Cross-Sectional Study

ANNALS OF MEDICINE & SURGERY

OPEN

Clinical profile and complications seen in the patients in the later stages of chronic kidney disease presenting to the Emergency Department in a tertiary care center in Nepal: a cross-sectional study

Aditi Sharma, MBBS[a,*], Laxman Bhusal, MD[a], Ajaya Rajbhandari, MD[b], Swojay Maharjan, MBBS[a], Abhishek Adhikari, MBBS[a], Egesh Aryal, MBBS[a]

Introduction: Chronic kidney disease (CKD) has an estimated prevalence of 6% in Nepal, which has resulted in a huge public health and socioeconomic burden for the country. People with different stages of CKD come to the Emergency Department (ED) with various clinical features and complications, which if detected and managed early can result in a decreased need for renal replacement therapy and thus decreased medical cost.

Methods: The authors conducted a cross-sectional analysis taking nonprobability convenience sampling in the ED of a tertiary-level hospital of Nepal, after getting approval from the Institutional Review Committee and obtaining informed consent from the patient. Kruskal–Wallis test and χ^2 test of homogeneity were conducted to determine if there were differences in the continuous variables and categorical variables of three stages of CKD. Pairwise comparisons with a Bonferroni correction was done for both variables.

Result: Among 291 patients of CKD, 25 were in stage 3, 15 in stage 4, and 251 in stage 5. Significant differences between groups were found in continuous variables of SBP, pulse, temp, TLC, platelet, sodium, potassium, urea, and creatinine. Similarly, a significant difference was found for the categorical variables of hyperkalemia, hyponatremia, thrombocytopenia, leukocytosis, and high creatinine levels.

Conclusion: Patients with CKD commonly present to the ED due to electrolyte imbalances, uremia, shortness of breath, and high SBP. Hyperkalemia, thrombocytopenia are more frequently observed in stage 5 CKD, whereas the incidence of hypertension significantly increase from stage 4 onwards. Hyponatremia, on the other hand, is more prevalent in stage 3 than in the later stages.

Keywords: chronic kidney disease, complication, emergency, Nepal, stage

Introduction

Chronic kidney disease (CKD) has been defined as any damage to kidney structure or function lasting at least 3 months and having adverse effects on health[1]. It encompasses a spectrum of kidney disease, from mild damage to End-Stage Renal Disease (ESRD)[2]. The incidence and prevalence of CKD have been rising worldwide, particularly in developing and underdeveloped countries[3]. In Nepal, its prevalence is estimated to be around 6%[4].

CKD significantly increases the risk of hospitalization, cardiovascular events, and death[5]. A large number of patients, especially those dependent on dialysis, visit the emergency department (ED) due to complications such as hyperkalemia and fluid overload[6]. Countries with limited resources, like Nepal, are likely to face a huge public health and socioeconomic burden due to this[4].

Early detection and treatment can often keep CKD from getting worse, thereby preventing the need for renal replacement therapy and reducing medical costs[7]. Understanding the clinical

HIGHLIGHTS

- Patients with later stages of chronic kidney disease present with different clinical findings and complications in the emergency room.
- While complications like hyperkalemia, thrombocytopenia, and shortness of breath were seen commonly in stages 4 and 5, hyponatremia was more prevalent in stage 3.
- Serum creatinine could be a reliable and cost-effective marker for evaluating disease progression in chronic kidney disease.

[a]Nepalese Army Institute of Health Sciences and [b]Department of Medicine, Shree Birendra Hospital, Kathmandu, Nepal

Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

*Corresponding author. Address: Nepalese Army Institute of Health Sciences, 44600 Kathmandu, Nepal. Tel.: +977 986 134 0417. E-mail: meaditi314@gmail.com (A. Sharma).

Annals of Medicine & Surgery (2024) 86:5106–5111

Received 29 April 2024; Accepted 5 July 2024

Published online 18 July 2024

http://dx.doi.org/10.1097/MS9.0000000000002377

profile of patients with CKD is prudent for identifying and planning strategies to prevent the occurrence of CKD and establishing screening protocols to prevent its progression. However, only a few studies have been conducted in Nepal to study the clinical profile of patients with CKD, and to the best of our knowledge, none have been conducted to date regarding their status in the ED. Thus, our research aims to assess the clinical profile and complications seen in patients with later stages of CKD presenting to the ED at a tertiary care hospital in Nepal.

Method

This is a cross-sectional study conducted in the ED of a tertiary-level hospital in Nepal, over a period of 6 months, from December 2021 to May 2022. The study began after obtaining prior approval from the Institutional Review Board (IRB) of the institution.

All cases of CKD who visited the ED of the hospital during the study period and met the inclusion criteria were included.

Inclusion criteria: All patients with glomerular filtration rate (GFR) of <60 ml/min/1.73 m^2, calculated using the modification of diet in renal disease (MDRD) formula, corresponding to CKD stages 3–5, above the age of 16 years and providing informed consent for participation in the study were included.

Exclusion criteria: Any patient under the age of 16 years or with other co-existing chronic medical conditions that could affect their overall prognosis or anyone who has already undergone a renal transplant or obtained a do-not-resuscitate order was excluded.

The sample size was calculated by using the following formula:

$$n = (Z^2 \times p \times q)/e^2$$
$$= (1.96^2 \times 0.06 \times 0.94)/(0.03)^2$$
$$= 0.216/0.0009$$
$$= 240$$

where, n = minimum required sample size; $Z = 1.96$ at 95% CI; P = prevalence taken as 6%; e = margin of error, 3%.

We accounted for 10% nonresponse rate; resulting in a final sample size of 264. However, we included a total of 291 patients who met the inclusion criteria by using nonprobability sampling.

The work has been reported in accordance with the STROCCS criteria[8].

Study tool and data collection

Data were collected using a structured proforma that included questions regarding demographic profiles, vitals at the time of presentation to the ED, hematologic and biochemical parameters, and parameters of ABG analysis. The ABG analysis was performed using the BG-800 Blood Gas Analyzer from Cornley Company.

All data were recorded in a standardized data collection form using standard units for measurement and were verified by nephrologists.

The outcomes were recorded based on the three stages of CKD (stages 3, 4, and 5) determined by their GFR: stage 3 with GFR of 30–59 ml/min, stage 4 with GFR of 15–29 ml/min, and stage 5 with GFR below 15 ml/min.

Data management and statistical analysis

The data were first entered into Microsoft Excel 2013 and appropriate commands were used for data clearing. Entered data were then analyzed using Statistical Package for Social Sciences (SPSS) version 22. Descriptive data with normal distribution were reported as mean ± SD or as percentage wherever appropriate.

Quantitative variables were classified into categories such as hyperkalemia, acidosis, decreased bicarbonate levels, anemia, hypocalcemia, hyperphosphatemia, hyponatremia, hyperuricemia, increased urea, increased creatinine, thrombocytopenia, leukocytosis, high SBP, and high DBP.

The parameters were considered as follows:

1. Decreased bicarbonate: HCO3— < 22mEq/l,
2. Hyperkalemia: K + > 5.0mEq/l,
3. Acidemia: pH <7.35,
4. Hypocalcemia: Ca2 + <8.4 mg/dl,
5. Hyperphosphatemia: Phosphorous (inorganic) <3.0 mg/dl,
6. Hyponatremia: Na + <136mEq/l,
7. High blood pressure: SBP > =140 or DBP > = 90
8. Anemia: Hemoglobin <7 gm/dl,
9. Hyperuricemia: Uric acid level > 8.2 mg/dl,
10. Thrombocytopenia: Platelet count: <150 000/mm^3,
11. Leukocytosis: TLC count: > 11 000/mm^3,
12. Raised creatinine: Serum creatinine > 1.2 mg/dl.

Metabolic acidosis was determined using HCO3- and pH values, while Acidosis was based solely on the pH value.

Normality was checked using the Shapiro–Wilk test. If normally distributed, data were described as mean with SD. When normality was rejected, the data were described as median with interquartile range.

A Kruskal–Wallis test was conducted to determine if there were differences in age, blood pressure, pulse, saturated partial pressure, temperature, hemoglobin, total leukocyte count, platelet count, sodium, potassium, calcium, phosphorous, uric acid, urea, creatinine, pH value, bicarbonate levels between the three stages of CKD. Medians were compared for both similar and dissimilar distributions. Subsequently, pairwise comparisons were performed using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons.

The χ^2 test/ Fischer's exact test of homogeneity was used to compare the nominal variables within the three stages. Post-hoc analysis for the significant findings involved pairwise comparisons using the z-test of two proportions with a Bonferroni correction.

Results

A total of 291 patients diagnosed with CKD were categorized into three stages based on their GFR levels. Out of these, 25 patients were in stage 3, 15 in stage 4, and 251 in stage 5 of CKD. Among the participants, there were 154 male and 137 female patients.

From Table 1:

Statistically significant differences were found for several variables, including hyperkalemia, hyponatremia, high SBP, thrombocytopenia, leukocytosis, and high creatinine levels. The difference in hyponatremia was significant only in patients at stage 5 of CKD ($P = 0.000$) compared to stages 3 and 4.

Table 1

Comparison of categorical variables across the stages of CKD.

			GFR stage					
Variable	**State**		**Stage 3**	**Stage 4**	**Stage 5**	**Total**	**Chi square value**	***P***
Sex	Male	Count	12	7	135	154	0.554	0.758
		% within GFR stage	48.0%	46.7%	53.8%	52.9%		
	Female	Count	13	8	116	137		
		% within GFR stage	52.0%	53.3%	46.2%	47.1%		
Decreased bicarbonate	Absent	Count	1	0	19	20	0.641	0.764
		% within GFR stage	4.0%	0.0%	7.6%	6.9%		
	Present	Count	24	15	232	271		
		% within GFR stage	96.0%	100.0%	92.4%	93.1%		
Hyperkalemia	Absent	Count	22a	11a, b	130b	163	14.023	0.001
		% within GFR stage	88.0%	73.3%	51.8%	56.0%		
	Present	Count	3a	4a, b	121b	128		
		% within GFR stage	12.0%	26.7%	48.2%	44.0%		
Acidosis	Absent	Count	9	3	75	87	1.092	0.584
		% within GFR stage	36.0%	20.0%	29.9%	29.9%		
	Present	Count	16	12	176	204		
		% within GFR stage	64.0%	80.0%	70.1%	70.1%		
Hypocalcemia	Absent	Count	12	10	130	152	1.452	0.484
		% within GFR stage	48.0%	66.7%	51.8%	52.2%		
	Present	Count	13	5	121	139		
		% within GFR stage	52.0%	33.3%	48.2%	47.8%		
Hyperphosphatemia	Absent	Count	9	6	81	96	0.653	0.760
		% within GFR stage	36.0%	40.0%	32.3%	33.0%		
	Present	Count	16	9	170	195		
		% within GFR stage	64.0%	60.0%	67.7%	67.0%		
Hyponatremia	Absent	Count % within GFR stage	5a 20.0	3a 20.0	163b 64.9	171 58.8	28.755	0.000
	Present	Count % within GFR stage	20a 80.0	12a 80.0	88b 35.1	120 41.2		
High DBP	Absent	Count	8	5	91	104	0.219	0.896
		% within GFR stage	32.0%	33.3%	36.3%	35.7%		
	Present	Count	17	10	160	187		
		% within GFR stage	68.0%	66.7%	63.7%	64.3%		
Anemia	Absent	Count	17	9	192	218	2.950	0.224
		% within GFR stage	68.0%	60.0%	76.5%	74.9%		
	Present	Count	8	6	59	73		
		% within GFR stage	32.0%	40.0%	23.5%	25.1%		
Hyperuricemia	Absent	Count	19	11	203	233	1.129	0.610
		% within GFR stage	76.0%	73.3%	80.9%	80.1%		
	Present	Count	6	4	48	58		
		% within GFR stage	24.0%	26.7%	19.1%	19.9%		
Thrombocytopenia	Absent	Count	3a	1a	121b	125	20.663	0.000
		% within GFR stage	12.0%	6.7%	48.2%	43.0%		
	Present	Count	22a	14a	130b	166		
		% within GFR stage	88.0%	93.3%	51.8%	57.0%		
Leukocytosis	Absent	Count	5a	2a	187b	194	50.634	0.000
		% within GFR stage	20.0%	13.3%	74.5%	66.7%		
	Present	Count	20a	13a	64b	97		
		% within GFR stage	80.0%	86.7%	25.5%	33.3%		
Increased creatinine	Absent	Count	4a	0	0b	4		0.000
		%	16%	0	0	1.4		
	Present	Count	21a	15	251b	287		
		%	84	100	100	98.6		
High SBP	Absent	Count	8a	0b	82a	90		0.016,0.007
		%	32.0%	0.0%	32.7%	30.9%		
	Present	Count	17a	15b	169a	201		
		%	68.0%	100.0%	67.3%	69.1%		

*a and b were written to signify the difference between the groups.

Table 2

Comparison of continuous variables across the stages of CKD.

	GFR stage 3	GFR stage 4	GFR stage 5	*P*
Age	51 (33)	46 (25)	58 (20)	0.225
Systolic blood pressure	146 (40)a, b	160 (30)a	148 (30)b	0.015
Diastolic blood pressure	90 (20)	90 (30)	90 (20)	0.625
Pulse	110 (25)a	120 (20)a	86 (22)b	0.000
Saturated partial pressure	97 (6.5)	96 (4)	96 (7)	0.385
Temperature	100 (2)a	99 (1)a	97.8 (1.2)b	0.000
Hemoglobin (mg/dl)	7.7 (1.15)	7.7 (2.2)	7.9 (1.5)	0.481
Total leukocyte count	18 000 (6900)a	17 000 (4220)a	7400 (5400)b	0.000
Platelet count	110 000 (77 500)a	90 000 (45 000)a,b	147 000 (134 000)b	0.037
Sodium (mEq/l)	132 (6.5)a	131 (6)a	137 (7)b	0.000
Potassium (mEq/l)	4 (1.28)a	4.2 (1.4)a,b	5 (1.21)b	0.000
Calcium (mg/dl)	8.23 (1.29)	8.58 (1.32)	8.45 (1.28)	0.390
Phosphorous	5.68 (4.3)	5.32 (3.03)	5.64 (3.02)	0.856
Uric acid (mg/dl)	6.2 (4.8)	6.6 (4.9)	6.2 (4.4)	0.989
Urea (mg/dl)	147 (74.25)a	181.9 (89.9)a,b	177.7 (61)b	0.042
Creatinine (mg/dl)	1.469 (0.5)a	2.7459 (1.25)a	9.27 (5.67)b	0.000
pH value	7.32 (0.25)	7.32 (0.14)	7.315 (11)	0.806
Bicarbonate (mEq/l)	14 (9.5)	12 (6.1)	14.4 (6.8)	0.120
Shortness of breath				
Absent	17 (68%)	9 (60%)	83 (33.1%)	
Mild	2 (8%)	6 (40%)	96 (38.2%)	
Severe	6 (24%)	0 (0%)	72 (28.7%)	

*a and b were written to signify the difference between the groups.

Hyperkalemia was present in 121 patients in stage 5 compared to 3 and 4 patients in stages 3 and 4, respectively. However, the proportions of hyperkalemia were significantly different only between stages 3 and 5.

Similarly, thrombocytopenia was present in 130 patients in stage 5 CKD, compared to 22 in stage 3 and 14 in stage 4, which was a significant finding ($P = 0.000$).

Likewise, leukocytosis was present in 64 patients in stage 5 compared to 20 patients in stage 3 and 13 patients in stage 4, which was another significant finding ($P = 0.000$).

We found a significant difference ($P = 0.000$) in the levels of increased creatinine between stages 3 and 5.

However, when comparing the proportions of patients with high SBP, we found a significant difference between stage 3 and stage 4 ($P = 0.016$) and between stage 4 and stage 5 ($P = 0.007$).

From Table 2:

The study found significant differences in SBP, pulse, temperature, TLC, platelet, sodium, potassium, urea, and creatinine levels between the different stages of CKD. A visual inspection of a boxplot indicated similar distributions of all variables except for pulse, saturated partial pressure, temperature, total leukocyte counts, and creatinine levels.

For SBP, a significant difference in median values was indicated by a *P*-value of 0.019. Post-hoc analysis revealed statistically significant differences in median scores between stages 4 (160) and 5 (148) with $P = 0.015$, but no difference between stages 3 and 4, and between stages 3 and 5. A similar pattern of significant difference was observed for the variables of pulse, temperature, sodium, TLC, and creatinine.

For potassium, the Kruskal–Wallis test revealed a significant difference in median scores ($P = 0.000$). Post-hoc analysis showed a significant difference only between the median scores of stages 3 and 5 ($P = 0.000$), but not between stages 3 and 4, or between stages 4 and 5. Similar findings were observed for the median scores for urea.

Shortness of breath was classified as absent, mild, or severe with number and percentage in each stage depicted in the table. However, the χ^2 test of homogeneity could not be performed for the 3 by 3 table.

Discussion

All the patients included in this study were distributed across three stages of CKD according to their eGFR, calculated by using the MDRD formula. The median age of patients was 51 for stage 3, 46 for stage 4, and 58 for stage 5. There was no significant difference in age distribution according to the stages. However, the median age observed in our study was lower than that in Southern Denmark, where the median age is 76.4[9]. This discrepancy could be due to the delays in diagnosing and managing diseases like hypertension and diabetes mellitus, which significantly contribute to CKD in developing countries like Nepal. The lack of health infrastructure and poor health-seeking behaviors in Nepal results in disease progression, causing patients to present only in the later stages when they develop symptoms. This causes symptomatic CKD to occur at an earlier age[5,10,11].

In our study, we found that 44% of patients had hyperkalemia with 94.5% of these patients in stage 5. This indicates that patients with advanced CKD are at high risk of developing hyperkalemia. A retrospective analysis conducted by Lara Belmar Vega *et al.* showed an overall prevalence of hyperkalemia in CKD to be 12.6%, which is much lower than what we observed in our study. However, the analysis also revealed an inverse relationship between GFR and the degree of hyperkalemia[12]. Several other studies have also reported higher mean values of serum potassium with decreasing GFR[13,14]. These studies have highlighted the role of medications, especially Renin-Angiotensin-Aldosterone-System (RAAS) inhibitors, which

have a renoprotective role, in the development of hyperkalemia[13,14]. Apart from symptoms such as fatigue and muscle aches, hyperkalemia can lead to life-threatening cardiac arrhythmias and sudden death, thus requiring early management[10].

Our research found that hyponatremia is more prevalent in patients with stages 3 and 4 of CKD rather than in stage 5. A study conducted by Kovesdy *et al.*[15] in 2012 also showed a relatively higher prevalence of hyponatremia in patients with high eGFR and an increased risk of mortality associated with both hyponatremia and hypernatremia. Another study by Han *et al.*[16] found that hyponatremia in patients with CKD was associated with an increased risk of disease progression to ESRD and an increased risk of death with dysnatremia. However, the prevalence of hyponatremia seen in our study (41.2%) is much higher than that noted in other studies by Han SW *et al.* and Megumi Inoue *et al.*, where the prevalence among CKD patients is 6 and 2%, respectively[16,17].

Thrombocytopenia was frequently seen in CKD stage 5 in our study, unlike in a study done by Huang *et al.*[18] in 2017, which showed no significant difference between patients with CKD stages 3–5 when compared with the healthy controls. Thrombocytopenia seen in stage 5 could be due to the patients on maintenance hemodialysis, where blood interacts with the biocompatible membrane during dialysis, leading to complement activation and significant thrombocytopenia[19]. On the other hand, the use of anticoagulants like heparin to inhibit coagulation in extracorporeal circuits may cause heparin-induced thrombocytopenia[20]. Additionally, some studies show mild to moderate thrombocytopenia in end-stage renal disease when associated with lupus vasculitis, hemolytic uremic syndrome, thrombotic thrombocytopenic purpura, disseminated intravascular coagulation, eclampsia, and renal allograft rejection[21]. Existing literature focuses on hemodialysis patients, and limited studies were available for conclusion in nonhemodialysis patients.

Our study revealed that leukocytosis was present in 33.3% of the patients and was more prevalent among stages 3 and 4 of CKD rather than in stage 5. A study conducted by Oi and Oa[22], among predialysis CKD patients, also showed a statistically higher level of leukocytosis in patients with CKD compared to the control group (24 vs. 7.8%). However, unlike our study, other studies have found higher WBC count in stage 5 and the post-dialysis state[23,24]. The relatively low percentage of leukocytosis seen in stage 5 could be due to increased oxidative stress and damage to the leukocytes in CKD, which may be more severe in patients undergoing dialysis[25]. A spike in WBC count could be associated with inflammatory events such as pneumonia, bacteremia, and UTI, as CKD patients are more prone to these illnesses[26]. Alternatively, a study by Erlinger *et al.*[27] has shown a statistically significant association between increasing WBC count and risk for CKD.

Hypertension was prevalent in advanced stages of CKD (stages 4–5) with significantly elevated systolic blood pressure (SBP) in more than two-thirds of the study population. Similarly, Munter *et al.*[28] (2010) showed that the prevalence of hypertension increases with a decline in renal function. SBP was higher in patients with lower eGFR, possibly due to arterial stiffness brought by atherosclerosis in CKD patients and accelerated vascular aging[28,29].

Our study found an increasing trend of serum creatinine levels between stages 4 and 5, with a significantly high level in stage 5. This trend was also observed in a study by Janice *et al.* However, their study also highlighted that serum cystatin C is more sensitive than serum creatinine in detecting early stages of kidney disease[30]. Another study by Peralta *et al.*[31] emphasized the importance of a triple marker approach that includes serum creatinine, cystatin C, and albuminuria to better predict the risk of developing future ESRD and death in patients with early stages of CKD. Serum creatinine could be a reliable and cost-effective marker for evaluating disease progression in CKD.

Our research was carried out in a single center that primarily serves Nepalese Army personnel and their families. Therefore, the findings may not be representative of the wider population. We did not account for the presence of other comorbidities, such as hypertension, and diabetes, in our patients which is a risk factor for CKD.

Conclusion

Patients with CKD commonly present to the ED due to electrolyte imbalances, uremia, shortness of breath, and high SBP. Hyperkalemia and thrombocytopenia are more frequently observed in stage 5 CKD, whereas the incidence of hypertension significantly increases from stage 4 onwards. Hyponatremia, on the other hand, is more prevalent in stage 3 than in the later stages. To improve clinical outcomes, it is important to develop kidney centers for early diagnosis and complication management, pursue capacity building, and provide government subsidies for renal replacement therapy, particularly in low socioeconomic countries.

Ethical approval

Ethical approval for this study was provided by the Institutional Review Board of the Nepalese Army Institute of Health Sciences, Kathmandu, Nepal on June, 2021 with Reg no: 418.

Consent

Written informed consent was obtained from the patients for publication and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Source of funding

The study did not receive any grant from funding agencies in the public, commercial or not-for-profit sectors.

Author contribution

A.S.: conceptualization, data curation, formal analysis, methodology, investigation, software, writing original draft preparation, writing – reviewing, editing, and project administration; L. B.: conceptualization, data curation, formal analysis, investigation, methodology, writing – reviewing, editing, and supervision; A.R.: conceptualization, supervision, methodology, writing – reviewing and editing; S.M.: formal analysis, software, methodology, writing original draft, and writing – reviewing and editing; A.A.: writing original draft, writing – reviewing and editing, software, and formal analysis; E.A.: writing original draft,

writing – reviewing and editing, formal analysis, and project administration. All the authors read and approved the final manuscript.

Conflicts of interest disclosure

The authors report no conflicts of interest.

Research registration unique identifying number (UIN)

1. Name of the registry: Research registry.
2. Unique identifying number or registration ID: research registry10225.
3. Hyperlink to your specific registration (must be publicly accessible and will be checked): https://www.researchregistry.com/browse-the-registry#home/.

Guarantor

Laxman Bhusal, Nepalese Army Institute of Health Sciences, 44600.

Kathmandu, Nepal. Phone: +977 9847185378. E-mail: bhusal.laxman@gmail.com.

Data availability statement

Available upon reasonable request.

Provenance and peer review

Not applicable.

Acknowledgements

Not applicable.

References

[1] KDIGO2024. Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease.; 2024 https://kdigo.org/wp-content/uploads/2024/03/KDIGO-2024-CKD-Guideline.pdf
[2] Go AS, Chertow GM, Fan D, *et al*. Chronic kidney disease and the risks of death, cardiovascular events, and hospitalization [published correction appears in N Engl J Med. 2008;18(4):4]. N Engl J Med 2004;351:1296–305.
[3] Abraham G, Varughese S, Thandavan T, *et al*. Chronic kidney disease hotspots in developing countries in South Asia. Clin Kidney J 2016;9:135–41.
[4] Poudyal A, Karki KB, Shrestha N, *et al*. Prevalence and risk factors associated with chronic kidney disease in Nepal: evidence from a nationally representative population-based cross-sectional study. BMJ Open 2022;12:e057509.
[5] Chaudhari ST, Sadavarte AV, Chafekar D. Clinical profile of end stage renal disease in patients undergoing hemodialysis. MVP J Med Sci 2017;4:8–13; Published online. Accessed 30 March 2024. http://www.informaticsjournals.com/index.php/mvpjms/article/view/8555
[6] Ronksley PE, Tonelli M, Manns BJ, *et al*. Emergency department use among patients with CKD: a population-based analysis. Clin J Am Soc Nephrol 2017;12:304–14.
[7] Honeycutt AA, Segel JE, Zhuo X, *et al*. Medical costs of CKD in the Medicare population. J Am Soc Nephrol 2013;24:1478–83.
[8] Mathew G, Agha R. for the STROCSS Group. STROCSS 2021: strengthening the reporting of cohort, cross-sectional and case-control studies in surgery. Int J Surg 2021;96:106165.
[9] Kampmann JD, Heaf JG, Mogensen CB, *et al*. Prevalence and incidence of chronic kidney disease stage 3-5 - results from KidDiCo. BMC Nephrol 2023;24:17.
[10] Chhetri PK, Manandhar DN, Tiwari R, *et al*. In-center hemodialysis for end stage kidney disease at Nepal Medical College and Teaching Hospital. Nepal Med Coll J 2009;11:61–3.
[11] Nepal R, Sapkota K, Paudel M, *et al*. Clinical profile of end stage renal disease patients undergoing hemodialysis in Chitwan, Nepal. J Nepal Health Res Counc 2021;19:467–73.
[12] Belmar Vega L, Galabia ER, Bada da Silva J, *et al*. Epidemiology of hyperkalemia in chronic kidney disease. Epidemiología de la hiperpotasemia en la enfermedad renal crónica. Nefrologia (Engl Ed) 2019;39:277–86.
[13] Gasparini A, Evans M, Barany P, *et al*. Plasma potassium ranges associated with mortality across stages of chronic kidney disease: the Stockholm CREAtinine Measurements (SCREAM) project. Nephrol Dial Transplant 2019;34:1534–41.
[14] Trevisan M, Clase CM, Evans M, *et al*. Patterns of chronic and transient hyperkalaemia and clinically important outcomes in patients with chronic kidney disease. Clin Kidney J 2021;15:153–61.
[15] Kovesdy CP, Lott EH, Lu JL, *et al*. Hyponatremia, hypernatremia, and mortality in patients with chronic kidney disease with and without congestive heart failure. Circulation 2012;125:677–84.
[16] Han SW, Tilea A, Gillespie BW, *et al*. Serum sodium levels and patient outcomes in an ambulatory clinic-based chronic kidney disease cohort. Am J Nephrol 2015;41:200–9.
[17] Inoue M, Nakai K, Tanaka S, *et al*. Prevalence of hyponatremia and associated factors in patients with chronic kidney disease: the Fukuoka Kidney Disease Registry (FKR) study. Clin Exp Nephrol 2023;27:1023–31.
[18] Huang MJ, Wei RB, Wang Y, *et al*. Blood coagulation system in patients with chronic kidney disease: a prospective observational study. BMJ Open 2017;7:e014294.
[19] Knudsen F, Nielsen AH, Kristensen SD. The effect of dialyser membrane material on intradialytic changes in platelet count, platelet aggregation, circulating platelet aggregates and antithrombin III. Scand J Urol Nephrol 1985;19:227–32.
[20] Hamadi R, Sakr F, Aridi H, *et al*. Heparin-Induced Thrombocytopenia in Chronic Hemodialysis Patients. Clin Appl Thromb Hemost 2023;29:10760296231177993.
[21] Boccardo P, Remuzzi G, Galbusera M. Platelet dysfunction in renal failure. Semin Thromb Hemost 2004;30:579–89.
[22] Oi I, Oa A. TITLE: HAEMATOLOGIC profile in pre-dialysis chronic kidney disease patients in a tertiary hospital in Southern Nigeria https://oer.unimed.edu.ng/OTHER%20OER%20VARIETIES/1/5/IYAWE-OI--ADEJUMO-OA--HAEMATOLOGIC-PROFILE-IN-PRE-DIALYSIS-CHRONIC-KIDNEY-DISEASE-PATIENTS-IN-A-TERTIARY-HOSPITAL-IN-SOUTHERN-NIGERIA.pdf
[23] Khadayate R, Sahu P, Sahu S, *et al*. Study of Hematological Profile in Chronic Renal Failure Patients on Hemodialysis in a Tertiary Care Hospital Kindly add it as required. Int J Health Sci Res (wwwijhsrorg) 2020;10:12. https://www.ijhsr.org/IJHSR_Vol.10_Issue.12_Dec2020/1.pdf.
[24] Habib A, Ahmad R, Rehman S. Hematological changes in patients of chronic renal failure and the effect of hemodialysis on these parameters. Int J Res Med Sci 2017;5:4998–5003.
[25] Vida C, Oliva C, Yuste C, *et al*. Oxidative stress in patients with advanced CKD and renal replacement therapy: the key role of peripheral blood leukocytes. Antioxidants (Basel) 2021;10:1155.
[26] Agarwal R, Light RP. Patterns and prognostic value of total and differential leukocyte count in chronic kidney disease. Clin J Am Soc Nephrol 2011;6:1393–9.
[27] Erlinger TP, Tarver-Carr ME, Powe NR, *et al*. Leukocytosis, hypoalbuminemia, and the risk for chronic kidney disease in US adults. Am J Kidney Dis 2003;42:256–63.
[28] Muntner P, Anderson A, Charleston J, *et al*. Hypertension awareness, treatment, and control in adults with CKD: results from the Chronic Renal Insufficiency Cohort (CRIC) Study. Am J Kidney Dis 2010;55:441–51.
[29] Briet M, Boutouyrie P, Laurent S, *et al*. Arterial stiffness and pulse pressure in CKD and ESRD. Kidney Int 2012;82:388–400.
[30] DSa J, Shetty S, Bhandary RR, *et al*. Association between serum cystatin C and creatinine in chronic kidney disease subjects attending a Tertiary Health Care Centre. J Clin Diagn Res 2017;11:BC09–12.
[31] Peralta CA, Shlipak MG, Judd S, *et al*. Detection of chronic kidney disease with creatinine, cystatin C, and urine albumin-to-creatinine ratio and association with progression to end-stage renal disease and mortality. JAMA 2011;305:1545–52.