



بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ



**Republic of Sudan**  
**Ministry of Higher Education and scientific Research**  
**Shendi University**  
***Faculty of Graduate Studies and Scientific Research***

**Nurses knowledgeregarding acute kidney injury in patient post  
cardiac surgery at Alshaab teaching hospital**

A Thesis Submitted in Fulfillment for the Requirements of the master Degree in  
Medical surgical nursing.

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# الاية

قال تعالى:

(اقرأ باسم ربك الذي خلق (1) خلق الإنسان من علقٍ (2) اقرأ وربك الأكرم (3) الذي علم بالقلم (4) علم الإنسان ما لم يعلم (5) كلا إن الإنسان ليطغى (6) أن رآه استغنى (7) إن إلى ربك الرجعى (8) أرأيت الذي ينهى (9) عبداً إذا صلى (10) أرأيت إن كان على الهدى (11) أو أمر بالتقوى (12) أرأيت إن كذب وتولى (13) ألم يعلم بأن الله يرى (14) كلا لئن لم ينته لنسفعا بالناصية (15) ناصية كاذبة خاطئة (16) فليدع ناديه (17) سندع الزبانية (18) كلا لا تُطعه وأسجدواقترِب (19))

صدق الله العظيم

سورة العلق

## *Dedication*

I dedicate this work first to Allah Almighty who helped me to complete this study.

Also I dedicate this to my mother khadrajafer and my father AltohamiAlhasan , it's impossible to thank you adequately for everything you've done, from loving me unconditionally to raise me, in stable household, where you instilled traditional value taught your children to celebrate and embrace life. For all wonderful memories of growing up and for continue support and encouragement. I could not have asked for better parents.

For all of my loved ones who've gone on to a better life especially my brothers(khaled , &Mohamed) &my sisters (Nahed ,Zeinab, Entesar ,&Alzohour) and their children,, my uncles and my Aunts.

For all of my wonderful friends old and new –thanks for always being there for me.

Finally, this dedication would not be complete without a very special thanks to my university and my faculty nursing science especially medical surgical department.

## ***Acknowledgement***

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*I would like to gratitude all the people who supported me, my family, my friends, especially my mother ,father , my sisters, my brother who helped me with every things.*

*Also my gratitude to all nurses who work at Alshaab teaching hospital.*

## ***Abstract***

**Background:** Acute kidney injury (AKI) following cardiac surgery is associated with increased morbidity and mortality, longer hospital stays, and significantly increased health care costs. This study was undertaken to assess nurses' knowledge regarding acute kidney injury post cardiac surgery at Alshaab teaching hospital.

**Methods:** It was descriptive; cross sectional, hospital based study conducted at Alshaab teaching hospital sample size (30 nurses) who worked in open heart surgery (OHS). Data were collected by using self-structured questionnaire to assess nurses' knowledge, & analyzed by using SPSS, in form of frequency & percentage. Presented in form of Tables. For groups comparison we used mean & standard deviation significant at p value = 0.005.

### **Result:**

study showed that they had poor knowledge regarding AKI post cardiac surgery include signs & symptoms (31.1%), risk factors (42.23), main criteria for diagnosing AKI (41.1), & complication of AKI (48.9%) also they had moderate knowledge about care of patient with AKI (76.7%). & they had good knowledge regarding causes of AKI post cardiac surgery (100%).

**Conclusion:-** The researcher concluded that the nurses had poor knowledge regarding AKI post cardiac surgery.

## المستخلص

**الخلفية:** الفشل الكلوي الحاد الذى ياتي بعد عمليات القلب يؤدي الي زيادة الامراضيات الوفيات والمكوث لفترة طويلة بالمستشفى ويؤدي ايضا الي زيادة التكاليف , والهدف من هذا البحث هو تقييم معرفة الممرضات بشأن الفشل الكلوي الحاد بعد عملية القلب المفتوح في مستشفى الشعب التعليمي.

**الطريقة:** هذه الدراسة الوصفية المقطعية اجريت بمستشفى الشعب التعليمي بعينة حجمها (30) ممرض وممرضة يعملون بالعناية المكثفة لجراحة القلب المفتوح وقد تم جمع العينات عن طريق الاستبيان لتقييم معرفة السسترات حيث تم تحليل البيانات بواسطة الكمبيوتر عن طريق برنامج التحليل الإحصائي في شكل تكرارات ونسب مئوية وقد تم عرضها في شكل جداول, ولمقارنة المجموعات تم استخدام الوسط الحسابي والانحراف المعياري باستخدام ( p value = 0.005 )

النتيجة: توصلت الدراسة إلى أن معظمهم لديه معرفة ضعيفة في معظم النقاط المهمة عن الفشل الكلوي الحاد بعد عمليات القلب وتشمل الاعراض و العلامات ( 31.1% ), العوامل المؤهبة ( 42.23% ), كيفية التشخيص ( 41.1% ) والمضاعفات ( 48.9 % ) و ( 76.7 % ) لديهم معرفة متوسطة عن العناية بمريض الفشل الكلوي الحاد ، و( 100 % ) لديهم معرفة جيدة عن اسباب الفشل الكلوي الحاد بعد عمليات القلب .

## الخاتمة:

توصلت الدراسة الي ان الممرضين والممرضات الذين يعملون بالعناية المكثفة بمستشفى الشعب التعليمي لديهم معرفة ضعيفة عن الفشل الكلوي الحاد بعد عمليات القلب المفتوح.

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## List of abbreviation

| <b>Abbreviation</b>   |   |
|-----------------------|---|
| <b>AKI</b>            | Acute kidney injury                                   |
| <b>RRT</b>            | renal replacement therapy                             |
| <b>CSA-AKI</b>        | Cardiac surgery associated acute kidney injury        |
| <b>GFR</b>            | Glomerular filtration rate                            |
| <b>RIFLE</b>          | the risk-injury failure-loss-end-stage kidney disease |
| <b>AKIN</b>           | Acute Kidney Injury Network                           |
| <b>KDIGO</b>          | Kidney Disease: Improving Global Outcomes             |
| <b>CABG</b>           | coronary artery bypass graft                          |
| <b>NYHA</b>           | New York heart association                            |
| <b>CPB</b>            | Cardiopulmonary bypass                                |
| <b>BUN</b>            | Blood urea nitrogen                                   |
| <b>OPCAB</b>          | Off pump coronary artery bypass                       |
| <b>COPD</b>           | Chronic obstructive pulmonary disease                 |
| <b>UO</b>             | urine output  |
| <b>SCr</b>            | serum creatinine                                      |
| <b>AKISCr</b>         | Acute kidney injury serum creatinine                  |
| <b>AKIUO</b>          | Acute kidney injury urine output                      |
| <b>BMI</b>            | Body mass index                                       |
| <b>NSAIDs</b>         | Non steroidal anti inflammatory drugs                 |
| <b>ACE inhibitors</b> | Angiotensine converting enzyme                        |
| <b>GI</b>             | Gastrointestinal                                      |
| <b>MRI</b>            | Magnetic resonance imaging                            |
| <b>CT</b>             | Computer tomography                                   |
| <b>US</b>             | Ultra sonography                                      |
| <b>Mg/dl /hr</b>      | Milligram per deciliter per hour                      |
| <b>P</b>              | Probability value                                     |
| <b>Min</b>            | Minute  |
| <b>ML</b>             | Milliliter  |
| <b>L/day</b>          | Liter per day   |
| <b>ML/kg/hr</b>       | Milliliter per kilogram per hour                      |
| <b>CCU</b>            | Coronary care unit                                    |

|             |  |
|-------------|--|
| <b>ICU</b>  | Intensive care unit                    |
| <b>HDU</b>  | High dependent unit                    |
| <b>SPSS</b> | Statistical package for social science |

# Chapter one

## Introduction

Cardiac surgery associated acute kidney injury (CSA-AKI) is a common and severe complication in patients undergoing cardiac surgery and is associated with poor outcomes .

Acute kidney injury (AKI) following cardiac surgery is associated with increased morbidity and mortality, longer hospital stays, and significantly increased health care costs.

The physiological functions performed by the kidney, which include acid-base control, blood pressure regulation, water balance, and waste excretion, are crucial to the maintenance of homeostasis and can only partially be accomplished using renal replacement therapy (RRT)(1).

Acute kidney injury (AKI) is an abrupt loss of the kidney function characterized by an acute increase in serum creatinine concentration.

At present, there are three widely accepted and used consensus definitions providing uniform criteria for the diagnosis of AKI.

Based on acute change in serum creatinine, urine output and GFR.

In 2004, the risk-injury failure-loss-end-stage kidney disease (RIFLE) classification was developed by the Acute Dialysis Quality Initiative Group and then improved by the Acute Kidney Injury Network (AKIN) in 2005.

In 2012, a modified definition, harmonized and not balancing the limitations of the AKIN and RIFLE, was established by the Kidney Disease: Improving Global Outcomes (KDIGO) group (2).

Based on RIFLE or AKIN criteria the incidence of AKI after CABG varies from 6.9% to 42.5%. Some studies have reported AKI in half of the cardiac surgical patients.

The cardiopulmonary bypass (CPB) is the most important source of the inflammation in cardiac surgery. So, some studies believe that the CPB is a risk factor for AKI and the elimination of CPB reduces the inflammation and AKI.

## **Justification:-**

Acute kidney injury (AKI) following cardiac surgery is associated with increased morbidity and mortality, longer hospital stays, and significantly increased health care costs (1). Nurses have an important role in diagnosing and preventing the complications following cardiac surgery. They also start the first line care and therapeutic measures in the field of life threatening complication (3). So the study was conducted to assess nurses' knowledge regarding acute kidney injury post cardiac surgery.

## **Objectives:-**

### **General objective:-**

To assess nurse's knowledge regarding acute kidney injury in post cardiac surgery patients at Alshaab teaching hospital.

### **Specific objectives:-**

To assess nurse's knowledge regarding:

- Indication of cardiac surgery.
- Complication of cardiac surgery.
- Risk factor of acute kidney injury in post cardiac surgery patients.
- causes of acute kidney injury in post cardiac surgery patients
- The main criteria for diagnosing acute kidney injury in post cardiac surgery patients.
- Phases of AKI.
- Signs & symptoms of AKI.
- Complication of AKI.
- The management of acute kidney injury in post cardiac surgery patients

## **Literature review**

Acute kidney injury (AKI) is a sudden and almost complete loss of Kidney function (decreased GFR) over a period of hours to days. Although AKI is often thought of as a problem seen only in hospitalized Patients, it may occur in the outpatient setting as well. There are three major categories of conditions cause AKI:

Pre renal (hypo perfusion of kidney).

Intra renal (actual damage to kidney tissue).

Post renal (obstruction to urine flow).

### **Pre renal cause of AKI:-**

Conditions occur as a result of impaired blood flow that leads to hypo perfusion of the kidney and a drop in the GFR. Common clinical situations are volume-depletion States (hemorrhage or GI losses), impaired cardiac performance (myocardial infarction, heart failure, or cardiogenic shock), and vasodilatation (sepsis or anaphylaxis).

### **Intra renal cause of AKI:-**

Result of actual parenchyma damage to the glomeruli or kidney tubules. Conditions such as burns, crush injuries, and infections, as well as nephrotoxic agents, may lead to acute tubular necrosis and cessation of renal function. With burns and crush injuries, myoglobin (a protein released from muscle when injury occurs) and hemoglobin are liberated, causing renal toxicity, ischemia, or both.

Severe transfusion reactions may also cause intra renal failure; hemoglobin is released through hemolysis, filters through the glomeruli, and becomes concentrated in the kidney tubules to such a degree that precipitation of hemoglobin occurs. Medications may also predispose a patient to intra renal damage, especially non-steroidal anti-inflammatory drugs (NSAIDs) and ACE inhibitors. These medications interfere with the normal auto regulatory mechanisms of the kidney and may cause hypo perfusion and eventual ischemia.

Other potential causes of intra renal or intrinsic ARF include rhabdomyolysis, which results in accumulation of myoglobin in the glomeruli secondary to damage to skeletal muscle, and nephrotoxicity secondary to herbal remedies.

## **Post renal causes of AKI:-**

Are usually the results of an obstruction somewhere distal to the kidney. Pressure rises in the kidney tubules; eventually, the GFR decreases.

## **Phases of AKI:-**

There are four clinical phases of ARF: (initiation, oliguria, diuresis and recovery).

### **Initiation phase:-**

The initiation period begins with the initial insult and ends when oliguria develops.

### **Oliguria phase:-**

The oliguria period is accompanied by a rise in the serum concentration of substances usually excreted by the kidneys (urea, creatinine, uric acid, organic acids, and the intracellular cations [potassium and magnesium]). The minimum amount of urine needed to rid the body of normal metabolic waste products is 400 mL. In this phase uremic symptoms first appear and life-threatening conditions such as hyperkalemia develop.

Some patients have decreased renal function with increasing nitrogen retention, yet actually excrete normal amounts of urine (2 L/day or more). This is the non oliguric form of renal failure and occurs predominantly after nephrotoxic antibiotic agents are administered to the patient; it may occur with burns, traumatic injury, and the use of halogenated anesthetic agents.

### **Diuresis phase:-**

In the diuresis period, the third phase, the patient experiences gradually increasing urine output, which signals that glomerular filtration has started to recover.

Laboratory values stop rising and eventually decrease.

Although the volume of urinary output may reach normal or elevated levels, renal function may still be markedly abnormal. Because uremic symptoms may still be present, the need for expert medical and nursing management continues.

The patient must be observed closely for dehydration during this phase; if dehydration occurs, the uremic symptoms are likely to increase.

### **Recovery phase:-**

The recovery period signals the improvement of renal function and may take 3 to 12 months. Laboratory values return to the patient's normal level. Although a permanent 1% to 3% reduction in the GFR is common, it is not clinically significant.

### **Clinical manifestation of AKI:-**

May progress through phases of onset oliguria, diuresis and recovery. In some situation the patient dose not recover from AKI and chronic renal failure result.

### **Initial phase:-**

Start of injury to the kidney, reversal or prevention of kidney dysfunction is possible at this stage by early intervention, in this phase, there is hypotension, ischemia, hypovolemia this symptoms last for hour to days.

### **Oligouric phase:-**

Follow within one day of the onset, major problems of this phase include inability to excrete fluid loads, regulate electrolyte and excrete metabolic waste product. When urine output is less than 400ml/24hours, there is inability excrete metabolic waste and increase serum urea nitrogen and creatinine. BUN may increase 20mg/dl/day. The symptom include nausea, vomiting, drowsiness, confusion, coma, gastrointestinal bleeding, asterixis and pericarditis.

These symptom last for 1-3weeks and may extend to several weeks in older patient. When urine output is less than 300ml/24hours, there is inability to regulate electrolytes (hyperkalemia, acidosis, hypocalcaemia and hyperphosphatemia), inability to excrete fluid over load lead to hypervolemia), hematological dysfunction (anemia, platelet dysfunction, leucopenia) the patient may require dialysis.

### **Diuretic phase:-**

This phase begins gradual increase in daily urine output of 1-3 liters per day, but may reach 3-5liters or more per day there is increase urine production with deficit in concentrating ability of tubule and osmotic diuretic effect of high BUN, slowly excretion of metabolic wastes, hypovolemia, loss of sodium, loss of potassium, high BUN initially and BUN gradually returns to baseline. Symptom include urine output up to 4-5 liters per day, postural hypertention, tachycardia, improving mental alertness and activity, weight loss thirst, dry mucus membranes and decrease skin



turgor this symptom last for 2-6 weeks after onset of oliguria, but duration may vary accordingly.

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up to 4-5 liters per day, postural hypertension, tachycardia, improving mental alertness and activity, weight loss, thirst, dry mucus membranes and decrease skin turgor this symptom last for 2-6 weeks after onset of oliguria, but duration may vary accordingly.

### **Recovery phase:-**

This phase begins when the GFR increase so that BUN and creatinine levels are starting stabilize and then decrease.

Kidneys are returning to normal functioning, there is some residual renal insufficiency. Thirty Percent of patients do not attain full recovery of GFR, there is decreased energy level which last for 3-2months.<sup>(4)</sup>

### **AKI diagnostic evaluation:-**

Urine analysis reveals proteinuria, hematuria. Renal function test show rising serum creatinine and BUN level. Urine chemistry examination to distinguish various forms of acute kidney injury.

Renal ultrasonography for estimation renal size and to exclude treatable obstructive uropathy.<sup>(5)</sup>

### **Cardiac surgery**

Cardiac surgery is one of major operation, it can be either CABG or valvular repair or replacement. During this operation the patient may develop life threatening complication as AKI, MI, hemorrhage & dysrhythmia.

Acute kidney injury (AKI) occurs in as many as 40% of patients after cardiac surgery and requires dialysis in 1% of cases. Acute kidney injury is associated with an increased risk of mortality and morbidity, predisposes patients to a longer hospitalization, requires additional treatments, and increases the hospital costs. It is characterized by a progressive worsening course, being the consequence of interplay of different pathophysiologic mechanisms, with patient-related factors and cardiopulmonary bypass as major causes. Recently, despite ongoing efforts to decrease its occurrence, acute kidney injury (AKI) remains a frequent complication of cardiac surgery. Its incidence varies depending on the adopted definitions, the mode of detection, and the clinical profile of the analyzed patients. Therefore, the incidence

of AKI is different across studies, occurring in 1% to 30% of the patients when defined broadly, whereas frequency of AKI requiring dialysis is generally lower, ranging between less than 1% and 6%. The incidence of AKI is certainly influenced by the type of cardiac operation. Typically, patients undergoing coronary artery bypass graft surgery (CABG) present the lowest incidence (2% to 5%), whereas patients undergoing valvular or combined procedures show a higher rate (as high as 30%). Similarly, AKI after Trans-catheter aortic valve implantation is registered in approximately 10% of the patients, whereas after complex operations such as aortic surgery for aneurysm repair or aortic dissection, incidences of AKI have been reported at 10% to 50% [11]

### **Pathogenesis:-**

Although different studies have attempted to determine etiologic factors in its pathogenesis, postoperative AKI is the consequence of an interplay of different pathophysiologic mechanisms, with patient-related factors and cardiopulmonary bypass (CPB) as major causes. Kidneys are prone to ischemic damage because of their peculiar blood circulation, in which renal medulla is normally perfused at a low oxygen tension with a limited reserve; and CPB determines unavoidable alterations in blood flow by ischemia-reperfusion injury, low cardiac output, renal vasoconstriction, hemodilution, and loss of pulsatile flow during CPB. All these factors lead to an oxygen supply/demand renal imbalance, with significant cellular injury. A correlation between AKI and CPB hypothermia has been also documented. The causative mechanism seems to be related to the increased metabolic demand, with the subsequent nephron damage due to low perfusion temperatures as the result of hypoperfusion of the superficial cortex that occurs during rewarming and restoration of normothermia. A CPB perfusion temperature less than 27°C seems to be directly associated with AKI occurrence. The CPB-induced systemic inflammatory response should be considered as one of the relevant determinants of postoperative AKI, with a final interstitial inflammation with tubular injury. Cardiopulmonary bypass also exposes blood cells to non-physiologic surfaces and shear forces, leading to cell lysis. The subsequent mechanical destruction of erythrocytes determines a release of plasma free hemoglobin into the circulation, finally causing occlusion of renal tubules with hemoglobin casts and necrosis of tubular cells. Finally, CPB-related embolization should be mentioned in the occurrence of AKI [11].

## **Risk Factors**

### **Pre disposing Factors**

- Age
- heart failure
- basal renal function
- anemia
- diabetes
- COPD
- Emergency
- Nephrotoxic drugs

### **Intra operative Factors**

- Renal hypo perfusion
- Type of surgery (CABG& valve surgery).
- CPB use.(hemodilution,hypothermia, inflammation ,embolization)

### **postoperative Factors**

- Low cardiac output
- Sepsis
- Volume depletion

### **Phases of AKI:-**

#### **Early phase:-**

Vasomotor nephropathy,renal perfusion alteration.

#### **Initiation:-**

Cellular ATP depletion, oxidative injury.

#### **Extension:-**

Micro vascular injury, inflammation

#### **Maintenance:-**

Proliferation, re differentiation

#### **Repair:-**

Re differentiation, repolarization(11)

## **Biomarkers for the Detection of AKI**

Conventional renal biomarkers either do not detect injury in the real-time and become abnormal many hours later in the course of injury serum creatinine, urea, lack specificity & urine output (11).

## **Strategies to Prevent AKI**

The most relevant preventive strategies have been focused on deleterious effects related to CPB use. Such as hemodilution and nonpulsatile flow (11) With regard to the flow characteristics during

CPB, pulsatile perfusion demonstrated superior renal protection, improving organ perfusion by reducing vaso-constrictor reflexes, optimizing oxygen consumption.

## **Management of acute kidney injury:**

The most important tool for distinguishing pre renal, intra renal, post renal causes is the history, including thorough review of recent clinical events and drug therapy, urine analysis is an important diagnostic test. Urine sediment containing abundant cells, cast or protein suggest intra renal causes. Normal urine sediment is possible in both pre renal and post renal. Hematuria, pyuria and crystal may be associated with postrenal cause. If needed further test may be necessary, such as CT scan, MRI, renal US and retrograde pyelogram.

The use of medication in the treatment of acute kidney injury determined by underlying cause and the presenting symptom, hypovolemia is treated with hypotonic solution such as 0.9% saline. If hypovolemia due to blood or plasma loss, packed red blood cells and isotonic saline are given, volume replacement rate must match in one to one basis.

Loop diuretics are used to manage potassium level doses of up to 320 mg /days required to produce adequate. Renal failure from nephrotoxic or ischemia is treated with agents that increase renal flow this include renal dose dopamine, mannitol and loop diuretics, inflammatory states of acute glomerulonephritis are treated with glucocorticosteroids, patients with impaired renal function may have altered responses to therapeutic doses of many medications and uremia altered the protein binding site absorption, distribution and metabolism of many drugs, NSAIDs and ACE inhibitors contraindicated in patients with acute kidney injury (4).

When conservative management is not effective dialysis is required.

While taking care of person with acute kidney injury following points to be kept in mind which include:

**Maintain fluid and electrolytes balance :**

Fluid restriction.

Monitor intake and output.

Weight patient daily.

Monitor vital signs frequently, including postural signs.

Administer phosphate binding medications as prescription.

Assess change in mental status indicate low serum levels(diuretics phase).

Assess present of irregular pulse indicate hyperkalemia(4).

**Restricted protein as prescribed:**

High in carbohydrate and fat during protein restriction.

Low potassium during hyperkalemia.

Anti-emetic is given as prescribed(4).

**Maintaining rest / activity balance :**

Bed rest in acute phase.

Assist patient when needed.

Promote early ambulation when renal function permits.

Provide planned rest periods(4).

**preventing infection:**

Assess signs and symptoms of infection.

Avoid source of infection.

Administer prescribed antibiotics.

Provide meticulous skin

**Previous studies:-**

There was study done regarding acute kidney injury in the postoperative period of cardiac surgery conducted by Marcia Cristina da Silva Magro. Faculdade Ceilândia da Universidade de Brasília. Centro Metropolitano (April 9, 2015) it was aim to identify the occurrence of acute kidney injury (AKI) in the postoperative period of cardiac surgery. A prospective cohort study including 51 patients exposed to coronary artery bypass surgery, valve replacement, or combined surgery (bypass surgery and valve replacement) without history of kidney disease and kidney transplant, and who were followed from the preoperative period until 72 hours after surgery. Acute renal failure was defined as baseline creatinine increase of 0.3 mg/dL in 48 hours or less, or its increase from 1.5 to 1.9-fold, or a reduction in urine flow <0.5mL/kg/h for 6 hours. The Kidney Disease: Improving Global Outcomes (KDIGO) classification was used. the result show The KDIGO classification showed that 92.2% of patients had renal

impairment. The urinary flow criterion of this classification alone showed that 31.4% of patients had renal dysfunction in stage of risk, 33.3% in stage of renal injury, and 21.6% in stage of renal failure. By the serum creatinine criterion, 27.5% were identified in the stage of risk, 3.9% in stage of injury and another 3.9% in stage of kidney failure. The study concluded by A high percentage of patients in the postoperative period of cardiac surgery (coronary artery bypass surgery and valve replacement) progressed to acute kidney injury.<sup>(6)</sup>

Another study was done regarding Incidence and outcomes of acute kidney injury after cardiac surgery using either criteria of the RIFLE classification conducted by Lagny et al (2015) in University of Liège Hospital. it was aim to assess Incidence and outcomes of acute kidney injury after cardiac surgery using either criteria of the RIFLE classification. All adult patients undergoing cardiac surgery, with or without cardiopulmonary bypass, from April 2008 to March 2009 were included. The result show that 443 patients (Male/Female ratio, 2.3; median age, 69y) were included, with 221 (49.9 %) developing postoperative AKI. Elevated serum creatinine (AKISCr) and oliguria (AKIUO) was observed in 9.7 % and 40.2 %, respectively. AKI patients had a significantly higher BMI and baseline SCr. In comparison to AKIUO, AKISCr mostly occurred in patients with co-morbidities, and was associated with an increased mortality at 1-year post surgery. In line with previous reports, our present study urges the need for appropriately powered multi-centric follow-up trials to clarify the actual utility of UO as a criterion for AKI diagnosis and management in patients undergoing cardiac surgery<sup>(7)</sup>.

Other study was done regarding the Incidence of Acute Kidney Injury after Coronary Artery Bypass Surgery with or without Cardiopulmonary Bypass conducted by Mohammad Saeid Ghiasi (2016) in Jamaran heart hospital. It was aim to compare the incidence of acute kidney injury and laboratory findings in patients undergoing cardiac surgery with or without cardiopulmonary bypass. 167 patients were selected by systematic randomized sampling. The result showed that there was no significant difference in the demographics (age, sex, drug history, and chronic disease) between the groups ( $P > 0.05$ ). The acute kidney injury (AKI) was observed in 19.3 and 33.7% of the off-pump and on-pump patients, respectively. A total number of 16 (19.3%) in the off-pump and 44 (52.9%) in on-pump group needed blood transfusion. The mean hospital stay was 6.74\_1.86 days for OPCAB and 7.2\_1.72 for on-pump patients. Hemoglobin and hematocrit level, also, were higher in OPCAB.

This study showed that off-pump coronary artery bypass (OPCAB) is superior in acute kidney injury, blood transfusion, blood glucose management, and hospital stay. Considering these complications and those adverse effects, it seems that off-pump technique is better in selected patients, but it is proposed that more prospective multi-disciplinary studies with larger sample sizes should be done.<sup>(3)</sup>

Other study was done regarding Risk factors for acute kidney injury after cardiac surgery was conducted by Alfredo José Rodrigues<sup>II</sup> et al. It was aim to identify risk factors for acute kidney injury in patients with normal levels of serum creatinine who underwent coronary artery bypass graft (CABG) surgery and/or valve surgery. Data from a cohort of 769 patients, after the exclusion criteria were applied, were analyzed using bivariate analyses and binary logistic regression modeling. The result show Three hundred eighty one patients experienced CABG, 339 valve surgery and 49 went through both simultaneously. Forty six percent of the patients were female and the mean age was  $57 \pm 14$  years (13 to 89 years). Seventy eight patients presented renal dysfunction postoperatively (10%), of these 23% needed hemodialysis (2.4% of all patients). The mortality for the whole cohort was 10%. The overall mortality for patients experiencing postoperative renal dysfunction was 40 % (versus 7%,  $P < 0.001$ ), 29% for those who did not need dialysis and 67% for those who needed dialysis ( $P = 0.004$ ). The risk factors that were independently associated with AKI were: age ( $P < 0.000$ , OR: 1.056), congestive heart failure ( $P = 0.091$ , OR: 2.238), COPD ( $P = 0.003$ , OR: 4.111), Endocarditis ( $P = 0.001$ , OR: 12.140, myocardial infarction  $< 30$  days ( $p = 0.015$ , OR: 4.205), valve surgery ( $P = 0.016$ , OR: 2.137), cardiopulmonary bypass time  $> 120$  min ( $P = 0.001$ , OR: 7.040), peripheral arterial vascular disease ( $P = 0.107$ , 2.296).

The study was concluded by Renal dysfunction was the most frequent postoperative organ dysfunction in patients who underwent CABG and/or valve surgery and age, congestive heart failure, COPD, Endocarditis, myocardial infarction  $< 30$  days, valve surgery, cardiopulmonary bypass time  $> 120$  min, and peripheral arterial vascular disease were the risk factors independently associated with AKI.<sup>(8)</sup>

Also there was study done regarding reassessment of Acute Kidney Injury after Cardiac Surgery was conducted by Xiangcheng Xie<sup>1,2</sup> at Nanjing First Hospital in Nanjing, China, between January 2008 and December 2013. It is aim To evaluate the incidence, risk, or protective factors of acute kidney injury (AKI) in patients after cardiac surgery based on the Kidney Disease: Improving Global Outcomes (KDIGO) criteria. 2,575 patients undergoing their first documented cardiac surgery with



cardiopulmonary bypass (CPB) were included. the study show that 931 (36%) developed AKI. A total of 30 (1.2%) patients required renal replacement therapy. In the multivariate analysis, mechanical ventilation duration (OR1.446, 95% CI 1.195-1.749,  $p < 0.001$ ), CPB duration of more than 110 min (OR 1.314, 95% CI 1.072-1.611,  $p = 0.009$ ), erythrocytes transfusion (OR1.078, 95% CI 1.050-1.106,  $p < 0.001$ ), and postoperative body temperature greater than 38c within 3 days (OR 1.234, 95% CI 1.018-1.496,  $p = 0.032$ ) were independent risk factors for CSA-AKI, while ulinastatin use was associated with a reduced incidence of CSA-AKI (OR 0.694, 95% CI 0.557-0.881,  $p = 0.006$ ). CSA-AKI was significantly associated with in-hospital mortality (adjusted HR: 2.218, 95% CI 1.161-4.238,  $p = 0.016$ ), especially in patients needing renal replacement therapy (adjusted HR: 18.683, 95% CI 8.579-40.684,  $p < 0.001$ ).

Our study showed that, when the KDIGO definition was applied, CSA-AKI commonly occurred in adult patients who underwent cardiac surgery with CPB and was associated with in-hospital mortality and a longer length of ICU and hospital stay. Mechanical ventilation duration, RBC transfusions during surgery, and a postoperative body temperature

Greater than 38c within 3 days after surgery were found to be independent risk factors for CSA-AKI. Our findings suggest that effective and proper management of these modifiable risk factors may decrease the risk of developing AKI in this setting. Furthermore, the administration of ulinastatin may be beneficial for patients undergoing cardiac surgery.<sup>(2)</sup>

Another study was done regarding Prediction of acute kidney injury within 30 days of cardiac surgery was conducted by MasoumehSanagou (2014) in 18 hospitals in Australia. It was aim To predict acute kidney injury after cardiac surgery. The study included 28,422 cardiac surgery patients who had had no preoperative renal dialysis from June 2001 to June 2009. Two models were developed, one including the preoperative risk factors and another including the pre-, peri-, and early postoperative risk factors. The area under the receiver operating characteristic curve was calculated, using split-sample internal validation, to assess model discrimination. the result show that The incidence of acute kidney injury was 5.8% (1642 patients). The mortality for patients who experienced acute kidney injury was 17.4% versus 1.6% for patients who did not. On validation, the area under the curve for the preoperative model was 0.77, and the HosmerLemeshow goodness-of-fit P value was. 06. For the postoperative

model area under the curve was 0.81 and the Hosmer-Lemeshow P value was .6. Both models had good discrimination and acceptable calibration.

Acute kidney injury after cardiac surgery can be predicted using preoperative risk factors alone or, with greater accuracy, using pre-, peri- and early postoperative risk factors. The ability to identify high-risk individuals can be useful in preoperative patient management and for recruitment of appropriate patients to clinical trials. Prediction in the early stages of postoperative care can guide subsequent intensive care of patients and could also be the basis of a retrospective performance audit tool.<sup>(9)</sup>

On the other hand there was a study done regarding the Nurses' knowledge to identify early acute kidney injury was conducted by Suzana Margareth Ajeje Lobo (2016). It was aimed to evaluate the knowledge of nurses on early identification of acute kidney injury (AKI) in intensive care, emergency and hospitalization units. 216 nurses were included. The results show that 57.2% of nurses were unable to identify AKI clinical manifestations, 54.6% did not have knowledge of AKI incidence in patients admitted to the ICU, 87.0% of the nurses did not know how to answer as regards the AKI mortality rate in patients admitted to the ICU, 67.1% answered incorrectly that slight increases in serum creatinine do not have an impact on mortality, 66.8% answered incorrectly to the question on AKI prevention measures, 60.4% answered correctly that loop diuretics for preventing AKI is not recommended, 77.6% answered correctly that AKI does not characterize the need for hemodialysis, and 92.5% said they had no knowledge of the Acute Kidney Injury Network classification. Nurses do not have enough knowledge to identify early AKI, demonstrating the importance of qualification programs in this field of knowledge.<sup>(10)</sup>

## **Chapter three**

### **Methodology**

#### **Study design:-**

It was a descriptive cross section hospital base study to assess nurses' knowledge regarding acute kidney injury post cardiac surgery.

#### **Study area:-**

This study was conducted at Alshaab teaching hospital, which located in mc Nemr Street established in 17 November 1959, governmental and referral hospital located in Khartoum state, consist of the following. Cardiopulmonary center: include CCU, intermediate CCU, respiratory ICU and asthma care unit, cardiac catheterization unit, cardiothorathic surgery ICU&HDU. Medicine and surgery wards male and female cardiology, male and female respiratory and asthma wards. Other department: X-ray, electrocardiography and laboratory department.

#### **Study population:-**

Nurses work in post cardiac surgery unit. Having the following criteria

Inclusion criteria:

All nurses working in post cardiac surgery ICU holding BSc& MSc

#### **Variable:-**

**Independent variable:** socio –demographic characteristic.

#### **Dependent variable:-**

Nurses' knowledge regarding AKI

**Sampling:-****Sample size:**

30 nurses

**Sampling technique;**

Total coverage

**Data collection tools&technique:**

Self-structured questioner, closed ended question have three section, section one was about socio demographic data, section two about general nurses' knowledge regarding cardiac surgery & section three about nurses' knowledge regarding AKI.

**Data analysis:-**

Data were analyzed by social package of statistical science (SPSS) program in form of frequency & percentage. Presented in form of tables. For groups comparison we used mean & standard deviation significant at p value = 0.005.

**Scoring system:-**

Nurses knowledge scored as (60% or less) were grade as poor knowledge; (60%-80%) were grade as moderate knowledge and (>80%) were grade as good knowledge

**Ethical consideration:-**

Official letter from Post graduated study, Alshaab teaching hospital manager and explanation to all nurses, verbal Consent was taken from all nurses.

## Results

**Table (1): Frequency distribution of socio-demographic characteristics of nurses at Alshaab teaching hospital (sample size = 30)**

|   | Frequency (%) |
|---|---------------|
| (1) Age (years)                                   |               |
| a-20-30   | 24(80%)       |
| b-31-40   | 5(16.7%)      |
| c-41-50   | 1(3.3%)       |
| (2) Gender  |               |
| a-Male  | 4(13.3%)      |
| b-Female  | 26(86.7%)     |
| (3) Level of education                            |               |
| a-Bachelor's degree                               | 24(80%)       |
| b-Master degree                                   | 6(20%)        |
| c-Ph.D  | 0             |
| 4- Experience in post-cardiac surgery ICU setting |               |
| a-months – 1 year                                 | 13(43.3%)     |
| b->1 year – 2 years                               | 13(43.3%)     |
| c->2 years  | 4(13.4%)      |

**Section (II):**

**Table (2): show Frequency distribution of nurses' knowledge regarding cardiac surgery at Alshaab teaching hospital sample size = 30**

| <b>Parameter</b>   | <b>N (%)</b>   |
|--|--|
| 1- The following is true regarding cardiac surgery:<br>a- CABG is a surgical procedure in which a blood is grafted to an occluded coronary artery so that blood can follow beyond the occlusion<br>b- It include CABG and valve replacement<br>c- Most cardiac surgeries done by using CPB   | <br>21(70%)<br>19(63.3%)<br>18(60%)                  |
| 2- Indication of cardiac surgery include:-<br>a- Alleviation of angina that cannot be controlled with medication or PCI<br>b- Prevention and treatment of MI, dysrhythmias, or heart failure<br><br>c- Treatment of left main coronary artery stenosis or multi-vessel CAD<br>d- Repair or replace valve stenosis or regurgitation | <br>8(26.7%)<br>8(26.7%)<br><br>10(33.3%)<br>9(30%)  |
| 3- Complication of cardiac surgery<br>a- Hemorrhage<br>b- Acute kidney injury<br>c- Dysrhythmias<br>d- Myocardial infraction   | <br>16(53.3%)<br>16(46.7%)<br>17(56.7%)<br>16(46.7%) |

**Section (III):**

**Table (3): Frequency distribution of nurses' knowledge regarding AKI post cardiac surgery Alshaab teaching hospital sample size = 30**

| <b>Parameter</b>   | <b>n( %)</b>                                 |
|--|--|
| 1- The following is true about AKI:<br>a-AKI is a sudden and almost complete loss of kidney function (decreased GFR) over a period of hours to days<br>b-AKI is often thought of as a problem seem only in hospitalized patients<br>c-AKI can occur due to hypo-perfusion of the kidney<br>d-AKI may occur in the outpatient setting | 8(26.7%)<br>7(23.3%)<br>7(23.3%)<br>7(23.3%) |
| 2- The following are signs and symptoms of AKI:<br>a-Oliguria<br>b-Anuria<br>c-Decrease cardiac output   | 14(46.7%)<br>7(23.3%)<br>7(23.3%)            |
| <b>3-The normal urine output equal 0.5 ml/kg/hr</b>  | 29(96.7%)                                    |
| 4- Risk factor for developing AKI in post-cardiac surgery patient is:<br>a-Age<br>b-Cardiopulmonary bypass time AKI more than 120 minutes<br>c-Peripheral vascular disease   | 11(36.7%)<br>16(53.3%)<br>11(36.7%)          |
| <b>5- Hypo perfusion is leading causes of AKI post cardiac surgery</b>   | 30(100%)                                     |

|   |  |
|---|--|
| <b>6- The main criteria for the diagnosis of AKI acute change in:</b><br>a- Serum creatinine<br>b- Urine output<br>c-GFR  | 16(53.3%)<br>12(40%)<br>9(30%)                 |
| <b>7- Phase of AKI is:</b><br>a-Onset<br>b-Oliguric<br>c-Diuretic<br>d-Recovery   | 15(50%)<br>19(63.3%)<br>14(46.7%)<br>14(46.7%) |
| <b>8- Fluid overloaded typically begins during oliguric phase of AKI:</b>   | 24(80%)  |
| <b>9-Patient who recover from AKI has GFR that is 75% of normal</b>   | 28(93.3%)                                      |
| <b>10-In diuretic phase of AKI there is electrolyte depletion</b>   | 30(100%)                                       |
| <b>11-The following are important for caring patient with AKI:</b><br>a-Maintains fluid and electrolytes balance<br>b-Restricted protein as prescribed<br>c-Maintaining rest/activity balance | 23(76.7%)<br>23(76.7%)<br>23(76.7%)            |
| <b>12-Complication of AKI:</b><br>a- Pulmonary edema<br>b- Hyperkalemia<br>c- Chronic kidney disease  | 14(46.7%)<br>12(40%)<br>18(60%)                |



**Table (4): show scoring of nurses' knowledge regarding AKI post cardiac surgery at Alshaab teaching hospital sample size = 30.**

| Item  | Good<br>80% > | Moderate<br>79 -60 | Poor <<br>60 |
|---|---------------|--------------------|--------------|
| 1- The following is true about AKI:                               |               |                    | 24.15%       |
| 2-signs and symptoms of AKI:                                      |               |                    | 31.1%        |
| 4- Risk factor for developing AKI in post-cardiac surgery patient |               |                    | 42.23%       |
| 5-Hypo perfusion is leading causes of AKI post cardiac surgery    | 100%          |                    |              |
| 6-The main criteria for the diagnosis of AKI                      |               |                    | 41.1%        |
| 7- Phase of AKI   |               |                    | 51.67%       |
| 8-Fluid overloaded typically begins during oliguric phase of AKI  | 80%           |                    |              |
| 9-Patient who recover from AKI has GFR that is 75% of normal      | 93.3%         |                    |              |
| 10-In diuretic phase of AKI there is electrolyte depletion        | 100%          |                    |              |
| 11-The following are important for caring patient with AKI        |               | 76.7%              |              |
| Complication of AKI:  |               |                    | 48.9%        |

**[B] Relationships:**

**Table (5): Comparison of means between nurses' qualifications and their knowledge scores regarding AKI**

| Nurses knowledge regarding AKI                                    | Qualifications |           | P-value             |
|---|----------------|-----------|---------------------|
|   | Bachelors'     | Master    |                     |
|   | Mean±SD        |           |                     |
| 1- Definition of AKI  | 0.51±0.37      | 0.72±0.42 | 0.046 <sup>*</sup>  |
| 2- Signs and symptoms of AKI                                      | 0.65±0.21      | 0.81±0.33 | 0.017 <sup>*</sup>  |
| 3- The normal urine output equal 0.5 ml/kg/hr                     | 0.49±0.25      | 0.48±0.27 | 0.078 <sup>NS</sup> |
| 4- Risk factor for developing AKI in post-cardiac surgery patient | 0.61±0.12      | 0.80±0.24 | 0.013 <sup>*</sup>  |
| 6- The main criteria for the diagnosis of AKI acute change        | 0.63±0.35      | 0.75±0.41 | 0.027 <sup>*</sup>  |
| 7- Phase of AKI Onset   | 0.72±0.29      | 0.93±0.36 | 0.001 <sup>**</sup> |
| 8- Fluid overloaded typically begins during oliguric phase of AKI | 0.38±0.19      | 0.36±0.22 | 0.729 <sup>NS</sup> |
| 9-Patient who recover from AKI has GFR that is 75% of normal      | 0.51±0.17      | 0.50±0.23 | 0.481 <sup>NS</sup> |
| 11-Important steps for caring patient with AKI                    | 0.75±0.36      | 0.89±0.15 | 0.002 <sup>**</sup> |
| 12- Complication of AKI   | 0.68±0.19      | 0.77±0.13 | 0.039 <sup>**</sup> |

**Table (6): Comparison of means between nurses' experience and their knowledge scores regarding AKI**

| Nurses knowledge regarding AKI                                    | Experience (years) |            |           | P-value             |
|---|--------------------|------------|-----------|---------------------|
|   | 3 m-1yr            | >1yr-2 yrs | >2 years  |                     |
|   | Mean±SD            |            |           |                     |
| 1- Definition of AKI  | 0.41±0.26          | 0.52±0.19  | 0.69±0.35 | 0.041*              |
| 2- Signs and symptoms of AKI                                      | 0.32±0.18          | 0.48±0.22  | 0.92±0.26 | 0.0**               |
| 3- The normal urine output equal 0.5 ml/kg/hr                     | 0.44±0.21          | 0.46±0.15  | 0.49±0.31 | 0.068 <sup>NS</sup> |
| 4- Risk factor for developing AKI in post-cardiac surgery patient | 0.55±0.29          | 0.67±0.14  | 0.88±0.23 | 0.002**             |
| 6- The main criteria for the diagnosis of AKI acute change        | 0.39±0.12          | 0.57±0.41  | 0.95±0.16 | 0.0**               |
| 7- Phase of AKI Onset   | 0.56±0.13          | 0.69±0.25  | 0.84±0.11 | 0.006**             |
| 8- Fluid overloaded typically begins during oliguric phase of AKI | 0.42±0.25          | 0.53±0.24  | 0.71±0.22 | 0.044*              |
| 9-Patient who recover from AKI has GFR that is 75% of normal      | 0.39±0.22          | 0.40±0.18  | 0.42±0.15 | 0.760 <sup>NS</sup> |
| 11- Important steps for caring patient with AKI                   | 0.51±0.26          | 0.53±0.17  | 0.54±0.22 | 0.45 <sup>NS</sup>  |
| 12- Complication of AKI   | 0.38±0.14          | 0.49±0.16  | 0.92±0.15 | 0.0**               |

## **Discussions:**

It was descriptive cross sectional hospital based study to assess nurse's knowledge regarding acute kidney injury in post cardiac surgery patient; data were collected by self-structure questionnaire.

The majority of nurses under study (80%) their ages between 20-30 years that mean they were juniors. Most of them (86.7%) are females and this normal because most Sudan nursing faculty graduate female nurses. (80%) are bachelors' holders. (43.3%) of them their experience in post-cardiac surgery ICU setting were 3 months-year and >1 year-2 years, respectively

The study displayed that more than half of nurses had good knowledge regarding definition of cardiac surgery (70%). Most of them had poor knowledge regarding indication of surgery (29.17%), half of them had poor knowledge regarding complications of cardiac surgery (50.85).

study showed that they had poor knowledge regarding AKI post cardiac surgery include signs & symptoms (31.1%), risk factors (42.23), main criteria for diagnosing AKI (41.1), & complication of AKI (48.9%) this may be related to working in intensive care unit is stressful & heavy so the nurses have no time for searching & reading .& they had moderate knowledge about care of patient with AKI (76.7%). Although they have good knowledge regarding causes of AKI post cardiac surgery (100%), this good indicator because caring for patient with AKI important to prevent complication.

There was significant relationship between nurses' experience and knowledge regarding AKI. Also they have significant relationship between qualification and nurses' knowledge regarding AKI.

## **Conclusion**

The study concluded that nurses who worked in post cardiac surgery unit at Alshaab teaching hospital had poor knowledge in the most important points regarding AKI post cardiac surgery include signs & symptoms , risk factors, main criteria for diagnosing AKI, & complication of AK ,also they had moderate knowledge about care of patient with AKI . & they had good knowledge regarding hypoperfusion leading cause of AKI post cardiac surgery.

## **Recommendations**

The following points are suggested as suitable recommendations to promote nurses knowledge regarding acute kidney injury in post cardiac surgery patients:

- Encourage more interventionalresearches to be conducted among nurses to promote knowledge and practices.
- Continuous in-service education to update knowledge.
- The clinical supervisor or head nurse should closely observed nurses performance regarding care of patients post cardiac surgery.

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## Appendix:-

### Republic of the Sudan

### Ministry of Higher Education and scientific Research

### University of Shendi

*Faculty of Graduate Studies and Scientific Research*

### Questionnaire:

To assess nurses' knowledge regarding acute kidney injury in patient post cardiac surgery at Alshaab teaching hospital from September –February 2019

Please put (√) around the best answer:

#### Section (1): socio-demographic characteristic

1- Age: a- 20-30yrs ( )      b- 30-40 yrs ( )      c- 40-50 yrs ( )

2-Gender:a- male ( )      b- female ( )

3- Level of education:    a- bachelor's degree ( )b- master degree ( )

c- PhD ( )

#### 4-Experience in post cardiac surgery ICU setting:

a- 3month - 1 year ( )

b- > I year -2 years ( )

c- > 2 years ( )

#### Section (2) nurses' knowledge regarding cardiac surgery

5-The following is true about Cardiac surgery:-

- a- CABG is a surgical procedure in which a blood vessel is grafted to an occluded coronary artery so that blood can flow beyond the occlusion ( )
- b- it includes CABG& valve replacement ( )
- c- most Cardiac surgeries done by using CPB ( )

6-Indication of Cardiac surgery includes:

- a- Alleviation of angina that cannot be controlled with medication or PCI ( )
- b- Treatment of left main coronary artery stenosis or multi vessel CAD ( )
- c- Prevention and treatment of MI, dysrhythmias, or heart failure ( )
- d- To repair or replace valve stenosis or regurgitation. ( )

7-complications of Cardiac surgery include:

- a- hemorrhage, ( )
- b- dysrhythmias, ( )
- c- Myocardial infarction ( )
- d- Acute kidney injury. ( )

**Section (3) nurses' knowledge regarding KI**

**8-The following is true about AKI:-**

- a- AKI is a sudden and almost complete loss of Kidney function (decreased GFR) over period of hours to days. ( )
- b- AKI is often thought of as a problem seen only in hospitalized Patients. ( )
- c- AKI may occur in the outpatient setting ( )
- d- AKI can occur due to hypo perfusion of the kidney. ( )

**9-the following are signs &symptoms of AKI :-**

- a- Oliguria————— ( )
- b- Anuria————— ( )
- c- Decrease cardiac output ( )

**10-The normal urine output equal 0, 5 ml/kg/hr.**

- a-Yes ( )
- b- No ( )

**11- Risk factor for developing AKI in post cardiac surgery patient is?**

- a. Age————— ( )
- b. Cardiopulmonary bypass time more than 120 minute ( )
- c. Peripheral vascular disease————— ( )

**12- Hypoperfusion is leading causes of AKI post cardiac surgery**

- a-Yes ( )
- b- No ( )

**13- The main criteria for the diagnosis of AKI acute change in**

- a- serum creatinine ( )
- b- urine output ( )
- c- GFR ( )

**14 -Phase of AKI is:-**

- a-onset ( )
- b-oliguric ( )
- C-diuretic ( )
- d-recovery ( )

**15- Fluid overload typically begins during oliguric phase of AKI**

a-Yes ( )

b- No ( )

**16--patient who recover from AKI has GFR that is 75% of normal ;-**

a-Yes ( )

b- No ( )

**17-in Diuretic phase of AKI there is electrolyte depletion**

a-Yes ( )

b- No ( )

**18- The following are important for caring patient with AKI?**

a. maintains fluid and electrolytes balance ( )

b. restricted protein as prescribed ( )

c. maintaining rest / activity balance ( )

**19--The following consider as complication of AKI?**

a. pulmonary edema. ( )

b. hyperkalemia. ( )

c. chronic kidney disease ( )

**Thanks**