Prevalence of Post-Operative Acute Kidney Injury and Associated Risk Factors at A Tertiary Trauma Center in Dar Es Salaam, Tanzania

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Abstract

Background: Acute kidney injury is one of the complications that can occur in every anaesthetized/operated patient but the magnitude of individual risk will also depend on other contributory factors for each particular patient. Acute Kidney Injury (AKI) may have a spectrum of outcome which include complete recovery, development of chronic kidney disease or if severe may result into death. AKI also contributes to a long hospital stay, total hospital cost, morbidity and mortality. Objective: The aim of this study was to determine the prevalence of post-operative acute kidney injury and associated risk factors at Muhimbili Orthopedic Institute (MOI). Materials and Methods: This was a hospital based quantitative cross-sectional study which was carried out among operated patients at Muhimbili Orthopaedic Institute (MOI). Laboratory blood results for serum creatinine before surgery (baseline serum creatinine), 48 hours, 7th day and 28th day post operatively was used for this purpose. Data was processed using IBM Statistical Package for the Social Sciences (SPSS) v23.0 software. Frequency and percentages was used to summarize the demographic, perioperative risks and serum creatinine levels. Bivariate and Multivariate analysis was done to examine the association between risk factors and outcome of interest (AKI). Results: Study involved 156 participants who underwent surgical intervention at MOI from October 2019 to March 2020. Among the participants males were 102 (65.4%) and females were 54 (34.6%). Mean age of participants was 48.26 years with standard deviation of 16.75. Study managed to find a prevalence of 12.8% (20/156) of post-operative acute kidney injury among the participants. Most observed risk factors were old age (above 600 years) with prevalence of 16.7% within age group, emergence procedures with prevalence of 18.9%. Other risk factors includes ASA status and pre-existing medical conditions having a prevalence of 18.8% and 20.7% respectively. Prolonged operations had a prevalence of 23.1% with a p-value of 0.001 and intraoperative use of ephedrine had a post-operative kidney injury prevalence of 50% with a p-value of <0.0001. Recovery was observed in 60% of those found to have post-operative acute kidney injury with 30% complete recovery and 30% partial recovery. Conclusion: Good documentation of perioperative events can also help determine those in danger of developing post-operative AKI and thus help to provide preventive measures for those at high risk.
Keywords: Acute kidney injury; Intraoperative; Perioperative; Post-operative; Risk factors; Serum creatinine

Introduction

Acute Kidney Injury (AKI) is as a sudden episode of kidney damage that happens within a few hours or a few days [1]. AKI is still a challenge both in management and prevention in many settings within the developing world. Although it is regarded as reversible condition if patient survive this stage and apart of being one of the most common post-operative complications, AKI also contributes to a long hospital stay, total hospital cost, morbidity and mortality. Less severe forms of AKI can go unnoticed in some cases but where the predisposing risk persist or proper action not taken within a critical period this can results into progressive loss of functional unit within renal mass. KDIGO AKI Guideline of 2011 published on 2012 defines Acute Kidney Injury as:[1,2]. Increase in serum creatinine (SCr) by ≥0.3 mg/dl (≥26.5 µmol/l) within 48 hours; or Increase in SCr to ≥1.5 times baseline, which is known or presumed to have occurred within the prior 7 days; or Urine volume of <0.5 ml/kg/h for 6 hours. KDIGO also classifies AKI in to stages, having stage 1, 2 and 3. Etiology and risk factors ranges from trivial cases to most fare and well known risks in daily practice. Pre-existing medical conditions in surgical conditions {HIV, malaria, sepsis, diabetes mellitus, pre-existing kidney dysfunction, hypertension,cancer, malnutrition etc}, [3-8] nephrotoxic drugs and contrast dyes [9]. Surgical procedures{cardiac and vascular surgeries, abdominal surgeries, orthopedic surgeries, emergency surgeries}, [10,11] age and obesity may also carry an increased risk that can results into several complications in a period immediate post operatively or late during recovery and rehabilitation from particular surgery [12,13].

The extent and outcome of risk for any surgical and anaesthetic complication arises from the interactions between a patient’s perioperative health and physiological capacity to withstand surgical and anaesthesia related stresses, and also the type of surgery to be performed, anaesthetic technique used, drugs in perioperative period, fluid and blood products management, competency of anaesthesia provider as well as the role of preoperative evaluation and optimization of a patient [14,15]. Thus there is risk of acute kidney injury in every anaesthetized/operated patient although the magnitude of individual risk varies depending on other contributory factors for each particular patient.

Materials and Methods

Study design

This was a Quantitative descriptive cross-sectional hospital based study that involved adult patients whom were operated at MOI at the stated time period. The evaluation of patient for post operative acute kidney injury was determined by laboratory values of pre-operative and post operative (at 48 hours) serum creatinine using KDIGO criteria which is validated and internationally accepted tool [16-18]. Risk factors and outcome of those found to have AKI within 28 days post operatively was documented and analyzed [19].

Study setting

Study was conducted at Muhimbili Orthopedic Institute patients’ wards, ICU and HDU. The hospital has more than 500 beds with 8 operating rooms, among which two operating rooms are designated for emergency operations. The hospital is located in Ilala district, Dar es salaam, Tanzania. MOI also serves as a teaching hospital for the Muhimbili University of Health and Allied Sciences (MUHAS) and other nearby universities in the region. The hospital serves a national trauma, orthopedic and neurosurgery center in the country. The study period was 9 months, divided into the first 5 months of data collection from October 2019 to March 2020 then followed by another 4 months of data analysis, interpretation and report writing from April to July 2020.

Exclusion criteria

- Patients on renal replacement therapy
- Same Day Surgery (SDS) patients
- Death before 48 hours post operatively
- American Society of Anesthesiologists patients physical classification category five and six (ASA V, VI patients)

Data source

Data was collected by the researcher and one trained research assistants (medical officers who are registrar in the department of Anaesthesia at MOI). Patient demographic data, presence of comorbidity and other significant medical/surgical information was obtained from patient’s records in the hospital information system. Preoperative Patient evaluation and determination of risk was done by a researcher, research assistants and hospital anaesthesia team. Intra-operative events/risks was obtained from anaesthetic record form used during operation for monitoring and anaesthetic recordings. Structured checklist was used to record the demographic characteristics, preoperative information, risk factors, baseline serum creatinine, postoperative serum creatinine and intraoperative events, medications and type of anaesthesia given.
Data management and analysis

Checklist was checked for completeness, accuracy and consistency then presented for editing, classification, cleaning, transformation, tabulation and coding. The quantitative data was entered into the computer system for quantitative analysis by using Statistical Package for Social Sciences (SPSS) computer software version 24. The descriptive statistical analysis was used to summarize the results for the objective (i) which was to determine the prevalence of post-operative acute kidney injury in adult patients at MOI. The descriptive analysis was also used to summarize the results from the objectives.

Ethical considerations

Ethical clearance was granted by MUHAS Institutional Review Board (IRB) (Ref. No.) and the permission to conduct the study from MOI authority. Patient’s names were not used to ensure confidentiality and access to participants’ information was restricted to researchers only. Data collection tool had demographic parameters such as age and sex and other variables such as diagnosis, procedures done, part of the body that has been operated on, baseline and post-operative serum creatinine, intra-operative events, medications given intraoperatively, fluids and blood products given intraoperatively.

Results

Social-demographic characteristics of study participants

As shown in Table 1, majority of participants were males 102 (65.4%), most participants were aged between 35-60 years 66 (42.3%) with a median age of 49 years. Mean serum creatinine before surgery an 48 hours postoperatively were 77.68 (std deviation of 24.72) and 81.47 (std deviation of 33.70) respectively. Hypertension was the most comorbidity among the participants involving 38 (24.4%) of cases while. Many participants underwent elective surgeries 119 (76.3%). On physical fitness classification, 71 (45.5%) participants were ASA class 2 at the time of surgery. Majority of surgery were done under general anaesthesia 105 (67.3%) and most surgeries were done less than two hours 91 (58.3%).

| Demography                  | Frequency (%) |
|-----------------------------|---------------|
| Sex                         |               |
| Male                        | 102 (65.4%)   |
| Female                      | 54 (34.6%)    |
| Age                         |               |

Table 1: Social-demographic characteristics of study participants (n=156).

Risk factors associated with post-operative AKI

In this study, among the risk factors we were looking upon, there were those factors that were observed to be significantly associated with post-operative AKI. These were, operation duration more than 2 hours (p-value 0.001), intraoperative use of ephedrine (p-value 0.000), intraoperative hypotension (p-value 0.002) and intraoperative blood transfusion (p-value 0.000) as shown in table below.
| Variable                              | Normal (%) | With Post Op Aki (%) | P-Value |
|---------------------------------------|------------|----------------------|---------|
| Category Of Operation                 |            |                      |         |
| Emergence                             | 30 (81.1%) | 7 (18.9%)            |         |
| Elective                              | 106 (89.1%)| 13 (10.9%)           | 0.204   |
| ASA Status                            |            |                      |         |
| ASA 1                                 | 64 (92.8%) | 5 (7.2%)             |         |
| ASA 2                                 | 59 (83.1%) | 12 (16.9%)           | 0.176   |
| ASA 3                                 | 13 (81.3%) | 3 (12.8%)            |         |
| Pre Existing Medical Conditions       |            |                      |         |
| Hypertension                          | 33 (86.8%) | 5 (13.2%)            |         |
| Hypertension and Diabetes Melitus     | 3 (37.5%)  | 5 (62.5%)            |         |
| Others                                | 11 (91.7%) | 1 (8.3%)             | 0.09    |
| Duration Of Operation                 |            |                      |         |
| <2hrs                                 | 86 (94.5%) | 5 (5.5%)             |         |
| >2hrs                                 | 50 (76.9%) | 15 (23.1%)           | 0.001   |
| Type of Anaesthesia                   |            |                      |         |
| GA                                    | 89 (84.8%) | 16 (15.2%)           |         |
| SAB & L. infiltration                 | 47 (92.2%) | 4 (8.3%)             | 0.396   |
| Intraoperative fluids                 |            |                      |         |
| Crystalloids                          |            |                      |         |
| ≤2liters                              | 40 (93.0%) | 3 (7.0%)             |         |
| >2 liters                             | 96 (85.0%) | 17 (15.0%)           | 0.337   |
| Colloids given                        | 9 (69.2%)  | 4 (30.8%)            | 0.913   |
| Intraoperative ephedrine              |            |                      |         |
| Given                                 | 9 (50%)    | 9 (50%)              |         |
| Not given                             | 127 (92.0%)| 11 (12.8%)           | 0.000   |
| Intraoperative hypotension            |            |                      |         |
| Had Hypotension                       | 26 (72.2%) | 10 (27.8%)           |         |
| No hypotension                        | 110 (91.7%)| 10 (8.3%)            | 0.002   |
| Preoperative Hb                       |            |                      |         |
| <11 g/dl                              | 21 (91.3%) | 2 (8.7%)             |         |
| ≥11 g/dl                              | 113 (86.3%)| 18 (13.7%)           | 0.04    |
| Intraoperative blood loss             |            |                      |         |
Intraoperative blood transfusion

| <300mls | ≥300mls |  Intraoperative blood transfusion |
|---------|---------|----------------------------------|
| 83 (93.3%) | 6 (6.7%) | 53 (79.1%) | 14 (20.9%) | 0.116 |

| Given | Not given |  |
|-------|-----------|--------|
| 34 (73.9%) | 102 (92.7%) | 12 (26.1%) | 8 (7.3%) | 0.000 |

### Table 2: Risk factors associated with post-operative AKI (n=156).

**Multivariate logistic regression**

Prolonged operations (aOR 2.881, 95% CI 0.867-9.566, p-value 0.044), intra-operative use of ephedrine (aOR 0.169, 95% CI 0.042-0.684, p-value 0.013) and intra-operative hypotension (aOR 0.831, 95% CI 0.215-3.207) were found to be independent risk factors of developing post-operative acute kidney injury as shown in the table below.

| Risk factor | Crude OR(95% CI) | p-value | Adjusted OR(95% CI) | p-value |
|-------------|------------------|---------|---------------------|---------|
| Operation duration | | | | |
| >2 hours | 5.160 (1.769-15.050) | 0.002 | 2.881 (0.867-9.566) | 0.044 |
| <2 hours | 1 | | 1 | 0.044 |
| Intraop ephedrine | | | | |
| Given | 6.273 (3.019-13.033) | 0.169 (0.042-0.684) | |
| Not given | 1 | 0 | 1 | 0.013 |
| Intraop hypotension | | | | |
| Hypotension | 3.333 (1.508-7.370) | 0.831 (0.215-3.207) | |
| No hypotension | 1 | 0.008 | | 0.038 |
| Intraop BT | | | | |
| Blood given | 4.5 (1.697-11.932) | 1.747 (0.549-5.562) | |
| Blood not given | 1 | 0.003 | 1 | 0.345 |
| Operation category | | | | |
| Emergency | 1.732 (0.746-4.018) | 0.259 | 0.623 (0.19-2.045) | 0.435 |
| Elective | 1 | | 1 | |

**Table 3: Multivariate logistic regression.**
Outcome of AKI at day 7 post op

Complete recovery was observed in 6 participants (30%) and partial recovery in another 6 (30%) participants while there were loss of follow up in 3 participants (Table 4).

| Outcome                  | Count and percentage |
|--------------------------|----------------------|
| Complete recovery        | 6 (30%)              |
| Partial recovery         | 6 (30%)              |
| No recovery              | 3 (15%)              |
| Death                    | 2 (10%)              |
| Lost follow up at day 7  | 3 (15%)              |
| Total                    | 20 (100%)            |

Table 4: Outcomes of post-operative acute kidney injury.

Discussion

Prevalence of post-operative acute kidney injury at MOI

We carried out a Quantitative descriptive cross-sectional hospital based study involving 156 adult patients whom were operated at MOI from October 2019 to March 2020 to determine the prevalence of post-operative AKI and associated risk factors. We also looked on outcome in those found to have post-operative acute kidney injury. The overall prevalence of post-operative AKI we found in this study was 12.8% (20/156) that encompasses all cases with different risk factors, surgical interventions (orthopedic and neurosurgery) as well as different demographic characters. These results are close to findings from other similar studies done by Nicker et al in South Africa who reported a prevalence of 11% from surgical causes [8] and one done by Deng et al in China where the postoperative acute kidney injury had a prevalence of 13.5% [20]. However, a study done by Nowicka and team on elective hip and knee arthroplasty cases had a lower AKI incident of only 6.2% [21] and one by Raji et al in Nigeria on all type of surgeries reported a prevalence of 22.5% both studies looked at subjects who were different from the ones in this work i.e. combined orthopedic and neurosurgery cases [22]. The most affected group were participants aged above 60 years (16.7% prevalence), this was also reported in the study done by Biteker, et al. [12]. On the other hand females shows relatively high prevalence of post-operative AKI with 14.8% (8/54) of post-operative AKI compared with males 11.8% (12/102). These results differ from most studies done in other centers [23] as in this study we used KIDGO definition of AKI and only serum creatinine was used while in other studies there were other components like eGFR, and cystatin C.

Risk factors associated with post-operative AKI

In this study we found that length of the operation is an independent risk factor for developing post-operative acute kidney injury, this was also reported in other studies done by Raji et al in Nigeria and Deng et al in China. [18, 20]. Raji et al found that, among those surgeries took more than 2 hours, the incidence of perioperative AKI was 65.3% (32/49). There for a good patient preparation for those surgeries known to take long time or presumed to be prolonged surgeries together with close intraoperative monitoring and surveillance is important in order to minimize the risk. On the other hand, intraoperative hypotension was significantly associated with a post-operative AKI and plays as independent risk. Other studies also reported the same finding on the effect of hypotension and post-operative AKI using either MAP or direct measurement of blood pressure [20,24]. Walsh et al found a prevalence of 7.2% among the patients who had intraoperative MAP <55mmHg indicating the contribution of hypotension on the post-operative AKI. In this study it was also observed that, intraoperative use of ephedrine and blood transfusion was significantly associated with post-operative AKI as ephedrine (vasoconstrictor) and blood transfusion are mostly utilized to restore hemodynamic stability in cases of hypotension and severe bleeding signifying the effect of hypotension intraoperatively. Biteker et al in their study they reported a prevalence of 18% among those received intraoperative vasopressors while Deng et al observed an increased incidence among those received blood intraoperatively [12,20]. Generally all measure to prevent and/or early identification of intraoperative hypotension and its aggressive managements is important for prevention and reduction of complications that are associated with post-operative AKI [12,15,22,24,25]. Compared to other studies there were a slight difference from observation in other studies upon looking at the pre-operative hemoglobin level and the prevalence of post-operative kidney injury as those with acceptable level of hemoglobin had high prevalence of post-operative AKI in our study compared to those whom were operated with low preoperative hemoglobin level. Raji et al in Nigeria found a prevalence of 44.9% among those who had pre-operative anemia [22,24]. Further studies are needed to look upon the relationship between pre-operative low hemoglobin levels and post-operative renal function. On the other hand the amount of blood lost intraoperatively and the prevalence of post-operative AKI found in this study correlates with findings obtained in other studies on the linear increase in the incidence of post-operative AKI with increase in amount of blood lost intraoperatively. Deng et al reported an increased risk of 1.04 fold for each 100mls of blood lost intraoperatively [20,22].

Emergence procedures is an independent risk for patients to develop post-operative AKI and this was also reported in the study
done by Biteker et al in US that found a prevalence 21% among those underwent emergence surgeries, Raji et al also pointed out the same findings on the relationship between urgency of surgery and post-operative AKI [12,22]. This reflects the fact that most of the emergency surgeries are done to restore physiological function or to save lives and thus there is little time to evaluate the patients or even to do the proper optimization of these patients before surgery. Results from our study were not statistically significant hence calling for more studies with big sample size to be done on this area. ASA status of the participants was found to be a risk factor related to post-operative AKI as there was a relation between the ASA status and post-operative AKI, the high the ASA status the higher the risk of developing post-operative acute kidney injury. It has to be noted that ASA status also encompasses pre-existing medical conditions that has been pointed out in study done by Raji et al in Nigeria as an independent risk factor for developing post-operative AKI [22]. Biteker et al reported a prevalence of 49% among patients who had hypertension and 30% in those having diabetes mellitus [12]. Patients with more than one preexisting medical condition had more risk, for example patients with both hypertension and diabetes had a prevalence of 62.5% of post-operative AKI in our study. There is a need to do a thorough preoperative evaluation in those patients to know their renal function status and optimize before schedule them for surgery. It also imperative to weigh the risk a particular surgery carries and the type of comorbidity a patient has as well having a perioperative plan for renal care. Also further studies are needed to evaluate the exact risk of each particular disease in our settings.

We also observed a high prevalence of post-operative AKI in patients who received general anaesthesia compared to other anaesthesia techniques. But the choice and type of anaesthesia technique given to particular patient depends on the type of surgery, expected length of surgery, patient’s particular conditions and urgency of surgery thus all of these could act as a cofounder of results in this particular group. Thus studies are needed to clarify the risk of anaesthesia technique towards post-operative acute kidney injury. It was found that patients who received between 2 and 4 liters of crystalloids had high prevalence of post-operative AKI compared to others, this could be reflecting intraoperatively fluid overload or deficit. On the other hand those who received colloids had a high prevalence representing the ongoing fluid deficit or observed hemodynamic disturbances requiring plasma expanders to restore it back to normal. Monitoring central venous pressure in this group would have provided additional information, however this is not routine practice at the facility for patients undergoing trauma surgery.

Recovery was observed in 60% of those found to have developed post-operative AKI, with complete recovery in 30% of the cases and partial recovery in the other 30%. During the follow up period 15% of the subjects did not recover while mortality was observed in 10% of those who developed AKI. These findings are similar to those observed in other studies where analysis of recovery patterns after AKI revealed a non-recovery rate of 41.2% of patients with AKI before hospital discharge [26-28]. The studies also demonstrated a mortality rate ranging between 10-20% which is comparable to one observed in our patients who developed AKI [29]. Despite a good proportion of the subjects recovering from AKI, those with severe AKI usually require temporary Renal Replacement Therapy(RRT). None of the subjects who developed post-operative AKI underwent temporary RRT. Those who do not recover may end up with chronic renal failure and require long term RRT or death in the event of complications or lack of access to this life sustaining therapy due to economic hardships [29,30,31]. These observed outcomes and anticipated social economic and health impact of post-operative AKI on quality of life calls for deliberate efforts to prevent and aggressively treat perioperative AKI.

Study limitations

Findings from this study cannot be used to generalize the rest of the population as it is a cross section study and time limited. Due to the nature and reality of patients turn-over at MOI, there was missing information and data from some of the subjects that causes a drop out from the study despite initial enrollment. Data collection activities were also interrupted by CORONA VIRUS diseases pandemic and preventive measures which affected number and type of most surgeries during the period. It also resulted in changes of academic activities and public service requirements. This caused a short in number of participants recruited in this study to fall to 156 with complete information rather than 290 that was expected to be involved. We need more studies looking at the identified risk factors for post operative AKI and mitigation strategies in similar resource constrained environment post the COVID 19 pandemic.

Conclusion

Post operative acute kidney injury is a problem in our settings and MOI could be a representative of other surgical settings in our country. Most of the risk factors that has been observed in this study are preventablemodifiable thus a strong follow up and adherence to Standard operating procedures together with multidisciplinary care of patients can help to reduce the incidence as well provide a good care for the affected individuals. Good documentation of perioperative events can also help determine those in danger of developing post operative AKI and thus help to provide preventative measures for those at high risk. Apart from primary surgical issues that patients present with at our surgical centers, we should also try to find and optimize other underlying medical issues that are known to increases risks of perioperative unwanted and avoidable

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complications such as post operative acute kidney injury as observed in this study

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