Scientific Research Publishing

World Journal of Cardiovascular Diseases, 2026, 16(5), 355-368
https://www.scirp.org/journal/wjcd
ISSN Online: 2164-5337
ISSN Print: 2164-5329

Short-Term Renal Function Monitoring by Physicians after Initiation of Antihypertensive Therapy: A Cross-Sectional KAP Survey in Sub-Saharan Africa

Christian Ngongang Ouankou[1], Sylvain Raoul Simeni Njonnou[1], Joël Manuel Nanfa Nguefack[2], Mai-Pamela Mekieje Tumchou[2], Rostand Dimitri Messanga Bessala[3], Lamine Dieng[4], François Jérôme Kaze Folifack[5]

[1]Faculty of Medicine and Pharmaceutical Sciences, University of Dschang, Dschang, Cameroon
[2]Université des Montagnes, Bangangté, Cameroon
[3]Faculty of Medical Sciences, Newcastle University, Newcastle, United Kingdom
[4]Medical Director, Servier West and Central Africa, Ivory Coast
[5]Faculty of Medicine and Biomedical Sciences, University of Yaounde 1, Yaounde, Cameroon
Email: ngongangco@gmail.com

How to cite this paper: Ngongang Ouankou, C., Simeni Njonnou, S.R., Nanfa Nguefack, J.M., Mekieje Tumchou, M.-P., Messanga Bessala, R.D., Dieng, L. and Kaze Folifack, F.J. (2026) Short-Term Renal Function Monitoring by Physicians after Initiation of Antihypertensive Therapy: A Cross-Sectional KAP Survey in Sub-Saharan Africa. *World Journal of Cardiovascular Diseases*, **16**, 355-368.
https://doi.org/10.4236/wjcd.2026.165036

Received: March 13, 2026
Accepted: May 26, 2026
Published: May 29, 2026

Abstract

Introduction: Renin-angiotensin-aldosterone-system (RAAS) blockers are central to hypertension management due to their cardio- and nephroprotective effects. However, their initiation may cause a transient rise in serum creatinine, often misinterpreted as acute kidney injury, leading to inappropriate discontinuation. This study aimed to assess the knowledge, attitudes, and practices (KAP) regarding renal monitoring after antihypertensive initiation in sub-Saharan Africa. **Methods**: We conducted an analytical cross-sectional KAP survey among physicians across sub-Saharan Africa from January to March 2026 using an online questionnaire. The primary outcome was the proportion of participants correctly identifying the acceptable creatinine rise (≤30%) following RAAS initiation. Secondary outcomes included monitoring timelines, clinical decision-making, and perceived barriers. Data were analyzed using descriptive and inferential statistics. **Results**: A total of 136 physicians participated, predominantly from Central Africa (81.6%). Only 16.2% correctly identified the acceptable creatinine rise threshold. While 88.2% of respondents acknowledged the importance of post-initiation monitoring, only 34.6% reported performing it within the recommended 7 - 14 days. In a clinical scenario involving a 20% creatinine rise, only 21.3% selected the correct approach (continuing treatment with monitoring), whereas 78.7% modify or discontinue therapy inappropriately. No significant differences were observed

between specialists and non-specialists. Financial constraints were the most frequently reported barrier to monitoring. **Conclusion**: Significant gaps in knowledge and practice regarding RAAS-related renal monitoring exist among physicians in sub-Saharan Africa. These deficiencies may contribute to suboptimal hypertension management. Targeted education, improved guideline dissemination, and health system interventions are needed to optimize care and preserve the benefits of RAAS therapy.

Keywords

Hypertension, Serum Creatinine, Renal Function (GFR), Antihypertensives Drugs, RAAS Blockers, Sub-Saharan Africa

1. Introduction

Hypertension is a growing global burden affecting 1.4 billion people worldwide with an emerging disproportionate impact in low- and middle-income countries [1] [2]. This overall burden is secondary to multiple misfortunes caused by the morbidity of the disease, high-rate mortality and the high cost-related expenses faced by patients in limited resource settings.

Due to the high cardiovascular risk factor this disease constitutes, the cornerstone of its control lies in the optimal management involving anti-hypertensive medications. These medications have various properties besides being able to reduce blood pressure, depending on the class. It is the case for example for renin angiotensin aldosterone system (RAAS) blockers which, in addition to their blood pressure reducing power, confer cardiovascular and nephroprotective benefits, placing them as a consistent choice in therapeutic guidelines for the management of hypertension [3] [4].

This class of antihypertensive medication is known to cause a transient elevation in serum creatinine which reflects as a drop in the glomerular filtration rate (GFR) [5]. While traditionally in a clinical setting a rise in serum creatinine may cause concern for the investigation of an acute kidney injury (AKI), in this case the rise in creatinine reflects a hemodynamic adjustment operated in the kidney where the drug lowers the intraglomerular pressure [5] [6]. This rise in creatinine should not exceed 30% from the baseline, which is the clinically acceptable threshold under these medications [7] [8]. The changes reported in the creatinine levels often stabilize within a maximum of 2 months, after observing a peak rise at 2 weeks following the start of the therapy [8]. There are however documented cases of patients who experienced an actual AKI under RAAS blockers, but these scenarios came with precipitating factors such as congestive heart failure, intensive diuretic treatment, or concurrent use of non-steroidal anti-inflammatory drugs (NSAIDs) [5] [8].

Unfortunately, it is not uncommon to witness therapy discontinuation or modification by physicians who notice this rise in creatinine without clear clinical ev-

idence backing up this decision [8]. This practice deprives patients of a clear therapeutic advantage in the optimal management of their condition and may lead to the perennity of the already existing burden of hypertension [9]. Such malpractice can be remedied by carrying out targeted actions aimed at capacitating physicians involved in the follow-up of hypertensive patients.

2. Methods

2.1. Study Design

We conducted an analytical cross-sectional knowledge, attitude, practice study.

2.2. Setting

This study was an online survey conducted among physicians practicing in sub-Saharan Africa.

2.3. Participants

The study population included specialists and non-specialist physicians across sub-Saharan Africa with no restrictions regarding the specialty, years of practice or level of healthcare facility.

2.4. Recruitment Process

An online questionnaire was designed through google form and disseminated across different physicians' professional interest groups via the WhatsApp platform allowing them to freely participate in the study. Physicians' country of practice was not reported, rather African regions were used as the main geographical identifier. Physicians self-declared their professional status via a dedicated item in the "demography" section of the questionnaire. Duplicate submissions were prevented by enabling single-response per google-account setting within the form. As the questionnaire was distributed via an open link within close messaging groups, the total number of physicians who received the survey invitation could not be established and a formal response rate could not be calculated.

2.5. Variables

The questionnaire was designed by the principal investigator and structured around the three KAP domains:

- Knowledge: to assess the participants' understanding in monitoring patients' GFR after antihypertensive therapy initiation, the recommended window, the specific drug class involved in the recommendation and the accepted maximum tolerated variation of serum creatinine/GFR under RAAS blockers and preferred GFR estimation formular [10].
- Attitudes: to explore the participants' self-reported ordering of baseline and follow-up creatinine assays, the importance of post-initiation monitoring, the self-assessed knowledge level (Likert scale), influence of a low pre therapeutic GFR on clinical judgement (Likert scale) and expected reaction to a post ther-

apeutic rise in creatinine.

- Practice: to evaluate real-world experience habits on time of first renal function, reaction to a simulated clinical scenario and perceived barriers to monitoring.

A demography section was designed to report physicians' professional status, region of practice, years of medical experience and healthcare level facility.

The complete questionnaire is provided as Supplementary File S1. Items that permitted multiple selection were: antihypertensive drug classes considered to require renal monitoring (item 8), and the intended clinical course of action to be undertook in case of a 20% post-therapeutic serum creatinine rise (item 18). All the remaining items were single-select. The primary outcome of interest was the proportion of physicians correctly identifying the maximum tolerable threshold variation to a rise in serum creatinine following RAAS blockers' initiation defined as a rise ≤30% from baseline (corresponding to an approximate drop of ≤25% in the GFR) as mentioned by NICE NG203 guideline [11]. The secondary outcomes included: 1) proportion agreeing with systematic GFR monitoring, 2) proportion selecting the recommended monitoring window (7 - 14 days), 3) proportion choosing the appropriate reaction to a 20% post therapeutic rise in serum creatinine (to maintain the RAAS blocker and recheck later), and 4) comparison across different clinical profile groups.

2.6. Bias

While our study may have been subject to measurement bias, the questionnaire underwent expert review for content validity and we piloted the questionnaire with a few participants to identify and correct ambiguous phrasing. Within the online survey, participants were briefed on the anonymity of their responses to reduce social desirability bias. Finally, we varied data collection times, including weekends and evenings to capture a diverse demographic and minimize non-response bias from working individuals.

2.7. Sampling

We performed a convenience sampling method using a self-administered online questionnaire disseminated via google form from January to March 2026.

2.8. Ethical Clearance

This study was conducted in accordance with the principles of the Declaration of Helsinki [12]. Given the non-interventional nature of the survey, formal ethical approval was not required at the time of data collection. Participation was entirely voluntary and anonymous. No personal identifying data were collected at any point, and respondents were not offered any incentive for participating to the study. Informed consent was operationalized digitally prior to accessing the questionnaire and each participant was presented with a study information notice outlining the objectives, the voluntary nature of participation, and the conditions of data confidentiality. Proceeding to the survey was conditional upon the partici-

pant actively selecting "Yes, I agree to participate", ensuring that no responses were recorded without prior explicit acknowledgement of consent

2.9. Statistical Methods

Data collected were organized in a spreadsheet database on google excel and data were analyzed using Python 3.12 (SciPy 1.17.1) [13]. Participants who did not respond to the primary outcome item were excluded from the primary proportion sample. For items with non-universal responses, item-specific denominators are reported where they differ from the general sample (N = 136). Free text responses to the barrier items (item 28) were reviewed and grouped into themes before proceeding to numerical summarization of that data. Categorical variables were expressed as frequencies and proportions with Wilson score 95% confidence intervals (95% CI). Ordinal Likert data were summarized as mean ± standard deviation (SD). Group comparisons used the chi-square test with Yates' continuity correction, Fisher's exact test where cell counts were below 5, and the Mann-Whitney U test for Likert variables. The participants were subsequently divided into two analytical groups: specialists and non-specialists (residents and general practitioners). Among the specialist group, a further stratification was performed to analyze the subgroup cardiologists and nephrologists (termed the cardio-nephrologist group) against the rest of the clinical profiles since they are directly implicated in the management of antihypertensives and the renal function. All p-values were two-tailed with a significance threshold of 0.05. Given the limited sub-group sizes in the specialist stratifications, all sub-groups comparisons are considered exploratory and hypothesis-generating and should not be interpreted as definitive.

3. Results

3.1. Participants Characteristics

We included a total of 136 participants practicing in sub-Saharan Africa. The majority practiced in Central Africa (n = 111, 81.6%) and West Africa (n = 9, 6.6%). 16 respondents (11.8%) did not specify their region. The most common professional categories included medical residents and interns (n = 50, 36.8%) and general practitioners (n = 42, 30.9%). These constituted the non-specialist group (n = 92, 67.6%). Cardiologists represented 13.2% (n = 18) and nephrologists 4.4% (n = 6) of respondents.

Table 1. Demographic and professional profile of survey respondents.

Characteristic	Frequency	Percentage [95% CI]
Professional Status		
Resident/Medical Intern	50	36.8% [29.2 - 45.1%]
General Practitioner	42	30.9% [23.7 - 39.1%]
Cardiologist	18	13.2% [8.5 - 20.0%]
Nephrologist	6	4.4% [2.0 - 9.4%]

Continued

Endocrinologist/Diabetologist	5	3.7% [1.6 - 8.4%]
Other specialties (≥1 each)	15	11.0% [6.8 - 17.3%]
Region of Practice		
Central Africa	111	81.6% [74.2 - 87.2%]
West Africa	9	6.6% [3.5 - 12.2%]
Not reported	16	11.8% [7.4 - 18.3%]
Years of Medical Practice		
< 1 year	15	11.0% [6.8 - 17.3%]
1 - 5 years	45	33.1% [25.8 - 41.3%]
6 - 10 years	36	26.5% [19.8 - 34.4%]
11 - 20 years	30	22.1% [16.0 - 29.6%]
> 20 years	10	7.4% [4.1 - 13.0%]

Regarding practice setting, 54.4% (n = 74) worked in Level 3 (teaching/university) hospitals and most participants had between 1 and 10 years of professional experience (1 - 5 years: 33.1%, n = 45; 6 - 10 years: 26.5%, n = 36). Table 1 summarizes participants' characteristics.

3.2. Knowledge

When asked whether it is necessary to check GFR shortly after initiating antihypertensive therapy in a treatment-naïve patient, 51.5% of respondents (n = 70) endorsed systematic monitoring for all patients. A further 39.7% (n = 54) considered it necessary only for specific drug classes, while 9.6% expressed no systematic recommendation or deferred the decision to financial constraints.

Regarding the ideal timing for the first GFR/creatinine check after antihypertensive initiation, only 23.5% (n = 32) selected the guideline-concordant window of 7 - 14 days. An additional 17.6% (n = 24) chose within 7 days, while 41.9% preferred delayed windows of one month or beyond, and 16.2% reported having no specific timeframe.

This question on the maximum tolerable RAAS-induced creatinine variation constituted the primary knowledge outcome of the study. The guideline-concordant answer a creatinine rise of ≤30% from baseline (corresponding to a GFR reduction of ≤25%) was selected by only 16.2% of respondents (n = 22). The most common response was "Don't know", endorsed by 34.6% (n = 47), followed by an underestimated tolerance threshold of 0% - 10% creatinine rise in 25.7% (n = 35) and 0% - 20% in 12.5% (n = 17). A total of 8.8% (n = 12) endorsed zero tolerance for any creatinine rise, and 2.2% (n = 3) considered RAAS blockers unconditionally safe. These findings confirm a profound and widespread knowledge deficit regarding the acceptable range of RAAS-induced creatinine variation in this population.

The most frequently used method for GFR estimation was the CKD-EPI for-

mula, used by 36.0% of respondents (n = 49), followed by MDRD (23.5%, n = 32) and Cockcroft & Gault (19.9%, n = 27). Concerningly, 14.0% (n = 19) reported relying solely on the raw serum creatinine value without any formula-based GFR estimation a practice that fails to account for age, sex, and body weight and is therefore insufficient for accurate renal monitoring.

3.3. Attitudes

A large majority of respondents (69.1%, n = 94) reported systematically ordering a baseline serum creatinine measurement before initiating antihypertensive therapy. This item assessed clinical policy using a "yes or no" binary format rather than actual routine practices which assessed prescription frequency on a four point-scale (reported in the Practices section below). Among those who did so, patient compliance with the prescribed test was estimated to be ≥80% by 45.7% of respondents, while 18.1% estimated compliance at 40% - 60%, and 2.1% below 20%, indicating a considerable implementation gap on the patient side.

Most respondents (88.2%, n = 120) agreed that repeating creatinine after antihypertensive initiation is useful. However, when asked about the preferred timing, only 29.4% (n = 40) selected the guideline-concordant window of 2 weeks; 26.5% chose 1 month, 13.2% chose 2 months, and 13.2% (n = 18) would recheck only annually. Among the minority who did not regard repeat monitoring as necessary, patient financial limitations and the absence of perceived need were the principal reasons cited.

When presented with a hypothetical significant creatinine rise after initiating a RAAS blocker, only 12.5% of respondents (n = 17) intended to maintain the dose and recheck the guideline-concordant watch-and-wait approach. In contrast, 42.6% (n = 58) intended to stop treatment immediately, 17.6% (n = 26) to reduce the dose, and 44.9% (n = 61) to refer to a specialist. Investigating precipitating factors such as dehydration, NSAID use, or diarrhea was endorsed by 43.4% (n = 59) a critical and appropriate step, yet this was rarely combined with the decision to maintain the RAAS blocker. These responses were not mutually exclusive, as the question allowed multiple selections. Self-assessed knowledge of the short-term renal impact of antihypertensives was rated at a mean of 2.88 ± 1.19 out of 5, consistent with the objective knowledge gap identified.

3.4. Practices

In real-world clinical practice, only 34.6% of respondents (n = 47) reported ordering the first post-initiation renal check within 7 - 14 days the guideline-concordant window. The largest group (29.4%, n = 40) waited until 1 month, 19.9% (n = 27) until 3 months, and a combined 16.2% (n = 22) never ordered a systematic check or did so only in the presence of symptoms.

Faced with a concrete clinical scenario of a 20% creatinine rise two weeks after initiating an ACE inhibitor, only 21.3% of respondents (n = 29) chose the correct guideline-based approach of maintaining the treatment and rechecking later (tol-

erance strategy). The most common response was to switch drug class (33.1%, n = 45), followed by stopping treatment immediately (26.5%, n = 36) and reducing the dose (19.1%, n = 26). Taken together, 78.7% of respondents would have modified or discontinued RAAS blockade in response to a creatinine rise that is, per current guidelines, within the acceptable range a practice that would deprive patients of nephroprotective benefit.

Regarding systematic baseline creatinine prescription, this item assessed the actual prescribing behavior on a four-point frequency scale complementing the attitude item reported above. Of the 136 physicians, 66.2% (n = 90) reported always prescribing a baseline creatinine before initiating antihypertensive therapy, with a further 22.8% (n = 33) doing so often. However, 5.5% (n = 8) did so rarely and 2.8% (n = 4) never indicating that a minority of patients in this population begin anti-hypertensive therapy without any renal baseline, precluding accurate monitoring.

The principal barrier to close post-initiation renal monitoring was overwhelmingly patient-side financial constraints, reported across most open-text responses. Notably, 56.6% of respondents (n = 77) expressed strong interest in participating in a future clinical or observational study on this topic, with a further 33.8% (n = 46) open to participation depending on modalities reflecting a favorable research environment.

3.5. Comparative Analyses

Across most of the knowledge and practice indicators, no statistically significant differences were observed between non-specialists (n = 92) and all specialist physicians (n = 44). Both groups had similarly low correct identification rates for the RAAS tolerance threshold (non-specialists: 14.1% vs. specialists: 20.5%; p = 0.491) and comparable proportions ordering the first renal check at 7 - 14 days (32.6% vs. 38.6%; p = 0.618). The clinical scenario response was likewise similar (correct response: 21.7% vs. 20.5%; p = 1.000). The single significant difference was that specialist physicians self-rated their renal knowledge considerably higher (mean 3.35 ± 1.41 vs. 2.66 ± 1.00; p = 0.003, Mann-Whitney U) though this perceived knowledge advantage did not translate into superior objective performance on any practice indicator.

The comparison between cardiologists (n = 18) and nephrologists (n = 6) should be interpreted with caution given the small nephrologist sample and is considered exploratory. The only statistically significant difference was in the correct identification of the RAAS tolerance threshold: 83.3% of nephrologists correctly identified the ≤30% creatinine rise as acceptable, compared with only 11.1% of cardiologists (p = 0.003, Fisher's exact). This finding, while striking, was based on a very small cell count and requires confirmation in a larger sample. No significant differences were found between the two groups on any other indicator.

When the combined cardio-nephrology group (n = 24) was compared to other specialist physicians (n = 20), three significant differences emerged. First, the car-

dio-nephrology group was significantly less likely to report uncertainty about the RAAS tolerance threshold (16.7% "don't know" vs. 55.0%; p = 0.019). Second, this group was substantially more likely to order the first renal check within 7 - 14 days in clinical practice (58.3% vs. 15.0%; p = 0.009). Third, they more frequently selected 2 weeks as the appropriate timing for repeat creatinine in the attitude domain (50.0% vs. 10.0%; p = 0.012). They also rated their renal knowledge significantly higher (mean 3.92 ± 1.18 vs. 2.63 ± 1.38; p = 0.003, Mann-Whitney U). Nevertheless, even within this most informed subgroup, the correct identification rate for the RAAS creatinine tolerance threshold reached only 29.2%, and the correct clinical scenario response was 25.0% reinforcing the systemic rather than subspecialty-specific nature of this knowledge gap. Comparative results are summarized in Table 2.

Table 2. Comparative analysis of key knowledge, attitude and practice indicators across specialist and non-specialist categories.

Indicator	Non-Spec (n = 92)	Spec (n = 44)	p-value[1]	CN (n = 24) vs Other Spec (n = 20)	p-value[3]
K1. GFR monitoring "Yes, systematically"	48.9%	56.8%	0.497	66.7% vs 45.0%	0.255
K4. Correct RAAS threshold (≤30%)	14.1%	20.5%	0.491	29.2% vs 10.0%	0.150
K4. "Don't know" RAAS threshold	34.8%	34.1%	1.000	16.7% vs 55.0%	**0.019**
K5. CKD-EPI formula used	38.0%	31.8%	0.605	41.7% vs 20.0%	0.226
A1. Baseline creatinine always ordered	67.4%	72.7%	0.666	79.2% vs 65.0%	0.477
A4. Repeat timing 2 weeks	28.3%	31.8%	0.822	50.0% vs 10.0%	**0.012**
A6. Self-knowledge score (mean ± SD)	2.66 ± 1.00	3.35 ± 1.41	**0.003**	3.92 ± 1.18 vs 2.63 ± 1.38	**0.003**
P1. First check at 7 - 14 days (practice)	32.6%	38.6%	0.618	58.3% vs 15.0%	**0.009**
P2. Correct management of 20% Cr rise	21.7%	20.5%	1.000	25.0% vs 15.0%	0.477
P2. Stop treatment immediately	23.9%	31.8%	0.441	41.7% vs 20.0%	0.226
P3. Baseline creatinine "always" prescribed	60.9%	77.3%	0.090	-	-

[1]Non-specialists vs. all specialists. [3]Cardiologists + Nephrologists (CN) vs. other specialists. Chi-square (Yates) or Fisher's exact for proportions; Mann-Whitney U for Likert data. Bold cells: p < 0.05. GFR: Glomerular filtration rate; RAAS: Renin-angiotensin-aldosterone system; CKD-EPI: Chronic kidney disease epidemiology; Non-spec: Non-specialist; Spec: Specialist; CN: Cardio-nephrologist; Cr: creatinine.

4. Discussion

4.1. Principal Findings

The findings in this study identified a serious knowledge gap regarding the tolerable range of creatinine rise following RAAS blocker initiation, with only 16.2% of respondents (N = 136) able to correctly identify the guideline-concordant threshold [11] [14]. This finding is compounded by a discordance between attitude and practice: 88.2% acknowledged the necessity of post-therapeutic renal monitoring but only 34.6% implemented it within the 7 - 14-day window. Most critically, 78.7% of respondents would have modified or discontinued RAAS ther-

apy in response to a 20% creatinine rise which falls within the tolerable variation confirming that knowledge deficits drive clinical behaviors that probably deprive patients of the nephroprotective benefits of their treatment.

4.2. The RAAS Creatinine Knowledge Gap and Its Mechanistic Context

The fact that only one in six physicians was able to correctly identify the maximum tolerable creatinine rise is concerning given the central role of RAAS blockers in the pharmacological management of hypertension [4]. The mechanism by which ACEIs and ARBs dilate the efferent glomerular arteriole leads to a decrease in intraglomerular pressure, producing an expected, hemodynamic, reversible rise in serum creatinine that is an indicator of drug efficacy [15]. NICE NG203 (2021) recommends not changing the dose as long as the eGFR decline is <25% or the creatinine rise is <30% from baseline [11]. KDIGO 2024 and the ADA 2022 Standards of Medical Care reinforce this position, cautioning that a rise in serum creatinine of up to 30% should not be confused with AKI and should not trigger therapy discontinuation [14] [16].

The poor correct response rate could be explained by multiple intervening factors: the absence of locally accessible guidelines communicating the tolerable threshold at the point of prescribing, the persistent misconception among physicians that every rise in serum creatinine signals drug nephrotoxicity, and the structural constraints of limited-resource settings where close therapeutic monitoring is financially burdensome [17] [18]. Clinicians who cannot afford to monitor closely are rationally more conservative, creating a feedback loop in which knowledge gaps are reinforced by structural constraints.

4.3. The Attitude-Practice Gap and the Financial Barrier Dimension

The paradox between the strong endorsement of monitoring (88.2%) and its low implementation (34.6%) is a well-characterized attitude–practice gap consistent with KAP literature across sub-Saharan African clinical contexts [17]. Financial barriers on the patient side emerged as the overwhelmingly dominant barrier [18] a context-specific finding that distinguishes this population from the high-income settings where most existing evidence was generated. This reflects the need for a more nuanced approach beyond educational programmes alone, including the integration of post-initiation renal monitoring into essential laboratory service packages and national health insurance frameworks.

4.4. Interpretation of Comparative Analyses

The near-total absence of statistically significant differences between non-specialists and all specialist physicians with the exception of self-assessed knowledge and baseline creatinine prescription frequency underscores the systemic rather than specialty-specific nature of this deficit. The knowledge gap regarding the RAAS

creatinine tolerance threshold does not spare cardiologists or even nephrologists in meaningful numbers: only 11.1% of cardiologists and 83.3% of nephrologists answered correctly ($p = 0.003$), and while the nephrologist advantage is expected and statistically significant, it was based on only 6 respondents and cannot be generalized.

The cardio-nephrology group versus other specialists' comparison yielded three significant differences in "don't know" rates, in clinical practice timing, and in the attitude toward repeat creatinine timing that together suggest a meaningful subspecialty effect on practice patterns even in the absence of significant differences in the primary knowledge outcome. That the cardio-nephrology group still achieved only a 29.2% correct identification rate on the primary knowledge item highlights how widely and evenly the knowledge gap is distributed, and reinforces the need for targeted, cross-specialty educational initiatives.

4.5. Strengths and Limitations

This study provides a novel quantitative KAP assessment of RAAS-specific renal monitoring practices among clinicians in Sub-Saharan region, with a geographically focused sample (81.6% Central Africa) that directly reflects the target population for clinical guideline implementation. The inclusion of a standardized clinical scenario (P2) strengthens the ecological validity of practice assessment beyond self-reporting alone.

Limitations include the convenience sampling approach, which introduces selection bias toward digitally connected and potentially more knowledgeable clinicians, likely overestimating knowledge levels relative to the broader practitioner population. The bespoke instrument has not undergone formal psychometric validation. The small nephrologist sample ($n = 6$) substantially limits the reliability of that subgroup comparison. Furthermore, the central African concentration of physicians in our study (81.6%) limits the applicability of our findings to other sub-Saharan African regions which may present with different healthcare infrastructures, policies and medical practice culture. The cross-sectional design precludes causal inference, and self-reported practices are subject to social desirability bias.

4.6. Recommendations

These findings lead us to formulate four recommendations. First, targeted continuing medical education addressing the hemodynamic mechanisms underlying GFR changes induced by RAAS blockade and clarifying the creatinine rise thresholds endorsed by NICE NG203 and KDIGO 2024 [11] [14]. should be systematically delivered through both specialist and primary care training channels. Second, national hypertension management guidelines applicable to sub-Saharan African contexts should incorporate explicit renal monitoring protocols for patients initiating RAAS-based antihypertensive therapy. Third, accessible point-of-care clinical decision tools should be developed to communicate, at the moment of

prescribing, the range of creatinine variation that is considered acceptable and does not warrant treatment discontinuation. Fourth, and most urgently, a prospective observational cohort study is needed to measure actual short-term GFR changes in Sub-Saharan African hypertensive patients initiating antihypertensive treatment the local safety data required to inform safe prescribing practice is currently absent, and the knowledge gaps documented by this survey make its implementation a research priority.

5. Conclusion

This KAP survey reveals a profound and clinically consequential knowledge gap regarding the guideline-accepted creatinine tolerance range under RAAS blockade among healthcare professionals in Sub-Saharan Africa, a deficit that spans all professional categories and translates directly into inappropriate RAAS therapy discontinuation. The financial barriers to monitoring documented here demand structural solutions beyond clinician education alone. Generating local prospective safety data on GFR variation after antihypertensive initiation in this population is the necessary next step to demystify the creatinine rise and build the evidence base required for confident, evidence-guided clinical practice in the region.

Ethical Approval

Given the non-interventional nature of the survey, formal ethical approval was not required at the time of data collection.

Availability of Data and Materials

All datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Funding

The authors did not receive funding for this project

Authors' Contributions

Authorship for this systematic review was based on the International Committee of Medical Journal Editors (ICMJE) and participants to this review who did not fulfil all of the four criteria were considered as non-author contributors and acknowledged in the final manuscript [19].

Conceptualization, literature review, data analysis, writing, editing, and critical revisions: NGONGANG OUANKOU Christian, SIMENI NJONNOU Sylvain Raoul, NANFA NGUEFACK Joël Manuel, MEKIEJE TUMCHOU Mai-Pamela, Rostand Dimitri MESSANGA BESSALA, Lamine DIENG, KAZE FOLIFACK François Jérôme

Literature review, data collection, writing, editing: NGONGANG OUANKOU Christian, SIMENI NJONNOU Sylvain Raoul, NANFA NGUEFACK Joël Ma-

nuel, MEKIEJE TUMCHOU Mai-Pamela, Rostand Dimitri MESSANGA BESSALA, Lamine DIENG, KAZE FOLIFACK François Jérôme

Editing and critical revisions: NGONGANG OUANKOU Christian, SIMENI NJONNOU Sylvain Raoul, NANFA NGUEFACK Joël Manuel, MEKIEJE TUMCHOU Mai-Pamela, Rostand Dimitri MESSANGA BESSALA, Lamine DIENG, KAZE FOLIFACK François Jérôme

Conflicts of Interest

The authors declare no competing interest.

References

[1] NCD Risk Factor Collaboration (NCD-RisC) (2021) Worldwide Trends in Hypertension Prevalence and Progress in Treatment and Control from 1990 to 2019: A Pooled Analysis of 1201 Population-Representative Studies with 104 Million Participants. *Lancet*, **398**, 957-980.

[2] WHO (2025) Hypertension. https://www.who.int/news-room/fact-sheets/detail/hypertension

[3] Whelton, P.K., Carey, R.M., Aronow, W.S., Casey, D.E., Collins, K.J., *et al.* (2018) 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APHA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: Executive Summary: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Hypertension*, **71**, 1269-1324. https://doi.org/10.1161/hyp.0000000000000066

[4] Williams, B., Mancia, G., Spiering, W., Agabiti Rosei, E., Azizi, M., Burnier, M., *et al.* (2018) 2018 ESC/ESH Guidelines for the Management of Arterial Hypertension. *European Heart Journal*, **39**, 3021-3104. https://doi.org/10.1093/eurheartj/ehy339

[5] Schoolwerth, A.C., Sica, D.A., Ballermann, B.J. and Wilcox, C.S. (2001) Renal Considerations in Angiotensin Converting Enzyme Inhibitor Therapy: A Statement for Healthcare Professionals from the Council on the Kidney in Cardiovascular Disease and the Council for High Blood Pressure Research of the American Heart Association. *Circulation*, **104**, 1985-1991. https://doi.org/10.1161/hc4101.096153

[6] Cohen, D.L. and Townsend, R.R. (2008) What Should the Physician Do When Creatinine Increases after Starting an Angiotensin-Converting Enzyme Inhibitor or an Angiotensin Receptor Blocker? *The Journal of Clinical Hypertension*, **10**, 803-804. https://doi.org/10.1111/j.1751-7176.2008.00023.x

[7] Bakris, G.L. and Weir, M.R. (2000) Angiotensin-Converting Enzyme Inhibitor-Associated Elevations in Serum Creatinine: Is This a Cause for Concern? *Archives of Internal Medicine*, **160**, 685-693. https://doi.org/10.1001/archinte.160.5.685

[8] Schmidt, M., Mansfield, K.E., Bhaskaran, K., Nitsch, D., Sørensen, H.T., Smeeth, L., *et al.* (2017) Serum Creatinine Elevation after Renin-Angiotensin System Blockade and Long Term Cardiorenal Risks: Cohort Study. *BMJ*, **356**, j791. https://doi.org/10.1136/bmj.j791

[9] Humphrey, T.J.L., James, G., Wittbrodt, E.T., Zarzuela, D. and Hiemstra, T.F. (2021) Adverse Clinical Outcomes Associated with RAAS Inhibitor Discontinuation: Analysis of over 400 000 Patients from the UK Clinical Practice Research Datalink (CPRD). *Clinical Kidney Journal*, **14**, 2203-2212. https://doi.org/10.1093/ckj/sfab029

[10] Inker, L.A., Eneanya, N.D., Coresh, J., Tighiouart, H., Wang, D., Sang, Y., *et al.* (2021)

New Creatinine- and Cystatin C-Based Equations to Estimate GFR without Race. *New England Journal of Medicine*, **385**, 1737-1749. https://doi.org/10.1056/nejmoa2102953

[11] National Institute for Health and Care Excellence (NICE) (2019) Hypertension in Adults: Diagnosis and Management. NICE guideline NG203. NICE. https://www.nice.org.uk/guidance/ng203

[12] Kurihara, C., Kerpel-Fronius, S., Becker, S., Chan, A., Nagaty, Y., Naseem, S., *et al.* (2024) Declaration of Helsinki: Ethical Norm in Pursuit of Common Global Goals. *Frontiers in Medicine*, **11**, Article 1360653. https://doi.org/10.3389/fmed.2024.1360653

[13] (2025) Python for Data Analysis: When and How to Use It. Anaconda. https://www.anaconda.com/topics/python-for-data-analysis

[14] Stevens, P.E., Ahmed, S.B., Carrero, J.J., Foster, B., Francis, A., Hall, R.K., *et al.* (2024) KDIGO 2024 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease. *Kidney International*, **105**, S117-S314. https://doi.org/10.1016/j.kint.2023.10.018

[15] Calvo, D.M., Saiz, L.C., Leache, L., Celaya, M.C. and Gutiérrez-Valencia, M. (2025) Acute Kidney Injury and Morbi-Mortality Associated with "Triple Whammy" Combination: Systematic Review and Meta-Analysis. *British Journal of Clinical Pharmacology*, **91**, 3031-3041. https://doi.org/10.1002/bcp.70263

[16] American Diabetes Association Professional Practice Committee (2022) 2. Classification and Diagnosis of Diabetes: Standards of Medical Care in Diabetes—2022. *Diabetes Care*, **45**, S17-S38. https://doi.org/10.2337/dc22-s002

[17] Iwelunmor, J., Blackstone, S., Gyamfi, J., Airhihenbuwa, C., Plange-Rhule, J., Tayo, B., *et al.* (2015) A Concept Mapping Study of Physicians' Perceptions of Factors Influencing Management and Control of Hypertension in Sub-Saharan Africa. *International Journal of Hypertension*, **2015**, Article ID: 412804. https://doi.org/10.1155/2015/412804

[18] Nyame, S., Boateng, D., Opoku Marfo, K., Hussen, A.M., Amoah, J., Adjei, K., *et al.* (2025) Determinants, Barriers, and Facilitators of Healthcare Access for Patients with Hypertension in Rural Ghana: Applying the Andersen-Newman Model of Healthcare Utilization. *Global Health Action*, **18**, Article ID: 2599567. https://doi.org/10.1080/16549716.2025.2599567

[19] Mondal, H., Mondal, S. and Haldar, R. (2023) Criteria to Be an Author of a Manuscript: Time to Revisit the ICMJE Criteria and Credit. *Journal of Anaesthesiology Clinical Pharmacology*, **39**, 674-675. https://doi.org/10.4103/joacp.joacp_175_22

Appendix

https://docs.google.com/forms/d/1PyHolbyTMvhiJ0cuccll1O0kXUdDL4-FNh8h0el5g9U/edit?pli=1