Scientific Research Publishing

Open Journal of Nephrology, 2024, 14, 157-175
https://www.scirp.org/journal/ojneph
ISSN Online: 2164-2869
ISSN Print: 2164-2842

# Clinical Presentation and Treatment Outcomes of Pregnancy-Related Acute Kidney Injury among Pregnant Women Admitted at the Benjamin Mkapa Hospital in Tanzania

**Kessy Shija[1*], Hindu Ibrahim[2], Sylvia Jumbe[3], Bushi Lugoba[4], Stephen Mathew Kibusi[5], Alphonce Chandika[6*]**

[1]Department of Nephrology and Urology, Benjamin Mkapa Hospital, Dodoma, Tanzania
[2]Clinical Research and Innovation, Benjamin Mkapa Hospital, Dodoma, Tanzania
[3]Outreach Services and Clinical Coordination, Benjamin Mkapa Hospital, Dodoma, Tanzania
[4]Clinical Audit and Quality Assurance, Benjamin Mkapa Hospital, Dodoma, Tanzania
[5]School of Nursing and Public Health, University of Dodoma, Dodoma, Tanzania
[6]Executive Director, Benjamin Mkapa Hospital, Dodoma, Tanzania
Email: *Kessyshija@gmail.com

**How to cite this paper:** Shija, K., Ibrahim, H., Jumbe, S., Lugoba, B., Kibusi, S.M. and Chandika, A. (2024) Clinical Presentation and Treatment Outcomes of Pregnancy-Related Acute Kidney Injury among Pregnant Women Admitted at the Benjamin Mkapa Hospital in Tanzania. *Open Journal of Nephrology*, **14**, 157-175.
https://doi.org/10.4236/ojneph.2024.142016

**Received:** February 26, 2024
**Accepted:** April 23, 2024
**Published:** April 26, 2024



## Abstract

**Background:** Globally, PRAKI is among the leading causes of death in pregnant women. The prevalence, causes and outcome of this condition vary among countries due to differences in environmental, socioeconomic, and health delivery systems. The common causes that have been reported in several studies are PIH, Haemorrhages and Sepsis while the outcomes may be either complete renal recovery, progression to CKD and hence dialysis dependency or death. This study aimed at determining clinical presentation and treatment outcomes of Pregnancy-Related Acute Kidney Injury in Pregnant women admitted at the Benjamin Mkapa Hospital, Dodoma, Tanzania. **Results:** Out of 4007 pregnant women who were admitted to the maternity ward 51 pregnant women were found to have PRAKI. Of those with PRAKI, 74.5% were between 21 to 25 years. The leading causes of PRAKI were PPH 12 (23.53%), Eclampsia 12 (23.53%), and pre-eclampsia 12 (23.5%). Hemodialysis therapy was provided to 22 (43.1%) patients, 15 (29.4%) individuals recovered spontaneously with medical management and 14 (27.5%) missed haemodialysis therapy due to various reasons. The mortality due to PRAKI was 17 (33.3%). **Conclusion and Recommendation:** Pre-eclampsia/eclampsia and post-partum haemorrhage were found to be the main causes of PRAKI. The mortality related to PRAKI is high and Hemodialysis therapy is vital help to prevent deaths for pregnant women with PRAKI. Pregnant women who de-

velop acute kidney injury should be followed closely and a nephrologist should be consulted early. Early referral should be done by the lower level facilities for all at-risk pregnant women to a specialized multidisciplinary health facility.

## Keywords

Clinical Presentation, Treatment Outcomes, Pregnancy-Related Acute Kidney Injury

## 1. Introduction

Acute Kidney injury (AKI) is defined as a sudden decline in kidney function leading to the accumulation of nitrogenous toxins due to failure of excretion. In pregnancy, the term AKI is called Pregnancy-related acute kidney injury (PRAKI) and happens at any time of pregnancy from intrapartum to the postpartum period [1] [2]. A high level of suspicion for early diagnosis and prompt intervention is important since the condition is associated with significant mortality and morbidity [3]. Globally, PRAKI is an important public health problem especially in developing countries due to the high maternal mortality rate [4].

Any stage of pregnancy has a risk of PRAKI and the causes vary in different periods of pregnancy [2] [4]. The common causes of PRAKI are hypertensive disorders in pregnancy known as pregnancy-induced hypertension (PIH) such as pre-eclampsia/eclampsia and HELLP syndrome (hemolysis, elevated liver enzyme levels, and low platelet levels) syndrome and obstetric haemorrhage [1] [4] and sepsis [2] [5]. Other causes are thrombotic microangiopathy and acute fatty liver in pregnancy [4] [5] [6]. So, in the first trimester of gestation AKI is often due to septic abortion or hyperemesis gravidarum. In the second trimester, AKI is less likely to occur while in the third trimester may occur due to specific pregnancy conditions such as preeclampsia/HELLP syndrome, acute fatty liver of pregnancy and thrombotic microangiopathies of pregnancy (P-TMA). In the post-delivery period, the causes of AKI are puerperal sepsis and postpartum haemorrhage [3].

The pathophysiology of kidney injury in PIH is mainly due to significant elevations in total peripheral resistance, enhanced responsiveness to angiotensin II, and marked reductions in renal blood flow and glomerular filtration rate and proteinuria [7] [8]. Regarding HELLP syndrome, the exact mechanism is not fully known but there is impaired placentation during the early stages of pregnancy, associated with hepatic and coagulation cascade involvement and coexists with PIH [9] [10]. In Postpartum haemorrhage (PPH), there is low renal blood flow that causes cellular ATP depletion that in turn leads to acute cell injury and dysfunction in the proximal tubules. Ischaemia in the vascular smooth muscle cells and endothelial cells contribute to abnormalities in the renal vasculature. The renal impairment depends on the extent of cell alteration and duration of ischaemic injury [11].

The risk factors for kidney injury in developing countries include environmental, socioeconomic, and health delivery systems [12] [13]. In India for example, one tertiary Hospital reported a prevalence of 0.3% [2] while in another study it was 9.8% [14]. In Saudi Arabia PRAKI prevalence at different pregnancy periods was 9% in the first trimester, 10.8% in the second trimester, 11.7% in the third trimester and 68.4% in the postpartum period [15]. In Pakistan, 56 pregnant women developed PRAKI of which 4 (10%) were in AKI stage I, in stage II 4 (10%) and 33 (80%) in stage III [16]. In Nepal study, PRAKI was 93.3% in the postpartum period [17].

In Africa, a report from studies in tertiary hospitals showed variation in the prevalence of PRAKI, for example, it was shown to be 11% and 8.1% in Cameroon and Malawi respectively [12] [18]. A similar portrait is also exhibited in East Africa where the prevalence of PRAKI was 3.2% at Kenyatta National Hospital in Kenya [19] and 8.6% at Muhimbili National Hospital in Tanzania [20].

The common causes of PRAKI that have frequently been reported are PIH, haemorrhages and Sepsis [4] [16] [18] [19] [20]. Early diagnosis and prompt treatment with medical management or dialysis therapy have been shown to reduce mortality associated with PRAKI [4] [17] [20]. The outcome of PRAKI depends on the management provided and so can be complete recovery, dialysis dependency or death [2] [12] [16] [17] [18] [20] [21].

Strategies towards reducing maternal mortality in Tanzania according to the National Roadmap strategic plan from 2008 to 2015 were; Pregnant women should be attended and delivered by skilled personnel, attend at least four antenatal visits and be examined for early detection of maternal risk factors. However maternal mortality is still high by 578/100,000 as reported in TDHS. The target was to reduce maternal mortality from 578 to 193 deaths per 100,000 live births as per TDHS of 2015-2016.

Despite various Strategies set to reduce the maternal mortality rate in developing countries including Tanzania, maternal mortality remains high; overall mortality was found to be 20% in Tanzania [22]. The only published study that was done at Muhimbili National Hospital in Dar es Salaam found the prevalence of PRAKI to be 8.6% and 4% deaths [20]. Therefore, there is still limited published study on PRAKI in Tanzania specifically in Dodoma. This study determined the clinical presentation and treatment outcome of PRAKI at Benjamin Mkapa Hospital.

## 2. Methods

### 2.1. Study Setting

The study was conducted in the maternity ward and hemodialysis unit at Benjamin Mkapa Hospital. The Benjamin Mkapa Hospital is a tertiary teaching Hospital of the University of Dodoma and is located within the University campus in Dodoma region. The Hospital is a zonal referral serving a population of central Tanzania regions. Daily, 1000 to 1200 patients of different conditions at-

tend attended outpatient clinic which has a bed capacity of 400 beds with bed occupancy of 200 to 250 patients. There is a range of specialized and superspecialized services and Nephrology is among them. Renal replacement therapy in the form of dialysis and kidney transplantation is being offered as the main treatment for kidney failure patients.

### 2.2. Study Design

The study was a cross-sectional analysis of Hospital-based secondary data from June 2019 to June 2023. The patients' information was retrieved from the Hospital Health information system and register books in the maternity ward and haemodialysis unit. Pregnant women who had PRAKI were obtained using KDIGO criteria.

### 2.3. Study Population

The study population comprised pregnant women who were admitted to the maternity ward and sustained acute kidney injury during or post-pregnancy. The kidney injury was confirmed using KIDGO criteria. The treatment of kidney injury was either a haemodialysis service or recovery without dialysis.

### 2.4. Inclusion Criteria

All pregnant women were admitted to the maternity ward at BMH within the period of study and confirmed with PRAKI using KDIGO AKIN criteria.

### 2.5. Exclusion Criteria

Pregnant women who did not meet the definition of AKI by KDIGO criteria had incomplete/wrong records in the BMH information system or were known to have chronic kidney disease were excluded.

### 2.6. Sample Size Estimation and Sampling

All pregnant women meeting the inclusion criteria and having a complete record of their admission at the BMH from June 2019 to June 2023 were enrolled in the study. The sample size was calculated according to the formula below but the study managed to obtain only 51 pregnant women who had PRAKI and who were enrolled between the year 2019 to 2023.

$$N = (Z)2p(1-p)/d2$$

where:

N—was sample size required.

Z—was the desired significance level of 1.96 for a 95% confidence interval.

p—was the proportion of 3.2% obtained from a study in Kenya (Kivai, 2019).

d—was the size of the mean difference of 0.05.

$$N = (1.96)20.032(1-0.032)/0.052$$

N = 48 participants.

48 sample size of participants was determined.

## 2.7. Sampling Procedure/Process

A non-probability purposeful sampling technique was employed whereas directly searching from a Hospital computer database system (medipro-5 and Mapping Tag ERX) women who sustained PRAKI and obtained 51 out of 4007 pregnant women who were admitted in the maternity ward for delivery or referrals women from lower facilities further management due to maternal related complication.

## 2.8. Data Collection Methods and Instruments

The Questionnaire contained variables such as sociodemographic characteristics, clinical characteristics, mode of treatment and treatment outcome which include complete recovery, dialysis dependency or death were used to extract patient data from the Mapping Tag ERX Computer system of the Hospital. We retrieved information from 4007 women who were admitted for delivery or referred from other facilities as being detected to have kidney injury for further treatment. The diagnosis of PRAKI was made using KIDGO criteria in which patients with an increase in serum creatinine by 26.5 μmo/L within 48 hours of admission or creatinine of more than 50% from the normal creatinine of 84 to 96 micromol/l (μmo/L) within 7 days or there was a failure to pass urine (anuria) in 6-12 hours. The information extracted was entered into Excel, cleaned to ensure its quality then shifted into the SPSS system for data analysis. The participants were classified into three stages according to disease severity using the KDIGO criteria of AKI as follows (Table 1).

## 2.9. Variables

Independent Variable included; Social demographic characteristics such as age, sex, place of residence, parity, and Hospital /Place of referral. Social demographic information was checked and extracted from the Medipro-5 and Mapping Tag ERX Tag system which included age, sex, place of residence, and Hospital /Place of referral.

**Table 1.** KDIGO AKI.

| Stage | Serum creatinine | Urine output |
|---|---|---|
| **1** | 1.5 - 1.9 times baseline OR ≥ 0.3 mg/dl (≥26.5 mmol/l) increase | <0.5 ml/kg/h for 6 - 12 hours |
| **2** | 2.0 - 2.9 times baseline | <0.5 ml/kg/h for ≥12 hours |
| **3** | 3.0 times baseline OR Increase in serum creatinine to ≥353.6 mmol/l) OR Initiation of renal replacement therapy OR, In patients <18 years, decrease in eGFR to <35 ml/min per 1.73 m | <0.3 ml/kg/h for ≥24 hours OR Anuria for ≥12 hours |

Hemorrhage was determined by haemoglobin and platelet levels as well as findings of blood in urine. Hemorrhage was determined by measuring haemoglobin, platelets, and blood in urine blood; the normal level of haemoglobin was determined to be 13 - 16 g/dl, normal level of platelets was determined to be 150,000 - 450,000/microliter (μL), blood in urine was measured by negative test of blood and no red blood cells. If the woman has a haemorrhage, the amount of haemoglobin was determined to be less than 13 g/d, platelets were determined to be less than 150,000/μL and in urine may have blood-positive and red blood cells

Puerperal sepsis was defined as having a high total leukocyte count and neutrophil absolute count. Puerperal sepsis was defined as high total leukocyte count and absolute neutrophil counts. In our laboratory, the normal total Leukocyte count was 3.5 − 10.8 × 103 per microliter (μL) and the absolute neutrophil count was 1.5 − 7.5 × 103 cells/μL. When the woman had puerperal sepsis the number of total Leukocytes was above 10.8 × 109 cells per litre and the absolute neutrophil count was above 7.5 × 103 cells/μL.

Eclampsia and pre-eclampsia were defined as the patient having high blood pressure and protein in the urine. Pre/Eclampsia was defined as having high blood pressure and the presence of protein in the urine. Normal blood pressure was defined as having blood pressure of 110/60 mmHg to 140/90 mmHg and normal urine protein was a urine dipstick of negative protein. Women with eclampsia were those with a blood pressure of more than 140 mmHg systolic and 90 mmHg diastolic blood pressure and had urine dipstick positive for protein (+1 or more). HELLP syndrome was defined as a syndrome of symptoms of High blood pressure, haemolysis (anaemia), elevated liver enzymes and low platelets HELLP syndrome syndrome with High blood pressure, haemolysis (low haemoglobin), elevated liver enzymes (ALT and AST) and low platelets. A woman who had HELLP syndrome had haemoglobin less than 13 g/dl, alanine transaminase (ALT) was 4 to 36 U/L aspartate transaminase (AST) was 9 to 32 U/L and platelets were less than 150,000/μL

The dependent variable was the patient outcome, defined as either recovery or death. Recovery was counted as the recovery of kidney function to normal functioning either spontaneously or after some sessions of haemodialysis. Normalization of kidney function whereas creatinine and urea return to normal value and good urine output. The normal creatinine was 84 to 96 μmo/L and blood urea nitrogen was 2.1 to 8.5 mmol/L). Therefore, the patient should no longer perform hemodialysis for those who were on haemodialysis or spontaneous recovery of kidney function for those who did not undergo haemodialysis and possibly discharged. Death; Patient counted to have died after death being certified. So death was confirmed by brain death.

## 2.10. Validity

The content validity of the research tool was checked by a statistician with good experience in quantitative research methods. The expert was asked to review each question to determine if it addressed the research objectives. The feedback

from experts was analyzed and compared to determine the degree of content validity for each question. Any modification suggested was considered before pre-testing and data collection.

### 2.11. Reliability

A pre-test to check the reliability of the tool was done with respondents with similar criteria as the study sample and appropriate modifications were made. The data collection tool was pre-tested at a nearby facility with a small number of patients (10% of the sample size). The purpose of pre-testing was to verify the adequate collection of desired information as well as ensure the consistency of the questions. In the pre-testing process, minor corrections were made before data collection.

### 2.12. Data Analysis

Data was analyzed using STATA version 15 where descriptive analysis to generate proportions for the distribution of participants by the respective variable. Description statistics were conducted for all variables to obtain a clear description of the information; including a distribution of participants by the antecedents of PRAKI, mode of treatment, and treatment outcomes. Data was checked for their completeness and uniformity based on the daily collection.

## 3. Results

### 3.1. Sociodemographic Characteristics

In this cross-sectional study, 51 pregnant women with PRAKI were studied out of 4007 women who were admitted to the maternity ward in the period between 2019 and 2023. Out of the 51 participants with PRAKI, 74.5% were in the age group between 21 to 25 years. There were 78.4% of women whose parity was less than 5. Half (49.02%) came from the Dodoma Region as shown in Table 2.

### 3.2. Clinical Characteristics

At admission, 76.5% of individuals were in stage 3 of KIDGO Creatinine criteria. Reduced urine output was found to be 68% and of these 54.3% had anuria. Of about platelets, 23 (45.1%) were found to have Thrombocytopenia. 92.2% of patients presented with anemia and 63.5% with leukocytosis as shown in Table 3.

### 3.3. Antecedents of PRAKI

The causes of PRAKI were 23.53% PPH, 23.53% Eclampsia and 23.5% pre-eclampsia, as shown in Table 4.

### 3.4. Mode of Treatment of PRAKI

Out of 51 pregnant women with PRAKI, 43.1% of patients received hemodialysis therapy as the renal replacement therapy, as shown in Table 5.

**Table 2.** Socio-demographic characteristics of patients with PRAKI at Benjamin Mkapa hospital (n = 51).

| Age of the patients | Frequency(n) | Percentages (%) |
|---|---|---|
| <20 | 5 | 9.80 |
| 21 - 35 | 38 | 74.5 |
| >36 | 8 | 15.69 |
| Mean age 28, STD = 7.024216 | | |
| Min. 15, Max. 41 | | |
| **Parity** | | |
| <5 | 40 | 78.43 |
| >5 | 11 | 21.57 |
| **Region** | | |
| Dodoma | 25 | 49.02 |
| Iringa | 5 | 9.80 |
| Singida | 15 | 29.41 |
| Tabora | 2 | 3.92 |
| Manyara | 3 | 5.88 |
| Simiyu | 1 | 1.96 |

**Table 3.** Clinical characteristics of pregnant women with PRAKI at BMH between 2019 and 2023 (n = 51).

| Variable | Frequency (n) | Percent (%) |
|---|---|---|
| **PLATELETS** | | |
| Thrombocytopenia | 23 | 45.1 |
| Normal | 28 | 54.9 |
| **ANAEMIA** | | |
| Anaemia | 47 | 92.2 |
| Normal | 4 | 7.8 |
| KIDGO CRETERIA OF AKI | | |
| **Urine output** | | |
| Oliguria | 16 | 31.37 |
| Anuria | 19 | 37.25 |
| Normal | 16 | 31.37 |
| **Creatine** | | |
| Stage 1 | 3 | 5.88 |
| Stage 2 | 9 | 17.65 |
| Stage 3 | 39 | 76.47 |
| **WBC** | | |
| Leukocytosis | 33 | 63.46 |
| Normal | 19 | 36.54 |

### 3.5. Outcome of PRAKI

Recovery from renal injury after renal replacement therapy or other therapy was 66.7% and the rest died as shown in Table 6.

### 3.6. Mode of Treatment and Outcome

Among the individuals who recovered, 19 (86.36%) were treated with hemodialysis therapy, and others recovered spontaneously without renal replacement therapy. The rest did not receive haemodialysis treatment as renal replacement therapy (RRT). Among those who died majority did not get renal replacement therapy as shown in Table 7.

Table 4. The antecedents of PRAKI among pregnant women were admitted at BMH between 2019 and 2023 (n = 51).

| Variables | Frequency (n) | Percentages (%) |
|---|---|---|
| HELLP syndrome | 3 | 5.88 |
| Pre-Eclampsia | 11 | 21.57 |
| Eclampsia | 12 | 23.53 |
| PPH | 12 | 23.53 |
| APH | 2 | 3.92 |
| Puerperal sepsis | 8 | 15.69 |
| Postpartum cardiomyopathy | 2 | 3.92 |
| Hyperemesis gravidarum | 1 | 1.96 |

Table 5. Mode of treatment of PRAKI among pregnant women admitted at BMH between 2019 and 2023 (n = 51).

| Variables | Frequency (n) | Percentages (%) |
|---|---|---|
| Haemodialysis | 22 | 43.14 |
| Missed Haemodialysis | 14 | 27.45 |
| Spontaneous recovery | 15 | 29.41 |

Table 6. The outcome of PRAKI among pregnant women who were admitted at BMH between 2019 and 2023 (n = 51).

| Outcome of PRAKI | Frequency(n) | Percent (%) |
|---|---|---|
| Death | 17 | 33.33 |
| Recovered from PRAKI | 34 | 66.67 |

**Table 7.** The distribution between mode of treatment and outcome of pregnant women with PRAKI admitted between 2019 and 2023 (n = 51).

| Mode of Treatment | Outcome After Intervention | |
|---|---|---|
| **Variable** | **Death** | **Recovered** |
| Haemodialysis | 3 (13.64%) | 19 (86.36%) |
| Haemodialysis missed | 14 (100%) | 0 (0.00%) |
| Spontaneous recovery | 0 (0.00%) | 15 (100%) |

## 4. Discussion

The study was conducted among the pregnant women who attended BMH in the Dodoma Region of Tanzania and explored the causes, mode of treatment and outcome of PRAKI. The majority of the patients at admission were in stage 3 of KIDGO Creatinine criteria and more than half presented with reduced urine output in the form of anuria. Almost all of the participants had anaemia and 63.5% presented with features of leukocytosis.

### 4.1. Antecedents of PRAKI among Pregnant Women

In this study, it was noted that eclampsia/preeclampsia and PPH were the main contributing factors of PRAKI. These findings are comparable to other similar studies such as the one from Muhimbili National Hospital in Tanzania and other studies from other places in Africa and across the globe. The study from Muhimbili National Hospital which is the tertiary Hospital like Benjamin Mkapa Hospital noted that PRAKI was due to HELLP syndrome, severe pre-eclampsia and postpartum haemorrhage [20]. Similarly, the study from Kenya reported that almost half of the patients with PRAKI were due to preeclampsia, eclampsia and HELLP syndrome [19] and that of Morocco indicated PRAKI was due to pre-eclampsia/eclampsia and Haemorrhagic shock were the main causes of PRAKI [4]. Likewise, a study in Malawi demonstrated that pre-eclampsia/eclampsia and antepartum haemorrhage were the main causes of PRAKI [18]. Moreover, a study from Tunisia showed hypertensive disorders (eclampsia/pre-eclampsia and HELLP syndrome) and haemorrhage were the common causes of PRAKI [23]. Furthermore, similar findings were also observed in a study from Somalia where pre-eclampsia/eclampsia and post-partum haemorrhage were reported as the main causes of PRAKI [24]. A systematic review study from the African continent also found pre-eclampsia, post-partum haemorrhage and sepsis as the main causes of PRAKI [25].

Similarly, haemorrhage and hypertensive disorders as the main causes of PRAKI were also reported other studies from India, Nepal and China. A study from India observed antepartum haemorrhage and pre-eclampsia as the main causes of PRAKI [26]. Likewise, in a study from Nepal, HELLP syndrome and haemorrhages were the major causes of PRAKI [17]. Equally a systematic study

from China showed pre-eclampsia/ecmplasia and post-partum haemorrhage as the main causes of PRAKI [6]. In another systematic review, the study demonstrated that preeclampsia is the main cause of PRAKI [27]. Contrasting findings were noted in studies from India and Pakistan which found sepsis as the main cause of PRAKI [16] [28] [29].

In the study, eclampsia/preeclampsia and PPH might have contributed to the development of PRAKI because these disorders are very common inpregnancy and normally present at third trimester of pregnancy, at delivery or post-delivery periods [1] [16] [30] [31] [32] and are reported to cause acute kidney injury in pregnancy [32] [33] [34]. Pre-eclampsia and eclampsia causes systemic vasoconstriction due to release of antiangiogenic factors. Kidney injury develops due to thrombotic microangiopathy, glomeruloendotheliosis, mesangiolysis and vasoconstriction of peritubular vessels [3] [35]. Likewise, PPH causes kidney injury due to tubular necrosis and cortical necrosis as a result of ischemia [36]. The risk factors of PPH are poor obstetric history, anaemia and prolonged labour [37]. In the study, majority of patients had anaemia which put them in a risk of developing PPH and subsequently PRAKI if no urgent correction of haemorrhage. It is also reported that more PRAKIs occur in low-income countries due to a lack of adequate perinatal care and inappropriate management of pregnancy-related complications [3] [6]. Tanzania is a low-income country the women are at risk of developing PRAKI due to poor management of pregnancy-related complications and lack of adequate perinatal care as shown in the findings of the study.

### 4.2. The Mode of Treatment for Pregnant Women Who Had PRAKI

In this study of 51 patients with PRAKI, Hemodialysis therapy as the mode of treatment was provided to more than half of patients. Of the remaining patients, a quarter recovered spontaneously from renal failure without renal replacement therapy and the rest deserved haemodialysis but missed it. Reasons for missing haemodialysis were ICU admission for mechanical ventilation where there is no set up of renal replacement. Some patients who were admitted in ICU and missed haemodialysis died. This observation was also reported from other studies where patients with PRAKI admitted in ICU due to critical condition the majority were reported to have died [26].

Similar approach of treatment of pregnant women with PRAKI is demonstrated in similar studies from other places. In a study from Muhimbili National Hospital Tanzania, there were also pregnant women with PRAKI who underwent Haemodialysis [20]. It is also demonstrated in a study from Morocco that a proportional of patients with PRAKI required haemodialysisservices [4]. Moreover, asystematic review study and a study from Pakistan showed that more than quarter of women who had PRAKI needed underwent Haemodialysisservices [16] [34]. Furthermore, a study from Nepal showed more than a half ofwomen who presented with PRAKI required hemodialysis [17]. However, a study from

Malawi reported spontaneous recovery with medical management without renal replacement therapy for all women with PRAKI [18].

### 4.3. The Outcome of PRAKI among Pregnant Women Who Were Admitted

More than half of the patients survived at discharge with complete recovery from kidney injury. Of those who survived, the majority recovered following couples of hemodialysis therapy sessions for an average period of 11 days and the rest recovered without renal replacement therapy. Patients who died mostly were those who did not receive hemodialysis services and few deaths occurred to those who underwent haemodialysis services. Patients who were admitted to ICU most of them missed haemodialysis services and died. The explanation of death in these patients could be ICU admission and missing haemodialysis services. Patients admitted to ICU and in need of haemdialysis services are transferred to the haemodialysis unit. Other factors the patients had and might have contributed to high mortality were other co-morbidities such as anaemia, infections and pulmonary congestion.

This is similar to the Study that was done in India which showed patients with PRAKI when admitted to ICU had poor prognoses compared to patients without PRAKI [25] [26] [38]. High mortality was also revealed PRAKI coexist with other medical conditions compared to non-PRAKI of the same underlying disease [26]. Furthermore, patients with eclampsia who later develop PRAKI are reported to have poor outcomes [25] [39]. Black race with PRAKI is also associated with more deaths than other races, a study from the USA [40]. It is also reported that inaccessibility to dialysis services contributes to more deaths of patients with PRAKI as revealed in a study from Cameroon where 31.5% of death rates are due to dialysis inaccessibility [12].

Death rate due to PRAKI varies in the African continent, it ranges between 0-34.4% as demonstrated in a systematic study from the African continent [25]. A study at Muhimbili National Hospital, Tanzania reported a 4% death rate due to PRAKI [20]. Similarly, a study from Cameroon reported more than half of PRAKI patients required dialysis therapy and at three months of follow-up some of the patients died, others had completely recovered and the rest had partial recovery [12]. Moreover, the Morocco study illustrated that mortality due to PRAKI was 20% [4]. Unlike the study from Malawi where there were no death due to PRAKI and complete recovery from PRAKI [18].

Whereas a study from India reported complete recovery from PRAKI was three-quarters of the patients and few patients died [2]. A study from Pakistan showed different progression among PRAKI patients; complete resolution, partial resolution and progression to End-stage renal diseases (ESRD). Some of the patients died in three months follow-up [16]. A study from Nepal on patients with PRAKI reported that three-quarters of the patients recovered completely while the rest became dialysis-dependent [17] [41].

### 4.4. Strengths and Limitations of the Study

#### 4.4.1. Strength of the Study

The strength of this study is that all necessary clinical information on PRAKI was obtained. The data of 4-year periods were collected and analysed in a feasible time. As long as Tanzania is still among the countries experiencing high maternal mortality rates, this study is relevant because it obtained results which will help the efforts in the reduction of maternal death in support of Sustainable Development Goal number three (Good Health and Well-being).

#### 4.4.2. Limitation of the Study

The sample size of this study which was obtained was small; This might be due to some of the admission books which was used to store patients' information in some years being lost, also at the Dialysis Unit they don't document PRAKI data as separate information. The study took a long time to be conducted this is due to Investigators and data collectors being involved in multitasking such as curative and preventive hospital services.

At our setting there is no routine assessment of the renal function tests which are creatinine and urea, therefore there may be some patients who resolved spontaneously and they were missed to be recognized and taken as a study sample thus this might have contributed to a small sample size of the study.

## 5. Conclusions

This study concludes that Pregnant women with pre-eclampsia/eclampsia and postpartum haemorrhage are at high risk of developing PRAKI. The mortality related to PRAKI is high and hemodialysis therapy is paramount in recovering and preventing deaths for pregnant women with PRAKI. Patients with PRAKI and other complications are at major risk of death if proper management is delayed or missed.

Some patients missed renal replacement therapy, this might be due delay in consulting nephrologists and hence accelerated poor condition and death of the patients. The absence of renal replacement therapy especially the continuous replacement therapy machine in ICU might have contributed death of some patients. Some of the patients had multiple complications so it was difficult to identify the causes of death.

## Recommendation

All pregnant women especially those with pregnancy-induced hypertension, haemorrhage and sepsis should have their renal function monitored by measuring urine output and renal function.

Pregnant women who develop acute kidney injury should be followed closely and a nephrologist should be consulted early. Renal replacement therapy especially CRRT should be set in the ICU for prompt treatment of critically ill patients to prevent death.

It is suggested that a Renal Function Test should be done on every pregnant woman with a risk of developing AKI to have early detection of kidney injury for timely interventions.

Early referral should be done by the lower level facilities for all at-risk pregnant women to a specialized multidisciplinary health facility.

## Suggestions for Further Research

Further study preferably a Cohort Study should be done which will aim at assessing the status of renal function of all the pregnant women attending Antenatal, Natal and Postnatal Periods to identify even those with low risk of AKI.

A national study should be done, which will contain a larger sample size to identify and determine the actual burden of PRAKI and the underlying risk factors.

## Authors' Contribution

Idea developed by Kessy Charles Shija; Permission to conduct this research - Alphonce Chandika, Patients care - AlphonceChandika and Kessy Charles Shija; Concept development and clearance - Kessy Charles Shija, Hindu Ibrahim, Stephen Kibusi, BushiLugoba and Alphonce Chandika, Literature search - Kessy Charles Shija, Hindu Ibrahim Sylvia Jumbe and Stephen Kibusi; Data collection and processing - Kessy Charles Shija, Hindu Ibrahim, Anderson Kilovele, Catherine Sanga, Happyphaniar Nyoni, Henry Masuka, Fredrick Ndunguru; Data collection, cleaning, analysis and data interpretation - Hindu Ibrahim, Kessy Charles Shija, Stephen Kibusi; Manuscript writing - Kessy Charles Shija, Hindu Ibrahim; Manuscript review - Stephen Kibusi and Alphonce Chandika. All authors have read the article and agreed with the final manuscript version.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

## References

[1] Van Hook, J.W. (2014) Acute Kidney Injury during Pregnancy. *Clinical Obstetrics Andgynecology*, **57**, 851-861. https://doi.org/10.1097/GRF.0000000000000069

[2] Amrita, P., Pallavi, C. and Binal, P. (2018) Pregnancy Related Acute Kidney Injury—A Prospective Study of 42 Cases and Outcome. *International Journal of Science and Research*, **7**, 1257-1259.

[3] Prakash, J. and Ganiger, V.C. (2017) Acute Kidney Injury in Pregnancy-Specific Disoder. *Indian Journal of Nephrology*, **27**, 258-270. https://doi.org/10.4103/0971-4065.202406

[4] Arrayhani, M., El Youbi, R. and Sqalli, T. (2013) Pregnancy-Related Acute Kidney Injury: Experience of the Nephrology Unit at the University Hospital of Fez, Morocco. *International Scholarly Research Notices*, **2013**, Article ID: 109034. https://doi.org/10.5402/2013/109034

[5] Siribamrungwong, M. and Chinudomwong, P. (2016) Relationship between Acute Kidney Injury and Pregnancy Related Factors. *Journal of Acute Disease*, **5**, 22-28. https://doi.org/10.1016/j.joad.2015.08.002

[6] Liu, Y., Bao, H., Jiang, Z., Huang, Y. and Wang, N. (2015) Pregnancy-Related Acute Kidney Injury and a Review of the Literature in China. *Internal Medicine*, **54**, 1695-1703. https://doi.org/10.2169/internalmedicine.54.3870

[7] Ives, C.W., Sinkey, R., Rajapreyar, I., Tita, A.T.N. and Oparil, S. (2020) Pre Eclampsia—Pathophysiology and Clinical Presentations: *JACC* State-of-Art Review. *Journal of the American College of Cardiology*, **76**, 1690-1702. https://doi.org/10.1016/j.jacc.2020.08.014

[8] Braunthal, S. and Brateanu, A. (2019) Hypertension in Pregnancy: Pathophysiology and Treatment. *SAGE Open Medicine*, **7**, 2050312119843700. https://doi.org/10.1177/2050312119843700

[9] Petca, A., Miron, B.C., Pacu, I., Dumitrașcu, M.C., Mehedințu, C., Șandru, F., Petca, R.C. and Rotar, I.C. (2022) HELLP Syndrome—Holistic Insight into Pathophysiology. *Medicina*, **58**, Article 326. https://doi.org/10.3390/medicina58020326

[10] Abildgaard, U.H.K. (2013) Pathogenesis of the Syndrome of Hemolysis, Elevated Liver Enzymes and Low Platelet Count. *European Journal of Obstetrics & Gynecology and Reproductive Biology*, **166**, 117-123. https://doi.org/10.1016/j.ejogrb.2012.09.026

[11] Basile, D.P., Mellissa, D.A. and Sutton, T.A. (2012) Pathophysiology of Acute Kidney Injury. *Comprehensive Physiology*, **2**, 1303-1353. https://doi.org/10.1002/cphy.c110041

[12] Fouda, H., Ashuntantang, G., Halle, M.P. and Kaze, F. (2016) The Epidemilogy of Acute Kidney Injury in a Tertiary Hospital in Cameroon: A 13 Months Review. *Journal of Nephrology and Therapeutics*, *Open Acess*, **6**, Article 1000250. https://doi.org/10.4172/2161-0959.1000250

[13] Davey, M.A., Flood, M., Pollock, W. and Cullinane, F.M.S. (2020) Risk Factors for Severe Postpartum Haemorrhage: A Population-Based Retrospective Cohort Study. *Australia and NewZealand Journal of Obstetrics and Gynaecology*, **60**, 522-532. https://doi.org/10.1111/ajo.13099

[14] Godara, S.M., Kute, V.B., Trivedi, H.L., Vanikar, A.V., Shah, P.R., Gumber, M.R., Patel, H.V. and Gumber, V.M. (2014) Clinical Profile and Outcome of Acute Kidney Injury Related to Pregnancy Indeveloping Countries: A Single-Center Study from India. *Saudi Journal of Kidney Diseases and Transplantation*, **25**, 906-911. https://doi.org/10.4103/1319-2442.135215

[15] Haroon, F., Dhrolia, M.F., Qureshi, R., Imtiaz, S. and Ahmed, A. (2019) Frequency of Pregnancy-Related Complications Causing Acute Kidney Injury in Patient at a Tertiary Care Hospital. *Saudia Journal of Kidney Disease and Transplantation*, **30**, 194-201. https://doi.org/10.4103/1319-2442.252910

[16] Bokhari, S.R.A., Inayat, F., Jabeen, M., Sardar, Z., Saeed, S., Malik, A.M., Nasir, S., Zareen, A. and Ahmad, H.I. (2018) Characteristics and Outcome of Obstetric Acute Kidney Injury in Pakistan: A Single-Center Prospective Observational Study. *Cureus*, **10**, e3362. https://doi.org/10.7759/cureus.3362

[17] Paudyal, P., Pradhan, N., Bista, K.D.B. and Rawal, S. (2015) Pregnancy Related Acute Kidney Injury at a Tertiary Center in Nepal. *Nepal Journal of Obstetrics and Gynaecology*, **10**, 43-47. https://doi.org/10.3126/njog.v10i1.13195

[18] Cooke, W.R., Hemmila, U.K., Craik, A.L., Mandula, C.J., Mvula, P., Msusa, A., Dreyer, G. and Evans, R. (2018) Incidence, Aetiology and Outcome of Obste-

tric-Related Acute Kidney in Malawi: A Prospective Observational Study. *BMC Nephrology*, **19**, Article No. 25. https://doi.org/10.1186/s12882-018-0824-6

[19] Kivai, J. (2019) Assessment of Characteristic of Patient with Pregnancy Related Acute Kidney Injury in Kenyatta National Hospital. Ph.D. Dissertation, University of Nairobi, Nairobi.

[20] Ruggajo, P.J., Appollo, E.O., Bramania, P.K., Basil, T.B., Furia, F.F. and Mngumi, J.W. (2022) Prevalence, Risk Factors and Short-Term Outcomes of Acute Kidney Injury in Women with Obstetric Complications in Dar es Salaam, Tanzania. *Tanzania Medical Journal*, **33**, 14-29.

[21] Minnoli, S.M. (2020) Pregnancy Related Acute Kidney Injury a Cross Sectional Study in Tertiary Care Center Chennai. Master's Thesis, Kilpauk Medical College, Chennai.

[22] Embassy of Ireland in Tanzania. (2020) Responding to COVID-19 and Gender Inequalities through Community Radio. https://www.dfa.ie/irish-embassy/tanzania/news-and-events/latestnews/responding-to-covid-19-and-gender-inequalities-through-community-radio.html

[23] Msehli, M., Jbali, H., Ikram, M., Ben Kaab, B., Ben Hamida, F., Rais, L., Ben Fatma, L. and Karim, Z. (2021) Pregnancy Related Acute Kidney Injury in Tunisia: A Clinical Challenge. *Nephrology Dialysis Transplantation*, **36**, gfab082.0024. https://doi.org/10.1093/ndt/gfab082.0024

[24] Omar, N.M.S., Osman, M.M., Hilowle, I.A., Erismis, B., Osman, A.A., Fiidow, O.A. and Bashir, A.M. (2022) Demographic Characteristics and Risk Factors Affecting the Development of Postpartum Acute Kidney Injury in Somalia: Single-Center Experience. *International Journal of Women's Health*, **14**, 881-888. https://doi.org/10.2147/IJWH.S372453

[25] Shalaby, A.S. and Shemies, R.S. (2022) Pregnancy-Related Acute Kidney Injury in the African Continent: Where do We Stand? A Systematic Review. *Journal of Nephrology*, **35**, 2175-2189. https://doi.org/10.1007/s40620-022-01349-2

[26] Yadav, S., Chauhan, M., Jain, D., Aggarwal, H.K. and Yadav, R.K. (2022) Renal Outcomes of Pregnancy Related Acute Kidney Injury: A Single Centre Experience in India. *Maedica*, **17**, 80-87.

[27] Trakarnvanich, T., Ngamvichchukorn, T. and Susantitaphong, P. (2022) Incidence of Acute Kidney Injury during Pregnancy and Its Prognostic Value for Adverse Clinical Outcomes: A Systematic Review and Meta-Analysis. *Medicine*, **101**, e29563. https://doi.org/10.1097/MD.0000000000029563

[28] Haroon, F., Dhrolia, M.F., Qureshi, R., Imtiaz, S. and Ahmed, A. (2019) Frequency of Pregnancy-Related Complications Causing Acute Kidney Injury in Pregnant Patients at a Tertiary Care Hospital. *Saudi Journal of Kidney Diseases and Transplantation*, **30**, 194-201. https://doi.org/10.4103/1319-2442.252910

[29] Pahwa, N., Bharani, R. and Kumar, R. (2014) Post-Partum Acute Kidney Injury. *Saudi Journal of Kidney Diseases and Transplantation*, **25**, 1244-1247. https://doi.org/10.4103/1319-2442.144259

[30] Rakash. J., Prakash, S. and Ganiger, V.C. (2019) Changing Epidemiology of Acute Kidney Injury in Pregnancy: A Journey of Four Decades from a Developing Country. *Saudi Journal of Kidney Diseases and Transplantation*, **30**, 1118-1130. https://doi.org/10.4103/1319-2442.270268

[31] El Minshawy, O., Khedr, M.H.S., Youssuf, A.M., Abo Elela, M., Kamel, F.M.M. and Keryakos, H.K.H. (2021) Value of the Cell Cycle Arrest Biomarkers in the Diagnosis of Pregnancy-Related Acute Kidney Injury. *Bioscience Reports*, **41**, BSR20200962.

https://doi.org/10.1042/BSR20200962

[32] Poon, L.C., Shennan, A., Hyett, J.A., Kapur, A., Hadar, E., Divakar, H., McAuliffe, F., da Silva Costa, F., von Dadelszen, P., McIntyre, H.D., Kihara, A.B., Di Renzo, G.C., Romero, R., D'Alton, M., Berghella, V., Nicolaides, K.H. and Hod, M. (2019) The International Federation of Gynecology and Obstetrics (FIGO) Initiative on Pre-Eclampsia: A Pragmatic Guide for First-Trimester Screening and Prevention. *International Journal of Gynaecology and Obstetrics*, **145**, 1-33. https://doi.org/10.1002/ijgo.12802

[33] Tyagi, A., Yadav, P., Salhotra, R., Das, S., Singh, P.K. and Garg, D. (2021) Acute Kidney Injury in Severe Preeclamptic Patients Admitted to Intensive Care Unit: Epidemiology and Role of Serum Neutrophil Gelatinase-Associated Lipocalcin. *Indian Journal of Critical Care Medicine*, **25**, 1013-1019. https://doi.org/10.5005/jp-journals-10071-23966

[34] Downes, K.L., Grantz, K.L. and Shenassa, E.D. (2017) Maternal, Labor, Delivery, and Perinatal Outcomes Associated with Placental Abruption: A Systematic Review. *American Journal of Perinatology*, **34**, 935-957. https://doi.org/10.1055/s-0037-1599149

[35] Cabarcas-Barbosa, O., Capalbo, O., Ferrero-Fernández, A. and Musso, C.G. (2022) Kidney-Placenta Crosstalk in Health and Disease. *Clinical Kidney Journal*, **15**, 1284-1289. https://doi.org/10.1093/ckj/sfac060

[36] Villie, P., Dommergues, M., Brocheriou, I., Piccoli, G.B., Tourret, J. and Hertig, A. (2018) Why Kidneys Fail Post-Partum: A Tubulocentric Viewpoint. *Journal of Nephrology*, **31**, 645-651. https://doi.org/10.1007/s40620-018-0488-0

[37] Tsu, V.D. (1993) Postpartum Haemorrhage in Zimbabwe: A Risk Factor Analysis. *British Journal of Obstetrics and Gynaecology*, **100**, 327-333. https://doi.org/10.1111/j.1471-0528.1993.tb12974.x

[38] Ding, M., Luan, L., Zhang, J., Jiang, J., Qie, G., Sha, J., Zhu, W., Zeng, J. and Chu, Y. (2019) Incidence and Mortality Risk Factors of Acute Kidney Injury in Critical Ill Pregnancies: A Single Center Retrospective Analysis. *Zhonghua Wei Zhong Bing Ji-Jiu Yi Xue*. **31**, 1506-1511.

[39] De Barros, J.F.S., Amorim, M.M., De Lemos, C.D.G. and Katz, L. (2021) Factors Associated with Severe Maternal Outcomes in Patients with Eclampsia in an Obstetric Intensive Care Unit: A Cohort Study. *Medicine*, **100**, e27313. https://doi.org/10.1097/MD.0000000000027313

[40] Beers, K., Wen, H.H., Saha, A., Chauhan, K., Dave, M., Coca, S., Nadkarni, G. and Chan, L. (2020) Racial and Ethnic Disparities in Pregnancy-Related Acute Kidney Injury. *Kidney*, **1**, 169-178. https://doi.org/10.34067/KID.0000102019

[41] Najar, M.S., Shah, A.R., Wani, I.A., Reshi, A.R., Banday, K.A., Bhat, M.A. and Saldanh, C.L. (2008) Pregnancy Related Acute Kidney Injury: A Single Center Experience from the Kashmir Valley. *Indian Journal of Nephrology*, **18**, 159-161. https://doi.org/10.4103/0971-4065.45291

## List of Abbreviations

| | |
|---|---|
| AKI | Acute Kidney Injury |
| BMH | Benjamin Mkapa Hospital |
| HELLP | Hemolysis, Elevated Liver Enzymes, Low Platelet |
| PE | Pre-Eclampsia |
| PIH | Pregnancy Induced Hypertension |
| PPH | Postpartum Haemorrhage |
| PRAKI | Pregnancy Related Acute Kidney Injury |
| P-TMA | Thrombotic Microangiopathies of Pregnancy |
| TNF α | Tumour Necrotic Factor Alpha |

# Appendices

## Appendix 1. Questionnaire with Study Variables

| Variables | Definition |
|---|---|
| **Age** | Age of pregnant women in years |
| **Region** | Region from which the pregnant women live |
| **District** | Respondent district |
| **Hospital Referred from** | The hospital in which the patient came from |
| **Date of Admission** | The date in which the patient was admitted to the hospital |
| **Date of Discharge** | The date in which the patient was discharged from the hospital |
| **Cause of Kidney Injury** | The reasons that caused kidney failure |
| **Co-Morbid** | Any existing Disease that was present to the women |
| **Amount of Urine at Admission** | The amount of urine measured during hospitalization |
| **Creatinine** | The amount of creatinine measured during hospitalization |
| **Protein in Urine** | The amount of protein measured in urine during hospitalization |
| **WBC** | The amount of WBC measured during hospitalization |
| **HB** | The amount of HB measured during hospitalization |
| **Platelets** | The amount of platelets measured during hospitalization |
| **Albumin in Blood** | The amount of albumin measured in blood during hospitalization |
| **Intervention** | Treatment given to the client due to other complications other than kidney injury |