



RESEARCH ARTICLE

Clinical Outcomes and Common Complications in Patients with Chronic Kidney Disease

Walter A¹, H Santosh², Suma D^{3*}

ABSTRACT

Background: Chronic kidney disease (CKD) is a progressive condition associated with multiple systemic complications and adverse clinical outcomes. Early identification of complications and recognition of patients at increased risk are important for improving outcomes. This study assessed the clinical profile, common complications, and clinical outcomes among patients with CKD. **Methods:** A hospital-based observational study was conducted among 107 adult patients with CKD during one year period. Demographic and clinical characteristics, comorbidities, laboratory parameters, CKD stage, complications, and clinical outcomes were assessed. CKD was staged according to estimated glomerular filtration rate. The association between CKD stage and complications was analyzed using appropriate statistical tests. A *p* value <0.05 was considered statistically significant. **Results:** The mean age of the study population was 56.8 ± 13.2 years, with males comprising 62.6% and females 37.4%. Hypertension was the most common comorbidity (72.9%), followed by diabetes mellitus (57.9%). Advanced CKD was predominant, with stage 4 and stage 5 accounting for 25.2% and 36.4%, respectively. Anaemia was the most common complication, occurring in 77 (72.0%) patients. Its prevalence increased significantly with advancing CKD stage, from 42.1% in stage 3 to 70.4% in stage 4 and 92.2% in stage 5 (*p*<0.001). Fluid overload/edema (50.5%), electrolyte abnormalities (44.9%), metabolic acidosis (38.3%), and CKD-mineral and bone disorder (29.9%) were also frequent. Hospitalization occurred in 29.0%, renal replacement therapy was required in 26.2%, acute kidney injury superimposed on CKD occurred in 15.9%, and mortality was 7.5%. **Conclusion:** CKD was associated with a high burden of complications and adverse clinical outcomes. Anaemia increased significantly with advancing CKD stage, emphasizing the importance of early detection, regular monitoring, and timely management of CKD and its complications.

Keywords: Chronic kidney disease; Anaemia; Hypertension; Diabetes mellitus; CKD complications; Renal replacement therapy; Clinical outcomes.

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INTRODUCTION

Chronic kidney disease (CKD) is a major global health problem characterized by abnormalities of kidney structure or function that persist for more than three months and have implications for health. The burden of CKD has increased substantially with the growing prevalence of diabetes mellitus, hypertension, obesity, cardiovascular disease, and an ageing population. Current clinical practice emphasizes assessment of both estimated glomerular filtration rate (eGFR) and albuminuria because these parameters provide important information regarding the severity of kidney disease and the risk of adverse outcomes. The clinical impact of CKD extends beyond progressive loss of renal function. Patients with CKD are at increased risk of cardiovascular disease, hospitalization, acute kidney injury, kidney failure, and premature mortality. Cardiovascular disease is particularly important, as the risk of cardiovascular morbidity and mortality is

substantially elevated across the spectrum of CKD.

¹Assistant Professor, Department of General Medicine / Nephrology, The Oxford Medical College, Hospital & RC, Bangalore, Karnataka, India

²Assistant Professor, Department of Paediatrics/ Neurology, The Oxford Medical College, Hospital & RC, Bangalore, Karnataka, India

³Professor, Department of General Medicine, The Oxford Medical College, Hospital & RC, Bangalore, Karnataka, India

Corresponding Author: Suma D, Professor, Department of General Medicine, The Oxford Medical College, Hospital & RC, Bangalore, Karnataka, India

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Coronary artery disease, heart failure, arrhythmias, cerebrovascular disease, and peripheral vascular disease are frequently encountered complications, with risk influenced by both traditional cardiovascular risk factors and CKD-related mechanisms such as inflammation, oxidative stress, anaemia, vascular calcification, volume overload, and disturbances of mineral metabolism. [1,2] Progressive reduction in renal function is also associated with a wide range of systemic complications. Anaemia is a common complication of CKD and is associated with impaired quality of life and increased cardiovascular risk. Disorders of calcium, phosphate and parathyroid hormone metabolism may result in CKD-mineral and bone disorder (CKD-MBD), contributing to bone disease, vascular calcification, cardiovascular complications, fractures, and premature mortality. Patients with advanced CKD may additionally develop fluid and electrolyte disturbances, metabolic acidosis, uraemic manifestations, nutritional abnormalities, and susceptibility to infections.

The occurrence and severity of these complications vary according to the stage and underlying cause of CKD, degree of albuminuria, presence of comorbid conditions, and access to appropriate treatment. Importantly, several CKD-associated complications are potentially preventable or modifiable through early identification, appropriate risk stratification, and timely intervention. The KDIGO 2024 guideline therefore emphasizes comprehensive assessment of CKD severity, risk prediction, management of complications, and measures aimed at slowing disease progression. [3,4]

Despite advances in the diagnosis and management of CKD, delayed recognition and presentation at advanced stages remain important clinical challenges, particularly in resource-constrained settings. Characterizing the clinical profile, complications, and outcomes of patients with CKD in different clinical settings can provide useful information regarding the burden of disease and areas requiring earlier intervention. Therefore, the present study was undertaken to evaluate the **clinical outcomes and common complications among patients with chronic kidney disease**, with particular emphasis on the pattern of complications and outcomes across different stages of CKD.

Materials and Methods

Study design and setting

A hospital-based observational study was conducted among patients diagnosed with chronic kidney disease (CKD) attending the Department of General Medicine or Nephrology, during the study period from **april 2024 to march 2025**. The study was undertaken to assess the clinical profile, common complications, and clinical outcomes among patients with CKD.

Study population

The study included adult patients diagnosed with chronic kidney disease who fulfilled the predefined eligibility criteria. A total of **107 patients** were included in the study.[5]

Sample size calculation

Formula:

$$n = \frac{Z^2 pq}{d^2}$$

Where:

- $Z = 1.96$ for 95% confidence
- $p = 50\%$
- $q = 50\%$
- $d = 10\%$ precision

$$n = \frac{(1.96)^2 (0.5) (0.5)}{(0.10)^2}$$

$$n = 96.04$$

Therefore, the minimum sample size is **97 patients** (rounding up).

If you add **10% for incomplete records/non-response**:
 $97 + 9.7 = 106.797 + 9.7 = 106.7$

Final sample size = 107 patients

Inclusion criteria

Patients fulfilling the following criteria were included:

1. Patients aged **≥18 years**.
2. Patients diagnosed with chronic kidney disease based on clinical, biochemical, and/or imaging findings.
3. Patients with evidence of kidney structural or functional abnormality persisting for more than 3 months, where documented.
4. Patients who provided informed consent to participate in the study.

Exclusion criteria

The following patients were excluded:

1. Patients with acute kidney injury without evidence of underlying CKD.
2. Patients with acute-on-chronic kidney injury where the baseline renal status could not be established.
3. Patients unwilling to participate in the study.
4. Patients with incomplete or inadequate clinical records.
5. Patients who had undergone renal transplantation, if this were considered a confounding factor in the study.

Data collection

After obtaining informed consent, relevant demographic and clinical information was collected using a structured data collection proforma. Data regarding age, sex, presenting symptoms, duration of illness, known comorbidities, medication history, and relevant clinical findings were recorded. A detailed physical examination was performed, including measurement of blood pressure, pulse rate, respiratory rate, body weight, and assessment for pallor, pedal edema, signs of fluid overload, and other clinically relevant findings.

Laboratory investigations

The following investigations were recorded or performed as clinically indicated as complete blood count, serum urea, serum creatinine, estimated glomerular filtration rate (egfr), serum electrolytes, including sodium and potassium, serum calcium and phosphorus, serum albumin, blood glucose and/or HbA1c, urinalysis, urine protein/albumin assessment and other investigations as clinically indicated

The eGFR was calculated using the appropriate validated equation available during the study period, and patients were categorized according to CKD stage.

Assessment of complications

Patients were evaluated for common complications associated with CKD, including anaemia, hypertension, fluid overload/peripheral edema, electrolyte abnormalities, metabolic acidosis, ckd-mineral and bone disorder, cardiovascular complications, infections,

uraemic manifestations and other clinically relevant complications. The presence of each complication was assessed using clinical findings, laboratory investigations, imaging, and relevant specialist evaluation where required.

Assessment of clinical outcomes

Clinical outcomes during the study period were recorded. These included improvement/stabilization of renal function, progression of CKD, hospitalization, development of acute kidney injury, initiation of renal replacement therapy, and death, where applicable. Patients requiring dialysis were identified based on clinical and nephrological indications. The relationship between CKD stage, associated complications, and clinical outcomes was subsequently evaluated.

Statistical analysis

Data were entered into Microsoft Excel and analyzed using SPSS version. Continuous variables were expressed as mean $\pm$ standard deviation or median with interquartile range, depending on the distribution of the data. Categorical variables were expressed as frequencies and percentages.

The association between categorical variables was assessed using the Chi-square test or Fisher's exact test, as appropriate. For comparison of continuous variables between groups, the independent-samples t-test or Mann-Whitney U test was used as appropriate. For comparisons involving more than two groups, ANOVA or Kruskal-Wallis test was applied as appropriate.

A **p-value <0.05** was considered statistically significant.

Ethical considerations

The study was conducted after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants before enrolment. Patient confidentiality was maintained throughout the study, and the collected information was used solely for research purposes.

RESULTS

A total of **107 patients with chronic kidney disease (CKD)** were included in the study. The demographic characteristics, clinical profile, laboratory parameters, common complications, and clinical outcomes were assessed.

Table-1: Demographic characteristics

Age group	Number	Percentage
≤ 40 years	10	9.3%
41–50 years	19	17.8%
51–60 years	29	27.1%
61–70 years	26	24.3%
>70 years	23	21.5%
Total	107	100%

Of the 107 patients, 67 (62.6%) were males and 40 (37.4%) were females, giving a male-to-female ratio of approximately 1.7:1. The mean age of the study population was 56.8 ± 13.2 years. The majority of patients belonged to the age group of 51–60 years (27.1%), followed by 61–70 years (24.3%).

Table-2: Clinical characteristics and comorbidities

Comorbidity	Number	Percentage
Hypertension	78	72.9%
Diabetes mellitus	62	57.9%
Diabetes + hypertension	51	47.7%
Ischemic heart disease	21	19.6%
Cerebrovascular disease	8	7.5%

Hypertension was the most frequently observed comorbidity, present in **78 (72.9%)** patients, followed by diabetes mellitus in **62 (57.9%)** patients. Both diabetes and hypertension were present in **51 (47.7%)** patients.

Table-3: Distribution according to CKD stage

CKD stage	Number	Percentage
Stage 1	3	2.8%
Stage 2	7	6.5%
Stage 3	19	17.8%
Stage 4	27	25.2%
Stage 5	39	36.4%
Stage 5D/on dialysis	12	11.2%
Total	107	100%

The majority of patients had advanced CKD. **Stage 5 CKD** was observed in 39 (36.4%) patients, followed by stage 4 in 27 (25.2%) patients.

Table-4: Distribution of anaemia according to CKD stage

CKD Stage	Total Patients (n)	Patients with Anaemia, n (%)	Patients without Anaemia, n (%)
Stage 1	3	1 (33.3)	2 (66.7)
Stage 2	7	2 (28.6)	5 (71.4)
Stage 3	19	8 (42.1)	11 (57.9)
Stage 4	27	19 (70.4)	8 (29.6)
Stage 5	51	47 (92.2)	4 (7.8)
Total	107	77 (72.0)	30 (28.0)

Chi-square test: $p < 0.001$

Among the 107 patients with chronic kidney disease, anaemia was present in 77 (72.0%) patients and absent in 30 (28.0%). The prevalence of anaemia showed a progressive increase with advancing CKD stage. Anaemia was present in 33.3% of stage 1, 28.6% of stage 2, 42.1% of stage 3, 70.4% of stage 4, and 92.2% of stage 5 patients. Thus, anaemia was markedly more common among patients with advanced CKD (stages 4 and 5), with the highest prevalence observed in stage 5 CKD. Overall, the findings suggest a strong association between increasing CKD severity and the occurrence of anaemia.

Table-5: Distribution of major complications according to CKD stage

Complication	Stage 1–2 (n=10)	Stage 3 (n=19)	Stage 4 (n=27)	Stage 5 (n=51)	Total, n (%)
Anaemia	3 (30.0%)	8 (42.1%)	19 (70.4%)	47 (92.2%)	77 (72.0%)
Fluid overload/edema	1 (10.0%)	5 (26.3%)	14 (51.9%)	34 (66.7%)	54 (50.5%)
Electrolyte abnormalities	1 (10.0%)	4 (21.1%)	12 (44.4%)	31 (60.8%)	48 (44.9%)
Metabolic acidosis	0 (0%)	3 (15.8%)	10 (37.0%)	28 (54.9%)	41 (38.3%)
CKD-MBD	0 (0%)	2 (10.5%)	7 (25.9%)	23 (45.1%)	32 (29.9%)
Cardiovascular complications	1 (10.0%)	3 (15.8%)	7 (25.9%)	16 (31.4%)	

Among the 107 patients with CKD, complications increased progressively with advancing CKD stage. Anaemia was the most frequent complication, increasing from 42.1% in stage 3 to 70.4% in stage 4 and 92.2% in stage 5 ($p < 0.001$). Fluid overload/edema, electrolyte abnormalities, metabolic acidosis, and CKD-mineral and bone disorder were also more common in advanced CKD, particularly stages 4 and 5.

Table-6: Clinical outcomes

Clinical outcome	Number	Percentage
Renal replacement therapy	28	26.2%
Hospitalization	31	29.0%
Acute kidney injury on CKD	17	15.9%
Death	8	7.5%

Clinical outcomes, 31 (29.0%) patients required hospitalization, 28 (26.2%) required renal replacement therapy, 17 (15.9%) developed acute kidney injury superimposed on CKD, and 8 (7.5%) patients died during the observation period.

Discussion

Chronic kidney disease (CKD) is an important public health problem associated with progressive loss of kidney function and a substantial burden of systemic complications. The present study evaluated 107 patients with CKD with respect to their demographic characteristics, associated comorbidities, CKD stage, common complications, and clinical outcomes. The major findings of the present study were a predominance of middle-aged and elderly patients, male predominance, a high prevalence of hypertension and diabetes mellitus, a greater proportion of patients with advanced CKD, and an increasing frequency of complications with worsening CKD stage.

Demographic characteristics

In the present study, the mean age of the participants was 56.8 ± 13.2 years, with the largest proportion belonging to the 51–60-year age group (27.1%), followed by the 61–70-year age group (24.3%). Males constituted 62.6% of the study population, with a male-to-female ratio of approximately 1.7:1. This male predominance is consistent with findings from the ICMR-INDIAB study by Pradeepa et al[6], which

reported a higher prevalence of impaired kidney function among males than females in the Indian population. The relatively high proportion of middle-aged and older adults in the present study may reflect the cumulative effect of long-standing hypertension, diabetes, vascular disease, and age-related decline in renal function. Since the present study was conducted in a hospital-based population, the age and sex distribution may also reflect referral patterns and the greater likelihood of advanced disease requiring hospital-based care.

Comorbidities

Hypertension was the most common comorbidity in the present study, affecting 72.9% of patients, followed by diabetes mellitus in 57.9%. Nearly half of the patients (47.7%) had both diabetes mellitus and hypertension. These findings are clinically important because hypertension and diabetes are among the major risk factors associated with CKD and its progression. The high prevalence of these comorbidities in the present study is consistent with the findings of Pradeepa et al[6], who examined more than 25,000 individuals in the ICMR-INDIAB study and demonstrated an

important association between impaired kidney function, type 2 diabetes, and systemic hypertension. Similarly, the START-India study by Unnikrishnan et al[7] and colleagues demonstrated a substantial burden of CKD among patients with type 2 diabetes, highlighting the close relationship between metabolic disease and renal dysfunction. The coexistence of diabetes and hypertension in almost half of the patients in our study suggests that aggressive management of these modifiable risk factors may have an important role in preventing or delaying CKD progression.

Distribution according to CKD stage

In the present study, advanced CKD was common, with stage 5 accounting for 36.4% of patients and stage 4 accounting for 25.2%. Thus, more than half of the study population had stage 4 or stage 5 CKD. This finding may be related to the tertiary-care hospital setting, where patients with more severe renal dysfunction are more likely to be referred for specialist evaluation and management.

The predominance of advanced CKD is clinically significant because declining renal function is associated with increasing risks of cardiovascular events, hospitalization, dialysis, and mortality. Go et al.[8] demonstrated a graded increase in the risks of death, cardiovascular events, and hospitalization with decreasing estimated GFR. Similarly, Nishikawa et al[9] reported that lower GFR was independently associated with increased risks of hospitalization, dialysis initiation, and all-cause mortality.

Anaemia and CKD stage

Anaemia was the most frequent complication observed in the present study, affecting 72.0% of patients. Importantly, the prevalence of anaemia increased substantially with advancing CKD stage, from 42.1% in stage 3 to 70.4% in stage 4 and 92.2% in stage 5. The association between CKD stage and anaemia was statistically significant ($p < 0.001$).

This finding is consistent with the observations of Astor et al[10], who demonstrated a strong association between declining kidney function and increasing prevalence of anaemia. In their study, the prevalence of haemoglobin ≤ 12 g/dL increased markedly as GFR declined, while more severe anaemia also became progressively more common at lower GFR levels.

The high prevalence of anaemia in advanced CKD may be explained by reduced erythropoietin production, iron deficiency or impaired iron availability, chronic inflammation, nutritional abnormalities, and shortened red-cell survival. The marked increase in anaemia in stages 4 and 5 in the present study therefore supports the importance of regular haemoglobin assessment and appropriate evaluation and management of anaemia in patients with progressive CKD.

Other complications

In addition to anaemia, fluid overload/edema was present in 50.5% of patients, electrolyte abnormalities in 44.9%, metabolic acidosis in 38.3%, CKD-mineral and bone disorder in 29.9%, and cardiovascular complications in 25.2%. These complications were more frequent among patients with advanced CKD,

particularly stages 4 and 5.

The progressive increase in these complications with worsening CKD is biologically plausible. As renal function declines, the kidneys become progressively less capable of maintaining fluid, electrolyte, acid-base, and mineral homeostasis. Advanced CKD is therefore associated with sodium and water retention, hyperkalaemia and other electrolyte abnormalities, metabolic acidosis, and disturbances of calcium-phosphate metabolism.

The cardiovascular findings are particularly important because CKD is associated with a substantially increased cardiovascular risk. Go et al[8] demonstrated that cardiovascular event risk increased progressively with declining eGFR, independent of other risk factors. Thus, the cardiovascular complications observed in the present study may reflect the cumulative effects of CKD, hypertension, diabetes, anaemia, vascular calcification, and other CKD-related metabolic abnormalities.

Clinical outcomes

In the present study, 29.0% of patients required hospitalization, 26.2% required renal replacement therapy, 15.9% developed acute kidney injury superimposed on CKD, and 7.5% died during the observation period. These findings demonstrate the substantial clinical burden associated with CKD, particularly in a population in which advanced stages of disease were common.

The findings are consistent with the longitudinal study by Nishikawa et al.[9], which demonstrated that lower GFR was associated with progressively higher risks of hospitalization, dialysis initiation, and mortality. Similarly, James et al[11] reported that progression from stage 3 to stage 4 CKD was associated with significantly increased risks of death, acute kidney injury, and hospitalization. These observations support the findings of the present study, in which advanced CKD was accompanied by a greater burden of complications and adverse outcomes.

The mortality observed in the present study should be interpreted in the context of the relatively small sample size and hospital-based design. Nevertheless, the occurrence of death in 7.5% of patients highlights the serious nature of advanced CKD. Recent Indian data from Sankarasubaiyan et al[12] also emphasize the importance of anaemia, hypoalbuminaemia, hospitalization, and other clinical factors in determining outcomes among patients receiving haemodialysis in India.

The findings of the present study indicate that CKD is associated with a substantial burden of comorbidities, complications, and adverse outcomes. Hypertension and diabetes were the predominant associated conditions, while anaemia was the most common complication. The frequency of anaemia and other complications increased considerably with advancing CKD stage. Furthermore, hospitalization, renal replacement therapy, acute kidney injury, and mortality were important clinical outcomes observed in the study population.

Taken together, these findings emphasize the importance of early detection of CKD, regular monitoring of renal function, aggressive control of diabetes and hypertension, early identification and

treatment of anaemia and metabolic complications, and timely referral to nephrology services. Early intervention may help delay progression to kidney failure and potentially reduce hospitalization and mortality.

Limitations

The findings should be interpreted in light of certain limitations. The study included a relatively small sample of 107 patients and was conducted in a hospital-based setting, which may limit generalizability to the wider community. The high proportion of patients with advanced CKD may also reflect referral bias. In addition, the study duration and follow-up period may influence the observed clinical outcomes. Larger, multicentric prospective studies with longer follow-up would be useful to confirm these findings and identify independent predictors of adverse outcomes.

Conclusion

The present study demonstrates that chronic kidney disease is associated with a substantial burden of comorbidities, complications, and adverse clinical outcomes. The study population showed a predominance of middle-aged and elderly patients, with males constituting the majority. Hypertension and diabetes mellitus were the most common associated comorbidities, highlighting the importance of early identification and optimal control of these modifiable risk factors. A considerable proportion of patients presented with advanced CKD, particularly stages 4 and 5. Anaemia was the most common complication, and its prevalence increased significantly with advancing CKD stage. Fluid overload, electrolyte abnormalities, metabolic acidosis, CKD-mineral and bone disorder, and cardiovascular complications were also more frequently observed in advanced stages. Hospitalization, renal replacement therapy, acute kidney injury superimposed on CKD, and mortality represented important adverse clinical outcomes. These findings emphasize the need for early diagnosis, regular monitoring of renal function, effective management of diabetes and hypertension, prompt recognition and treatment of CKD-related complications, and timely nephrology referral. Appropriate early intervention may help slow CKD progression, reduce complications and hospitalization, and improve overall patient outcomes.

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