Original Article

Prevalence of Complications in Chronic Kidney Disease: Comparative Analysis of Cardiovascular Outcomes with Hemoglobin Maintenance in Chronic Kidney Disease Patients

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ABSTRACT

Background: Chronic kidney disease (CKD) is a progressive condition marked by a gradual decline in kidney function. As CKD advances, it is associated with numerous complications, particularly cardiovascular disease (CVD), which is a leading cause of morbidity and mortality in affected individuals.

Aim: This study aims to explore the prevalence of complications in CKD, emphasizing anaemia and its implications for cardiovascular disease outcomes.

Methodology: This cross-sectional study will evaluate the complications associated with CKD, focusing on anaemia and its cardiovascular effects. Patients will be selected based on specific inclusion and exclusion criteria, with data collected from electronic health records, including demographic details, medical histories, laboratory results, and treatment information.

Results: The findings indicate that men are at a greater risk of developing CKD than women, particularly individuals aged 60-69. Among those with CKD, hypertension is more prevalent than diabetes or CVD. Calcium imbalances occur more frequently than other electrolyte disturbances, and the systemic effects of CKD notably impact cardiac health. Low hemoglobin levels can adversely affect cardiovascular well-being.

Conclusion: The prevalence of complications in CKD is high and multifaceted, significantly affecting patients' health and quality of life. Anemia, a common complication, worsens as CKD progresses and exacerbates cardiovascular disease, leading to increased cardiac workload, heart failure, and arrhythmias. Effectively managing anemia in CKD patients is essential for improving cardiovascular outcomes and overall patient well-being.

Keywords: Chronic Kidney Disease, Hypertension, Cardiovascular disease, Anemia, haemoglobin.

INTRODUCTION

Chronic kidney disease (CKD) is defined by either kidney damage or an estimated glomerular filtration rate (eGFR) below 60 mL/min/1.73 m², persisting for three months or longer. This condition entails a gradual decline in kidney function, often necessitating renal replacement therapies such as dialysis or transplantation [1]. According to the 2012 KDIGO classification, CKD is categorized into six stages based on the level of kidney function and three stages based on proteinuria, considering both the underlying causes and the severity of the disease. CKD is a significant global public health challenge, with rising incidence and prevalence rates, considerable healthcare costs, and unfavourable outcomes [2]. The earlier stages of CKD, in particular, are associated with negative consequences, including further kidney function decline, cardiovascular disease, and increased mortality risk. CKD often has no symptoms until advanced stages, when individuals may experience foamy urine, fatigue, and appetite loss. Severe cases can lead to concentration difficulties, numbness, and a breath odour resembling ammonia [3]. The impact of chronic kidney disease (CKD) extends beyond kidney function, influencing cardiovascular health, cognitive performance, bone metabolism, anaemia, blood pressure control, and numerous other health aspects. Early detection of CKD is essential for effective treatment, and there are various methods available for evaluating eGFR. The progression of CKD is affected by a combination of modifiable and non-modifiable risk factors. Diabetes and hypertension are the primary contributors to CKD, leading to significant renal damage over time. Additionally, conditions such as glomerulonephritis, polycystic kidney disease, and the long-term use of certain medications also play a role in the development of CKD [4].

Chronic kidney disease (CKD) significantly contributes to cardiovascular disease through several pathways, including increased blood pressure, inflammation, and vascular calcification. As kidney function declines, patients may face issues such as fluid overload and electrolyte imbalances, which place additional stress on the cardiovascular system. Moreover, the accumulation of uremic toxins can cause endothelial dysfunction and accelerate atherosclerosis, increasing the risk of cardiovascular complications. Anaemia in CKD mainly stems from a reduced production of erythropoietin (EPO), a crucial hormone for the formation of red blood cells. As kidney function worsens, EPO levels fall, leading to decreased red blood cell production. Additionally, CKD can lead to iron deficiency and the build-up of uremic toxins, both of which further exacerbate anaemia [5].

Aim:

To examine the prevalence of complications in chronic kidney disease (CKD) patients and analyse the impact of haemoglobin maintenance on cardiovascular outcomes.

Objectives:

- To assess the prevalence of chronic kidney disease (CKD) across various age groups and genders.
- To determine the prevalence of complications associated with chronic kidney disease (CKD).
- To quantify the prevalence and distribution of anemia across different stages of chronic kidney disease
- To investigate whether anemia treatment in CKD patients can enhance heart health and reduce cardiovascular disease risk.
- To examine the predictive role of hemoglobin levels on cardiovascular risk in CKD patients with anemia.

METHODS AND MATERIALS

Study Design: Cross-sectional study.

Study Site: The study was conducted in the Kumaran Medical Centre, Coimbatore. The study was approved by the institutional ethical committee.

Study Duration: The study was conducted over a period of 6 months.

Inclusion Criteria: Inclusion criteria consist of adult patients aged 18 years and older who have been diagnosed with chronic kidney disease (CKD) at any stage (1 through 5) and are currently inpatients in the nephrology department. Eligible participants must have comprehensive medical records that include documented hemoglobin levels and cardiovascular evaluations.

Exclusion Criteria: Exclusion criteria include patients experiencing acute kidney injury (AKI), women who are pregnant or breastfeeding, individuals with additional hematological disorders that may influence hemoglobin levels, individuals under 18 years of age, and those who have received a renal transplant.

Study Population: The study involved a total of 200 participants, with a focused analysis on 107 individuals diagnosed with cardiovascular disease (CVD) to assess the impact of sustained haemoglobin levels on cardiovascular outcomes.

Study Parameters: Our study involved a comprehensive review of electronic health records to gather essential data, such as patient age, gender, diagnosis, and key laboratory values, including phosphorus, potassium, calcium, sodium bicarbonate, sodium, blood pressure readings, echocardiogram findings, and levels of biomarkers like troponin I, thyroid-stimulating hormone (TSH), and parathyroid hormone (PTH). Additional parameters included peripheral smear analysis and hemoglobin (HB) levels.

Statistical Analysis: Statistical evaluations including calculations of odds ratios, Chi-square tests, and Fisher's exact tests to assess associations and significance.

RESULTS

Among the 200 CKD patients, 139 were men and 61 were women. This indicates that CKD is more prevalent in men, representing 69.5% of the total, while women make up 30.5%. Among the 200 patients with chronic kidney disease (CKD), the highest prevalence is found in the age group over 60 years (53.5%), followed by those aged 40 to 59 years (38%). The lowest prevalence occurs in the 20 to 39 age group (8.5%). This data suggests that CKD becomes more common with increasing age, particularly peaking in the over 60 category.

Among 200 CKD patients, 4.5% are lean, 59.0% have a normal BMI, and 36.5% are obese. This indicated that most of the CKD patients in the normal BMI. Table 1 indicates that prevalence and Co-Occurrence of chronic conditions prior to CKD diagnosis and found that 39.5% of participants have both DM-HTN in prior to CKD diagnosis.

Table 1: Prevalence and Co-occurrence of Chronic conditions prior CKD diagnosis

S.NO	Co-morbidities	Number of patient	Percentage
1	DM	24	12%
2	HTN	45	22.5%
3	CVD	9	4.5%
4	DM-CVD	4	2%
5	DM-HTN	79	39.5%
6	CVD-HTN	2	1.0%
7	DM-HTN-CVD	17	8.5%

In a study involving 200 patients with chronic kidney disease (CKD), sodium, potassium, calcium, and phosphorus imbalances were prevalent. Sodium levels showed that 43.5% of the patients had hyponatremia (low sodium), 55.0% had normal sodium, and 1.5% had hypernatremia (high sodium), indicating that sodium imbalance, especially hyponatremia, is a notable issue. For potassium, 11% of patients had hypokalemia (low potassium), 51.5% had normal levels, and 37.5% had hyperkalemia (high potassium), underscoring hyperkalemia as a significant risk. Calcium analysis revealed that 60.0% experienced hypocalcemia (low calcium), 33.5% had normal calcium, and 2.5% had hypercalcemia (high calcium), suggesting a higher prevalence of hypocalcemia. Phosphorus levels indicated that 4.0% had hypophosphatemia (low phosphorus), 44.5% were within normal range, and 51.5% had hyperphosphatemia (high phosphorus), highlighting hyperphosphatemia as a common concern among these

patients. Table 2 indicates Prevalence of overall complication in CKD patients.

Table 2: Prevalence of overall complication in chronic kidney disease

S.NO	Complication	No.of. Patients	Percentage
1	Hyponatremia	87	43.5%
2	Hyperkalemia	75	37.5%
3	Hypocalcemia	120	60%
4	Hyperphosphatemia	103	51.5%
5	Metabolic Acidosis	200	100%
6	Hypertension	35	17.5%
7	CVD	107	53.5%
8	Infection	64	32%
9	Neurological Disorders	11	5.5%
10	Uremia	197	98.5%
11	Anemia	189	94.5%
12	Hypothyroidism	19	9.5%
13	Hyperparathyroidism	17	8.5%

In a study of 200 chronic kidney disease patients, 107 developed cardiovascular disease, all of whom had anaemia. Among these, 66 maintained stable haemoglobin levels, while 41 experienced fluctuations in their levels. Table 3 indicated that severity of CVD in HB maintained and not maintained patient.

Table 3: Severity of CVD in HB maintained and not maintained patient

Condition	No. Of patients
Hb maintained CVD increased	1
Hb maintained CVD DECREASED	65
Hb not maintained CVD increase	38
Hb not maintained CVD decrease	3

Table 4: Statistical analysis of Odds ratio, Chi square test and Fishers exact test

Condition	CVD increased	CVD decreased	Total	Odds Ratio
Hb Maintained	1	65	66	0.0012
Hb Not Maintained	38	3	41	
Total	39	68	107	

Table 4 indicate the statistical analysis of Odds ratio, Chi square test and Fishers exact test. The Odds ratio is approximately 0.0012, indicating the odds of CVD increasing when Hb is maintained are much lower than when Hb is not maintained. A chi-square value this high suggests a strong association between association between maintaining haemoglobin levels and the increase /decrease of cardiovascular disease. Fishers exact test find that association between Hb maintenance and CVD outcome is extremely statistically significant.

DISCUSSION

Male were most commonly affected with ckd. Another study concluded that males were more commonly affected with females. Men are more likely to have high blood pressure and diabetes at younger ages, both major risk factors for CKD. Additionally, men often engage in higher-risk behaviors like smoking and alcohol consumption, which can contribute to kidney damage over time [6]. Our study result shows that more than half of the patients age is above 60 years old. Soni kk et al. conducted a study in CKD patients concluded that more than half of the patients age is more than 50 years old. Kidney filtration naturally declines, and structural changes, such as nephron loss and fibrosis, reduce the kidneys' ability to filter waste. This gradual deterioration is exacerbated by chronic diseases that are more common in older adults, leading to an increased risk of CKD [7]. Our study results shows that most of the participants in the normal BMI and 36.5% of patients were in the category of obese. Zaman SB et al. conducted a study in CKD patients and concluded that most of the CKD patients have normal BMI category [8]. Obesity also increases renal hyperfiltration, where the kidneys work harder to filter blood, causing gradual wear and tear on kidney tissues. Over time, this increased strain, coupled with metabolic dysregulation, can accelerate the progression of CKD, making obesity a key contributor to kidney disease risk[9].

Our study found that most of the patients (39.5%) having DM-HTN as comorbidities. According to the study by MacRae et al., 71.2% of patients had hypertension as a comorbidity, while 13% were affected by heart failure. Additionally, 26.3% of the patients had diabetes mellitus, 34.5% had coronary artery disease, and 15.4% had experienced a stroke [11]. Fraser et al. 2015 study findings that co-morbidities of ckd is Hypertension was common (88 %), 30 % had 'painful condition', 24 % anemia, 23 %, ischaemic heart disease, 17 % diabetes and 12 % thyroid disorders [12]. Chronic kidney disease (CKD) is often associated with conditions like coronary artery disease (CAD), anemia, stroke, diabetes mellitus (DM), hypertension (HTN), infections, uremia, and hypothyroidism due to shared risk factors and interconnected pathophysiological mechanisms. Hypertension and diabetes, for instance, are primary causes of CKD, as high blood pressure and elevated blood sugar levels can damage the renal blood vessels and filtering units, impairing kidney function over time. CAD and stroke

are prevalent due to the increased cardiovascular risk in CKD patients, arising from metabolic imbalances and vascular calcification. Anemia is common because the kidneys produce erythropoietin, a hormone essential for red blood cell production; as kidney function declines, so does erythropoietin, leading to anemia. Infections and uremia are frequent due to compromised immune function and toxin buildup as kidneys fail to filter waste efficiently. Lastly, hypothyroidism is often observed in CKD, likely due to the kidneys' role in metabolizing thyroid hormones, highlighting how kidney impairment can disturb multiple systems [13-17].

As per our study all patients have metabolic acidosis in CKD. Metabolic acidsosis is the most common acid base disturbance in CKD patients. This condition is usually associated with bicarbonate concentrations of 16e20 mEq/L [10].

CONCLUSION

A comprehensive and personalized management plan is essential for enhancing quality of life and outcomes for patients with chronic kidney disease (CKD). Effective management of CKD complications requires regular monitoring, prompt intervention, and a multidisciplinary approach. Comparative analyses indicate that maintaining hemoglobin (Hb) levels plays a significant role in improving cardiovascular outcomes in CKD patients. This study offers valuable insights into the link between Hb maintenance and cardiovascular outcomes in CKD, though further research is needed to confirm these findings and explore the underlying mechanisms in greater depth.

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