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ORIGINAL ARTICLE

Clinical profile and predictors of renal failure in emergency department patients at a tertiary level hospital, a cross sectional study

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ABSTRACT

Background: Since establishment of the emergency departments (ED) in the country, there is lack of information on clinical profile of patients admitted to the ED and predictors of renal failure in these patients. Renal failure is prevalent in critical patients and a cause of significant mortality and morbidity. The aim of this study was to assess the clinical profile and predictors of renal failure in admissions to the ED.

Methods: This was a cross-sectional study that was conducted at a tertiary level hospital in Zambia from January to December, 2019 among admissions to the ED after ethical approval. The primary outcome of the study was to describe the clinical profile of admissions to the ED and proportion of renal failure defined as estimated glomerular filtration rate (eGFR) < 60 mls/1.72 m^2

Results: The final analysis includes 152 patients, 7 excluded for missing key data. The median age was 43.5 years (IQR 32.5-59.5) and 94.7% of patients were medical. Nearly 70.0% of the patients were triaged as emergency (red) or very urgent (orange). The reason for admission to the ED were sepsis and/or sepsis shock in 25.0%, diabetic hyperglycaemia emergencies in 20.0%, hypertensive crisis in 10.5%, respiratory failure (9.9%), severe malaria (7.9%) and poisoning (5.0%). The prevalence of renal failure was 36.1% and proteinuria was observed in 23.0%. Oliguria and hypertension were 5.9-fold and 1.7-fold independent predictors of renal failure in the ED. Patients with renal failure were likely older, hypertensive, oliguric and anaemic compared to those without. During admission to the ED, 19.1% died.

Conclusion: Sepsis and diabetic and hypertensive emergencies accounted for nearly half of ED admissions. Hypertension and oliguria were key predictors of renal failure. Early diagnosis, management and follow-up of hypertension including urine output monitoring for high-risk patients is key in surveillance and prevention of renal failure.

Introduction

Renal Failure is a prevalent condition among admissions to the emergency department(ED) [1] that is associated with increased morbidity and mortality especially in Sub-Saharan Africa (SSA) where there is limited ED infrastructure [2–4]. The two spectra of kidney disease include acute kidney injury (AKI) and chronic kidney disease (CKD). AKI is characterized by rapid reduction in kidney function usually not exceeding three months [5]. The spectra of the condition include negligible variations in markers of kidney function due to injury to overt loss of kidney function and need for renal replacement therapy (RRT) [3]. Chronic kidney disease on the other hand is the persistent impairment in renal function for a period greater than 3 months or glomerular filtration rate less than 60 ml per minute/ 1.73 m2 [6].

Acute kidney injury occurs frequently in critically ill patients where it has been shown to be associated with very poor outcomes and increased health costs [7–10]. Mortality due to AKI in critically ill patients in most African countries is very high ranging between 21% and 60% [8, 11]. The greatest implication of AKI is likely to be experienced in the poorer parts of the world where unavailability of effective renal therapies, lack of resources and late presentation and delayed identification of AKI hinder its management [12, 13], especially in the emergency units with sub optimal infrastructure or equipment [2, 3].

In developing countries, the causes of renal failure are two sided. On one side non-communicable diseases like hypertension and diabetes lead to renal failure similar to the picture in high income countries [2]. For example, a number of studies in Africa have highlighted rates of hypertension and diabetes in renal failure patients in the emergency

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departments and intensive care units to be 27- 63% and 13-20% respectively [2, 5, 14]. On the other hand, communicable diseases are also leading to RF for instance; the leading causes of AKI in an African study were reported to be sepsis and hypoperfusion due to gastroenteritis, tuberculosis, heart failure, dehydration of unknown causes and malaria [12].

Despite the knowledge of magnitude of the burden imposed by renal failure on critical patients, renal failure is still an under researched topic in Zambia to the extent that predictors of renal failure in the Zambian emergency department are unknown. The aim of this study is to describe the clinical profile and predictors of renal failure in patients admitted to the emergency department at a tertiary hospital.

Objectives

General Objectives

- To assess the clinical profile and renal failure in admissions to the ED

Specific Objectives

- To determine the common presenting conditions in the ED
- To determine the renal failure rate in the ED
- To determine predictors of renal failure in the ED

Methods

Study design, setting and population

This was a cross-sectional study that was conducted in the Emergency Department (ED) at Ndola Teaching Hospital from January, 2019 to December, 2019. The ED was the first in the country and was commissioned in 2017 with a bed capacity of six. Ndola Teaching Hospital is a tertiary level hospital with a bed capacity of almost 800 and the facility caters for a vast catchment area for Northern Zambia. The study included patients aged 18 years and above who were admitted to the ED and consented to the study (or the next of kin). Patients younger than 18 years or those who demised immediately post admission were excluded. The study was conducted in line with the Helsinki declaration and was approved by the ethics. Confidentiality was adhered to and data was anonymized.

Sample size calculation

The sample size was calculated using a recommended formula for cross-sectional studies [15] the expected prevalence of renal failure was estimated at 30% from cited literature [1,2,4,5].

Study procedures

Data was extracted with the use of an extraction sheet that captured the patient's bio data; on clinical features at presentation, hematological and biochemical findings. Patients' examination findings were obtained on the primary ED diagnosis, level of Glasgow Coma Scale (GCS), triage color, vitals (blood pressure, temperature, pulse etc) as well as their laboratory results. Laboratory data (serum creatinine and urea were determined using Humastar 600). Hemoglobin was measured using Sysmex XT 2000i while proteinuria determination was by SD Urocolor^{TM}11 sticks.

Emergency department triage system

The ED at the study site utilizes the South African Triage Score (SATS) system, a triage that has been adopted in several resources limited countries including Zambia. The tool employs three parts to categorise the patient; the scoring, the discriminator and additional tests for example blood sugar levels. The patients are categorized into four categories; the red (emergency) or triage early warning score (TEWS ≥7, orange(very urgent) with TEWS 5 or 6, yellow (urgent) with TEWS 3 or 4 and green (routine) with TEWS 0,1 or 2; that is from critical, severe unstable patients needing immediate medical attention to those that are stable and can wait a bit longer [16,17, 18].

Missing data

When participant was unable to give responses to questions on clinical details, we were able to interview close relations of the participant. We were also able to transport urea and creatinine samples to nearby facilities when the study site was not able to run such tests.

Study outcomes

The primary outcome of the study was to establish the characteristics of patients admitted to the ED at Ndola Teaching Hospital and the proportion of renal failure defined as estimated glomerular filtration rate (eGFR) < 60 mls/1.72 m^2 plus other markers of renal dysfunction (urine output, serum creatinine) and proteinuria >1. Estimated glomerular filtration rate (eGFR) was calculated by inputting age, creatinine and sex in to the Cockcroft gault formula. Urine output was measured 6 hourly.

Handling bias

Potential sources of bias for this research include that we used convenience sampling to obtain our sample which could have made our sample unrepresentative of the sample population. This method of sampling was mainly chosen due to the limitation in availability of kidney function tests which was unpredictable. To ensure we captured a representative sample in our study we assigned a member of our team to be stationed in the emergency room from morning to evening during the data collection period to capture all candidates that fulfilled the eligibility criteria.

Data analysis

Data obtained from the extraction sheet was coded and entered into Microsoft Excel electronic spreadsheet. Analysis was performed using Statistical Program for Social Science (SPSS) version 23 package. For categorical data, proportions were described with percentages, and the chi squared test and its variants in assessing test associations. All statistical hypotheses were carried out at a 5% level of significance and 95% confidence intervals (CI) and a P value of 0.05 was considered statistically significant. For numerical data, medians were employed for non-parametric data and appropriate tests for comparisons.

Results

The study included a total of 159 patients who were admitted to the Emergency Department during the study period. The final analysis includes 152, seven excluded for incomplete data on clinical presentation and creatinine test results. Their characteristics are shown in Table 1 and 2. At least half of these patients were male and the median age of the participants was 43.5 years (IQR 32.5-59.5) and 95% were medical in nature while surgical and obstetrics were respectively 3% and 2%. At triage, nearly 43% and 26% were triaged as red and orange while almost 20% were triaged as green.

Reasons for admissions and outcome

Of the 152 participants, the major reason for admission to the ED was sepsis or sepsis shock in nearly 25% of the participants, diabetic emergencies (diabetic ketoacidosis and hyperosmolar and hyperglycaemia state) in almost 20%, and hypertensive emergencies in 12%. Respiratory failure, status epilepticus, severe malaria and poisoning were respectively reasons for admission in nearly 9%, 9%, 8% and 5%. Among the patients with poisoning, organophosphate was the major cause. The median GCS of the participants was 15 (13-15) and nearly half of these had a sepsis Q-sofa score exceeding one. 18.4% were in shock (MAP < 65 mmHg) and 21.1% received inotropes support. During admission to the ED, 19.1% died.

Table 1
Demographic and clinical characteristics of patients admitted to the ED.

Characteristic	All N=152
Age, media, IQR	43.5(32.5-59.5)
Male	81(53.3%)
Underlying comorbidity	
Diabetes mellitus,	35 (23.1%)
Hypertension	61 (40.1%)
HIV/AIDS,	45 (38.5%)
Stroke	26(17.1%)
Cardiac disease	15(9.9%)
Triage color	
Green (routine)	25(16.5%)
Yellow (urgent)	23(15.0%)
Orange (very urgent)	39(25.7%)
Red (emergency)	65(42.8%)
Clinical presentation	
Vomiting	36(23.6%)
Fever	19 (12.5%)
Diarrhea	21(13.8%)
Urine protein (≥1+)	35(23.0%)
MAP (<65 mmHg),	28(18.4%)
GCS, median,	15(13-15)
RR (breathes/minute), median, IQR	21(2-26)
DBP(mmHg(median, IQR	75(58-91)
Q Sofa, ≥1	63(41.5%)
Urea (mmol/L), median, IQR	6.3(3.7-12.9)
Creatinine (mmol/L)„ median, IQR	105.8(79.4-189.5)
Hemoglobin (g/dL), median, IQR	12.4(8.7-14.7)
CBC, median, IQR	8.3(5.9-13.6)
Died in ED	29(19.1%)/
Inotropes support	32(21.1%)

Abbreviations: CO; carbon monoxide poisoning, CCF; congestive cardiac failure, DKA; diabetic ketoacidosis, HHS; hyperglycaemic hyperosmolar state, HTN; hypertension, UGIB; upper gastrointestinal bleeding

Table 2
Reason for admission to the ED.

Characteristic	Frequency N=152
Septic shock	19 (12.5%)
DKA	18 (11.8%)
HTN emergency	16 (10.5%)
Sepsis	15 (9.9)
Respiratory Failure	13 (8.6%)
Status epilepticus	12 (7.9%)
Severe Malaria	12 (7.9%)
HHS	7 (4.6%)
Poisoning	
Organophosphate	3(1.9%)
Mushroom poisoning	1(0.7%)
CO	1(0.7%)
Drug overdose	1(0.7%)
Chemical	1(0.7%)
Cardiac	
Congestive cardiac disease	5(3.2%)
Myocardial infarction	1(0.7%).
Stroke	6 (3.5%)
Renal failure	4(2.6%)
UGIB	3(2.0%)
Subdural Hemorrhage	1(0.6%)
Others	11(7.2%)

Abbreviations: CO; carbon monoxide poisoning, CCF; congestive cardiac failure, DKA; diabetic ketoacidosis, HHS; hyperglycaemic hyperosmolar state, HTN; hypertension, UGIB; upper gastrointestinal bleeding

Renal failure in ED

The prevalence of renal disease was 36.1% and the frequency of renal disease was significantly high in females, hypertensive, patients with oliguria and those with reduced hemoglobin. Proteinuria was observed in 35% of the participants and showed significance in those who had underlying kidney disease (72.2% vs. 27.3%, p 0.000). Oliguria was observed in 12.5% of the participants and it was more in those with diarrhea (28.6% vs. 9.9%, p 0.028) and on inotropes support (25.0% vs. 9.1%, p 0.030).

Table 3
Baseline characteristics of those with renal failure versusthose without renal failure

Characteristic	Renal Failure N=52	No Renal Failure N=92	P value
Age, media (IQR)	47.5(39-64)	41(29-58)	0.028
Gender,			
Male	21 (28.0%)	54(72.0%)/	0.035
Female	31(44.9%)	38(55.1%)	
Underlying comorbidity			
Diabetes mellitus, yes	16(45.7%)	19(54.3%)	0.174
No	36(33.0%)	73(77.0%	
Hypertension, yes	28(42.3%)	30(51.1%)	0.013
No	24 (27.9%)	62(72.1%)	
Clinical presentation			
Vomiting, yes	16(47.1)	18(52.9%)	0.128
Diarrhea, yes	8(42.1%)	11(57.9%)	0.559
Oliguria, yes	16(88.9%)	2(11.1%)	<0.001
Inotropes, yes	14(46.7%)	16(53.3%)	0.176
Dehydration, yes	7(46.7%)	8(53.3%)	0.365
Cardiac, yes	5(33.3%)	10(66.7%)	0.813
Urine output (ml/hour) in 6 hours	312.5(115-675)	500(310-650)	0.044
Hemoglobin, g/dL	10.2(7.7-13.8)	13.1(10.4-14.9)	0.011
White cell count 9×10^3	9.5(6.6-15.2)	8.0(5.6-12.5)	0.080
Proteinuria, yes	23(69.7%)	10(30.0%)	<0.001
Creatinine mmol/L	252.3(154.5-451.5)	86.3(71.6-104.9)	<0.001
Urea, mmol/L	12.9(7.1-29.9)	4.5(2.9-6.7)	<0.001
Died in ED, yes	11(39.3%)	17(60.7%)	0.697

IQR; inter quartile range, ED; emergency department, Q-SOFA; sequential organ failure assessment

Table 4
Predictors of renal failure adjusted analysis

Characteristic	P value	Odds ratio	95% CI
Oliguria			
Yes	< 0.001	5.86	2.60 – 13.19
No		1	
Gender			
Male	0.059	0.62	0.41 – 0.93
Female		1	
Hypertension			
Yes	0.008	1.73	1.16 – 2.59
No		1	

Discussion

This study investigated the clinical profile of patients admitted to the emergency department (ED) and occurrence of renal failure in the ED. The study revealed that sepsis or septic shock, hyperglycemia and hypertensive emergencies were leading causes of admission to the ED in more than half of the patients seen. This pattern is similar to observations of other studies in the region and highlights the double disease burden that developing countries are now facing [2, 5]. This picture is fueled by the drift towards western culture including fast food consumption and industrialization in addition to the already existing lack of infrastructure and resources to manage infectious diseases.

The ED mortality rate reported in our study at 19.1% is in contrast with a similar study that was performed in a Tanzanian ED by Slyvanus *et al.* which revealed a mortality rate of 2.7% [2]. One way to explain this is that patients in the current study were critically ill at presentation as evidenced by the triage coding which showed that more than 40% fell in the red category. In contrast, it could also be that the Tanzanian cohort of ED patients spent less time in the ED compared to those in this study seeing as to how the mortality rate rose to 14 times the initial for the overall study after leaving the ED [2]. Mortality in ED has been reported to be at least five times higher in SSA [19] and patient delays in the ED and suboptimal infrastructure contribute to high mortality

The renal failure rate in the ED for this study was 36.1%. Studies in other regions have reported varying rates of renal failure. For instance, Slyvanus *et al.* in a Tanzanian ED reported an 8.8% for both AKI and CKD [2] while ElHafeez *et al.* [20] in an Egypt intensive care unit (ICU) reported an AKI rate of 39.6%. The main contributor to the renal failure rate variation specifically for AKI is the diagnostic criteria employed for AKI that is, either studies employed the Kidney Disease Improving Global Outcomes (KIDIGO) or the Risk, Injury, Failure; Loss, End-Stage Renal Disease (RIFLE) is employed to detect AKI cases or raised serum creatinine levels. Studies have shown that KIDIGO is able to capture more patients with AKI compared to other criteria [21], but this is limited in places with unavailable baseline creatinine.

In our present study, the rate of renal failure in the ED was much higher than other studies in the region [1, 2]. These studies employed the RIFLE criteria for AKI in Tanzania and acute on chronic and CKD for the South African Study and this could have accounted for varying rates. Furthermore, another study in Zambia that was performed in ICU patients and utilized KDIGO criteria and reported a renal failure rate of 52.9% indicating that our renal failure rate could be reflective of current findings in critical patients [14].

This study also found that renal failure was common in those with female gender (P 0.035) and those with hypertension (P 0.013). For hypertension, a reasonable explanation for this finding is that renal failure results from the long-standing impact of different insults to the kidney such as uncontrolled hypertension resulting in blood vessel damage and ischemia. The gender disparity could be attributed to the effects of longer life expectancy in women and natural reduction in renal function with aging. Country data for life expectancy in Zambia in 2020 by the World Bank indicate that women have a higher life expectancy than men 67.2 years (mean 33.6) versus 61.1 years (mean 30.0) [22]. Hence, renal disease prevalence is likely to be higher in the former.

Furthermore, oliguria predicted 5.8-fold development of renal failure in our study. This is consistent with previous studies that highlighted oliguria as an early traditional marker for acute kidney injury in critical patients admitted to intensive care units [23]. Gender was a marginally significant predictor of renal failure. Determining predictors of renal failure is key to instituting measures to prevent renal failure and overt progression to End Stage Renal Disease.

Strengths of this study include that it is the first in country study to highlight clinical, demographic and laboratory findings of patients in the emergency department with renal failure. Urine output and dipstick urinalysis were reported in the entire sample in addition to employing the use of a data extraction sheet which captured the signs and symptoms of renal failure recommended by Acute Dialysis Quality Initiative (ADQI) for low and middle-income countries (LMIC) to detect renal failure [13].

The first limitation to this study includes that we could not stratify renal failure into acute and chronic for lack of second creatinine test due to unavailability of reagents and lack of baseline creatinine in the past 1 year for patients getting admitted in order to establish underlying renal disease. Secondly, kidney ultrasound and other tests that would have provided vital information like arterial blood gases and lactate were also unavailable. Regarding Kidney ultrasound, at the study time the ED had an ultrasound machine but lacked trained personnel to perform test around the clock. Most Patients also presented in emergent states and thus we could not arrange for them to be moved to the specialised units for ultrasound within the hospital. Additionally, this study was not externally funded hence requesting an ultrasound test when the attending physician did not request one would have increased the cost of care for critical patients as emergency care is essentially free at government hospitals. Finally, the lack of information on treatment provided prior to ED presentation were further limitations which could possibly have been fuelled by the lack of a paramedic unit that could have provided more information and intervention prior to patient arrival to the ED.

Conclusion

Our study was able to highlight the profile of patients presenting to the ED who in majority presented with sepsis or septic shock, hyperglycemia and hypertensive emergencies and had an increased rate of renal failure. In addition, it also identified hypertension and oliguria as key predictors of renal failure. Early diagnosis, management and follow-up of hypertension including urine output monitoring for high-risk patients is are key in surveillance and prevention of renal failure.

Dissemination of results

Findings of this research were shared with staff at Ndola Teaching Hospital during a clinical meeting and abstract presented at the POHER-National Health Research Authority-Zambia annual symposium in 2020.

Authors contributions

Authors contributed as follow to the conception or design of the work; the acquisition, analysis, or interpretation of data for the work; and drafting the work or revising it critically for important intellectual content: NK and JB contributed 40% each, and SS contributed 20%. All authors approved the version to be published and agreed to be accountable for all aspects of the work.

Declaration of Competing Interest

The authors declared no further conflict of interest.

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