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The Role of Key Performance Indicators (KPIs) in Clinical Self-assessment of Quality of Service Offered to the Patients Under Chronic Hemodialysis in Low Income Countries

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Abstract

Introduction: Hemodialysis is the procedure using the dialysis machine and artificial kidney (dialyzer) in presence of the patient`s vascular access, to remove fluids and solutes (waste) in kidney failure patients, It gives supportive care and does not cure the kidney failure. Chronic kidney disease is clinical syndrome associated with definite change in kidney structure and function, it is mainly irreversible. KPIs are measurable metrics used to set goals in a certain period followed by assessment of the performance, and set the recommendations and the way forward. ***Methods:*** We analyzed the data which were recorded in Clinicea (electronic file) between February and November 2022 in early December 2022 using Key Performance Indicators (KPIs). ***Results:*** In all (3) centers, during the above-mentioned period, all sessions were recorded; more than 94% of patients, their Kt/V urea was recorded and the target was varying between 69% to 85%; almost half of the patients did their blood tests and less than three four met the target. Few patients had AVF (30% in November). The beds were under-used; no center has met 2 shifts per day at100%, the same for the nurses where there was less than 2.5 sessions per nurse per day. ***Conclusion:*** This study showed that KPIs are the best tools to monitor dialysis centers activity, as they help to keep updated about the current clinical state of patients for improving the quality of care and patients` quality of life especially in Low-Income Countries, where there is shortage of Physicians and Nephrologists.

Keywords: ***KPIs, hemodialysis service in Rwanda.***

Introduction

Hemodialysis is needed when kidneys are not able to clean blood by removing fluid and enough waste, this is the procedure is using the dialysis machine and a special filter, an artificial kidney called dialyzer and through the vascular access it is connect to the patient [1]. It helps to control blood pressure and balance some important minerals, such as serum sodium, potassium and calcium; and gives supportive care in improving better quality of life and to live longer but does not cure kidney failure [2].

Chronic kidney disease (CKD) is defined as a clinical syndrome associated with definitive change in structure of kidney or kidney function; it is mainly irreversible or associated with slow and progressive evolution [3]. CKD is associated with high-risk complications and mortality [3]. In adult patient, CKD is defined with glomerular filtration rate (GFR) less than 60 ml/min/1.73m^2 or greater than 60 ml/min/1.73m^2 when there is evidence of renal structure injury [3]. Worldwide the incidence of CKD is increasing and average being estimated to 150-200 per million population and its prevalence is estimated to 800 per million population [4]. In Low Income Countries (LIC), the prevalence and incidence of CKD are potentially surpassing [4]. Globally, there is annual increase of 7% needing chronic dialysis [4]. In sub-Saharan Africa, aging, life-style modification and rapid urbanization are the basis of CKD increment and also in consideration of overspreading of HIV, diabetes mellitus, hypertension and obesity [5].

Physician and patient have to decide together subjective and objectives parameters before starting dialysis; there is no absolute value that indicating to start dialysis [3]. Additional to the above consideration, physician has to evaluate quality of life, fall in renal function and the psychology of the patient and the dialysis is started when the patient becomes symptomatic or if there is remarkable changes in laboratory results suggesting high risk of developing symptoms [3].

The CKD patients under hemodialysis present the association between quality of life, socio-demographic and comorbidities problems and this makes difficult to do follow-up and may worse outcome [6].

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Key Performance Indicators (KPIs) are quantifiable metrics which express the performance of an institution in fulfilling its goals and objectives [7]. In the past, the use of KPIs have improved the quality of renal services such as CKD clinic, dialysis clinic and transplant clinic without extra-funding [8]. KPIs are used to assess the choice of measures and their results; the assessment is done in different principles such as quality indicators which are based on quality assurance and improvement [7]. Quality assurance targets are evidence-based and associated to a particular performance target that expected to achieve while quality improvement measures are measurable and able to be achieved in a certain timeframe [7]. In hemodialysis service, KPIs are used to set the measurable goals in certain range of the time followed by assessment of the performance; and set recommendations and next steps [7]. This study was looking whether KPIs can help to improve clinical service provided in dialysis centers at Africa Healthcare Network, Rwanda and the way forward by setting the goals and objectives to be achieved in the future in order to meet the targets.

Methods

This is a quantitative study, retrospective, and a mixed-method that assessed three hemodialysis centers of Africa Healthcare Network, Rwanda (2 centers, Gihundwe dialysis center and Gisenyi dialysis center of remote area and Kimihurura standalone of urban area, City of Kigali), all three centers localizations are shown on map of Rwanda by green arrow (**Figure 1**). We analyzed the recorded data in Clinicea (electronic file in use at Africa Healthcare Network, Rwanda in consultation) of from February to November 2022: the hemodialysis sessions, blood tests results, Kt/V urea, vascular access types, catheter infections breakdown, admissions, bed occupancy, deaths, and daily presented nursing staff and we compared the statistics of 2 months (October and November).

Hemodialysis centers in Rwanda

Rwanda is a Low Income, small, land-locked and sub-Saharan country of 12 million people in East and Central Africa region, bordering Tanzania in East, Uganda in North, Burundi in South, and the Democratic Republic of Congo in West (**Figure 1**). The country comprises an area of 26,338 km^2 with 496 per km^2 population density, most densely populated in Africa, and 75% of its residents engage in subsistence of Agriculture [9].

There are seven Hemodialysis centers, four centers are public in Teaching Hospital among them one is in rural area, Butare University Teaching Hospital (BUTH), Huye and three others in urban area in Kigali University Teaching Hospital (KUTH), Rwanda Military Hospital (RMH) and King Faisal Hospital (KFH), City of Kigali and the remaining three centers are private under Africa Healthcare Network, Rwanda, two centers of rural area are partnering with public hospitals through Private Public Partnership (Gihundwe and Gisenyi district hospitals) and one center is Standalone center. They are struggling in establishment of the dialysis centers all-over the country [10].

Figure 1: Location of dialysis centers on map of Rwanda

Statistical analysis

Recorded data in Clinicea were exported to Microsoft Excel 2021 for analysis

Results

We analyzed all data which were recorded in Clinicea (electronic file) between February and November 2022 in early December 2022. The findings: of 67 patients at all centers, all sessions were recorded in Clinicea (**Table 1**). From May to November 2022, more than 94%, their Kt/V urea was tested and recorded, the patients who did serum albumin dropped from 51% to 42%, there was improvement in testing Ferritin from 29% to 37%, TSAT was not tested during that period and other elements like Calcium, Phosphate and Hemoglobin

no much change between that period (**Figure 2**). Among the patients who were tested, from May to November 2022, there was improvement from 69% to 85% with much difference between October and November 2022, 77% to 85%; fall in serum albumin and calcium phosphorus to meet target from 63% to 9% and 82% to 58% respectively but when separately, calcium, the number of patients dropped from 72% to 41%; for other elements no much changes (**Figure 3**). For hemoglobin, overall, 40% of the patients have met the target (Hb 11-12g/dl), in consideration each center, Gihundwe dialysis center has high percentage of patients with anemia (Hb <8g/dl) and Kimihurura Standalone has high number (six patients) with anemia (Hb<8g/dl) (**Table 2**). Target hemoglobin over a period time showed in June 2022, the patients of Gisenyi dialysis centers has dropped to 30% while the patients of Gihundwe dialysis center has reached their apogee of 90% (**Figure 4**). For vascular access type: there is an increase in numbers of the patients who had AVF (21% to 30%) and in other side there is a fall in numbers of the patients who had PC from 66% to 57% (**Figure 5**). In assessment infections, admissions and mortality (all dialysis patients including AKI also or related to CKD only) rates, between May and November 2022, the highest prevalence was 5% in June 2022 for infections rate and 3% in November 2022 for both admissions, we recorded prevalence of 1% in November for both mortality (**Figure 6**). The over-all average sessions per day to nursing staff ratio was around 2.3 sessions per nurse per day with the highest record in Kimihurura standalone where the ratio is 2.5 sessions per nurse per day in September 2022 (**Figure 7**). For the bed occupancy, at all centers, many shifts were done in November 2022 with two full shifts at 60% and high predominance in Kimihurura standalone of 85% (**Figure 8**). In two months comparison (October and November 2022), in data recording in Clinicea, over-all there is no much difference between two months but by stratification, the Gihundwe dialysis center has recorded 100% Kt/V urea in both two months (**Table 3,4**); in meeting the target, at all centers, the average of Kt/V urea has improved from 77% to 85%, the Gisenyi dialysis did an excellent work from 44% to 73%, the hemoglobin target dropped from 82% to 60% at Gisenyi dialysis center, the calcium target dropped from 54% to 15% but the phosphorus target has improved from 67% to 835 at Gihundwe dialysis center and albumin target has dropped from 135 to 6% at Kimihurura standalone (**Table 5,6**); in vascular access, at all center the patients using AVF has increased from 29% to 30% with benefit at Gisenyi dialysis center from 6% to 13% and there was no patient using IJC at Gisenyi dialysis center in November 2022 (**Table 7,8**); and for catheter related blood stream infections (CRBSI), hospital admissions (all patients or related to CKD only) and mortality for all dialysis patients or related to CKD only rate, at all center, in November, they recorded 3% of the patients had catheter related infections and admissions for all patients, the highest the percentage of catheter related infection 5% was in Gisenyi dialysis center and highest percentage of admissions in all patients 10% was in Gihundwe dialysis center (**Table 9,10**).

Table 1: Clinicea Data Entry, all centers had approximately 100% of sessions entered in Clinicea

	Total Sessions	Sessions entered in Clinicea	% of sessions entered in Clinicea
Total	**1,053**	**1,052**	**100%**
Kimihurura	671	670	100%
Gisenyi	192	192	100%
Gihundwe	190	190	100%

Table 2: Patient Hemoglobin Breakdown (% and number of patients within each range)

	<8	8-9	9-10	10-11	11-12
Rwanda	16%(11)	7%(5)	15%(10)	21%(14)	40%(27)
KIMIHURURA	16%(6)	5%(2)	19%(7)	22%(8)	38%(14)
GISENYI	7%(1)	13%(2)	20%(3)	7%(1)	54%(8)
GIHUNDWE	27%(4)	7%(1)	0%(0)	33%(5)	33%(5)

Table 3. Clinical KPI: October Blood tests (% of patients tested)

	Kt/V	Albumin	Hemoglobin	TSAT	Ferritin	Serum Ca	Serum Po4	Ca*PO4
Total	98% (97)	45% (45)	62% (61)	0% (0)	37% (37)	58% (57)	43% (43)	43% (43)
KIMIHURURA	97% (65)	46% (31)	52% (35)	0% (0)	37% (25)	49% (33)	43% (29)	43% (29)
GISENYI	100% (16)	50% (8)	69% (11)	0% (0)	38% (6)	69% (11)	50% (8)	50% (8)
GIHUNDWE	100% (16)	38% (6)	94% (15)	0% (0)	38% (6)	81% (13)	38% (6)	38% (6)

Table 4. Clinical KPIs: November Blood tests (% of patients tested)

	Kt/V	Albumin	Hemoglobin	TSAT	Ferritin	Serum Ca	Serum Po4	Ca*PO4
Total	98% (106)	42% (45)	62% (67)	0% (0)	37% (40)	52% (56)	46% (50)	46% (50)
KIMIHURURA	99% (73)	42% (31)	50% (37)	0% (0)	38% (28)	42% (31)	39% (29)	39% (29)
GISENYI	94% (15)	69% (11)	94% (15)	0% (0)	44% (7)	75% (12)	56% (9)	56% (9)
GIHUNDWE	100% (18)	17% (3)	83% (15)	0% (0)	28% (5)	72% (13)	67% (12)	67% (12)

Table 5. Clinical KPIs: October Blood tests (% of the patients meeting the target and average value)

	Kt/v	Albumin	Hemoglobin	TSAT	Ferritin	Serum Ca	Serum Po4	Ca*PO4
Total	77% (1.34)	18% (27.36)	56% (10.28)	--	81% (488.2)	49% (31.26)	74% (1.57)	70% (42.16)
KIMIHURURA	82% (1.35)	13% (24.14)	49% (9.97)	--	80% (487.19)	58% (7.12)	76% (1.74)	69% (48.12)
GISENYI	44% (1.23)	13% (33)	82% (11.09)	--	67% (334.14)	18% (138.16)	75% (1.19)	75% (27.07)
GIHUNDWE	94% (1.43)	50% (36.5)	53% (10.42)	--	100% (646.5)	54% (2.1)	67% (1.28)	67% (33.43)

Table 6. Clinical KPIs: November Blood tests (% of the patients meeting the target and average value)

	Kt/v	Albumin	Hemoglobin	TSAT	Ferritin	Serum Ca	Serum Po4	Ca*PO4
Total	85% (1.38)	9% (14.58)	61% (10.19)	--	83% (477.99)	41% (2.21)	80% (1.23)	58% (36.86)
KIMIHURURA	84% (1.35)	6% (5.82)	59% (10.29)	--	82% (481.1)	55% (2.4)	72% (1.43)	69% (46.19)
GISENYI	73% (1.34)	9% (34.35)	60% (10.16)	--	71% (291)	33% (2.05)	100% (0.74)	44% (19.4)
GIHUNDWE	100% (1.53)	33% (32.67)	67% (9.95)	--	100% (722.4)	15% (1.93)	83% (1.12)	42% (27.38)

Table 7. Clinical KPI review, other clinical outcomes (% vascular access) in October

	Fistula	Permanent catheter	Acute catheter
Total	29% (29)	58% (57)	11% (11)
KIMIHURURA	39% (26)	45% (30)	13% (9)
GISENYI	6% (1)	81% (13)	13% (2)
GIHUNDWE	13% (2)	88% (14)	0% (0)

Table 8. Clinical KPI review, other clinical outcomes (% of vascular access) in November

	Fistula	Permanent catheter	Acute catheter
Total	30% (32)	57% (62)	12% (13)
KIMIHURURA	38% (28)	45% (33)	16% (12)
GISENYI	13% (2)	88% (14)	0% (0)
GIHUNDWE	11% (2)	83% (15)	6% (1)

Table 9: Clinical KPIs, other clinical outcomes (% of catheter related infection, hospital admissions in all patients or related to CKD only and mortality in all patients or related to CKD only) in October

	Catheter infection	Hospital admission (all patients)	Hospital admission (CKD only)	Mortality (all patients)	Mortality (CKD only)
Total	1% (1/102)	1% (1/102)	1% (1/99)	0% (0/102)	0% (0/99)
KIMI	1% (1/67)	0% (0/67)	0% (0/67)	0% (0/67)	0% (0/67)
GISENYI	0% (0/19)	5% (1/19)	5% (1/16)	0% (0/19)	0% (0/16)
GIHUNDWE	0% (0/16)	0% (0/16)	0% (0/16)	0% (0/16)	0% (0/16)

Table 10: Clinical KPIs, other clinical outcomes (% of catheter related infection, hospital admissions in all patients or related to CKD only and mortality in all patients or related to CKD only) in November

	Catheter infection	Hospital admission (all patients)	Hospital admission (CKD only)	Mortality (all patients)	Mortality (CKD only)
Total	3% (4/116)	3% (4/116)	3% (4/108)	1% (1/116)	1% (1/108)
KIMI	4% (3/74)	3% (2/74)	3% (2/74)	1% (1/74)	1% (1/74)
GISENYI	5% (1/22)	0% (0/22)	0% (0/16)	0% (0/22)	0% (0/16)
GIHUNDWE	0% (0/20)	10% (2/20)	10% (2/18)	0% (0/20)	0% (0/18)

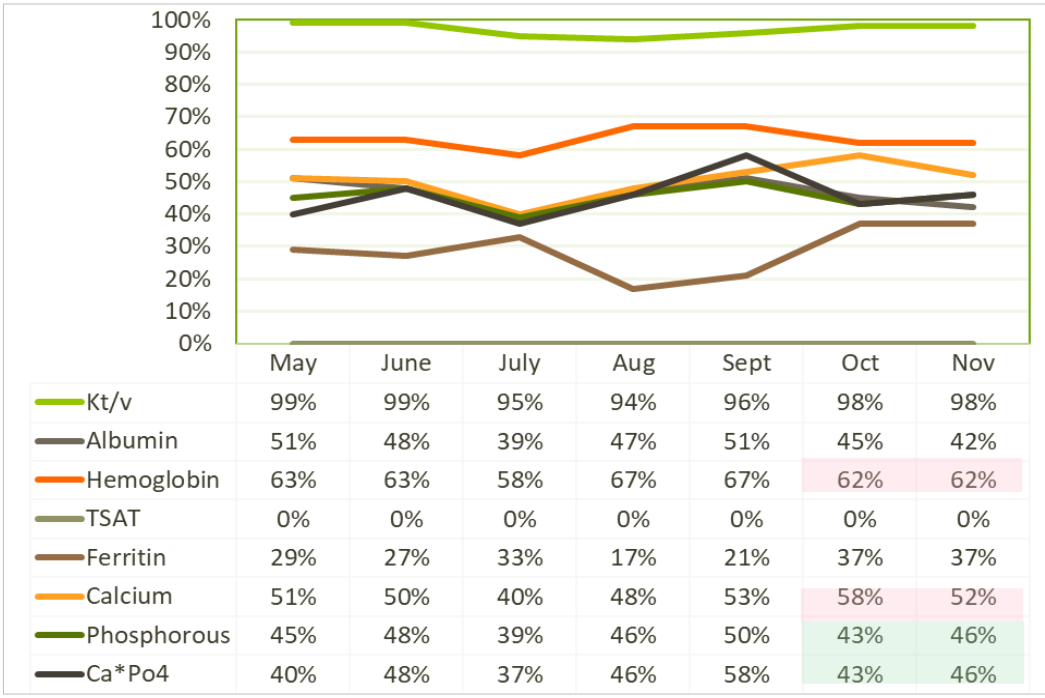
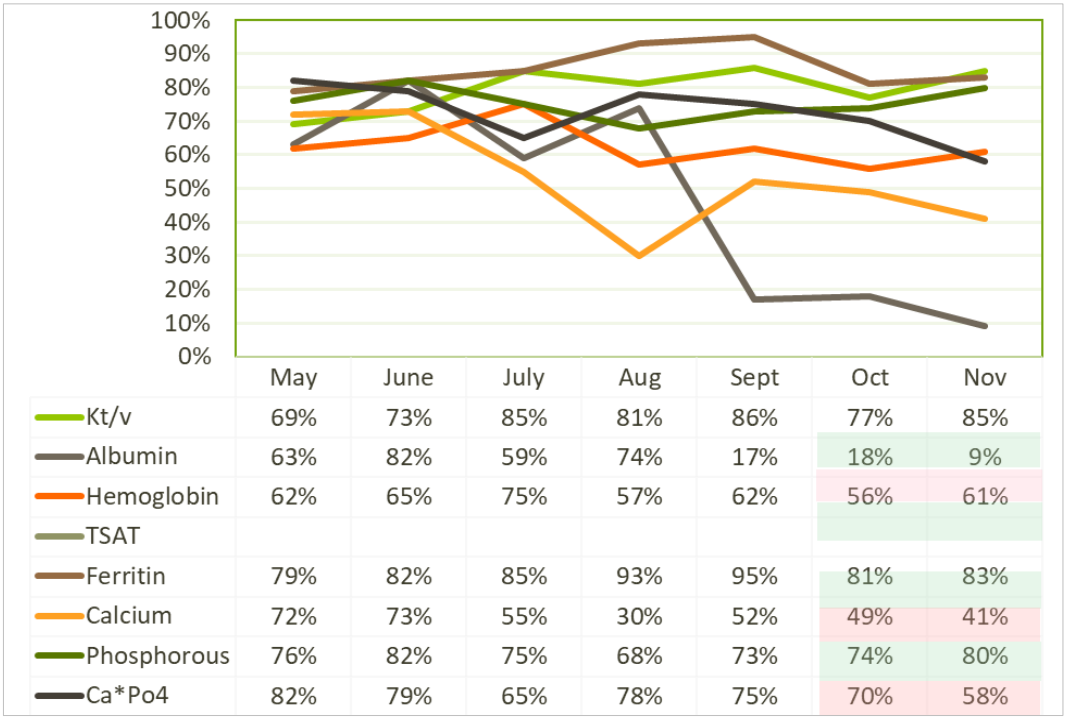


Figure 2: Patient level KPIs: Blood tests (% of the patients tested within relevant time window)



	May	June	July	Aug	Sept	Oct	Nov
Kt/v	69%	73%	85%	81%	86%	77%	85%
Albumin	63%	82%	59%	74%	17%	18%	9%
Hemoglobin	62%	65%	75%	57%	62%	56%	61%
TSAT							
Ferritin	79%	82%	85%	93%	95%	81%	83%
Calcium	72%	73%	55%	30%	52%	49%	41%
Phosphorous	76%	82%	75%	68%	73%	74%	80%
Ca*Po4	82%	79%	65%	78%	75%	70%	58%

Figure 3: Patient level KPIs review: Blood tests (% of the patients meeting target value)

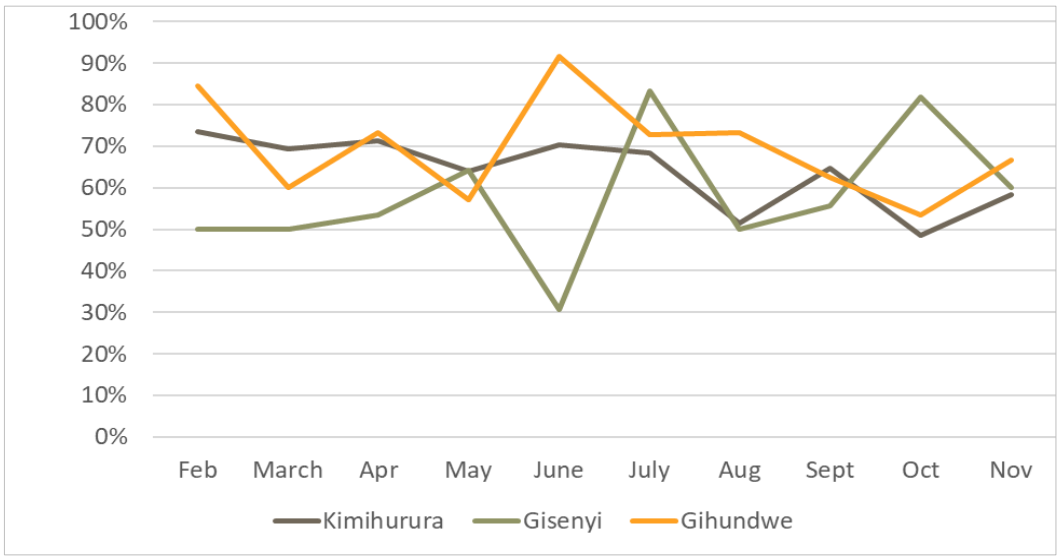
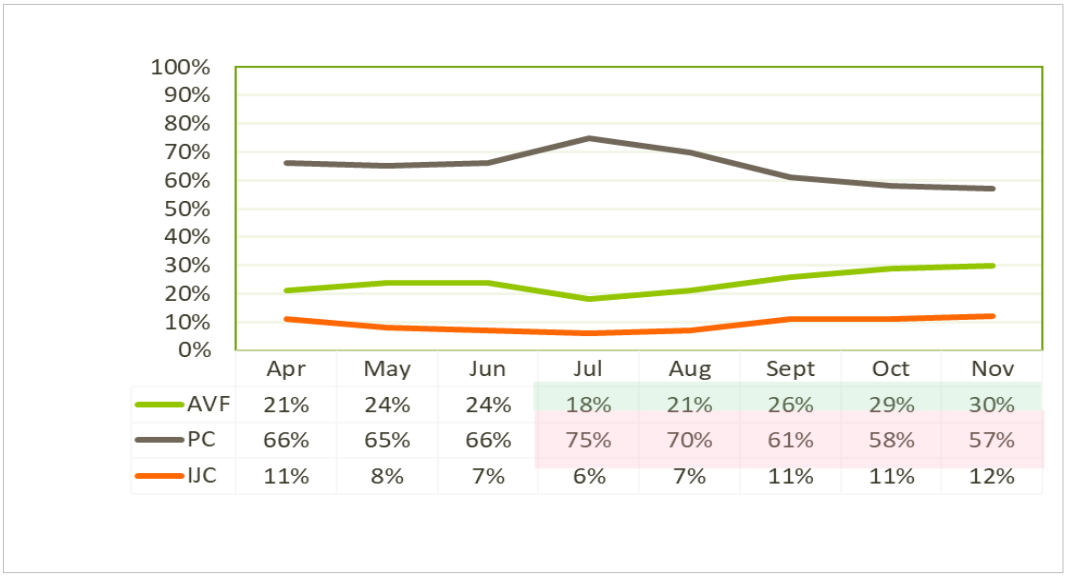
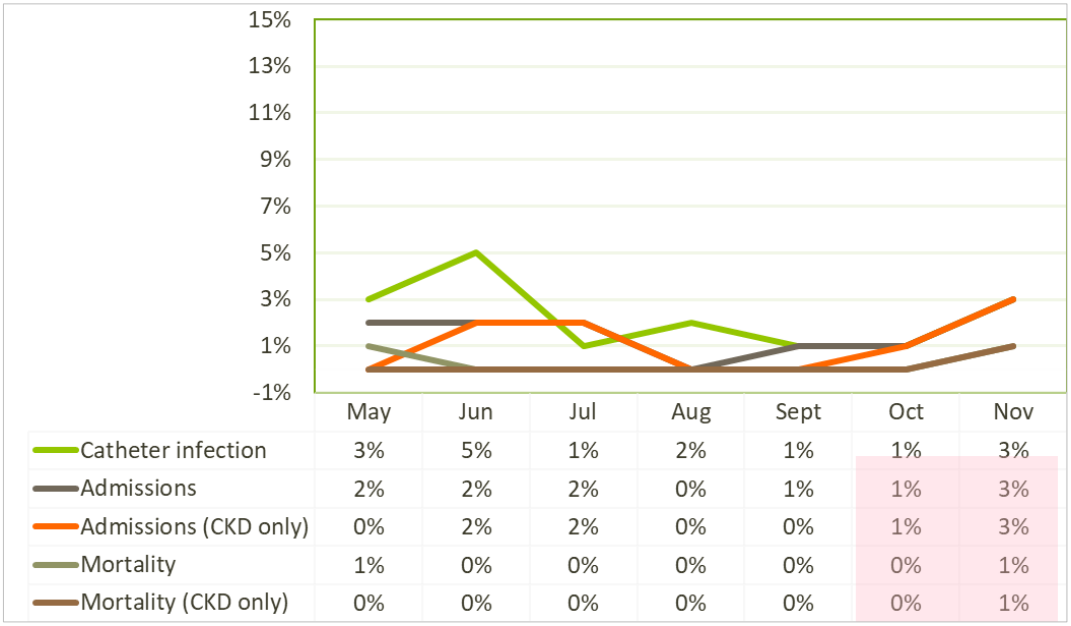


Figure 4: Patient level KPIs: Blood tests, Hemoglobin (overview of the patients meeting Hb target overtime in centers)



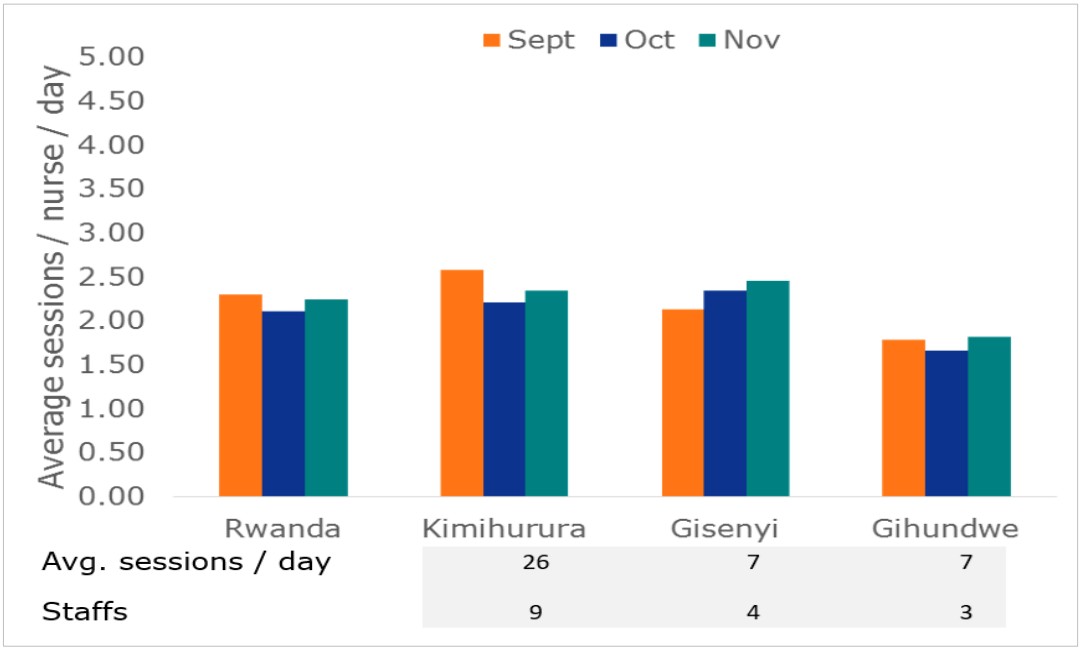
	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov
AVF	21%	24%	24%	18%	21%	26%	29%	30%
PC	66%	65%	66%	75%	70%	61%	58%	57%
IJC	11%	8%	7%	6%	7%	11%	11%	12%

Figure 5: Other clinical outcomes (% of vascular access types)



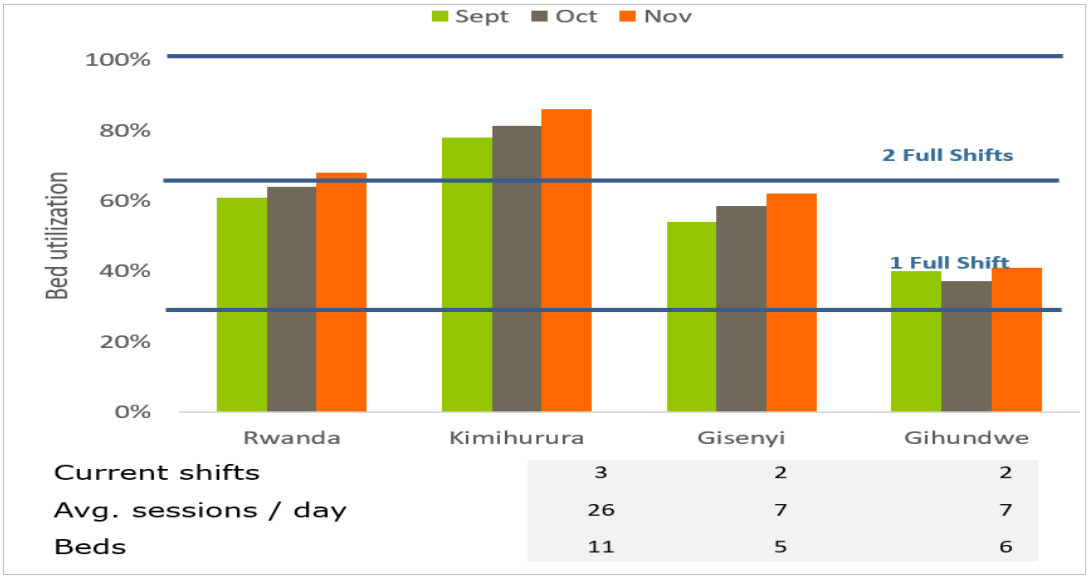
	May	Jun	Jul	Aug	Sept	Oct	Nov
Catheter infection	3%	5%	1%	2%	1%	1%	3%
Admissions	2%	2%	2%	0%	1%	1%	3%
Admissions (CKD only)	0%	2%	2%	0%	0%	1%	3%
Mortality	1%	0%	0%	0%	0%	0%	1%
Mortality (CKD only)	0%	0%	0%	0%	0%	0%	1%

Figure 6: Other clinical outcome (% of infections, admissions and mortality)



	Rwanda	Kimihurura	Gisenyi	Gihundwe
Avg. sessions / day	26	7	7	
Staffs	9	4	3	

Figure 7: Operational KPIs, average sessions per day to nursing staff ratio



	Rwanda	Kimihurura	Gisenyi	Gihundwe
Current shifts	3	2	2	
Avg. sessions / day	26	7	7	
Beds	11	5	6	

Figure 8: Operational KPIs, Bed occupancy

Discussion

Key Performance Indicator (KPIs) in monitoring and reporting have shown a key aspect in delivering standard hemodialysis service; its implementation may help to measure adherence to the dialysis standards [11]. Due to the increasing patients` number under chronic dialysis in Japan, they implemented KPIs in local public organizations and primary care physicians to improve the CKD medical treatment system for early detection, optimal management and criteria for refer to a nephrologist with a goal to achieve in reduction of new dialysis patients to < 35,000 by 2028 [12]. In a country like Libya where there is free access to dialysis service for citizens, this is associated with increased number of the patients under chronic dialysis, there is ninety-two centers hosting 713 hemodialysis machines, the ratio was 1:3.4 machine-patients, nurse to patients ratio was 1:3.7 and Nephrologist/internist to patient ratio was 1:40 [13]. Kt/V urea of ≥ 1.2 is associated with good general health status but very difficult to achieve Kt/V urea of 1.45 in men with body weight between 70 kg to 80 kg for treatments of 4.5-hour duration [14]. The patients with high or low serum concentration of serum albumin-corrected calcium, phosphorus and PTH had increased risk in all-cause mortality [15]. The erythropoietin response depends on different factors such as nutrition status, inflammation and oxidative stress markers, the serum albumin concentration is strong predictor of baseline hemoglobin and erythropoietin sensitivity, its improvement improves anemia in hemodialysis patients [16]. Serum albumin concentration level in patients under chronic dialysis was found to be predictor to determine the nutrition status of the patients [17]. At the side of Rwanda, where more than 90% are using Community Base Health Insurance (CBHI) [18], public health insurance under government control, the beneficiaries do not have access to chronic dialysis unless they are able to pay 100% hemodialysis services, this may justify low rate of bed occupancy and low ratio Nurse to hemodialysis sessions as well inability to reach at least 2 full shifts per day; besides this, the Nephrologist to hemodialysis patients ratio was 1:67 this explained the needs of Nephrologists in Rwanda as there was one Nephrologist covering all three centers during that period. There was significant portion of patients who presented low serum albumin concentration, this may be associated with low hemoglobin level or this hemoglobin level may be attributed to the inaccessibility to Erythropoeisis-stimulating agent. Many patients missed investigations, this is associated with high frequency reagents stock-out in laboratories of public hospitals and this is also supporting the study which documented sub-optimal diagnosis capacity of kidney diseases in different hospitals in Rwanda [19], the patients of Gihundwe and Gisenyi dialysis centers are using their respective public hospital laboratories for investigations. Still the patients with AVF were few; this is associated with lack of vascular surgeons in Rwanda while the AVF is considered as the gold standard hemodialysis vascular access [20]. At Kimihurura standalone, 2 full shifts were reached at 80% in November, this is should be attributed to the dialysis accessibility, rarely the patients are missing the schedules dialysis sessions compared to the rest of centers of remote area.

Conclusions and Recommendation

Based on these findings, KPI has helped in self-assessment of the clinical services that being offered to the chronic hemodialysis patients, the clinical teams were able to identify the weakness to improve such as Nutritionist has to be involved more, local vascular surgeons are highly needed, the public hospital administrations need to improve in purchasing the laboratory reagents, Kt/V urea has to be recorded 100% and meet the target as it is used to measure vascular access patency, the physicians have to check the drugs adherence and compliance with the patients, also to put enough effort in TSAT testing as it is helping to monitor the response to Erythropoeisis-stimulating agent and or iron therapy in CKD and Ministry of Health, Rwanda needs to collaborate with different stakeholders in order to improve renal service in terms of dialysis accessibility, increasing the numbers of Nephrologists and laboratory equipment. At the best of our knowledge, this was the first study assessing how KPIs can help in monitoring of hemodialysis centers in Rwanda, as well in Africa.

Study weakness: injectable Erythropoeisis-stimulating agent and Iron sucrose, their dosage and frequencies; serum glucose, glycated hemoglobin, missed scheduled hemodialysis sessions, body mass index and vital signs monitoring such as blood pressure, heart rate, temperature, and respiratory rate were not included in KPIs.

Acknowledgement

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Authors Contribution

A. Etienne Ntabanganyimana: conceived, designed and wrote the manuscript
B. Theophile Nishimwe: participated in analysis of the data
C. Jean Baptiste Tuyishime: participated in analysis of the data
D. Astrid Bora: involved in clinical management of the patients
E. Benjamin Kyavulikira: involved in clinical management of the patients
F. Eugene Nyandwi: contributed in study design and statistical analysis
G. Joseph Ntarindwa: participated in the study conception and reviewed the manauscript
H. Vincent Lloyd: participated in study design, conception and critically reviewed the manuscript

Funding

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Data Availability

The datasets generated and analyzed during the current study are not publicly available because we are not allowed to share individual level data. However additional information about the data is available from the corresponding author on reasonable request.

Declarations

Ethics approval

Both, ethical approval and informed consent were waived by Gihundwe Hospital and Gisenyi Hospital, Education and Research Committees considering the retrospective nature of the study, as it used the anonymized records that existed in dialysis centers, and did not involve interaction with the patients.

Consent for publication

Not applicable

Competing interests

All the authors have

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