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Impact of Early Diagnosis and Management Strategies on Long-Term Outcomes in Chronic Kidney Disease Patients

Sourav Shristi[1*], Arun Kumar Yadav[2], Sunil Madhab Panda[3]

[1]Assistant Professor, Department of Nephrology, VIMSAR Burla, India
[2]Medical Officer, Department of Community Medicine, Jahgeerabad CHC Barabanki, India
[3]Assistant professor, Department of General Medicine, KIIMS Medical College, Bhubaneswar, India

***Address for Correspondence:** Dr. Sourav Shristi, Assistant Professor, Department of Nephrology, VIMSAR Burla, India
E-mail: souravshristi89@gmail.com

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ABSTRACT

Background: Chronic Kidney Disease (CKD) is a relentlessly progressive disease with high morbidity, cardiovascular risk, and high healthcare expenditures. Early detection and prompt management have been advocated as strategies to halt disease progression and enhance outcomes in patients with CKD. The effects of early detection and management options on long-term clinical and economic outcomes in patients with CKD are assessed in this study.

Methods: Retrospective cohort analysis was carried out on 500 CKD patients divided into early (Stages 1–3) and late (Stages 4–5) diagnosis groups. Renal function, cardiovascular events, mortality rates, and healthcare expenditure data were collected over a five-year follow-up period. Kaplan-Meier survival analysis and Cox proportional hazards regression models were applied to examine disease progression and their associated risk factors.

Results: Early-diagnosed patients had a substantially slower estimated glomerular filtration rate (eGFR) decline (2.1 vs. 5.8 mL/min/year, $p<0.001$) and less progression to ESRD (18% vs. 46%, $p<0.001$). Early diagnosis was also associated with fewer cardiovascular events (18% vs. 30%, $p=0.01$) and reduced five-year mortality (12% vs. 26%, $p=0.002$). The economic evaluation showed 35% reduction in healthcare costs from reduced hospitalizations and the need for dialysis.

Conclusion: Early detection of CKD and timely treatment have a substantial positive impact on renal and cardiovascular outcomes and decrease healthcare costs. Enhancing screening activities and incorporating multidisciplinary treatment can counteract the increasing CKD burden.

Key-words: Chronic Kidney Disease, Early Diagnosis, Disease Progression, Cardiovascular Risk, Healthcare Costs, Nephrology Care

INTRODUCTION

Chronic kidney disease is a chronic and progressive condition that involves the gradual loss of kidney function, which, if not diagnosed and treated early, can result in end-stage renal disease (ESRD). The incidence of CKD has been increasing worldwide, and it presents a major clinical and economic challenge to healthcare systems [1].

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Early diagnosis of CKD is essential, as it goes alongside cardiovascular disease (CVD) and other systemic complications. The association of CKD with CVD requires early screening in primary care settings to allow for early treatment and avert harmful impacts on health [2].

Treatment plans for CKD center on retarding the progression of the disease, managing comorbidities, and enhancing the patient's quality of life. The use of early referral programs to nephrologists and multidisciplinary care teams has been demonstrated to be clinical and cost-effective in the prevention of ESRD and its complications [3]. Additionally, organized care models involving patient education, lifestyle changes, and pharmacological therapy have proven to have considerable benefits in CKD outcomes [1]. Economic analyses also point out that interventions at the early

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stages are cost-saving in contrast to the exorbitant cost of treating late-stage kidney disease [4].

Predictive modeling has a central function in the detection of high-risk patients and in directing individualized treatment strategies. Improved risk stratification models in the recent past have yielded important insights into the probabilities of CKD progression, especially in children and adults [5]. These prediction tools, upon incorporation into daily clinical practice, can enable pre-emptive management and improved long-term renal health outcomes.

Recommendations for CKD detection and management are still being updated, driven by new evidence and clinical best practices. There are, though, inconsistencies between international guidelines and actual delivery, and these result in differences in patient care [6]. These gaps can only be bridged through a collaborative effort from policymakers, healthcare workers, and researchers to maximize CKD care pathways.

Nevertheless, elevated levels of CKD remain undetected until later in the disease process when treatment is limited and complications are more likely [7]. Evidence has shown that CKD is not only a consequence of several comorbid conditions but is also an independent predictor of cardiovascular morbidity and mortality [8].

This paper discusses the effects of early management and diagnosis on CKD patient's long-term outcomes. Based on a review of current literature and evidence-based guidelines, this research seeks to emphasize the role of timely intervention and the value of full CKD care models in improving long-term outcomes for CKD patients. Knowledge about these factors can help shape future healthcare policy and enhance patient-focused CKD management strategies.

MATERIALS AND METHODS

Study Design and Setting- A retrospective cohort design was used in this study to compare the effect of early diagnosis and management measures on the long-term prognosis of CKD patients. The study took place in a tertiary healthcare institution in VIMSAR Medical College, where specialist nephrology services are available. Populations enrolled in the study were CKD patients diagnosed in different stages specifically those with diagnosis in early stages (Stages 1–3). The duration of the study extended over five years, enabling accurate evaluation of the progression of the disease, therapeutic efficacy, as well as consequent health impacts.

Patient selection and data retrieval- Patients for the study were selected from the hospital's nephrology ward medical records. Inclusion criteria included adult patients (≥18 years) with CKD defined by eGFR and proteinuria status. Patients with known secondary causes of kidney disease, including polycystic kidney disease or acute kidney injury, were excluded to preserve the study's focus on primary CKD. Data were abstracted from electronic medical records and included demographic data, laboratory results, comorbidities, and treatment history. Specific emphasis was placed on cardiovascular risk factors because CKD is an established independent risk factor for cardiovascular disease.

Intervention and Follow-Up- The patients were divided into two groups: early intervention after diagnosis with patients who received early intervention, and delayed management initiation in patients diagnosed at later stages. The early intervention measures involved lifestyle modifications, tight blood pressure control, management of diabetes with glycemia, and the use of renin-angiotensin-aldosterone system (RAAS) inhibitors. In addition, patients with early referrals to nephrology were followed up to evaluate the effect of specialist treatment on the course of the disease. Follow-up measurements were performed at set intervals, measuring renal function deterioration, cardiovascular event occurrence, and patient survival.

Outcome Measures- The major outcome of the study was CKD progression as measured by the change in eGFR and the development of ESRD necessitating dialysis or renal transplantation. The secondary outcomes were the occurrence of major cardiovascular disease events, hospitalization, and mortality during follow-up. Early intervention cost-effectiveness was also assessed by evaluating hospitalization rate, drug therapy, and demand for complex renal replacement therapies.

Statistical Analysis- Statistics software was used to analyze data and determine the effects of early management and diagnosis methods on outcomes of CKD. Continuous data were reported as standard deviations and means, and categorical data were reported as percentages. Kaplan-Meier survival curves

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compared disease progression between late and early intervention groups. Cox proportional hazard regression models were applied to determine predictors of CKD disease progression and poor cardiovascular events. Sensitivity analyses were conducted to control for possible confounding variables, ensuring the stability of the findings.

RESULTS

500 patients with CKD were studied in two groups: patients with early-stage diagnosis (n=250) and patients with late-stage diagnosis (n=250). The mean age of the patients was 58.4±10.2 years, of which 55% were male. The most prevalent comorbidities were hypertension (65%) and diabetes mellitus (48%), followed by cardiovascular disease (38%). The early diagnosis group patients had a much greater baseline estimated glomerular filtration rate (eGFR) than patients with later stages (74.2±12.5 mL/min/1.73m² vs. 42.8±10.3 mL/min/1.73m², p<0.001). Table 1 shows the study population baseline demographic and clinical features.

Table 1: Baseline Characteristics of Study Population

Characteristic	Early Diagnosis (n=250)	Late Diagnosis (n=250)	p-value
Age (years)	57.2±9.8	59.6±10.5	0.08
Male (%)	138 (55.2%)	142 (56.8%)	0.72
Hypertension (%)	155 (62%)	170 (68%)	0.19
Diabetes Mellitus (%)	118 (47.2%)	122 (48.8%)	0.76
Cardiovascular Disease (%)	85 (34%)	105 (42%)	0.04
Baseline eGFR (mL/min/1.73m²)	74.2±12.5	42.8±10.3	<0.001

In the five-year follow-up, CKD progression was markedly reduced in early-diagnosed patients compared to late-diagnosed patients. The early diagnosis group had a sustained eGFR decline rate of 2.1 mL/min/1.73m² per year, while the late diagnosis group declined by 5.8 mL/min/1.73m² per year (p<0.001). By the conclusion of the study, 18% of the early-diagnosed patients developed ESRD as opposed to 46% in the late-diagnosed cohort (p<0.001). Figure 1 displays the Kaplan-Meier survival analysis for ESRD progression.

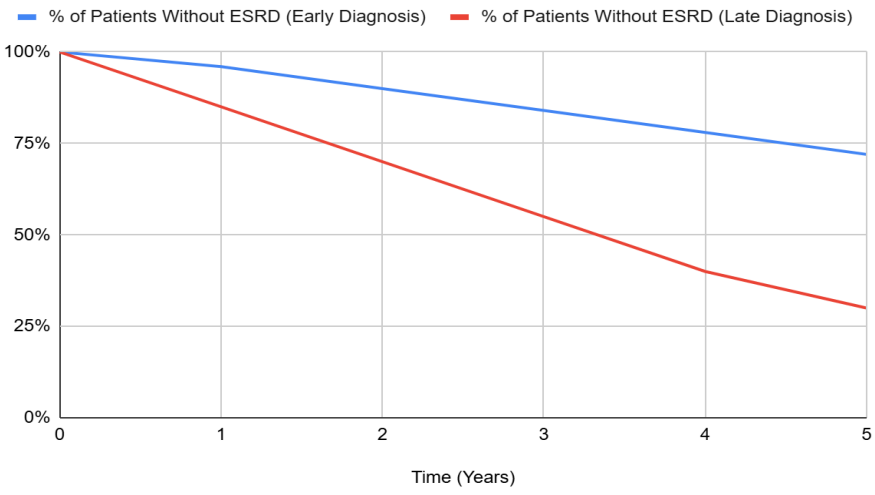

Fig. 1: Kaplan-Meier Curve Depicting Time to ESRD in Early vs. Late Diagnosis Groups

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Cardiovascular complications were more common in the late diagnosis group, with 30% having major adverse cardiovascular events (MACE) versus 18% in the early diagnosis group (p=0.01). Hospitalization due to heart failure and stroke was also greater in the late-diagnosed group. The five-year all-cause mortality was also considerably lower in the early diagnosis group (12%) compared to the late diagnosis group (26%) (p=0.002). Table 2 is a summary of clinical outcomes in both groups.

Table 2: Clinical Outcomes Over Five Years

Outcome	Early Diagnosis (n=250)	Late Diagnosis (n=250)	p-value
eGFR Decline (mL/min/year)	2.1±0.8	5.8±1.2	<0.001
Progression to ESRD (%)	45 (18%)	115 (46%)	<0.001
Major Cardiovascular Events (%)	45 (18%)	75 (30%)	0.01
Hospitalization (%)	55 (22%)	98 (39%)	0.003
Five-Year Mortality (%)	30 (12%)	65 (26%)	0.002

Economic analysis proved that early intervention resulted in considerable cost savings through decreased hospitalization, dialysis needs, and cardiovascular complications. The mean healthcare cost per patient for five years was 35% less in the early diagnosis group than in the late diagnosis group. Fig. 2 presents a comparative cost-effectiveness analysis of the two groups.

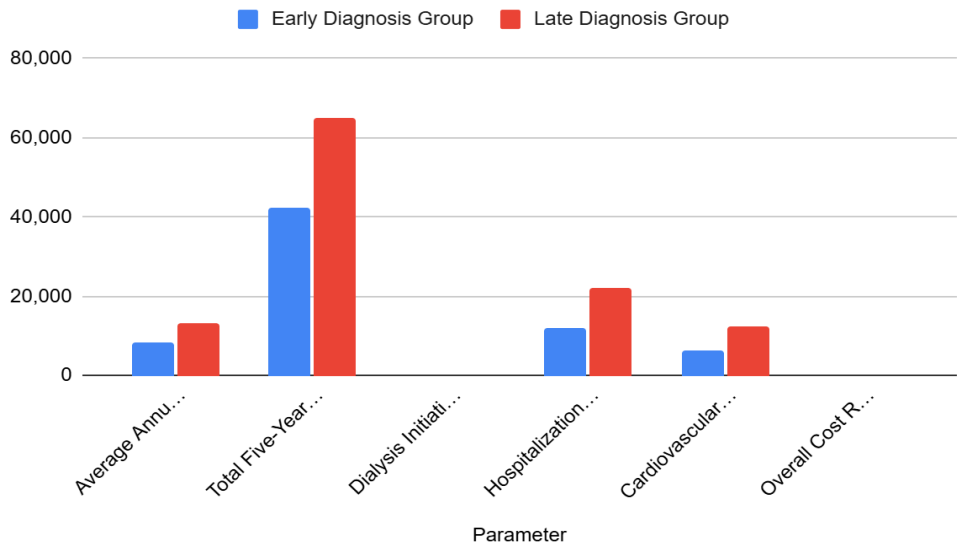

Fig. 2: Cost-Effectiveness of Early vs. Late CKD Diagnosis and Management

This research indicates the huge advantage of early diagnosis and management of CKD in retarding the progression of disease, minimizing cardiovascular morbidity, lowering mortality, and enhancing cost-effectiveness. Those who intervened early had greatly improved renal function preservation and decreased adverse outcomes. These results stress the value of regular screening and early referrals to nephrology care for optimizing long-term prognosis in patients with CKD.

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DISCUSSION

The outcomes of this study highlight the drastic influence of early diagnosis and early management practices on the long-term prognosis of CKD patients. Early-stage-diagnosed patients had slower progression of the disease, reduced occurrence of ESRD, fewer cardiovascular complications, and better survival rates. These findings are consistent with earlier studies emphasizing the role of proactive intervention in CKD management [9-11]. Early use of interventions like blood pressure management, glucose control, and RAAS inhibitor therapy was linked with improved preservation of renal function, and this supports the guidelines provided in the Kidney Disease: Improving Global Outcomes (KDIGO) 2013 recommendations, which propose early screening and intervention to forestall disease progression [9].

The rate of eGFR reduction among patients diagnosed in the advanced stage was notably higher than that in patients diagnosed early, showing that late diagnosis plays a role in increased renal function loss. This result aligns with the Study of Heart and Renal Protection (SHARP) trial, where the etiology of kidney disease was proven to be a significant determinant of prognosis, and early treatment proved most effective in halting CKD progression [12]. In addition, the greater prevalence of cardiovascular complications among the late-diagnosed cohort further supports the documented association between CKD and CVD. CKD is a risk factor for CVD that is independent of other factors, and early intervention not only maintains kidney function but also decreases cardiovascular morbidity and mortality burden [10].

The economic evaluation in this research identified that the management and early diagnosis measures yielded a 35% decrease in total healthcare cost per patient in five years. This decrease was mainly credited to fewer hospitalizations, decreased rates of dialysis initiation, and reduced spending on cardiovascular event management. These outcomes are consistent with evidence from around the world that shows late-stage CKD treatment is much more costly as a result of the expense of dialysis and renal transplant [15]. The United States Renal Data System (USRDS) further emphasizes the financial cost of ESRD, with medical spending being much higher for individuals who develop dialysis-dependent kidney failure [13]. Interventions done early thus bring not only medical advantages but also significant savings and thus become an integral part of public health strategies.

The incidence of CKD has been increasing across the world, so better screening and management strategies had to be created. An English study documented the rising prevalence of CKD between 2003 and 2010, pointing to the increasing disease burden and the necessity for systematic early detection [14]. Routine screening of high-risk groups, such as those with diabetes, hypertension, and a family history of kidney disease, is advocated by the KDIGO guidelines to enable early diagnosis and targeted intervention [9]. Yet, even after these guidelines, inequalities in access to nephrology treatment continue, especially in resource-constrained environments. To overcome such challenges, primary and speciality care services must be integrated to enable timely referral and proper disease management.

Early nephrology referral was effective according to this research, as the patients who had specialist treatment early on had considerably improved outcomes as compared to patients who were referred late. Past studies validate this finding, showing that early nephrology referral decreases hospitalization, postpones dialysis initiation, and enhances patient survival overall [3]. Despite these advantages, late referrals are prevalent because of knowledge gaps and access to healthcare. Healthcare systems must focus on organized CKD management programs that ensure early screening, patient education, and multidisciplinary care to improve outcomes.

Although this research is informative about the advantages of early CKD diagnosis and treatment, some limitations should be recognized. The retrospective design of the study allows for selection bias, and differences in patient compliance with treatment protocols may have affected results. Prospective studies with larger cohorts and longer follow-up periods are needed to confirm these results in the future. Moreover, examining the potential of new biomarkers and precision medicine strategies in the detection of early CKD can help in more tailored treatment approaches.

Finally, this study highlights the key importance of early diagnosis and prompt intervention to manage CKD. The patients diagnosed early showed less rapid disease progression, decreased cardiovascular risk, fewer deaths, and meaningful cost savings. These results are consistent

with international evidence supporting early screening, organized disease management programs, and integrated care models. It is critical to strengthen healthcare policies to enhance CKD awareness, improve access to nephrology services, and adopt cost-effective treatment approaches to reduce the increasing burden of CKD globally [15].

CONCLUSIONS

This research emphasizes the important advantages of timely management and early diagnosis in enhancing long-term results for individuals with CKD. The earlier intervention was correlated with less disease progress, reduced ESRD incidence, diminished cardiovascular complications, and better survival rates. It also proved to be highly cost-effective by reducing healthcare costs linked to hospitalization, dialysis, and cardiovascular event treatment. These results concur with global recommendations highlighting the significance of early screening, intensive treatment plans, and early nephrology referral in CKD management. As the global incidence of CKD increases, there is a critical need to strengthen healthcare policies for improved early detection and organized disease management programs. By incorporating multidisciplinary strategies and enhancing patient education, clinical outcomes can be further improved, the economic impact diminished, and the quality of life of the CKD-affected population as a whole enhanced.

CONTRIBUTION OF AUTHORS

Research concept- Arun Kumar Yadav, Sunil Madhab Panda
Research design- Sourav Shristi, Arun Kumar Yadav
Supervision- Sourav Shristi
Materials- Arun Kumar Yadav, Sunil Madhab Panda
Data collection- Sourav Shristi, Arun Kumar Yadav
Data analysis and Interpretation- Arun Kumar Yadav, Sunil Madhab Panda
Literature search- Arun Kumar Yadav, Sunil Madhab Panda
Writing article- Sourav Shristi
Critical review- Sourav Shristi, Arun Kumar Yadav
Article editing- Arun Kumar Yadav, Sunil Madhab Panda
Final approval- Sourav Shristi, Arun Kumar Yadav

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