency of session standard schedule for hemodialysis is three sessions a week due to logistics and financial reasons.

Procedure. The process of hemodialysis includes acquiring double access to blood arterial and venous, the arterial blood is pumped into the dialysis machine to pass through the dialyzer filter with addition of heparin for clot prevention, it's filtered through the specialized filter called dialyzer and then passes through an air trap and detector for embolus prevention and then returned back through the venous access to the circulation.

Patients that undergo dialysis are in need of the treatment chronically or till transplant is available, in these patients' continuous dialysis is done, there for achieving a safe and easy access cannulation of the vessels was invented.

Three types of vascular access exist:

- An arteriovenous (AV) fistula: is a connection, made by a vascular surgeon, of an artery to a vein.
- An AV graft: is a looped, plastic tube that connects an artery to a vein.
- A catheter: is a tube inserted into a vein in the neck, chest, or leg near the groin, usually only for short-term hemodialysis.

Risks:

1) vascular access complications-Due to intensive HD, number of access cannulations per week and overall stress on the access increases, patients undergoing intensive HD may have a higher incidence of access complications.

2) Infection- a major cause of morbidity and mortality in dialysis patients. Infection is the primary cause of death in almost 10% of cases.

3) Loss of kidney function-Accelerated loss of residual kidney function may increase the number of morbidity and mortality in dialysis patients.

4) Solute imbalances-Intensive HD increases the clearance of solutes. However, aggressive clearance may increase solute deficiencies.

5) Patient and care partner burden-Intensive HD increases the number of days per week that are accompanied by dialysis treatment. This may increase the burden of dialysis on patients and their care partners

Benefits. Vast availability, Different methods of application, IHD, peritoneal, nocturnal HD, CIHD, Quick solution for restoring metabolic balance in AKD, CKD.

Significant improvement in quality of life of the patient, the patient can maintain a close to normal functioning life style with some modification that are considered minor in comparison with the benefits of this procedure.

Renal Transplantation

Kidney transplantation is the act of transferring an organ (kidney) from a live or a deceased donor to a living one, Kidney transplant is the treatment of choice for patients with end-stage renal disease it offers the greatest potential in restoring a healthy, productive life in most patients who undergo this procedure, it has a high patient survival rate and quality of life and financially it's cost effective for the health care system and individual himself.

At the moment two types of donors are available cadaveric or living donors.

Living donor with HLA match is the optimal option for transplant and has the highest success and survival rate, with lower risk for rejection. Only in 2020 an amount of 5234 living donor kidney transplants and 17,583 of cadaveric kidney transplants were performed in the USA.

Procedure. Preoperative evaluation is the process to identify an absolute contraindication in transplant candidates and/or any factors that may compromise the organ after transplantation those include: medical, surgical, immunological, psychosocial.

Surgical procedure, a donated kidney is usually placed in the right iliac fossa because of the more superficial location of the iliac vein on this side the standard approach for this procedure is extra peritoneal.

Risks. Infection and bleeding (hemorrhage), lymphocele, occurs in up to 20% of transplant patients, urine leak outside of the bladder occurs in approximately 3% of kidney transplants, rejection hyper acute, acute, chronic, graft vs host rejection, post-op infection due to immunosuppression especially CMV and Varicella zoster may occur due to decreased immunity and reactivation.

Benefits. Permanent solution for kidney failure, independency from machinery and permanent vascular accesses, reduced risks caused by hemodialysis (infections, vascular collapse, coagulopathies), restored social status and activity, lower financial burden on individuals and on the health care system in the long run.

Comparison between hemodialysis and renal transplantation

Advantages of transplant over dialysis are lower average costs in the long run estimated savings with transplant by year 2 post transplantation the patient breaks even with the initial cost of transplantation, after 2 years estimated savings \$30,000-50,000 each year, deceased donor survival rate 10-12 years in which estimates savings per patient in the USA are ~ \$ 240,000-\$400,000 while a living donor survival rate 15-20 years with estimated savings ~ \$ 390,000-\$900,000.

The total expenditures on ESRD patients in the USA was 36.6 billion in 2018 alone.

When it comes to Quality of life[7] post transplantation patients experience independency from machinery, dietary freedom, Sense of well-being, ease of travel, ease of work, higher chances of successful pregnancy, better sleep quality and lastly decreased depression and anxiety.

Even when accounting for risks related to surgery and immunosuppressive therapy, transplant remains the optimal treatment option.

As discussed above both procedures have benefits and risks, one has higher benefit to risk ratio, both procedures help maintain fluid balance by filtration but as far as synthetic mesh and dialysate fluids it will never replace an organic kidney when it comes to function and percentage of successful fluid filtration and electrolyte balance. Having an organic option is superior to synthetic alternative even considering the risks that come with the procedure used to obtain such organ and transplanting it.

These two treatments are implemented to extend and better the quality of life of a diseased person both procedures help on decreasing the symptoms of edema and fluid retention, hypertension, fatigue, cardiovascular events, calcium and electrolyte disturbances, this is accomplished quite successfully in both procedures but the physical burden from hemodialysis impacts the social life of the patient significantly having to comply to a very strict dietary regimen and strict hemodialysis appointments 2-4 a week for months, this kind of procedure is very fatiguing impacting the patient in all aspects of life- socially, financially, physically and mentally

socially these patients cannot travel far and are restricted when it comes to normal gatherings having a physical cannulation is also awkward and embarrassing for some patients, the same cannulation is very restrictive in movements and what was considered normal movement for a patient is now a struggle and restricted function.

The longsome procedure and the quantity of caregivers and medical professionals required to attend to this procedure has a toll on the healthcare system and in terms financially on the patient as well, In some countries healthcare insurance and the government can cover most of these expenses but in others some unfortunate patients cannot maintain hemodialysis due to the expenses that come with it, therefore if a one-time expense such as kidney transplant is available it is a far better choice especially when the recovery is considerably short and returning to work capacity is possible as soon as the recovery period post-surgery is done, although restricted physically more jobs can be considered by the patient's because they are not restricted by hemodialysis regimens.

The mental impact of this chronic disease is debilitating, a greater improvement can be seen in patients post-transplant rather than in patients on hemodialysis due to the fact that the restrictions on the patient's lifestyle and financial status are far less.

Life expectancy for patients that went through renal transplantation shows significant increase for all groups of ages as well as groups with comorbidities such as diabetes mellitus and cardiovascular diseases.[8] This furthers the superiority of an organ transplantation over synthetic solution as in hemodialysis.

Conclusion

End stage renal disease treatments availability varies mostly dependent on the country of residence and the patient's socioeconomical status which dictates the treatment of choice for said patient, as for the treatment of choice always if there is availability in kidney failure patients that are able to undergo surgical procedure the choice should be a kidney transplantation it has been proven in numerous publications and studies how superior it is over any type of dialysis as well as significant increase of life expectancy even in the presence of co-morbidities.

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