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Chronic Kidney Disease: A Comprehensive Review

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Abstract

Chronic Kidney Disease (CKD) is a progressive condition characterized by a long-term decline in kidney function, leading to a gradual deterioration of the kidneys' ability to filter waste and maintain fluid balance. It is diagnosed when the Glomerular Filtration Rate (GFR) falls below 60 ml/min/1.73 m² or when there is evidence of kidney damage (such as proteinuria) lasting for 3 months or more. The most common causes of CKD are chronic conditions such as diabetes and hypertension, which contribute to the damage of the kidney's structures over time. As the disease advances, CKD can lead to several complications that impact overall health. Anemia, often due to reduced erythropoietin production by the kidneys, and cardiovascular diseases, including hypertension and heart failure, are prevalent in CKD patients. Furthermore, if left untreated, CKD may progress to end-stage renal disease (ESRD), where kidney function becomes critically low, and the patient may require dialysis or a kidney transplant to sustain life. Early detection of CKD is essential for effective management. Routine screening for individuals at risk, such as those with diabetes, hypertension, or a family history of kidney disease, is recommended. Treatment strategies focus on controlling the underlying causes, such as blood pressure and blood sugar management, alongside lifestyle changes, including dietary modifications and weight management. Medical interventions, such as medications to manage symptoms and slow the progression of the disease, also play a key role in preserving kidney function and preventing the need for more intensive treatments like dialysis.

Keywords: Chronic Kidney Disease (CKD), Glomerular Filtration Rate (GFR), End-stage Renal Disease (ESRD), hypertension, anemia

INTRODUCTION

Chronic Kidney Disease (CKD) is a long-term, progressive condition that results in the gradual decline of kidney function. The kidneys are essential for filtering waste, excess fluid, and regulating the body's electrolyte balance. As CKD advances, the kidneys' ability to carry out these crucial tasks decreases, potentially leading to severe health complications. If not properly managed or treated, CKD can progress to kidney failure, or end-stage renal disease (ESRD), which requires dialysis or a kidney transplant to sustain life. CKD has widespread effects, impacting not only the kidneys but also other organs, particularly the cardiovascular system [1].

The main causes of CKD are diabetes, hypertension (high blood pressure), and glomerulonephritis, which is an inflammation of the kidney's filtering units. Diabetes is the leading cause of CKD, mainly due to its impact on the kidneys' ability to filter effectively. High blood pressure causes damage to the kidneys by exerting excessive pressure on the blood vessels, resulting in scarring and gradually impairing kidney function [2].

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Glomerulonephritis, which may be caused by infections, autoimmune diseases, or other factors, damages the glomeruli, the kidney's filtration units. In addition to these primary causes, other factors such as obesity, smoking, a family history of kidney disease, and age can also increase the risk of developing CKD [3].

The insidious nature of CKD is that it often progresses silently in its early stages, with patients typically experiencing no noticeable symptoms. Many individuals with CKD may be unaware that they have the disease until it reaches more advanced stages, making early detection and monitoring crucial for effective management. Regular blood and urine tests are essential for identifying early kidney damage, as they can detect changes in kidney function, such as elevated creatinine levels or the presence of protein in the urine (proteinuria). Early detection enables prompt intervention, which can help slow the progression of the disease and avoid complications [4].

As the disease progresses, symptoms begin to manifest, particularly in the later stages. Common symptoms of advanced CKD include swelling (edema), especially in the legs, ankles, and around the eyes, fatigue, nausea, loss of appetite, difficulty concentrating, and frequent urination. The buildup of waste products in the body caused by impaired kidney function can lead to uremia, contributing to many of the associated symptoms. Additionally, CKD frequently causes other complications, including high blood pressure, anemia, bone disease, and cardiovascular issues, which can further weaken a patient's overall health.

CKD is divided into five stages based on kidney function, starting from Stage 1 (mild kidney damage with normal or slightly reduced kidney function) to Stage 5 (end-stage kidney failure, or ESRD). As CKD progresses, patients may need dialysis or a kidney transplant to survive. However, with proper treatment and lifestyle changes, it is often possible to slow down or even prevent progression to ESRD. Adopting healthy habits such as maintaining a balanced diet, controlling blood sugar and blood pressure, and quitting smoking can greatly lower the risk of CKD worsening [5].

The global prevalence of CKD is rising steadily, with an increasing number of individuals being diagnosed, particularly in regions with high rates of diabetes and hypertension. In fact, CKD has become a major public health concern worldwide. The disease's growing burden underscores the need for enhanced awareness, early detection, and effective management strategies. Improving access to healthcare, particularly in underserved areas, and promoting public health initiatives aimed at preventing diabetes, hypertension, and other risk factors are essential steps toward reducing the impact of CKD. Ultimately, by focusing on early diagnosis and intervention, the quality of life for individuals with CKD can be significantly improved, and the burden on healthcare systems can be alleviated [6].

Sign and symptom of Chronic Kidney Disease

The symptoms of Chronic Kidney Disease (CKD) typically progress slowly and may not be evident in the early stages. As kidney function deteriorates, the symptoms become more noticeable. Common signs and symptoms include:

1. *Fatigue:* A general sense of tiredness or low energy, often caused by anemia, is a common complication of CKD.
2. *Swelling (Edema):* Fluid retention can lead to swelling, particularly in the legs, ankles, feet, and around the eyes.
3. *Urine Changes:* Urine changes can be indicative of underlying health issues. One common change is foamy or bubbly urine, which may occur due to protein leakage, a sign of kidney problems. Another potential change is an increase or decrease in urination, particularly during the night, which can be associated with various conditions such as diabetes or urinary tract infections. Additionally, the presence of blood in the urine, known as hematuria, can cause the urine to appear pink or red. This may be a result of kidney stones, infections, or other more serious conditions affecting the urinary tract. Monitoring these changes is important for early detection and management of potential health concerns.

4. *Shortness of Breath:* Fluid accumulation in the lungs (pulmonary edema) can make breathing difficult.
5. *High Blood Pressure (Hypertension):* Since the kidneys regulate blood pressure, CKD can exacerbate high blood pressure.
6. *Nausea and Vomiting:* The buildup of waste products in the body can lead to nausea and vomiting, commonly due to uremia.
7. *Loss of Appetite:* Reduced appetite, often due to uremia or the body's inability to process nutrients properly.
8. *Itchy Skin:* Waste buildup in the body can lead to skin itching, which may worsen with kidney disease progression.
9. *Back Pain:* Pain in the lower back, where the kidneys are located, especially if there are issues such as kidney stones or infections.
10. *Confusion or Difficulty Concentrating:* Uremic toxins can affect brain function, leading to mental cloudiness or trouble concentrating.
11. *Ankle or Leg Cramps:* Often caused by imbalances in electrolytes, such as calcium or potassium, due to kidney dysfunction.
12. *Bad Breath or Metallic Taste:* Uremia can cause a metallic taste in the mouth or foul-smelling breath due to the buildup of waste products.[5]

Chronic Kidney Disease (CKD) is divided into five stages, which are determined by the glomerular filtration rate (GFR) and the extent of kidney damage. Below is an overview of these stages:

Stage 1: Mild Kidney Damage
- *GFR:* 90 or higher (normal kidney function)
- Kidney damage is present (e.g., protein in urine), but kidney function is still normal.
- No noticeable symptoms; typically detected through routine tests.

Stage 2: Mild Kidney Damage (with mild decrease in GFR)
- *GFR:* 60–89
- There is mild kidney damage (e.g., slight protein in the urine) and a slight reduction in kidney function.
- Symptoms are generally not noticeable at this stage.

Stage 3: Moderate Kidney Damage
- *GFR:* 30–59
- Moderate reduction in kidney function occurs. This stage is often when symptoms may begin to appear, such as fatigue, swelling, and high blood pressure.
- Regular monitoring is crucial to prevent further damage.

Stage 4: Severe Kidney Damage
- *GFR:* 15–29
- Severe reduction in kidney function, leading to more obvious symptoms like swelling, nausea, and trouble concentrating.
- Medical intervention is necessary to manage symptoms and prevent progression to end-stage renal disease.

Stage 5: End-Stage Kidney Failure (Kidney Failure)
- *GFR:* Less than 15
- Kidneys are no longer able to function effectively, and waste builds up in the body.
- Dialysis or a kidney transplant is needed for survival.

MANAGEMENT

Control Underlying Causes

- *Manage Diabetes:* Keep blood sugar levels in check through medication, diet, and exercise.
- *Control Blood Pressure:* Aim for a blood pressure under 130/80 mmHg using medications and a healthy lifestyle.

Medications

- *Blood Pressure Medicines:* ACE inhibitors, ARBs, or diuretics can help protect the kidneys.
- *Medications for Anemia:* To treat low red blood cell count due to CKD.
- *Phosphate Binders:* To manage high phosphorus levels in the blood (in later stages).

Lifestyle Changes

- *Diet:* Eat a low-salt, low-protein diet to reduce kidney strain. Limit phosphorus and potassium if needed.
- *Exercise:* Regular physical activity helps control weight, blood pressure, and overall health.
- *Quit Smoking:* Smoking worsens kidney damage and increases heart risks.

Monitor and Treat Complications

- *Fluid Balance:* Use diuretics to manage swelling (edema) and control fluid levels.
- *Bone Health:* Take calcium or vitamin D supplements to keep bones strong.
- *Electrolyte Management:* Regular blood tests to track and correct imbalances in potassium and other minerals.

Dialysis (If Needed)

- *Hemodialysis:* A machine cleans your blood if your kidneys cannot do it anymore (usually when kidney function is less than 15%).
- *Peritoneal Dialysis:* Uses the lining of your abdomen to filter waste, done at home.

Kidney Transplant (For End-Stage CKD)

- *Transplant:* If kidneys stop working completely (Stage 5), a kidney transplant may be the best option.

Regular Check-ups

- *Blood and Urine Tests:* Monitor kidney function, protein levels, and electrolytes regularly.
- *Blood Pressure Monitoring:* Keep blood pressure within the target range.

DISCUSSION

Finerenone, a nonsteroidal mineralocorticoid receptor antagonist (MRA), has garnered significant attention for its potential therapeutic effects in chronic kidney disease (CKD), especially due to its ability to reduce proteinuria and mitigate cardiovascular risks, both of which are major concerns in CKD patients. A growing body of evidence, including various clinical trials and meta-analyses, underscores its role in improving renal and cardiovascular outcomes, thus offering a promising treatment approach in this patient population [7].

Chronic kidney disease is a progressively worsening condition marked by the slow decline in kidney function, resulting in considerable morbidity and mortality. A key characteristic of CKD is proteinuria, which serves as a crucial indicator of kidney damage and a predictor of the disease's advancement. Proteinuria, often caused by glomerular hyperfiltration and damage to the glomerular filtration barrier, accelerates kidney function decline. Therefore, reducing proteinuria is a key therapeutic goal in CKD management. Finerenone has been shown to significantly reduce proteinuria, which directly correlates with improved kidney function and a slower disease progression [8].

In addition to its antiproteinuric effects, finerenone also addresses the increased cardiovascular risk associated with CKD. Cardiovascular diseases (CVD) are the leading cause of death in patients with CKD, with kidney dysfunction contributing to a heightened risk of heart failure, myocardial infarction, and stroke. The mineralocorticoid receptor, when activated by aldosterone, promotes sodium retention, fibrosis, and inflammation, all of which contribute to cardiovascular and renal damage. By inhibiting the mineralocorticoid receptor, finerenone reduces the deleterious effects of aldosterone on both the heart and kidneys. Clinical studies have demonstrated that finerenone significantly reduces the incidence of cardiovascular events, such as heart failure hospitalization and major adverse cardiovascular events (MACE), among CKD patients, thereby improving long-term outcomes.

Several large-scale clinical trials, including the FIDELIO-DKD and FIGARO-DKD studies, have provided robust evidence for the efficacy of finerenone in both proteinuria reduction and cardiovascular protection. These trials showed that finerenone, when added to standard therapy, not only reduced proteinuria but also improved renal outcomes by slowing the progression of CKD to end-stage renal disease (ESRD). The trials also demonstrated a decrease in the risk of cardiovascular complications, especially in individuals with type 2 diabetes and diabetic kidney disease, which are often linked to an increased risk of both kidney and heart-related issues. Furthermore, finerenone's safety profile has been proven, showing a reduced risk of hyperkalemia when compared to older MRAs such as spironolactone and eplerenone. This makes finerenone a more viable treatment option, as hyperkalemia is a common and potentially life-threatening side effect of MRA therapy, particularly in patients with impaired renal function [9].

In conclusion, finerenone offers a dual benefit for patients with CKD by effectively reducing proteinuria and lowering cardiovascular risks. These effects not only address the renal complications associated with CKD but also help mitigate the high burden of cardiovascular morbidity and mortality in this patient group. As such, finerenone stands out as a promising treatment option that can significantly improve both kidney and heart health in individuals with chronic kidney disease, especially those at high risk of cardiovascular events [10].

CONCLUSION

Chronic kidney disease (CKD) is a growing public health concern in Mexico, significantly impacting health outcomes. Screening for CKD is crucial due to its high prevalence, progressive nature, association with increased cardiovascular risk, and the availability of effective interventions to slow its progression and reduce mortality. While population-based screening remains debated, targeted screening for high-risk groups, such as those with diabetes, hypertension, cardiovascular disease, urinary tract disorders, autoimmune conditions, or a family history of kidney disease, is cost-effective. Integrating CKD screening and management into national non-communicable disease (NCD) programs is essential, as the limited number of nephrologists cannot meet the rising demand for renal care. Primary care providers are in an ideal position to spearhead efforts for preventing and detecting CKD at an early stage.

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