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Prevalence and predictors of anaemia among patients presenting with kidney diseases at the University of Dodoma Hospital in central Tanzania

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Abstract

Background: Anaemia is a common complication that contributes to the burden of kidney diseases. Anaemia confers significant risk of cardiovascular disease and contributes to decreased quality of life. While the primary cause of anaemia is the inadequate production of erythropoietin by the kidneys to support erythropoiesis, other factors may contribute to anaemia. The aim of this study was to determine the prevalence and predictors of anaemia among patients presenting with kidney diseases at the haemodialysis unit of the University of Dodoma (UDOM) hospital in central Tanzania.

Methodology: In this retrospective study we reviewed data of patients who presented at UDOM haemodialysis unit in Tanzania with kidney diseases as from January 2013 to June 2015. Data were descriptively and inferentially analysed using Stata version 11 software.

Results: A total of 1,395 patients were involved in this study. Of these, 792 (56.8%) presented with kidney diseases, 249 (31.4%) were found to have anaemia. The leading cause of anaemia was chronic kidney disease (CKD) 136 (54.6%), blood loss 74(29.7), haemolysis 15 (6.0%), Nutrition 13(5.2%) and others 11 (4.4%). Glomerular filtration rate of < 60 mL/min/1.73 m^2 accounted for 59.1% of CKD. Median [IQR] serum creatinine level: 246 [177 – 317] µmol/L, Urea level 16[8 -24] mmol/L and haemoglobin of 9.8 [6.2 - 13.4] g/dL. Prevalence of anaemia was strongly associated with declining glomerular filtration rate (P= 0.01).

Conclusion: Anaemia is very common among patients presenting with kidney diseases. These patients require a thorough evaluation to identify and correct causes of anaemia other than erythropoietin deficiency.

Keywords: chronic kidney disease, prevalence, predictors, anaemia, Tanzania

Introduction

Anaemia is defined as a state in which the quality and/or quantity of circulating red blood cells is below normal or the established cut off defined by the World Health Organization (WHO, 2001). Anaemia begins to develop early in the course of chronic kidney disease (CKD). Lower levels of kidney functions have been associated with lower haemoglobin levels and a higher prevalence and severity of anaemia (Coresh *et al*., 2003). CKD has been defined as evidence of kidney damage based on abnormal urinalysis results or structural abnormalities observed on ultrasound images or a glomerular filtration rate (GFR) of less than 60 mL/min for 3 or more months (NKF, 2006). The global CKD prevalence is estimated to be between 11 and 13% (Hill *et al.*, 2016). Future research should evaluate intervention strategies deliverable at scale to delay the progression of CKD and improve Cardiovascular Disease (CVD) outcomes.

Anaemia is a common complication that contributes to the burden of kidney diseases. High prevalence of anaemia among CKD patients has been reported in the United Kingdom (NCGC, 2015), Singapore (Lau *et al*., 2015) and United States (Stauffer *et al*., 2014).

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While the primary cause of anaemia is the inadequate production of erythropoietin by the kidneys to support erythropoiesis (Ramanath *et al*., 2012), other factors may contribute to anaemia (McFarlane *et al*., 2008; Hsu *et al*., 2002). These include iron-deficiency, recent bleeding (WHO, 2001), vitamin B12 or folate deficiency, myelodysplastic syndrome, acute leukaemia, chronic leukaemia and lymphoma-related disorders and multiple myeloma (NCGC, 2015). It has been known for some years that anaemia exists in patients with diabetes and CKD, and that this anaemia occurs early in the course of diabetic kidney disease and is associated with inappropriately low erythropoietin concentrations (Ishimura *et al.*, 1998; Thomas *et al.*, 2005; New *et al*., 2008; Mehdi *et al.*, 2009). Several retrospective studies have reported a higher prevalence of anaemia when inflammatory processes, malnutrition or diabetes are present in severe CKD (Otero *et al*., 2010; Meuwese et al., 2011). In a study in Singapore, the probability of developing anaemia was greater for patients with stage 5 CKD and among those with haematological disorders and with respiratory disorders (Lau *et al*., 2015).

Anaemia causes significant risk of CVD and contributes to decreased quality of life (McClellan *et al*., 2004). Anaemia in CKD is associated with memory loss, disturbances in sleep, CKD progression, CVD co-morbidities and higher mortality rates (Herzog *et al*, 2009). Direct costs for health care are higher for CKD patients with anaemia when compared to those without anaemia (van Nooten *et al*, 2010). The quality of life issues (e.g. fatigue, depression, reduced productivity) are more common in patients with anaemia (Smith *et al*., 2010). In a study in South Africa, primary hypertension was reported to occur in a quarter and was the putative cause of End Stage Renal Disease (ESRD) among a larger proportion of the patients (Meyers, 2015). In northern Tanzania, among those with CKD, 19.3% had hypertension alone, 14.0% had diabetes and hypertension, 7.0% had diabetes alone, 7.0% had HIV alone, and 3.5% had HIV and hypertension (Stanifer *et al*., 2015). In another study north-western Tanzania, it was reported that hypertension related diseases were the most common cause of hospital admissions and accounted for most number of deaths (Peck et al., *et al*., 2013).

Since anaemia is common among patients with kidney diseases and is associated with high mortality, most studies have concentrated on anaemia among patients who have CKD. The aim of this study is to determine the prevalence and predictors of anaemia among patients presenting with kidney diseases at the University of Dodoma haemodialysis unit. Improved clinical and haematology services as well as reassessment of empirical treatment guidelines for anaemia might contribute to better outcomes among patients who present with kidney diseases.

Materials and Methods

Study design, population and settings

This was a retrospective study that involved patients who presented with kidney diseases at the University of Dodoma (UDOM) Hospital Haemodialysis Unit in central Tanzania. The hospital has a bed capacity of 100 beds. The Haemodialysis Unit was established in January 2013 to serve as a referral centre for Singida, Morogoro, Iringa, Manyara, Tabora regional referral hospitals with a total population of 20 million people.

Data collection and Laboratory procedures

All patients with kidney diseases who presented at the Haemodialysis Unit from January 2013 to June 2015 were included. Data were carefully reviewed and all patients with incomplete records were excluded. The data included personal, clinical and laboratory findings. Information about age, sex, marital status, clinical signs (oedema, anuria, hypertension, Body mass Index), urinalysis, Hepatitis panel, full blood picture, urea, creatinine, electrolytes, random blood glucose and HIV test were

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carefully recorded. The estimated Glomerular Filtration Rate (eGFR) was calculated using the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation. Bedside isotope-dilution mass spectrometry (IDMS) traceable Schwartz GFR Calculator for Children was used to stage patients. Outcome measures were anaemia, kidney diseases and death.

Data analysis

Data collected were entered into a computer using epidata version 3.1 (CDC, Atlanta, USA) and analysed using STATA version 11 (College Station, Texas, USA). Depending on variable distribution, either mean with standard deviation or median with interquartile range were used to summarize continuous data. The correlation between the development of anaemia and different patient parameters was determined by performing logistic regression analyses. Odds ratios (OR) were calculated to estimate the percentage change in risk of anaemia development. Parameters with p-values <0.05 were considered statistically significant.

Ethical considerations

The study was approved by the University of Dodoma Research and Publications Ethics Review Board.

Results

Demographic and other characteristics of the study population

A total of 1,395 patients presented at The University of Dodoma haemodialysis unit. Out of all patients 151 (10.8%) were excluded from this study due to incomplete records and 452 (32.4%) patients had no kidney disease after screening. A total of 792 (56.8%) patients were found to have kidney diseases and 383 (48.3%) of them were males. The median age was 42 years (IQR 9 - 88). (Table 1)

Table 1: Demographic characteristics of the patients (N = 792)

Characteristic	Response	Proportion or Median [IQR)
Sex	Male	383 (48.3%)
	Female	409 (51.7%)
Age (years)	42 [9 – 88]	
Marital status	Single	244 (30.8%)
	Married	356 (45.0%)
	Divorced	92 (11.6%)
	Widow	100 (12.6%)

Thirty-eight (4.8%) and 17 (2.1%) patients had HIV and Hepatitis B infections, respectively. Glomerular filtration rate of < 60 mL/min/1.73 m^2 accounted for 59.1% of CKD patients. Median [IQR] serum creatinine level: 246 [177 – 317] µmol/L, Urea level 16[8 -24] mmol/L and haemoglobin of 9.8 [6.2 - 13.4] g/dL.

Prevalence of anaemia

Of the 792 patients 249 (31.4%) were found to have anaemia. CKD was the leading cause of anaemia accounting for 136 (54.6%) patients. Other causes included blood loss with 74 (29.7%) patients, haemolysis with 15 (6.0%) patients and nutrition with 13 (5.2%) patients. Eleven (4.4%) patients had anaemia attributed to infections and iatrogenic causes. Majority of the patients who presented with

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anaemia had hypertension (25.7 %) as the leading medical condition, followed by haematological disorders (23.3 %), gastrointestinal disorders (17.7 %) and diabetes mellitus (14.6%) (Table 2).

Table 2: Medical conditions patients who presented with anaemia (N = 249)

Medical condition	Anaemic patients	
	Number	Percentage
Hypertension	64 (25.7%)	
Haematological disorders	58 (23.3%)	
Gastrointestinal disorders	44 (17.7%)	
Diabetes mellitus	36 (14.6%)	
Heart failure	24 (9.6%)	
Hypertension and Diabetes	12 (4.8%)	
Others	11(4.4%)	

Predictors of anaemia

A total of 15 predictors of anaemia among patients with kidney disease were identified after performing univariate logistic regression analyses. Backward elimination reduced this to 5 parameters. The potential predictors identified were sex, previous haemoglobin level, CKD stage, haematological disorders and heart failure. Sex and heart failure were found to be significant variables in univariate logistic regression analyses. However, this significance was lost after multivariate logistic regression analyses (Table 3).

Table 3: Adjusted odds ratios of developing anaemia (serum Hb <10 g/dL)

Parameters		Adjusted OR (95 % CI)	*P-value*
Sex	Male	1.00	
	Female	0.80 (0.33– 1.76)	0.678
CKD Stage	Stage 1 & 2	1.00	
	Stage 3	0.78 (0.12– 3.19)	0.882
	Stage 4	1.57 (0.31– 5.75)	0.362
	ESRD	15.65 (2.38– 69.42)	<0.01*
Previous haemoglobin		0.43 (0.34– 0.55)	<0.01*
Blood disorders	Blood disorders	14.61 (6.22– 39.16)	<0.01*
Heart failure	Heart failure	0.65 (0.42– 1.62)	0.483

Key: CI= confidence interval; *P < 0.05

Previous haemoglobin level was predictive of developing anaemia (OR 0.43, 95 % CI 0.34-0.55, p<0.01). In addition, the multivariate adjusted odds of developing anaemia were 15.6 times higher for a patient with ESRD (OR 15.65, 95 % CI 2.38– 69.42, p < 0.01). Patients with blood disorders (OR 14.61, 95 % CI 6.22– 39.16, p< 0.01) also had higher odds of developing anaemia. A total of 23 (9.2%) patients among those who presented with anaemia died during the study period. Most of these patients presented with low haemoglobin levels, ESRD and disorders of the blood.

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Discussion

In this study, anemia was present in about one-third of the 792 patients with kidney disease and CKD was the leading cause of anaemia. Similar findings have been reported from other studies in the UK (27.5%) (NCGC, 2015) and Singapore (35.4 %) (Lau *et al.*, 2015). Lower prevalence has been reported from studies in the United States (Stauffer *et al.*, 2014). The different findings could be due to differences in geographical location, lifestyle, racial and genetic make-up. Also could be accounted by the differences in the study populations.

The most common cause of anaemia was CKD. Similar findings have been reported from other studies (Lau *et al*., 2015; Ramanath *et al.*, 2012; Mehdi et al., 2009; New et al., 2008; Thomas *et al*., 2005). The leading cause of CKD was hypertension which was as well the leading medical condition among patients who presented with anaemia. Similar findings have been reported in other studies in Tanzania and South Africa (Peck *et al*., 2013; Stanifer *et al*., 2015; Meyers, 2015). Different findings have been reported in the UK and USA whereby diabetes mellitus was found to be the leading cause of CKD and eventually anaemia (Coresh *et al*., 2003; Stauffer *et al.*, 2014; NCGC, 2015). Slightly less than half of the patients who presented with anaemia had blood disorders, gastrointestinal disorders and other medical conditions apart from CKD causing their anaemia. Similar findings have been reported from other studies (Hsu *et al.,* 2002; McFarlane *et al*., 2008).

Development of anaemia was higher for patients with ESRD. Similar findings have been reported from other studies (Ishimura *et al.,* 1998; Thomas *et al.,* 2005; New *et al.,* 2008; Mehdi & Toto, 2009). Previous haemoglobin level was predictive of developing anaemia and patients with blood disorders had higher chances of developing anaemia. Other studies have similarly reported higher prevalence of anaemia when inflammatory processes, malnutrition or diabetes mellitus were present in patients with kidney diseases (Otero et *al*., 2010; Meuwese *et al*., 2011). Although in our study respiratory disorders did not predict the development of anaemia, a study in Singapore indicated that the probability of developing anaemia was greater for patients with ESRD, with blood or respiratory disorders (Lau *et al*., 2015). The difference between the two studies is likely to be accounted for by differences in geographical location, lifestyle, racial and genetic make-up among the study population. In our study, about 1 in ten patients among those who presented with anaemia died during the study period. Similar findings have been reported elsewhere by Herzog *et al*. (2009) and McClellan *et al.* (2004). Complications associated with anaemia have been described to an increase in mortality (Silverberg *et al*., 2009; Lau *et al*., 2015).

In conclusion, anaemia is prevalent among patients presenting with kidney diseases. Such patients require a thorough evaluation to identify and correct causes of anaemia other than erythropoietin deficiency. Patients with kidney diseases can have anaemia for many reasons, including but not limited to their renal insufficiency. Thus efforts should be placed on the screening the different causes of anaemia among these patients.

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Authors' contributions

AJM participated design of the work, collection of clinical data of patients, data analysis and manuscript writing; MYM and MBM participated in data analysis and manuscript writing, JK; collection of clinical data of patients; RT collection of clinical data of patients; Both DPN and IS participated in manuscript writing. All authors have read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

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