World Journal of Pharmaceutical Science and Research
www.wjpsronline.com
Review Article
ISSN: 2583-6579
SJIF Impact Factor: 5.111
Year - 2025
Volume: 4; Issue: 3
Page: 1462-1467

A REVIEW OF DIAGNOSIS AND MANAGEMENT IN END-STAGE RENAL DISEASE

Lubina Sahnas*, Dr. K. Sreejith, Shabeeba O. P., Vismaya M.V. and Milin Thomas

College of Pharmaceutical Sciences, Govt. Medical College Kozhikode, Kerala, India.

Article Received: 20 May 2025 | | ***Article Revised: 10 June 2025*** | | ***Article Accepted: 30 June 2025***

***Corresponding Author: Lubina Sahnas**
College of Pharmaceutical Sciences, Govt Medical College Kozhikode, Kerala, India.
DOI: https://doi.org/10.5281/zenodo.15806756

How to cite this Article: Lubina Sahnas, Dr. K. Sreejith, Shabeeba O. P., Vismaya M.V. and Milin Thomas (2025) A REVIEW OF DIAGNOSIS AND MANAGEMENT IN END-STAGE RENAL DISEASE. World Journal of Pharmaceutical Science and Research, 4(3), 1462-1467. https://doi.org/10.5281/zenodo.15806756

ABSTRACT

End-Stage Renal Disease (ESRD) represents the terminal stage of chronic kidney disease (CKD), marked by irreversible loss of kidney function and a glomerular filtration rate (GFR) of less than 15 mL/min/1.73 m². This life-threatening condition necessitates renal replacement therapies, such as dialysis or kidney transplantation, to sustain life. The etiology of ESRD is multifactorial, with diabetes mellitus, hypertension, and glomerulonephritis being leading causes. Patients often present with symptoms like fatigue, fluid retention, and altered urinary output. Diagnosis relies on laboratory markers, imaging, and sometimes biopsy. Effective management includes dialysis, pharmacological interventions, dietary modifications, and ultimately transplantation. Additionally, addressing complications such as cardiovascular disease, anemia, mineral-bone disorders, and infections is critical. Despite significant morbidity and mortality, multidisciplinary care and early intervention can improve outcomes and quality of life. This review emphasizes comprehensive ESRD management, highlights novel therapeutic approaches, and underscores the importance of prevention through early risk factor control.

KEYWORD: End-Stage Renal Disease (ESRD), chronic kidney disease (CKD), glomerular filtration rate (GFR).

INTRODUCTION

End-Stage Renal Disease (ESRD) is defined by a persistent glomerular filtration rate (GFR) of 15ml/min/1.73m².[1]It is the final and most severe phase of chronic kidney disease (CKD). In ESRD, the kidneys have lost about 90% or more of their function and can no longer adequately filter waste products, maintain fluid and electrolyte balance, or regulate essential body processes. This condition is life-threatening and requires renal replacement therapy, such as dialysis or kidney transplantation, to sustain life.[2]

Significance in nephrology

ESRD represents irreversible kidney failure requiring renal transplantation therapy to sustain life. It is associated with the following.

1. **Irreversible Kidney Failure:** ESRD is characterized by irreversible kidney damage. Without intervention, accumulation of uremic toxins, electrolyte imbalances, and fluid overload can lead to fatal outcomes.
2. **High Morbidity and Mortality:** Patients with ESRD experience significantly increased risks of cardiovascular events, infection, and mortality.[3] Life expectancy and quality of life are markedly reduced.
3. **Economic and Healthcare Burden:** ESRD imposes a substantial economic burden. In the United States, for example, Medicare expenditure on ESRD patients exceeded $50 billion in 2020, despite representing less than 1% of the population.[4]
4. **Patient-Centered Decisions:** ESRD care involves complex decisions tailored to the patient's goals, especially concerning dialysis initiation, transplant candidacy, and end-of-life planning.

ETIOLOGY OF ESRD

ESRD is typically the result of long-standing kidney damage.

A. Most common causes include:

1. **Diabetes mellitus (Type 1 and 2)** - The leading cause, as high blood sugar damages kidney blood vessels.[5]
2. **Hypertension (High Blood Pressure)** - Increases pressure on kidney filters, causing progressive damage.[6]
3. **Glomerulonephritis** - Inflammation of the kidney's filtering units.[7]
4. **Polycystic Kidney Disease (PKD)** - A genetic disorder causing fluid-filled cysts to form in the kidneys.[8]
5. **Chronic pyelonephritis** - Long-term kidney infections.
6. **Obstructive uropathy** - Conditions that block the flow of urine, like kidney stones or enlarged prostate.

B. Risk factors

1. **Genetic predisposition**- genetic factors such as family history increase ESRD risk. Mostly observed genetic syndromes include Autosomal dominant polycystic kidney disease and Alport syndrome.
2. **Environmental and lifestyle factors**- lifestyle factors including diet, smoking and physical inactivity contribute to ESRD risk.
3. **Comorbidities**- comorbid conditions like cardiovascular disease also increase management of ESRD.

PATHOPHYSIOLOGY

In a healthy kidney, each nephron adds to the total glomerular filtration rate (GFR). In chronic kidney disease, function declines slowly and may not show symptoms early. Regardless of the cause, the kidneys compensate by increasing filtration and size of the remaining nephrons, which helps preserve GFR initially. As a result, early-stage kidney damage may not be detected due to normal serum creatinine levels.[9]

This adaptive process helps maintain normal waste removal but gradually harms the surviving nephrons. GFR often appears normal until it drops by about 50%, at which point levels of waste products like urea and creatinine begin to rise. For instance, an increase in creatinine from 0.6 to 1.2 mg/dL may signal a 50% loss in nephron function, even though it falls within the normal range.

While hyperfiltration helps at first, it eventually increases pressure in the glomeruli, leading to damage and scarring such as focal segmental glomerulosclerosis. Medications like ACE inhibitors or ARBs can help slow this progression and protect kidney function.[9]

SYMPTOMS

As kidney function declines, patients may experience:

- Fatigue and weakness
- Nausea and vomiting
- Loss of appetite
- Fluid retention (edema)
- Difficulty concentrating
- Itching
- Shortness of breath
- Muscle cramps or twitches
- Changes in urine output
- High blood pressure

DIAGNOSIS

Diagnosis is based on:

1. **Blood tests:** Elevated levels of urea (BUN) and creatinine indicate reduced kidney function.[10]
2. **Estimated Glomerular Filtration Rate (eGFR):** ESRD is defined as an eGFR of less than 15 mL/min/1.73 m^2.[11]
3. **Urine analysis:** Presence of protein, blood, or other abnormalities.
4. **Imaging:** Ultrasound or CT scan to assess kidney size and structure.
5. **Biopsy:** In selected cases, to determine underlying cause.

MANAGEMENT AND TREATMENT

1. Dialysis

- Hemodialysis (HD): Blood is filtered through a machine and returned to the body.[12]
- Peritoneal Dialysis (PD): Uses the lining of the abdomen to filter blood via a catheter.

2. Kidney Transplantation

A kidney transplant is the most definitive treatment for ESRD. Success depends on tissue match, overall health, and post-transplant care.[13]

3. Medications

Managing end-stage renal disease involves addressing specific clinical factors to slow down the disease's progression. Key strategies include:

a) **Blood pressure control and Proteinuria management:** Controlling the underlying condition and managing blood pressure and protein in the urine: Blood pressure should ideally be under 130/80 mmHg. In diabetic patients with proteinuria, medications like ACE inhibitors or ARBs are advised, especially when urine albumin levels are elevated. These medications help slow kidney damage progression and are most effective when started early.[14]

b) **Preventive care and monitoring:** This includes strict blood sugar control, cardiovascular risk reduction, and lifestyle changes such as quitting smoking and adjusting diet. Maintaining hemoglobin A1C levels below 7% is generally beneficial. In type 2 diabetes, medications like SGLT-2 inhibitors can reduce kidney stress.[15]

c) **Correcting metabolic acidosis:** Supplementing with renal bicarbonate may help slow kidney deterioration.[16]

d) **Managing lipid levels:** Patients often have abnormal lipid levels. Regular lipid panel checks and starting statin therapy (HMG-CoA reductase inhibitors) early can help.[17]

e) Treating fluid overload or lung congestion: Use of loop diuretics or procedures like ultrafiltration may be necessary.

f) **Addressing anemia:** Use of erythropoiesis-stimulating agents (ESAs), such as erythropoietin, can be beneficial.

g) **Managing high phosphate levels (hyperphosphatemia):** Phosphate binders (e.g., calcium acetate or sevelamer) and low-phosphate diets are recommended.

h) **Monitoring and treating low vitamin D levels:** If 25-OH vitamin D is below 10 ng/mL, ergocalciferol supplements are given weekly before switching to daily cholecalciferol.[18]

i) **Managing high parathyroid hormone levels:** Use of calcitriol, vitamin D analogs, or medications that mimic calcium is recommended.

4. Dietary Modifications

- Low-sodium, low-potassium, and low-phosphate diets
- Protein intake adjusted according to treatment modality
- Fluid restrictions in patients with low urine output

COMPLICATIONS

- Cardiovascular disease (leading cause of death in ESRD patients).[19]
- Anemia
- Mineral and bone disorders
- Infections (especially in dialysis patients)
- Malnutrition
- Depression and decreased quality of life

PROGNOSIS

Without treatment, ESRD is fatal. With dialysis or transplantation, patients can live for many years, but life expectancy is reduced compared to the general population.

PREVENTION

The best way to prevent ESRD is by managing risk factors:

- Tight control of blood sugar in diabetics
- Blood pressure control
- Regular monitoring of kidney function in at-risk individuals
- Avoiding nephrotoxic drugs
- Maintaining a healthy lifestyle (diet, exercise, smoking cessation)

CONCLUSION

End-Stage Renal Disease is a serious condition with significant health impacts. While it cannot be reversed, early detection and management of kidney disease can delay its progression. For those who reach ESRD, advances in dialysis and transplantation have significantly improved survival and quality of life.

REFERENCES

1. Kidney Disease: Improving Global Outcomes (KDIGO) CKD Work Group. KDIGO 2012 clinical practice guideline for the evaluation and management of chronic kidney disease. Kidney Int Suppl, 2013; 3(1): 1–150.
2. National Kidney Foundation. About Chronic Kidney Disease [Internet]. 2023 [cited 2025 Jun 16]. Available from: https://www.kidney.org/atoz/content/about-chronic-kidney-disease
3. Collins AJ, Foley RN, Gilbertson DT, Chen SC. The state of chronic kidney disease, ESRD, and morbidity and mortality in the United States. Kidney Int Suppl, 2020; 10(1): e1–15.
4. United States Renal Data System. 2022 USRDS Annual Data Report: Epidemiology of kidney disease in the United States. Bethesda (MD): National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases; 2022.
5. American Diabetes Association. Kidney Disease & Diabetes [Internet]. 2023 [cited 2025 Jun 16]. Available from: https://www.diabetes.org/diabetes/kidney-disease
6. American Heart Association. High Blood Pressure and Kidney Disease [Internet]. 2022 [cited 2025 Jun 16]. Available from: https://www.heart.org/en/health-topics/high-blood-pressure/health-threats-from-high-blood-pressure/kidney-damage-and-high-blood-pressure
7. Mayo Clinic. Glomerulonephritis [Internet]. 2023 [cited 2025 Jun 16]. Available from: https://www.mayoclinic.org/diseases-conditions/glomerulonephritis
8. PKD Foundation. What is Polycystic Kidney Disease? [Internet]. 2023 [cited 2025 Jun 16]. Available from: https://pkdcure.org/what-is-pkd/
9. Hashmi MF, Benjamin O, Lappin SL. End-stage renal disease [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan– [updated 2023 Aug 28; cited 2025 Jun 26]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK499861/
10. National Institutes of Health. Kidney Function Tests [Internet]. 2023 [cited 2025 Jun 16]. Available from: https://medlineplus.gov/lab-tests/kidney-function-tests/
11. National Kidney Foundation. GFR and Kidney Disease Staging [Internet]. 2023 [cited 2025 Jun 16]. Available from: https://www.kidney.org/atoz/content/gfr.
12. U.S. National Library of Medicine. Hemodialysis [Internet]. 2022 [cited 2025 Jun 16]. Available from: https://medlineplus.gov/ency/article/007029.htm.
13. National Institute of Diabetes and Digestive and Kidney Diseases. Kidney Transplant [Internet], 2023 [cited 2025 Jun 16]. Available from: https://www.niddk.nih.gov/health-information/kidney-disease/kidney-failure/kidney-transplant.
14. Son HE, Ryu JY, Go S, Yi Y, Kim K, Oh YK, Oh KH, Chin HJ. Association of ambulatory blood pressure monitoring with renal outcome in patients with chronic kidney disease. Kidney Res Clin Pract, 2020 Mar 31; 39(1): 70-80. doi: 10.23876/j.krcp.19.103. PMID: 32079380; PMCID: PMC7105625.
15. Weir MR, McCullough PA, Buse JB, Anderson J. Renal and Cardiovascular Effects of Sodium Glucose Co-Transporter 2 Inhibitors in Patients with Type 2 Diabetes and Chronic Kidney Disease: Perspectives on the

Canagliflozin and Renal Events in Diabetes with Established Nephropathy Clinical Evaluation Trial Results. Am J Nephrol, 2020; 51(4): 276-288. doi: 10.1159/000506533. Epub 2020 Mar 13. PMID: 32172239.

16. Tanemoto M. Progression of Metabolic Acidosis in Chronic Kidney Disease. Kidney Dis (Basel), 2020 Jan; 6(1): 59-63. doi: 10.1159/000502380. Epub 2019 Oct 18. PMID: 32021875; PMCID: PMC6995968.
17. Jung J, Bae GH, Kang M, Kim SW, Lee DH. Statins and All-Cause Mortality in Patients Undergoing Hemodialysis. J Am Heart Assoc, 2020 Mar 3; 9(5): e014840. doi: 10.1161/JAHA.119.014840. Epub 2020 Feb 22. PMID: 32089045; PMCID: PMC7335561.
18. Zand L, Kumar R. The Use of Vitamin D Metabolites and Analogues in the Treatment of Chronic Kidney Disease. Endocrinol Metab Clin North Am, 2017 Dec; 46(4): 983-1007. doi: 10.1016/j.ecl.2017.07.008. Epub 2017 Sep 29. PMID: 29080646; PMCID: PMC5977979.
19. Centers for Disease Control and Prevention. ESRD and Cardiovascular Disease [Internet]. 2023 [cited 2025 Jun 16]. Available from: https://www.cdc.gov/kidneydisease/publications-resources/ckd-national-facts.html11.United States Renal Data System. Annual Data Report [Internet]. 2023 [cited 2025 Jun 16]. Available from: https://usrds-adr.niddk.nih.gov/.