A BASIC APPROACH TO CKD MANAGEMENT AT THE PRIMARY CARE LEVEL IN LOW RESOURCE SETTINGS

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ABSTRACT

Chronic kidney disease (CKD) is defined as abnormal kidney function or structure that persists for >3 months, with implications for health. It is a common condition and a significant risk factor for cardiovascular disease. The most common causes of CKD are diabetes and hypertension, and its prevalence increases with age. In addition, CKD is associated with the risk of kidney failure, significant healthcare expenditure, and increased morbidity and mortality. Early detection is necessary to slow progression and prevent cardiovascular disease. Primary care providers (PCPs) are well suited to managing CKD, especially in low resource settings with shortage of nephrologists. Here, we review published guidelines and online resources to provide a practical approach to CKD management in primary care, focusing on low resource settings. The spectrum of kidney care discussed includes screening, detection, and management of CKD. We also describe novel decision-support aids to predict kidney failure and to help PCPs navigate care for patients with advanced kidney disease, especially when access to kidney replacement therapy is limited.

***Keywords**: Chronic kidney disease, Primary care, Prevention, Screening, Management*

Key points:

- Chronic kidney disease (CKD) is a common condition, and early identification and management at the primary care level is important to prevent cardiovascular morbidity and mortality, and kidney failure.
- CKD is defined as an abnormality in either kidney function and/or structure that is present for >3 months, and it is classified into five stages.
- Only high-risk populations such as patients with hypertension and diabetes should be screened for CKD.
- The 2 tests required to detect CKD are estimated glomerular filtration rate (eGFR) and urine albumin creatinine ratio (urine ACR).
- If either test is abnormal (eGFR <60 and/or urine ACR >3), repeat testing 3 months later is needed to confirm the diagnosis of CKD.
- CKD management involves reducing cardiovascular risk, preventing further kidney injury, and slowing the progression of kidney disease.

INTRODUCTION

Chronic kidney disease (CKD) is a common condition and a global public health issue.[1] Developing CKD increases the risk of hospitalization, hospital-acquired complications, cardiovascular events, and death.[2–4] CKD is also associated with increased costs to patients and the healthcare system, especially when it progresses to kidney failure, which requires kidney

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replacement therapy (KRT) in the form of dialysis or kidney transplantation.[5] The majority of patients with CKD do not progress to kidney failure.[6] Most patients with CKD die from cardiovascular disease-related causes before reaching the kidney failure stage.[2] Due to the silent nature of kidney disease, patients and providers may overlook its significance. This lack of CKD awareness can lead to missed opportunities for early intervention at the primary care level. Early CKD detection and cardiovascular risk management are crucial in disrupting the pathway between kidney disease and cardiovascular morbidity and mortality.[7]

Most CKD care (e.g., prevention, identification, detection, and treatment) can be provided in primary care settings. Thus, the majority of pre-dialysis CKD can be treated by primary care providers (PCPs), with specialist involvement in care when necessary.[8] Primary care is integral to optimal care delivery as well as shifting the focus of CKD care from kidney failure, which is expensive and complex to treat, to CKD prevention and early stage CKD management (**Figure 1**).[8]

The aim of this review is to provide a basic approach to CKD management in primary care, with a focus on low resource settings. By synthesizing published guidelines[9–14] and online resources, we hope to improve knowledge and confidence among PCPs to play a broader role in caring for CKD patients.

Epidemiology of CKD

It is estimated that approximately 10% of people worldwide are living with CKD.[15] CKD prevalence varies from country to country,[16,17] and is higher among high-risk populations[18] (**Table 1**). The prevalence of CKD is growing in both developed and developing countries. This is partly due to the rising prevalence of its two most common precursors, diabetes and hypertension.[19,20] CKD prevalence studies show that kidney failure (requiring KRT) affects less than 1% (0.01%) of CKD patients, thus representing the tip of the iceberg, while the more prevalent early stages of CKD remain hidden beneath the water line.[15] Given this high prevalence, nephrologists do not have the capacity to manage all patients with CKD. The International Society of Nephrology's Global Kidney Health Atlas reported a significant shortage of nephrologists in most low- and middle-income countries (LMICs).[21] In Nigeria, CKD prevalence was shown to be influenced by the equation used to estimate baseline kidney function. In a systematic review by Chukuonye et al., the MDRD and CKD-EPI equations yielded consistent eGFR estimates indicating a prevalence of 12–14%.[16]

The cost of kidney replacement therapy

Kidney replacement therapy (KRT) consumes a disproportionate amount of the healthcare budget. High income nations allocate approximately 2–3% of their total healthcare budgets to the provision of KRT. For instance, in Canada—a country with universal health care, about 10% of people have CKD, and approximately 43,000 are living with kidney failure. Among those with kidney failure, two-thirds receive dialysis, while a third are treated with kidney transplantation. First-year costs of both dialysis and kidney transplantation are approximately CAD 100,000; this amounts to an annual cost of approximately CAD 2.5 billion to provide care for less than 1% (0.06%) of the country's population.[22,23] In the United States, the government health insurance plan (Medicare) has subsidized the high cost of kidney dialysis since 1971.[24] According to a 2019 USRDS report, spending associated with care for kidney failure patients was more than USD 35 billion, accounting for more than 7% of all Medicare spending.[25]

These prohibitive costs are thought to be the most important contributor to disparities between high income countries and LMICs in the prevalence of KRT.[26] Liyanage et al. estimated that more than 2.5 million people worldwide who should be receiving KRT do not receive it.[27] The highest treatment gaps were found in Asia (-66%) and Africa (-

84%).[27] This is concerning, especially because current projections show that CKD burden is growing the fastest in LMICs. Furthermore, KRT in LMICs can be associated with catastrophic out-of-pocket expenditures.[28] Thus, it is imperative to develop effective prevention strategies and programs for optimal kidney care delivery in primary care settings to ease the burden of CKD.

The nomenclature for kidney disease and function

Prior to 2002, the nephrology community did not have a standardized definition for chronic kidney disease (CKD). Several terminologies such as chronic renal failure or insufficiency, chronic renal disease, and progressive renal insufficiency were used.[29] In 2002, the U.S. National Kidney Foundation established the Kidney Disease Outcomes Quality Initiative (the NKF-KDOQI) developed a standard framework for defining and classifying CKD.[29] This framework was endorsed widely by a large number of national and international professional organizations. The key premise of this initiative was that defining CKD and classifying the stages of severity would provide a common language for communication among healthcare providers, patients and their families, investigators, and policymakers, and serve as a framework for developing a public health approach to improve care and CKD outcomes.

A decade later, in 2012, Kidney Disease: Improving Global Outcomes (KDIGO) updated this framework by providing valuable prognostic tools and developing care management strategies based on CKD stage and baseline risk for progression to kidney failure or development of cardiovascular disease.[30] Markers of kidney damage vary depending on the type of kidney disease, and may include abnormalities in blood or urine composition or imaging tests, with or without decreased eGFR.[30] For example, albuminuria is widely accepted as a marker of damage, an early manifestation of CKD and also an important prognostic factor for the progression of kidney disease and development of cardiovascular events.

Recently in 2020, the global nephrology community met to further standardize the nomenclature for CKD and acute kidney injury (AKI).[31] They recommended using the term "kidney" rather than "renal" when referring to kidney disease and function, and the term "kidney failure" instead of "end-stage kidney disease" when referring to CKD requiring KRT.[31]

The definition and classification of CKD

CKD is defined as either a functional or structural abnormality of the kidney that persists for at least 3 months.[10] Based on this definition, CKD is classified into five different stages. The staging system was introduced more than 2 decades ago, and CKD diagnosis expanded from serum creatinine measurements alone to include measurements of estimated glomerular filtration rate (eGFR) and albuminuria.[10] The CKD staging system is divided into five stages (**Figure 2**).[10] After epidemiological studies showed that stage 3 is vast, it was further split into stages 3a and 3b.[10] The presence of albuminuria differentiates the five stages into three risk levels.[10]

Measuring kidney function

The gold standard test for kidney function is GFR.[32] However, the direct measurement of GFR is cumbersome and not feasible outside of specialized research settings.[32] Instead, an estimated GFR (eGFR) from serum creatinine is used in everyday clinical practice, as per guideline recommendations.[10] The CKD diagnosis threshold is eGFR of <60 mL/min/1.73 m^2 in two tests 90 days apart.[10]

Estimated glomerular filtration rate (eGFR)

Over the years, several equations were developed to estimate GFR using serum creatinine. The oldest is the Cockcroft-Gault equation which is now used only for medication dosing changes for patients with kidney failure.[32] It was replaced by the MDRD (Modification of Diet in Renal Disease) equation.[32] Today, The CKD-Epi (Chronic Kidney Disease Epidemiology

Collaboration) equation is the most widely used formula in clinical practice.[33] Although both MDRD and CKD-Epi equations have known limitations, CKD-Epi is recommended for use in general practice.[10] However, a systematic review of both eGFR methods noted limited data for use outside North America and Europe.[33] Previous work to validate both MDRD and CKD-Epi equations in Africa has shown satisfactory and comparable performance.[34] Larger studies are underway to further validate these equations in sub-Saharan Africa.[35] Ideally, labs should automatically report eGFR whenever a serum creatinine measurement is requested outside of acute care settings.[33] However, eGFR can be easily calculated based on demographic data (age, sex, and race) and serum creatinine levels. Several online calculators and decision-support tools (e.g., MDCalc) are available to convert serum creatinine to eGFR (**Figure 3**).

Assessment of structural kidney changes

The presence of albumin and/or protein indicates permeability in the glomerulus and is a marker of kidney damage.[10] For simplicity, albuminuria can be divided into normal (no albuminuria), microalbuminuria, and macroalbuminuria. In the CKD staging system, albuminuria is classified into 3 levels: normal, mild (A1), and moderate (A2).[10] The standard and most convenient method to measure albuminuria is by calculating the albumin-to-creatinine ratio in a morning spot urine sample (urine ACR).[10] The test allows for detection of microalbuminuria at an early stage (urine ACR 2–20 mg/mmol), which is below the detection threshold of a urine dipstick.[36] Guidelines recommend repeat testing of abnormal urine ACR to rule out false positive results from either causes of transient albuminuria (e.g., exercise, urinary tract infections) or intraindividual day-to-day variability.[36] However, some studies questioned the need for triplicate testing for urine ACR.[36,37] Given that urine ACR may not be widely available in some settings, urinalysis (either microscopic or urine dipstick) can be used as an alternative point-of-care test for proteinuria.

Screening and early detection of CKD

The challenge of detecting early CKD is that it is primarily an asymptomatic condition. Thus, the idea of screening for CKD is appealing. Nevertheless, several organizations recommend against screening the general population[9] because public screening for CKD is not cost-effective in developed countries.[38] Moreover, CKD testing does not meet many of the criteria required for a population-based screening program.[39] However, targeted screening of patients with increased risk of CKD is recommended, specifically patients with diabetes and hypertension.[40] Notably, age alone is not a reason to screen for CKD. Other unique causes of CKD in LMICs may increase patient risk, such as widespread use of herbal medicine in Southeast Asia and Africa,[41] and the prevalence of HIV, hepatitis B and C, and tuberculosis in sub-Saharan Africa.[42] Although the practice is not supported by guidelines, some countries perform targeted screening when children enroll in school and when adults enroll in university and/or enter the workforce.[43–45]

Prevention of CKD is essential in kidney care, especially in LMICs like Nigeria, which is rapidly undergoing epidemiological transitions with a dual burden of communicable and non-communicable diseases. Increasing awareness of CKD at the primary care level will increase people's commitment to proactively seek care and prioritize their health, and increase awareness of the dangers of taking unregulated herbal medications and drugs not prescribed by medical personnel. Other preventive measures include urging people to drink and use safe and clean water, practice good personal and environmental hygiene, and vaccinate against disease to prevent and reduce the prevalence of CKD.

Detection and management of CKD

Two laboratory tests are required to diagnose CKD: eGFR and urine ACR. If either measurement is abnormal (eGFR <60 and/or urine ACR >3 mg/mmol), the test must be repeated in 3 months to confirm a CKD

diagnosis.[10] The test can be repeated sooner if there is a concern of rapid decline (e.g., AKI).[10] Notably, acute illness and dehydration can affect how tests are interpreted. Once a CKD diagnosis is confirmed, electrolyte measurement and urinalysis (i.e., hematuria, RBC cast), are performed to assess for rare causes of CKD.[10] The overall goal of CKD management is similar to other cardiovascular-related conditions. The mainstays of treatment are measures to reduce cardiovascular disease risk, minimize further kidney damage, and slow CKD progression.[9–11]

Cardiovascular risk reduction

Low eGFR and albuminuria are risk multipliers for cardiovascular events and progression to kidney failure.[46] Taken together, they can outperform most individual traditional cardiovascular risk factors to predict cardiovascular disease risk.[47] All CKD patients should pursue non-pharmacological treatments, including a healthy diet, regular physical activity, and smoking cessation(**Table 2**)..[10] Blood pressure control using an angiotensin-converting enzyme inhibitor (ACEi) or an angiotensin II receptor blocker (ARB) is recommended to achieve target systolic blood pressure <140.[12] The use of a lower systolic target of 120 is not consistent among guidelines and is potentially harmful to some patients.[12] In CKD patients with diabetes, good glycemic control is important to reduce cardiovascular complications. Patients with CKD who are 50 years old or older or are at higher risk of CVD (diabetes, previous CVD) should be offered a statin[14] (**Table 2**).

Minimizing further kidney damage

Kidney injury can be mitigated by avoiding any nephrotoxic medications.[10] This includes avoiding common NSAID medications, not combining ACEi and ARB medications, and adjusting dosages if a patient is unwell (**Tables 3 and 4**).

Slowing progression of CKD

Optimal blood pressure and glycemic control are essential to slow progression and prevent further kidney damage in patients living with CKD.[10] Blocking the renin-angiotensin system (RAS) with an ACEi or ARB has been the mainstay of treatment in diabetes and CKD.[10] In addition to glycemic control and cardiovascular benefits, SGLT inhibitors recently have shown promise in decreasing CKD progression in patients with or without diabetes.[13] Similar to non-diabetic CKD, comprehensive care is recommended for patients with CKD and diabetes.[13] RAS blockade medications are the first-line option in patients with diabetic nephropathy and in patients with diabetes and hypertension and/or albuminuria, as they have been shown to decrease CKD progression.[13] A lower blood pressure target of 130/80 is recommended for this patient group.[12] These medications can be titrated to the highest approved dose that patients tolerate. Within 2–4 weeks of initiation or an ACEi or ARB dosage increase, follow-up monitoring for blood pressure changes, serum creatinine, and serum potassium should be performed.[13] For glycemic control, metformin continues to be the first-line treatment for patients with CKD and diabetes (eGFR >30).[13] However, the use of SGLT inhibitors as a first-line treatment after metformin is now recommended.[13] Other glucose-lowering drugs can be added based on individual patient factors (**Figure 4**).[13] Notably, unlike ACEi/ARBs and other oral hypoglycemic medications, the use of non-generic SGLT inhibitors can be cost-prohibitive in low resource settings. Guidelines recommend monitoring HbA1c to ensure glycemic control.[13] Daily self-monitoring of blood glucose is recommended, especially if taking insulin or sulphonylureas. Individualized targets ranging from 8.5% to 6.5% are recommended, depending on patient factors.[13]

Management of advanced CKD complications

Specialist input is often needed in advanced CKD care. Common complications in advanced CKD include cardiovascular disease, anemia, bone mineral disease, metabolic acidosis and malnutrition (**Table 5**). Complete blood counts should be performed annually for asymptomatic CKD

patients, and more frequently for patients with more advanced CKD.[48] If anemia is detected, further tests, including reticulocyte count, iron indices (e.g., ferritin, transferrin saturation), and assessments of vitamin B12 and folate levels are indicated.[48] In advanced CKD, testing for serum calcium, phosphorus, vitamin D, parathyroid hormone, and alkaline phosphatase levels is indicated to assess for bone mineral disease (**Table 5**).[49]

Referral to nephrology

Involving kidney specialists in care for patients with advanced kidney disease is important. Guidelines and kidney experts have published several lists to help PCPs make referral decisions.[9,10] Common referral indicators are: (a) low eGFR (<30), or rapid decrease in kidney function; (b) moderate albuminuria (urine ACR >60); (c) a suspected uncommon cause of CKD (e.g., glomerulonephritis, vasculitis); and (d) difficulties in managing aspects of CKD care (e.g., resistant hypertension, electrolyte disorder, anemia). Although the availability of nephrologists is often variable among and within countries,[21] telemedicine may help address shortages of kidney care providers in certain areas.[50]

Predicting kidney failure

The use of decision support aids is increasing in clinical settings. Fortunately, not all patients with CKD progress to kidney failure. Recently, the kidney failure risk equation (KFRE) was developed and validated to predict a patient's risk of kidney failure within the next 2 years and 5 years,[51,52] using only a patient's age, gender, eGFR, and urine ACR (**Figure 5**).[51] Guidelines recommend that patients with >5% risk of kidney failure within the next 5 years be referred to nephrologists. The tool also can reassure low-risk patients that it is safe to continue care with PCPs.

Palliative options for advanced CKD

In many low-resource settings, KRT in the form of dialysis or kidney transplantation is often not available or not accessible.[5] PCPs can provide conservative patient care in the form of symptom management and psychosocial and family support.[53,54] This form of care is called choice-restricted conservative kidney care, in contrast to choice-available conservative care, in which patients opt for symptom management instead of KRT.[55] The conservative kidney management tool provides a unique approach to palliative care in patients with advanced CKD in the form of an online resource that can help PCPs and patients navigate advanced kidney failure (**Figure 6**). This tool supports holistic patient-centered care and support at the end of life, especially in areas where access to KRT is limited.

Challenges associated with CKD management in Nigeria

The economic burden of managing CKD in Nigeria is enormous, and often compounded by a lack of CKD awareness, a lack of early identification of CKD, and late arrival to the hospital when dialysis is required, adding to treatment costs. CKD that is not identified early makes CKD management difficult in a country where most health financing is out-of-pocket and most patients have no access to health insurance. For the few who do have health insurance, plans do not cover for the costs of dialysis and medications. The costs of drugs and laboratory investigations are enormous and not affordable for many patients. For instance, a CKD patient with hypertension, diabetes, and a new diagnosis of stage 3 CKD might need to pay for a constellation of drugs (e.g., ramipril, indapamide, amlodipine, atorvastatin, metformin, gliclazide), monthly laboratory investigations, and consultation fees, at a total cost of approximately NGN 30,000 per month and NGN 360,000 per year, equivalent to the average wage. For patients with kidney failure, treatment costs are astronomical: the cost of a single dialysis session is NGN 25,000, amounting to NGN 3,600,000 per year, and the cost of a kidney transplant is NGN 13,558,200.

Table 1: CKD prevalence from selected observational studies in LMICs

Study	Country	World Bank country classification	Number of people screened	Mean age	Outcome reported	Albuminuria (%)	eGFR <60 (%)	eGFR equation	DM prevalence (%)	HTN prevalence (%)	Obesity prevalence (%)
Anand et al. 2014	Bangladesh	Lower middle income	357	49.4	Alb, CKD	22	10.08	CKD-EPI	38.6	37.2	20.1
Ene-Iordache et al. 2016	Bolivia	Lower middle income	3,410	41.6	Alb, CKD	4.5	1.7	CKD-EPI	-	-	-
Kaze et al. 2015	Cameroon	Lower middle income	439	47	Alb, CKD	12.1	10.9	CKD-EPI	9.8	25.5	53.3
Eastwood et al. 2010	Ghana	Lower middle income	944	54.7	CKD	-	1.6	MDRD	41	-	-
Singh et al. 2009	India	Lower middle income	5,252	38.9	Alb, CKD	2.25	4.2	MDRD	6.51	27.74	23.6
Singh et al. 2013	India	Lower middle income	5,588	45.22 (15.2)	CKD	-	5.9	MDRD	18.8	43.1	11.7
Gallieni et al. 2013	India	Lower middle income	2,536	51	Alb, CKD	7.7	4.2	MDRD	-	39.4	5.8
Anupama et al. 2014	India	Lower middle income	2,091	39.3	Alb, CKD	2.9	4.4	MDRD	3.8	33.6	13.3
Trivedi et al. 2016	India	Lower middle income	2,350	48.16 (14)	CKD	19.7	8.29	MDRD	9.79	26.85	18
Ene-Iordache et al. 2016	India	Lower middle income	3,196	50.1	Alb, CKD	15.4	2.5	CKD-EPI	-	-	-
Prodjosundjadi et al. 2009	Indonesia	Lower middle income	9,412	43.3	CKD	3	7.6	MDRD	3.5	15	32.5
Ene-Iordache et al. 2016	Moldova	Lower middle income	1,403	50.7	Alb, CKD	17.1	11.2	CKD-EPI	-	-	-
Sharma et al. 2010	Mongolia	Lower middle income	997	40	Alb, CKD	5.4	8.1	MDRD	2.2	24	-
Ene-Iordache et al. 2016	Mongolia	Lower middle income	832	41.1	Alb, CKD	11.3	9.6	CKD-EPI	-	-	-
O'Donnell et al. 2010	Nicaragua	Lower middle income	771	38.5	CKD	-	13	MDRD	-	-	24.2
Lebov et al. 2015	Nicaragua	Lower middle income	2,493	-	CKD	-	7.6	MDRD	-	-	-
Amira et al. 2007	Nigeria	Lower middle income	1,416	38.5	Alb, CKD	23.9	-	-	2.6	36.3	-
Afolabi et al. 2009	Nigeria	Lower middle income	250	50.5	Alb, CKD	12.4	10.4	MDRD	-	-	-
Arogundade et al. 2011	Nigeria	Lower middle income	286	49.5	Alb, CKD	29.7	-	-	-	37.7	-
Ayodele et al. 2011	Nigeria	Lower middle income	586	42.4	Alb	2.5	-	-	3.8	25.9	19.6
Egbi et al. 2014	Nigeria	Lower middle income	179	45.2	CKD	-	2.2	CG	-	-	-
Ene-Iordache et al. 2016	Nigeria	Lower middle income	1,912	44.3	Alb, CKD	3.9	20.7	CKD-EPI	-	-	-
Olanrewaju et al. 2020	Nigeria	Lower middle income	1,353	44.3	Alb, CKD	7.1	11.8	CKD-EPI	7.1	23.7	8.7
Jafar et al. 2009	Pakistan	Lower middle income	2,891	51.5	Alb	5.6	-	MDRD	21.4	-	68.4
Jessani et al. 2014	Pakistan	Lower middle income	2,873	51.5	Alb, CKD	9.4	5.3	CKD-EPI	21.4	44.9	-
Sharma et al. 2010	Nepal	Low income	8,398	38	Alb, CKD	10.3	14.4	MDRD	7.7	34	-
Sharma et al. 2013	Nepal	Low income	3,218	42.9	Alb, CKD	5.1	10.6	MDRD	7.5	38.6	5
Ene-Iordache et al. 2016	Nepal	Low income	21,066	40.8	Alb, CKD	5.8	16.2	CKD-EPI	-	-	-
Seck et al. 2014	Senegal	Low income	1,037	48	Alb, CKD	5.3	4.9	MDRD	12.7	39.1	23.4
Abu-Aisha et al. 2009	Sudan	Low income	273	34.3	CKD	4.7	7.7	MDRD	-	-	15.4
Stanifer et al. 2015	Tanzania	Low income	481	-	Alb, CKD	-	7	MDRD	-	-	-

Alb: albuminuria; CKD: chronic kidney disease; eGFR: estimated glomerular filtration rate; DM: diabetes mellitus; HTN: hypertension; CKD-EPI: chronic kidney disease epidemiology collaboration equation; MDRD: modification of diet in renal disease equation

Table 2: Evidence-based strategies for reduction of cardiovascular risk and affordable alternatives based on WHO essential medicines package

Risk factor	Guideline-concordant treatment goals and recommended agents	Access and availability in low resource settings	Common approach in Nigeria	Cheaper alternatives based on WHO essential medicines package[56]
Weight	• Achieve or maintain a healthy weight (BMI 20–25kg/m^2)			
Diet	• Limit salt intake to <90 mmol/day • Limit protein intake to 0.8 g/kg/day for adults with CKD (stages 4-5) with or without diabetes, with appropriate education	• Nutrition choices in low resource settings can be limited due to variations in food availability, cooking skills, comorbidities, and cost when recommending dietary options	• Limit salt intake to 1 small teaspoon (5 g) per day • Quantity of protein is based on patient weight, social status, and availability of food in the local environment	• Healthy and locally available food
Smoking	• Smoking cessation using counseling, NRT, and medications such as varenicline and bupropion	• Limited availability of medications such as varenicline and bupropion to aid in smoking cessation	• Modalities to stop smoking are mostly limited to counseling on the dangers of smoking and patient motivation to quit smoking	• Brief counseling • NRT
Exercise	• Moderate-intensity physical activity of at least 150 minutes per week	• Limited access to fitness amenities	• Despite limited access to fitness amenities, patients are encouraged to engage in aerobic exercise for at least 150 min/week indoors or outdoors, depending on the patient's preference	• Avoid sedentary behavior
Albuminuria	• Monitoring and follow up • Treatment with ACEi/ARBs for patients with proteinuria	• Urine ACR • ACEi or ARB • SGLTi	• Urinalysis dipstick and microscopy • ACEi treatment is expensive (lisinopril: NGN 2,500 [CAD 8]/month; ramipril: NGN 3,000 [CAD 10]/month) • ARB treatment is expensive (valsartan and telmisartan: NGN 3,000 [CAD 10]/month) • Lack of access to SGLT1i	• Urinalysis microscopy/urine dipstick • Enalapril • Losartan
Blood pressure	• BP <130/80mmHg (diabetes or proteinuric CKD) • BP <140/80 mmHg (non-diabetic or non-proteinuric CKD)	• ACEi or ARB (first line) • Calcium channel blockers • Thiazide diuretics	• Calcium channel blockers are available but expensive (e.g., amlodipine: NGN 2,500 [CAD 8]/month; nifedipine: NGN 2,000 [CAD 7]/month) • Thiazide diuretics are available but expensive (e.g., indapamide: NGN 5,000 [CAD 16]/month)	• In addition to enalapril and losartan, WHO list includes affordable BP medications such as amlodipine and hydrochlorothiazide
Diabetes	• HbA1c < 7% and use of newer agents (i.e., SGLT2i)	• SGLT2i and other hypoglycemia medications are not widely available and costs can be a barrier	• SGLT2i are not available; oral hypoglycemic medications are available, but expensive (e.g., metformin: NGN 1,500 [CAD 5]/month; insulin: NGN 5,000 [CAD 16]/month)	• Metformin • Insulin
Dyslipidemia	• Use of statins to decrease LDL cholesterol <120 mg/dl (2 mmol) or 50% reduction from baseline	• Generic statin medications are available in most low resource settings, but costs can be a barrier if out of pocket	• Generic statins are available, but expensive (e.g., atorvastatin: NGN 3,500 [CAD 12]/month; simvastatin: NGN 750 [CAD 2]/month)	• Simvastatin (the cheapest statin) appears on the WHO list

BP: blood pressure; WHO: World Health Organization; BMI: body mass index; NRT: nicotine replacement therapy; LDL: low-density lipoproteins; HbA1c: glycated hemoglobin; SGLT2i: sodium-glucose transport protein 2 inhibitor; ACEi: angiotensin-converting enzyme inhibitor; ARB: angiotensin II receptor blocker; ACR: albumin-to-creatinine ratio; CKD: chronic kidney disease; eGFR: estimated glomerular filtration rate

Table 3: Common medications to avoid when patients are unwell*

	Medication class	Examples
S	Sulfonylureas, other secretagogues	gliclazide, glyburide
A	ACE inhibitors	captopril, enalapril, lisinopril
D	Diuretics, direct renin inhibitors	hydrochlorothiazide, chlorthalidone
M	Metformin	
A	Angiotensin receptor blockers	candesartan, irbesartan, telmisartan
N	Nonsteroidal anti-inflammatory drugs	Ibuprofen, naproxen, indomethacin
S	SGLT2 inhibitors	empagliflozin, canagliflozin

ACE: angiotensin-converting enzyme; SGLT2: sodium-glucose transport protein 2

*SADMANS is an acronym that can be used as a memory aid.

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https://www.rxfiles.ca/rxfiles/uploads/documents/SADMANS-Rx.pdf

Table 4: Prevention of further kidney injury

Risk factor	Recommendations
Use of NSAIDs	Avoid prescribing NSAIDs; if such medications are necessary, do not prescribe for longer than 2 weeks.
Use of ACEi and ARB	Perform follow up electrolyte (serum potassium) and creatinine measurements 2 weeks after initial prescription or change in ACEi or ARB dosage.
Simultaneous use of both an ACEi and an ARB	Avoid co-prescribing ACEi and ARBs.
Use of nephrotoxic medications	Avoid all nephrotoxic medications.
Use of contrast agents for imaging	Caution should be exercised; if necessary, ensure pre- and post-contrast hydration.

NSAID: Nonsteroidal anti-inflammatory drugs; CKD: chronic kidney disease; ACEi: angiotensin-converting enzyme inhibitors; ARBs: angiotensin II receptor blockers

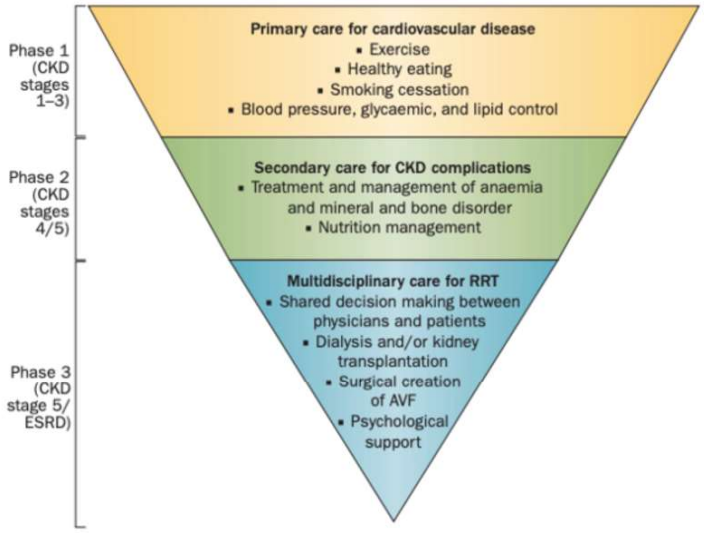
Table 5: Complications of CKD and intervention strategies

Complication	Investigations	Target	Interventions
Cardiovascular disease	• Left ventricular hypertrophy • Congestive heart failure	• BP <130/80 mmHg • LDL <2.0 mmol or 50% reduction from baseline	• Control hypertension • ACEi/ARBs as indicated • Control dyslipidemia/statins • Correct anemia • Control hyperparathyroidism • Cessation of smoking
Anaemia	• Complete blood count • Reticulocyte count • Iron, ferritin, and transferrin levels	Hgb 9–11g/L*	• Correct hematinic deficiencies • Supplement with parenteral iron in CKD stages 4-5 • Treat with erythropoietin in CKD stages 4-5
Mineral bone disorder	• ALP • Calcium and phosphorus • 25-hydroxyvitamin D • PTH level	• Serum calcium: >2.2 mmol/l • Serum phosphorus: <1.8 mmol/l • PTH: normal to 2–9 times the upper normal limit	• Reduce phosphate intake to ~ 800 mg/day • Consider phosphate binders • Calcium and vitamin D supplementation
Malnutrition	• Dietary intake • Weight • BMI • Serum albumin	BMI 18.5–24.5	• Adequate protein/calorie supplementation • Correct metabolic acidosis • Timely initiation of KRT (GFR~10ml/min)
Metabolic acidosis	Serum bicarbonate	Normal value	Bicarbonate supplementation if low values

* KDIGO guideline on anemia does not include specific cut-off levels for defining anemia among different races.

BP: blood pressure; LDL: low-density lipoproteins; ACEi: angiotensin-converting enzyme inhibitors; ARBs: angiotensin II receptor blockers; CKD: chronic kidney disease; BMI: body mass index; KRT: kidney replacement therapy; ALP: alkaline phosphatase; Hgb: hemoglobin; PTH: parathyroid hormone

Figure 1: Chronic kidney disease care pyramid[8]



Adapted with permission from:
https://www.nature.com/articles/nrneph.2015.85.pdf?origin=ppub

Figure 2: Chronic kidney disease prognosis by eGFR and albuminuria

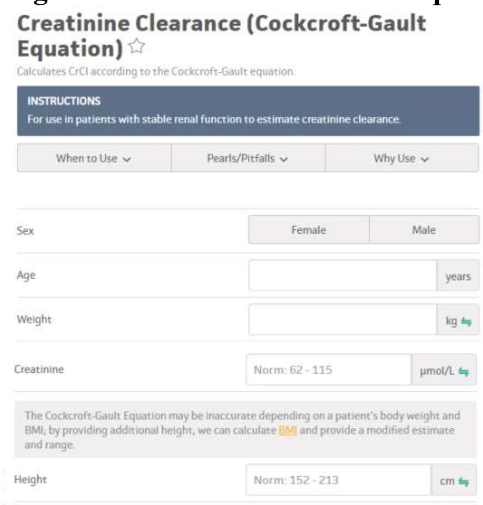
Prognosis of CKD by GFR and albuminuria categories: KDIGO 2012

GFR categories (ml/min per 1.73 m²) Description and range				Persistent albuminuria categories Description and range		
				A1	A2	A3
				Normal to mildly increased	Moderately increased	Severely increased
				<30 mg/g <3 mg/mmol	30–300 mg/g 3–30 mg/mmol	>300 mg/g >30 mg/mmol
	G1	Normal or high	≥90			
	G2	Mildly decreased	60–89			
	G3a	Mildly to moderately decreased	45–59			
	G3b	Moderately to severely decreased	30–44			
	G4	Severely decreased	15–29			
	G5	Kidney failure	<15			

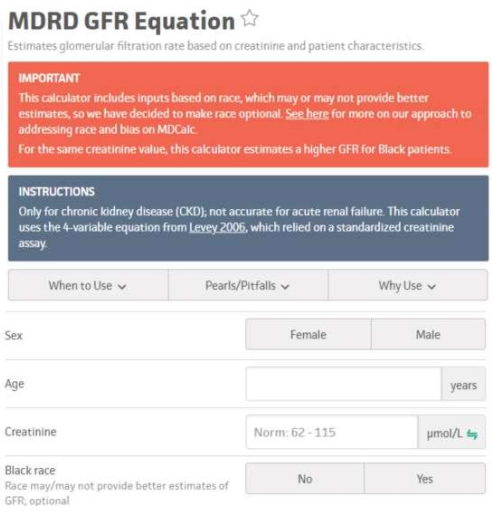
Green, low risk (if no other markers of kidney disease, no CKD); yellow, moderately increased risk; orange, high risk; red, very high risk.

Adapted with permission from:
https://kdigo.org/wp-content/uploads/2020/10/KDIGO-2020-Diabetes-in-CKD-GL.pdf

Figure 3: Online tool for eGFR equations



Adapted with permission from:
https://www.mdcalc.com/creatinine-clearance-cockcroft-gault-equation



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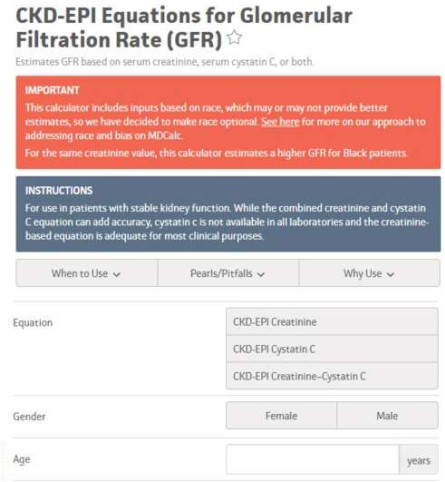
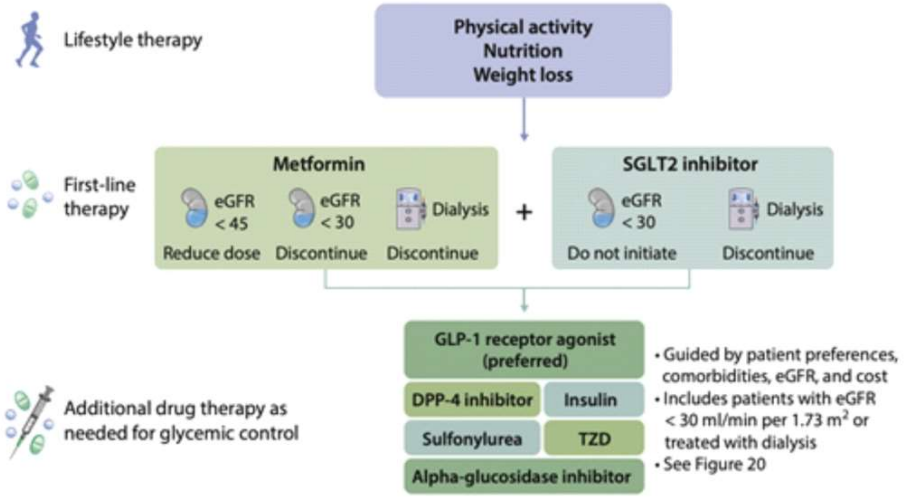


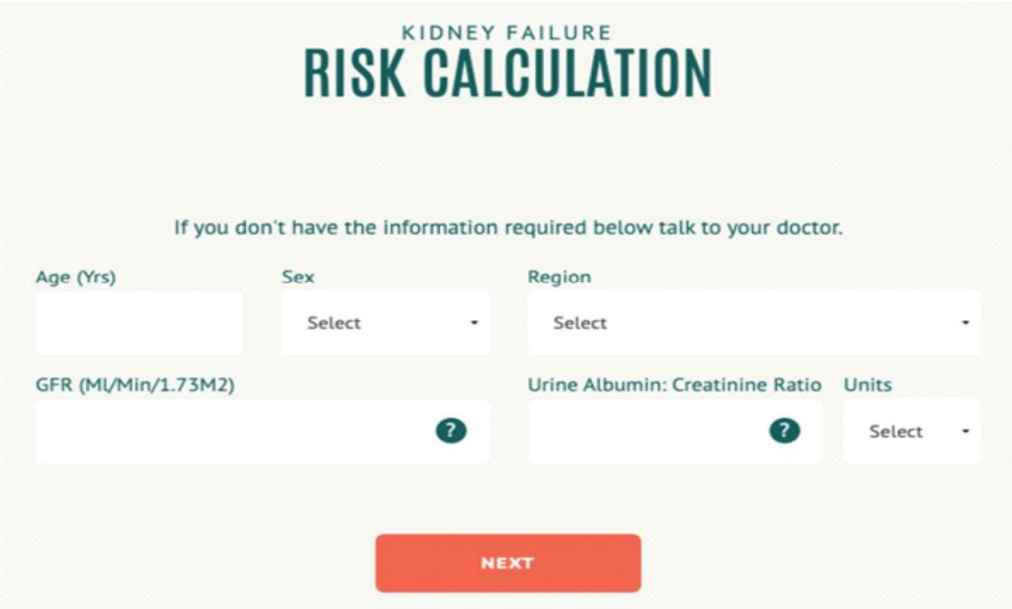
Adapted with permission from:
https://www.mdcalc.com/ckd-epi-equations-glomerular-filtration-rate-gfr

Figure 4: Glycemic management for patients with type 2 diabetes and CKD



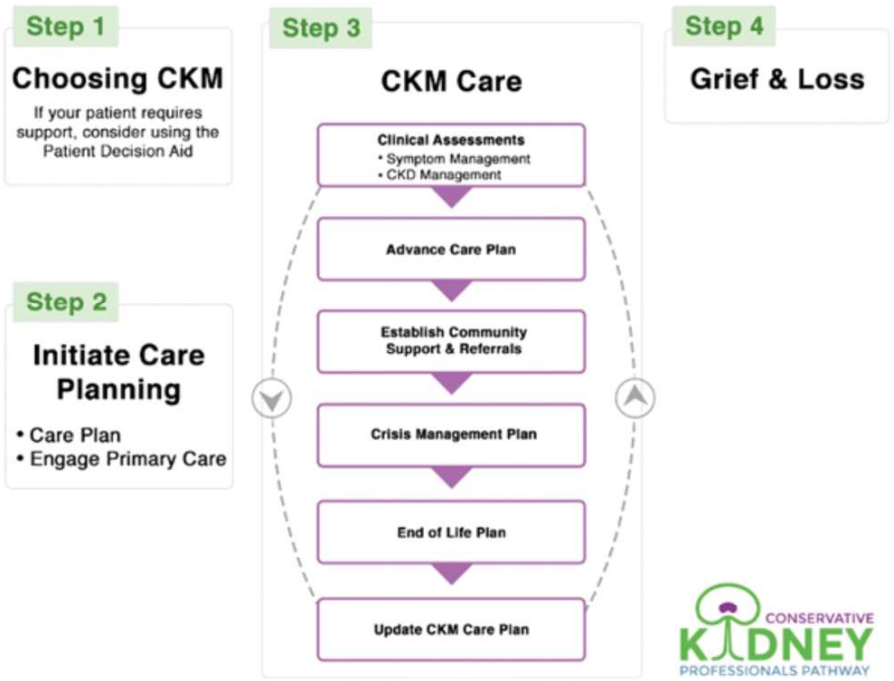
Adapted with permission from:
https://kdigo.org/wp-content/uploads/2020/10/KDIGO-2020-Diabetes-in-CKD-GL.pdf

Figure 5: Kidney failure risk equation (KFRE) calculator



Adapted with permission from:
https://kidneyfailurerisk.com

Figure 6: Conservative kidney management (CKM) tool



Adapted with permission from:
https://www.ckmcare.com/PractitionerPathway/AtAGlance

CONCLUSION

PCPs are well suited to manage CKD, especially in low resource settings. Early detection is vital to slow CKD progression and prevent cardiovascular mortality and kidney failure. Screening is only recommended for high-risk populations (e.g., hypertension and diabetes). The two main tests used to diagnose CKD are eGFR and urine ACR. Repeat testing (at least 90 days apart) is necessary to confirm a CKD diagnosis. The primary aims of CKD management are reducing CVD risk (controlling blood pressure and diabetes, preventing coronary artery disease), preventing further kidney injury, and slowing the progression of kidney disease. Patients with advanced CKD should be referred to nephrologists, as specialist care is associated with better outcomes for those with kidney failure.

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