

## Peripartum Acute Kidney Injury

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**Abstract: Objectives:** This work aimed to study positive cases of peripartum acute kidney injury, how to diagnose, manage each case and identify the factors related to the unfavorable evolution. **Background:** Acute kidney injury (AKI) is one of the most challenging and serious complications of pregnancy and postpartum period. It reflects the absence of prenatal care and early detection of high-risk pregnancies, the delay in transfer of patients and the paucity of relevant human and material resources. It is certainly a treatable and curable complication, but one that imposes a heavy burden of maternal morbidity and mortality if its diagnosis and treatment are delayed. The best treatment remains prevention, a goal very difficult to attain in the developing countries. **Patients and methods:** This study included 120 female patients during the peripartum period, divided into 2 groups; The acute kidney injury group of patients (**AKI Group**) included 49 patients and the non acute kidney injury (**Non AKI Group**) group of patients included 71 patients. In this study measurement serum creatinine, blood urea nitrogen, arterial blood gases, serum albumin, prothrombin time, international normalize ratio(INR), Complete blood count, complete urine analysis and urine albumin to creatinine ratio was determined in all participants. **Results:** There is no specific significant independent risk factor for AKI which means that the prediction of AKI is multi factorial such as hypertension, diabetes, preeclampsia, increased serum creatinine 48 hours postpartum and other factors. This means that the summation of more than one factor together increases the risk of AKI incidence in pregnant female. Also we found that the percentage of preeclampsia among AKI group is highly significant (83.7%) this means that the preeclampsia is one of the most common causes of peripartum AKI. The outcome was favorable, with a complete renal function recovery for (71.4%) of patients. Poor prognosis for mother and fetus and prediction of hemodialysis in AKI patients with DM, hypertension, increased serum creatinine 48 hrs post partum and increased serum uric acid. Fourteen patients who went hemodialysis were followed up after 6 weeks and up to 3 months of delivery which revealed that 6 patients recovered completely while 5 patients completely recovered, 2 patients became chronic kidney diseased patients and 1 patient became End Stage Renal Diseased patient after 3 months of follow up. **Conclusion:** AKI complicated 40.8% of total delivery in the peripartum period. Preeclampsia was the most common cause of AKI. Poor prognosis for mother and fetus and prediction of hemodialysis in 28.5% of AKI group of patients.

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**Key word:** peripartum – AKI

### 1. Introduction:

There is a high degree of heterogeneity of diagnostic definitions of renal diseases in pregnancy and therefore there is no validated definition for acute kidney injury (**AKI**)<sup>(1)</sup>

**Peripartum period** is defined as a period of few days before the onset of labour till 6 weeks after delivery<sup>(2)</sup>.

The use of the RIFLE classification, which focuses on the plasma creatinine percentage change and on the development of oliguria, is not consensual and further studies are necessary to demonstrate its usefulness in pregnant women. A creatinine level of  $\geq 1$  mg/dL or a rapid rise (by definition, in 48 hours) of 0.5 mg/dL above baseline should be investigated<sup>(3)</sup>. In developing countries pregnancy related AKI despite a

decrease in renal cortical necrosis following obstetrical complication<sup>(4)</sup>, Still accounts for 5–20% of total AKI<sup>(5)</sup>. Simultaneously, mortality decreased from 70% in 1984–1994 to 10–35% in 1995–2005<sup>(6)</sup>.

Usually, the development of peripartum AKI in the third trimester, due to late obstetric complications. As in the general population, the causes of AKI in pregnant women are divided into 3 groups: prerenal, intrarenal and postrenal<sup>(7)</sup>.

The prerenal causes are more common in the earlier stage of pregnancy due to hyperemesis gravidarum or acute tubular necrosis in the context of septic abortion. In the later stages, AKI development is more frequent and usually associated with preeclampsia, acute fatty liver of pregnancy, hemolytic uremic syndrome (HUS) and sepsis<sup>(8)</sup>.

There are 3 aspects to consider in the management of AKI related to pregnancy: **(a)** Renal function supportive measures such as: etiology treatment, suspension of nephrotoxic drugs or treatment of an infectious disease). These general measures are followed by pharmacologic therapy of AKI and its known complications: hypertension, hyperkalemia, metabolic acidosis and anemia. **(b)** Dialysis :if the previous procedures prove to be insufficient. **(c)** Treatment of the underlying disease <sup>(9)</sup>.

Understanding normal physiology during pregnancy provides a context to further describe changes in pregnancy that lead to renal dysfunction and may provide clues to better management <sup>(10)</sup>.

## 2. Patients and methods

This study was conducted on 120 female patients during the peripartum period selected from the Gynecology and Obstetric Department & Nephrology Unit of Meoufiya University Hospitals and Shebien Elkom Teaching Hospital during the period from December, 2012 to August, 2014.

The study population was divided into 2 groups:

**\*Group 1** patients with acute kidney injury **(AKI Group)**: included 49 patients (40.8%).

**\*Group 2** patients with non acute kidney injury **(Non AKI Group)**: included 71 patients (59.2%).

### Inclusion criteria:

- 1- Chronic hypertensive patients.
- 2- Diabetic patients.
- 3- Patients with autoimmune diseases (systemic lupus or antiphospholipid).
- 4- Patients with preeclampsia (previous history or current preeclampsia).
- 5- Cases of antepartum hemorrhage.
- 6- Fatty liver with pregnancy.
- 7- Patients with coagulation disorders.

### Exclusion criteria:

1. Patients with chronic kidney disease (CKD).
2. Patients with end stage renal disease (ESRD).

**All the studied groups were subjected to the following:**

#### 1- Full history taking including:

Age, Sex, gynecological and obstetric history, past history, family history, body weight, Cardiovascular diseases, (e.g. chronic hypertension), Pre-existing chronic kidney disease or genitourinary symptoms,, serum creatinine, urine output, RRT, Pre-existing chronic disease (e.g. Diabetes mellitus) Autoimmune diseases (e.g. antiphospholipid, systemic lupus), Preeclampsia (previous history and current preeclampsia)

#### 2- Thorough physical examination.

#### 3- Laboratory Investigations:

**A-Venous & arterial blood samples were taken.**

1. Serum creatinine.( Estimated at first visit, intrapartum, 6 weeks after delivery and follow up to AKI group of patients for more than 3 months), Blood urea nitrogen, Arterial blood gases, Liver function tests e.g. Serum bilirubin and serum albumin, Prothrombin time (PT), international normalized ratio (INR) and Complete blood count

**B-Complete urine analysis.**

**C- Urine Albumin to Creatinine ratio.**

(In cases of creatinine exceeding 1.5 mg/dl or hypertension > 140/90 mmHg.).

### Sampling:

Mid-stream urine samples were obtained from the studied subjects in sterile containers after instructing them to clean the genital area with soap and tap water. Morning urine samples were obtained whenever possible, in case of catheterized patients, the urine samples were collected after 30 minutes of clamping the catheter, through a syringe and needle inserted proximal to the site of clamping under all aseptic precautions. Urine samples were examined either immediately (within 2 hours) or, if not possible, refrigerated at 4°C to be examined within 24 hours **(7)**. measured by ichromia™ Microalbumin along with ichromia™ Reader is a fluorescence immunoassay that measures concentration of Microalbumin in human urine.

### Statistical analysis of the collected data:-

Data were collected, tabulated, statistically analyzed by computer using SPSS version 16. The quantitative data were expressed as mean and standard deviation (Mean ±SD). The qualitative data were expressed as number and percentage and analyzed by the chi-square test ( $\chi^2$ ) and the student's t test for the normally distributed variables and The Mann Whitney test was used for the non normally distributed variables. The student t-test for comparison between two means. All these tests were used as tests of significance at  $p < 0.05$  level.

## 3. Results:

Our study was conducted on 120 pregnant female patients during the peripartum period In this study 16 patients (13.3%) were diabetic and 55 patients (45.8%) were hypertensive. Mean age of patients was  $27.61 \pm 4.0$  years old ranging between 22-38 years old. The patients in this study were divided according to absolute increase in serum creatinine of  $\geq$  or  $> 0.3$  mg/dl or a percentage increase in serum creatinine of  $\geq$  or  $> 50\%$  (1.5-fold from baseline) (two creatinine values within 48 hours) into 2 groups:

**\*Group 1** patients with acute kidney injury **(AKI Group)**: included 49 patients (40.8%).

**\*Group 2** patients with non acute kidney injury **(Non AKI Group)**: included 71 patients (59.2%).

Our study revealed that The group with AKI is of significantly higher age, systolic blood pressure, diastolic blood pressure, mean blood pressure, diabetes mellitus, the percentage of preeclampsia, the heamodialysis and IUFD than non AKI group of patients.(Table1).also the group with AKI is of significantly higher levels of serum creatinine 48 hours post partum, serum creatinine during 6 weeks after delivery, BUN 48hrs postpartum, BUN during 6 weeks after delivery, uric acid, blood glucose, albumin to creatinine ratio in urine, urine albumin to creatinine ratio during 6 weeks after delivery (Table 2). There is no specific significant independent risk factor for AKI which means that the prediction of AKI is multi factorial such as hypertension, diabetes,preeclampsia, increased serum creatinine 48 hours postpartum and other factors ( Table 3),our study shows that the group of patients with AKI needing heamodialysis is of significantly higher systolic, and mean blood pressure, hypertension,

diabetes,preeclampsia than the group of patients with AKI not needing heamodialysis.(Table 4).And our study revealed that serum creatinine 48 hrs post partum,Serum creatinine during 6 weeks after delivery, BUN 48hrs postpartum, BUN during 6 weeks after delivery, serum uric acid and urine albumin to creatinine ratio during 6 weeks after delivery are highly significant in AKI group.(Table 5). DM, hypertension, serum creatinine 48 hrs post partum and uric acid are significant independent risk factors for prediction of heamodialysis patients with odds ratio (1.82, 2.34, 2.11, 1.73) respectively)Table 6). 14 patients who went heamodialysis were followed up after 6 weeks and up to 3 months of delivery which revealed that 6 (42.9%) patients recovered completely while 5 (35.7%) patients completely recovered, 2 (14.3%) patients became Chronic Kidney Diseased patients and 1 (7.1%) patient became End Stage Renal Diseased patient after 3 months of follow up. (Table 7).

**Table (1) Comparison between cases with acute and non acute kidney injury regarding to some clinical parameters.(N=120)**

| Variable                 | Group 1<br>AKI(N=49) | Group 2 Non AKI(N=71) | t-test | P value |
|--------------------------|----------------------|-----------------------|--------|---------|
|                          | Mean ± SD            | Mean ± SD             |        |         |
| Age                      | 30.27±4.29           | 25.77±2.5             | 6.60   | <0.001  |
| Systolic blood pressure  | 167.55±13.62         | 154.79±12.29          | 5.35   | <0.001  |
| Diastolic blood pressure | 99.18±8.12           | 93.38±5.33            | 4.73   | <0.001  |
| Mean blood pressure      | 121.97± 9.38         | 113.85±6.56           | 5.59   | <0.001  |

| Variable                                    | Group 1<br>AKI(N=49) |      | Group 2 Non AKI(N=71) |      | X <sup>2</sup> | P value |
|---|----------------------|------|-----------------------|------|----------------|---------|
|   | No                   | %    | No                    | %    |                |         |
| <b>DM</b>                                   |                      |      |                       |      |                |         |
| Positive                                    | 15                   | 30.6 | 1                     | 1.4  | 21.4           | <0.001  |
| Negative                                    | 34                   | 69.4 | 70                    | 98.6 |                |         |
| <b>Hypertension</b>                         |                      |      |                       |      |                |         |
| Positive                                    | 35                   | 71.4 | 20                    | 28.3 | 21.9           | <0.001  |
| Negative                                    | 14                   | 28.6 | 51                    | 71.7 |                |         |
| <b>Preeclampsia</b>                         |                      |      |                       |      |                |         |
| Positive                                    | 41                   | 83.7 | 48                    | 67.6 | 3.91           | 0.04S   |
| Negative                                    | 8                    | 16.3 | 23                    | 32.4 |                |         |
| <b>Drugs</b>                                |                      |      |                       |      |                |         |
| No drugs                                    | 6                    | 12.2 | 61                    | 85.9 | 64.2           | <0.001  |
| Antihypertensive                            | 29                   | 59.2 | 8                     | 11.3 |                |         |
| Insulin + Antihypertensive                  | 14                   | 28.6 | 2                     | 2.8  |                |         |
| <b>Heamodialysis</b>                        |                      |      |                       |      |                |         |
| Positive                                    | 14                   | 28.6 | 0                     | 0.0  | 22.96          | <0.001  |
| Negative(complete recovered conservatively) | 35                   | 71.4 | 71                    | 100  |                |         |
| <b>Foetal Outcome</b>                       |                      |      |                       |      |                |         |
| Living fetus                                | 39                   | 79.6 | 71                    | 100  | 15.8           | <0.001  |
| IUFD  | 10                   | 20.4 | 0                     | 0.0  |                |         |

**Table (2) Comparison between cases with acute and non acute kidney injury regarding to laboratory parameters.(N=120)**

| Variable  | Group 1<br>AKI(N=49) |      | Group 2<br>Non AKI(N=71) |      | Test of significance | P value |
|---|----------------------|------|--------------------------|------|----------------------|---------|
|   | Mean ± SD            |      | Mean ± SD                |      |                      |         |
| Platelets   | 233.98±81.13         |      | 255.46±61.99             |      | 1.92#                | 0.06    |
| Hb  | 10.90±1.35           |      | 10.69±1.07               |      | 0.92*                | 0.36    |
| Serum creatinine 1st visit                          | 0.69±0.10            |      | 0.66±0.09                |      | 1.25*                | 0.21    |
| Serum creatinine 48hrs postpartum                   | 1.42±0.35            |      | 0.77±0.08                |      | 15.3*                | <0.001  |
| Serum creatinine 6 weeks after delivery             | 3.53±2.28            |      | 0.85 ±0.21               |      | 9.12#                | <0.001  |
| BUN 48hrs postpartum                                | 67.63±36.80          |      | 43.72±9.13               |      | 3.78#                | <0.001  |
| BUN during 6 weeks after delivery                   | 87.55±37.17          |      | 63.38±9.32               |      | 3.80#                | <0.001  |
| Uric acid   | 8.08±1.59            |      | 7.02±1.87                |      | 3.23                 | 0.002   |
| blood glucose                                       | 142.98±52.52         |      | 102.37±23.83             |      | 3.86                 | <0.001  |
| Albumin   | 2.86±0.28            |      | 3.09 ±0.36               |      | 3.69                 | <0.001  |
| Total bilirubin                                     | 3.09±0.36            |      | 2.86±0.28                |      | 1.08*                | 0.28    |
| ALT   | 32.33±11.79          |      | 28.70±12.82              |      | 1.48#                | 0.13    |
| AST   | 46.22±12.32          |      | 41.93±11.90              |      | 1.92*                | 0.06    |
| INR   | 1.0±0.0              |      | 1.01±0.04                |      | 1.1                  | 0.44    |
| PH  | 7.4±0.07             |      | 7.42±0.02                |      | 1.37                 | 0.18    |
| PCO2  | 38.39±4.54           |      | 37.68±2.29               |      | 1.01                 | 0.32    |
| HCO3  | 23.47±4.84           |      | 24.79±2.82               |      | 1.72                 | 0.09    |
| Albumine / creatinine ratio                         | 289.90±75.16         |      | 80.35±31.09              |      | 9.01                 | <0.001  |
| Urine Alb / creatinine ratio 6 weeks after delivery | 221.43±74.91         |      | 48.93±24.89              |      | 8.95#                | <0.001  |
| Variable  | Group 1<br>AKI(N=49) |      | Group 2<br>Non AKI(N=71) |      | X <sup>2</sup>       | P value |
|   | No                   | %    | No                       | %    |                      |         |
| Pus cells   |                      |      |                          |      | 17.7                 | <0.001  |
| Positive  | 35                   | 71.4 | 23                       | 32.4 |                      |         |
| Negative  | 14                   | 28.6 | 48                       | 67.6 |                      |         |

\*= t test

# = Mann Whitney U test

**Table (3):- Logistic regression analysis for independent risk factors of acute kidney injury**

|                                      | B     | SE     | P value | Expected β | CI Lower | CI upper |
|--------------------------------------|-------|--------|---------|------------|----------|----------|
| Mean BP                              | 0.32  | 46.04  | 0.76    | 1.36       | 0.23     | 16.5     |
| DM                                   | -8.73 | 97.75  | 0.87    | 0.88       | 0.0      | 10.9     |
| HTN                                  | -6.41 | 78.90  | 0.91    | 0.72       | 0.02     | 8.77     |
| Serum creatinine 48hrs postpartum    | 26.0  | 125.08 | 0.63    | 2.22       | 1.12     | 22.9     |
| Uric acid                            | 1.90  | 89.48  | 0.45    | 1.12       | 0.66     | 51.3     |
| Serum albumin                        | 91.56 | 13.21  | 0.94    | 0.75       | 0.04     | 15.7     |
| Albumine / creatinine ratio in urine | -0.23 | 65.38  | 0.73    | 0.79       | 0.23     | 25.8     |
| Preeclampsia                         | -3.58 | 59.64  | 0.28    | 1.09       | 0.09     | 34.8     |

**Table (4) Comparison between acute kidney injury cases (needing heamodialysis and don't need) regarding to some clinical parameters. (N=120)**

| Variable                 | Needing heamodialysis (N=14) |  | Don't need (N=35) |  | Mann Whitney | P value |
|--------------------------|------------------------------|--|-------------------|--|--------------|---------|
|                          | Mean ± SD                    |  | Mean ± SD         |  |              |         |
| Age                      | 31.5 ± 4.86                  |  | 29.77 ± 4         |  | 1.25         | 0.21    |
| Systolic blood pressure  | 175.0 ± 14.54                |  | 164.6 ± 12.21     |  | 2.56         | 0.01    |
| Diastolic blood pressure | 102.9 ± 9.13                 |  | 97.7 ± 7.3        |  | 2.07         | 0.04    |
| Mean blood pressure      | 126.9 ± 10.6                 |  | 120.0 ± 8.2       |  | 2.45         | 0.02    |

| Variable                   | Needing heamodialysis (N=14) |      | Don't need (N=35) |      | Fisher | P value |
|----------------------------|------------------------------|------|-------------------|------|--------|---------|
|                            | No                           | %    | No                | %    |        |         |
| <b>DM</b>                  |                              |      |                   |      |        |         |
| Positive                   | 8                            | 57.1 | 7                 | 20   | 6.50   | 0.02    |
| Negative                   | 6                            | 42.9 | 28                | 80   |        |         |
| <b>Hypertension</b>        |                              |      |                   |      |        |         |
| Positive                   | 13                           | 92.9 | 22                | 62.9 | 4.41   | 0.04    |
| Negative                   | 1                            | 7.1  | 13                | 37.1 |        |         |
| <b>Preeclampsia</b>        |                              |      |                   |      |        |         |
| Positive                   | 14                           | 100  | 27                | 77.1 | 3.82   | 0.05    |
| Negative                   | 0                            | 0.0  | 8                 | 22.9 |        |         |
| <b>Drugs</b>               |                              |      |                   |      |        |         |
| No drugs                   | 1                            | 7.1  | 5                 | 14.3 | 4.45   | 0.11    |
| Antihypertensive           | 6                            | 42.9 | 23                | 65.7 |        |         |
| Insulin + Antihypertensive | 7                            | 50.0 | 7                 | 20   |        |         |
| <b>Fetal Outcome</b>       |                              |      |                   |      |        |         |
| Living fetus               | 11                           | 78.6 | 28                | 80   | 0.01   | 1.0     |
| IUFD                       | 3                            | 21.4 | 7                 | 20   |        |         |

Table (5) Comparison between acute kidney injury cases (needing heamodialysis and don't need) regarding to laboratory parameters.(N=120)

| Variable   | Needing heamodialysis (N=14) |              | Don't need (N=35) |        | Mann Whitney   | P value |
|--|------------------------------|--------------|-------------------|--------|----------------|---------|
|  | Mean ± SD                    | Mean ± SD    |                   |        |                |         |
| <b>Platelets</b>   | 217.07±90.44                 | 240.74±77.45 | 1.33              | 0.18   |                |         |
| <b>Hb</b>  | 11.09±1.39                   | 10.82±1.35   | 0.76              | 0.45   |                |         |
| <b>Serum creatinine 1st visit</b>                          | 0.71±0.12                    | 0.68±0.10    | 0.72              | 0.47   |                |         |
| <b>Serum creatinine 48hrs postpartum</b>                   | 1.61±0.40                    | 1.35±0.29    | 2.58              | 0.01   |                |         |
| <b>Serum creatinine durin 6 weeks after delivery</b>       | 6.61±1.24                    | 2.30±1.12    | 5.35              | <0.001 |                |         |
| <b>BUN48hrs postpartum</b>                                 | 120.14±26.78                 | 46.63±6.95   | 4.92              | <0.001 |                |         |
| <b>BUN during 6 weeks after delivery</b>                   | 140.93±26.22                 | 66.2±6.77    | 4.92              | <0.001 |                |         |
| <b>Uric acid</b>   | 9.19±1.53                    | 7.63±1.40    | 3.01              | 0.003  |                |         |
| <b>blood glucose</b>                                       | 156.0±54.22                  | 137.77±51.69 | 1.15              | 0.25   |                |         |
| <b>Albumin</b>   | 2.91±0.34                    | 3.16±0.35    | 2.46              | 0.01   |                |         |
| <b>Total bilirubin</b>                                     | 0.71±0.23                    | 0.74±0.24    | 0.42              | 0.67   |                |         |
| <b>ALT</b>   | 36.07±14.53                  | 30.83±10.38  | 1.19              | 0.23   |                |         |
| <b>AST</b>   | 47.71±14.51                  | 45.63±11.5   | 0.34              | 0.73   |                |         |
| <b>INR</b>   | 1.0±0                        | 1.0±0.0      | 0.0               | 1.0    |                |         |
| <b>PH</b>  | 7.38±0.08                    | 7.41±0.07    | 1.18              | 0.23   |                |         |
| <b>PCO2</b>  | 40.0±5.40                    | 37.74±4.05   | 1.53              | 0.13   |                |         |
| <b>HCO3</b>  | 22.57±4.2                    | 23.83±5.09   | 1.13              | 0.26   |                |         |
| <b>Albumine / creatinine ratio</b>                         | 311.41±84.81                 | 281.29±70.42 | 1.68              | 0.09   |                |         |
| <b>Urine Alb / creatinine ratio 6 weeks after delivery</b> | 247.8±83.5                   | 210.3±59.3   | 2.42              | 0.015  |                |         |
| Variable   | Needing heamodialysis (N=14) |              | Don't need (N=35) |        | X <sup>2</sup> | P value |
|  | No                           | %            | No                | %      |                |         |
| <b>Pus cells</b>   |                              |              |                   |        |                |         |
| Positive   | 13                           | 92.9         | 22                | 62.9   | Fisher<br>4.41 | 0.04    |
| Negative   | 1                            | 7.1          | 13                | 37.1   |                |         |

\*= t test

# = Mann Whitney U test

**Table (6) Logistic regression analysis for independent risk factors of heamodialysis.**

|                                      | B     | SE    | P value | Expected $\beta$ | CI Lower | CI Upper |
|--------------------------------------|-------|-------|---------|------------------|----------|----------|
| Mean BP                              | -0.01 | 0.09  | 0.87    | 0.99             | 0.63     | 1.16     |
| DM                                   | -1.51 | 1.49  | 0.03    | 1.82             | 0.01     | 4.12     |
| HTN                                  | -1.06 | 1.62  | 0.04    | 2.34             | 0.01     | 8.36     |
| Serum creatinine 48hrs postpartum    | -2.24 | 2.56  | 0.02    | 2.11             | 0.001    | 16.14    |
| Uric acid                            | -0.94 | 0.45  | 0.04    | 1.73             | 0.16     | 3.95     |
| Serum albumin                        | 2.29  | 1.55  | 0.14    | 1.03             | 0.48     | 16.11    |
| Albumine / creatinine ratio in urine | 0.04  | 0.01  | 0.62    | 1.004            | 0.59     | 1.02     |
| Preeclampsia                         | -5.80 | 34.55 | .87     | 0.93             | 0.22     | 46.34    |

**Table (7) The outcome of the heamodialysis patients after follow up for more than three months after delivery (NO=14).**

|  | Number (N=14) | %    |
|--|---------------|------|
| <b>Complete recovery</b>                     |               |      |
| After 6 weeks and up to 3 months of delivery | 6             | 42.9 |
| After 3 months of delivery                   | 5             | 35.7 |
| <b>CKD patients</b>                          | 2             | 14.3 |
| <b>ESRD patients</b>                         | 1             | 7.1  |

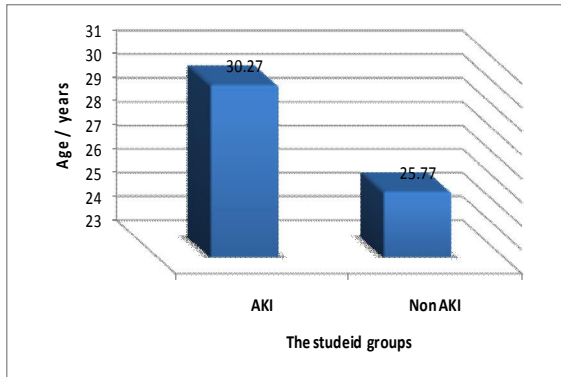


Figure (1) comparison between the studied groups regarding to age

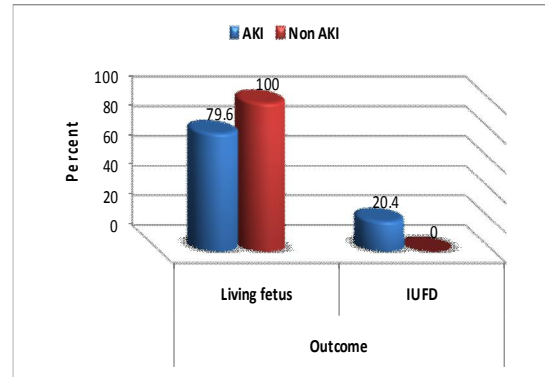


Figure (3) comparison between the studied groups regarding to the fetal outcome either the percentage of living fetus or IUFD in the study patients.

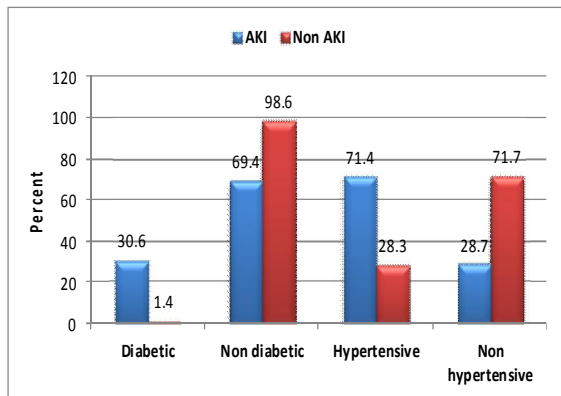


Figure (2) comparison between the studied groups regarding to the percentage of diabetic and hypertensive patients of the study.

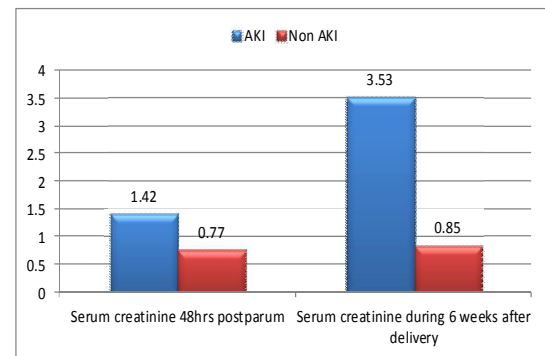


Figure (4) comparison between the studied groups regarding to levels of serum creatinine 48 hours post partum and serum creatinine during 6 weeks after delivery.



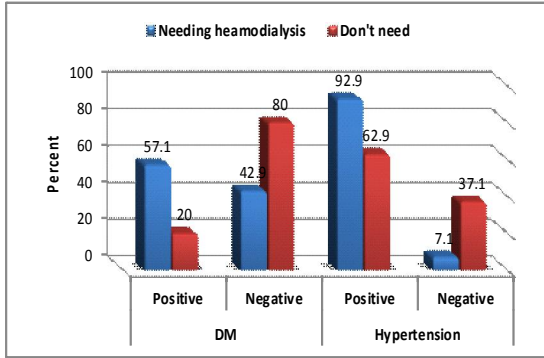


Figure (5) comparison between the studied groups regarding to the percentage of diabetic and hypertensive patients of the study.

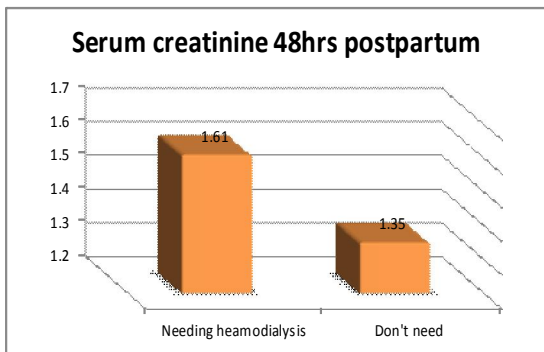


Figure (6) comparison between the studied groups regarding to levels of serum creatinine 48 hours post partum.

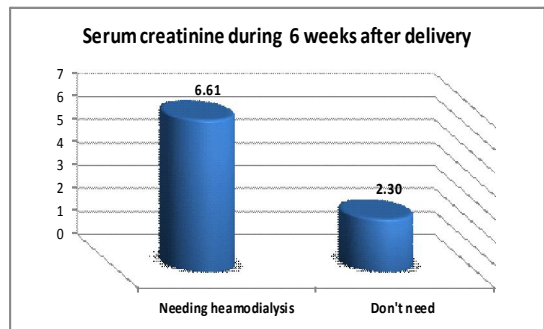


Figure (7) comparison between the studied groups regarding to levels of serum creatinine during 6 weeks after delivery.

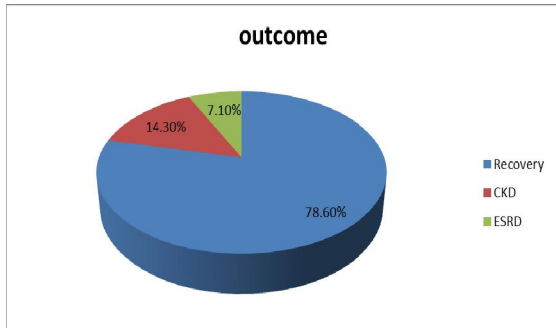


Figure (8) The outcome of the hemodialysis patients after follow up for more than three months after delivery.

**4. Discussion:**

AKI is a not very common yet serious complication occurring in pregnancy. The aim of this work is to study positive cases of peripartum acute kidney injury causes, risk factors, how to diagnose and manage each case.

In group 1 AKI patients in our study the mean age (30.27±4.29) years old, This goes with the study **Arrayhani et al. (2013)**<sup>(11)</sup> which report the mean age with an average of 29.03± 6.3 years old.

Other studies backing up our findings regarding mean age are: study **Khalil et al. (2009)**<sup>(12)</sup> which reports average age is 29 years old, study **Arora et al (2010)**<sup>(13)</sup> which reports average age of 25.8 years old and study **Altintepe et al. (2005)**<sup>(14)</sup> which reports average age 31.6 years old as well. Age appeared to be a factor significantly associated with unfavorable evolution (*p* value <0.001). In the literature, this factor was associated with increase perinatal complications, including premature delivery (**Colmant et al., 2009**)<sup>(15)</sup>.

In current study we found highly significant difference (*p*<0.001) between AKI and Non AKI groups as regards hypertension, systolic blood pressure, diastolic blood pressure and mean blood pressure, as hypertension was a common symptom present in 71.4 % in AKI group, this corresponding with **Arrayhani et al. (2013)**<sup>(11)</sup> study as hypertension was present in 55.6% of patients. Also the incidence rate of hypertension was significantly higher in AKI group than the Non AKI group (*P*<0.05) in **Zhu(2011)**<sup>(16)</sup> study. Most women (54 %) had hypertensive disorders during pregnancy in **Carmelina Gurrieri et al. (2012)**<sup>(17)</sup> study.

pre-existing hypertension increases the risk of adverse outcomes of pregnancy, most notably via an increased risk of superimposed pre-eclampsia, which may be associated with preterm delivery, fetal growth restriction and deterioration in renal function (**Centre for Maternal and Child Enquiries, 2011**)<sup>(18)</sup>.

In our study the mean peak urea was (67.63±36.80) mg/dl in AKI group patients after 48 hours of delivery and rises to the mean value of (87.55±37.17) mg/dl during 6 weeks after delivery with a high significant difference between AKI group patients and non AKI group patients, it reached to a mean value of (140.93±26.22) mg/dl in female patients who underwent hemodialysis. In concordant with other studies such as **Jai Prakash et al. (2010)**<sup>(19)</sup> study the mean peak urea was (143.24±59.91)mg/dl. Also in the study **Khalil et al. (2009)**<sup>(12)</sup> mean urea was (149±69)mg/dl.

In our work we found high significance between 48 hours post partum serum creatinine in AKI group rather than non AKI group with the mean value of (1.42±0.35) mg/dl and the same with serum creatinine

during 6 weeks after delivery with the mean value of  $(3.53 \pm 2.28)$  mg/dl, and rises to a mean value of  $(6.61 \pm 1.24)$  mg/dl in patients who underwent hemodialysis as well. This concurrent with other studies as **Prakash et al. (2010)**<sup>(19)</sup> in which the mean peak of serum creatinine concentration as  $(5.6 \pm 3.34)$  mg/d l, and in **Arrayhani et al. (2013)**<sup>(11)</sup> the mean serum creatinine was  $(3.48 \text{ mg/dl} \pm 2.54)$  with a maximum value of  $(10.5 \text{ mg/dL})$  and minimum value of  $(1.4 \text{ mg/dl})$ . these results are agreed with those published by study **Altintepe et al. (2005)**<sup>(14)</sup> with the mean serum creatinine as  $(5.7 \text{ mg/dl})$ , but significantly inferior to those found in the **Khalil et al. (2009)**<sup>(12)</sup> with the mean serum creatinine as  $(9.7 \text{ mg/dl})$ . Further more it was  $(6.5 \pm 2.5)$  mg/dl (range 2.2-16.22 mg/dL) in **Suraj et al. (2014)**<sup>(20)</sup> study as well.

In our present study the percentage of preeclampsia among AKI group significantly higher than its percentage among non AKI group (83.7% versus 67.6%) respectively. On the contrary in **Suraj et al. (2014)**<sup>(20)</sup> study pre-eclampsia/eclampsia was (33.3%), also in **Kilari et al. (2006)**<sup>(21)</sup> toxemias of pregnancy was (24.39%), (15%) in **Najar et al. (2008)**<sup>(24)</sup> and (12%) in **Ansari et al. (2008)**<sup>(25)</sup> While study **Carmelina Gurrieri et al. (2012)**<sup>(17)</sup> observed that KI was associated with preeclampsia in a substantial percentage (20.4 %) of patients as well.

The majority of the studies agreed with our study and reported eclampsia-preeclampsia as a major cause of obstetrical AKI. Studies of **Hachim et al. (2001)**<sup>(22)</sup>, **Erdemoglu et al. (2010)**<sup>(23)</sup> and **Arrayhani et al. (2013)**<sup>(11)</sup> found eclampsia-preeclampsia in (66.7%), (74.5%) and (75.2%) respectively. This discrepancy between various studies conducted in different countries might be due to good antenatal care leading to decrease incidence of obstetrical and early detection of eclampsia-preeclampsia.

Preeclampsia is the leading cause of acute kidney injury in the last trimester and occurs in 7% of all pregnancies. It is due to utero-placental ischemia. It is the leading cause of maternal and fetal mortality in the world. It is associated with intrauterine growth retardation and small for gestational age (SGA) babies. It is a triad of hypertension, proteinuria and oedema occurring after the 20<sup>th</sup> week of gestation with few cases developing postpartum within hours, usually in the first 24 to 48 hours. The definitive treatment of preeclampsia is delivery to prevent development of maternal or fetal complications from disease progression (**Carty et al., 2010**)<sup>(26)</sup>

In our work, the percentage of diabetic patients between AKI group patients is highly significant ( $p$  value  $< 0.001$ ) which is (30.6%) versus (1.4%) in non AKI group patients. In **Carmelina Gurrieri et al.**

**(2012)**<sup>(17)</sup> diabetes percentage about (13%) of AKI patients.

Contrary to that, in the United States, (0.65 %) of women have diabetes mellitus before pregnancy, and (4.1 %) of pregnancies are complicated by gestational diabetes. Pregnant women with diabetes are more likely to have proteinuria and are at higher risk for preeclampsia. Pregnant women with diabetes but preserved renal function appear to have low risk of kidney impairment, but those with diabetic nephropathy and moderate to severe renal insufficiency (prepregnancy sCr  $\geq 1.4$  mg/dL) have a more than 40 % chance of accelerated progression of kidney disease during pregnancy (**Powe et al., 2011**)<sup>(27)</sup>

In our study there is high significant difference between AKI and non AKI groups ( $p$  value  $< 0.001$ ) as regards urinary tract infection as it presents in (71.4%) of AKI group of patients. This is contradictory to the study **Suraj et al. (2014)**<sup>(20)</sup>, in which acute pyelonephritis was (5%), urinary tract infection with sepsis in **Khalil et al. (2009)**<sup>(12)</sup> was (1.66%), in **Carmelina Gurrieri et al. (2012)**<sup>(17)</sup> urinary tract infection was (18.5%) as well.

In developing countries, infections, especially those resulting in sepsis after abortion or delivery, are major risk factors for the development of pregnancy-associated KI (**Goplani et al., 2008**)<sup>(5)</sup>

The outcome of our study shows high significant difference between AKI group patients and non AKI group patients ( $p$  value  $< 0.001$ ) as regards needing for dialysis in AKI group patients and foetal outcome, as we found in AKI group the percentage of hemodialysis needing patients is (28.6%) and (71.4%) of AKI patients completely recovered conservatively after follow up for 6 weeks after delivery and did not need hemodialysis. We found that 14 patients who went hemodialysis were followed up after 6 weeks and up to 3 months of delivery which revealed that 6 (42.9%) patients recovered completely while 5 (35.7%) patients completely recovered, 2 (14.3%) patients became Chronic Kidney Diseased patients and 1 (7.1%) patient became End Stage Renal Diseased patient after 3 months of follow up. (Table 7). This goes with other studies as dialysis needing in **Erdemoglu et al. (2010)**<sup>(23)</sup> was (33.3%), **Khanal et al. (2010)**<sup>(28)</sup> was (25%), **Najar et al. (2008)**<sup>(24)</sup> was (60%), and in **Kilari et al. (2006)**<sup>(21)</sup> was (53.66%) as well, while in **Khalil et al. (2009)**<sup>(12)</sup> (73.33%) of the patients required haemodialysis while the rest were treated conservatively.

Obstetrical ARF causes significant maternal morbidity. Although some of the patients regain their renal function back to normal, others are left with persistent renal dysfunction. **Khalil et al. (2009)**<sup>(12)</sup>



found recovery of renal function in (76.66%), with full recovery in (46.66%) cases. The majority of the remaining patients (30%) had partial recovery, not requiring renal replacement therapy. Only (8.33%) of the patient had dialysis dependent chronic kidney disease. Abroad **Hachim et al. (2001)**<sup>(22)</sup>, **Akhter et al. (2004)**<sup>(28)</sup> and **Alexopoulos et al. (1993)**<sup>(29)</sup> reported better results than ours. They reported recovery of renal functions in (87.3%), (82%) and (84.6%) of their cases. On the other hand the percentage of patients who needed dialysis much less than ours in **Hassan et al. (2009)**<sup>(30)</sup> was (6%), **Khalil et al. (2009)**<sup>(12)</sup> was (5%), **Prakash, et al (2010)**<sup>(19)</sup> was (1%) and in **Arora, et al (2010)**<sup>(13)</sup> was (3%) as well. The better results reported in various studies from developed world might be due to good literacy rate, better health care facilities and good antenatal and obstetrical care.

Our study revealed that the percentage of intrauterine foetal death is (20.4%). Other studies when compared with our study as regards the percentage of intrauterine foetal death reported different results such as in **Suraj et al. (2014)**<sup>(20)</sup> foetal loss was (49.12%) and in **Kilari et al. (2006)**<sup>(21)</sup> intrauterine deaths were noted in (17.07%), The foetal mortality in **Khalil et al. (2009)**<sup>(12)</sup> study is also high as compared to various studies abroad. It was found foetal loss is (66.66%) of cases as compared to (44–55%) in other studies. These findings might be due to better health care facilities and good antenatal and perinatal care in those countries.

Intra-uterine death and still birth has been reported as high as 30-70% (**Khanal et al., 2010**).<sup>(28)</sup>

High incidence of foetal loss was associated with increased incidence of dialysis dependency in mothers. This could be owing to the increased severity of illness. Perinatal mortality is significantly low in neonates born to pregnant mothers without AKI as compared to those who developed AKI during pregnancy (**Khanal et al., 2010**).<sup>(28)</sup>

Our study demonstrates that there is no significant independent risk factors for AKI which means that the prediction of AKI is multi factorial in the total risk factors this means that the summation of more than one factor from such factors; diabetes, hypertension, hyperuricemia, serum creatinine 48 hrs post partum, urine albumin to creatinine ratio, decreased serum albumin and preeclampsia together increases the risk of AKI incidence in pregnant female. Also the presence of some of these risk factors in AKI group patients such as diabetes mellitus, hypertension, serum creatinine 48 hrs post partum and uric acid are significant independent risk factors for prediction of hemodialysis in female patients with AKI with odds ratio of (1.82, 2.34, 2.11, 1.73) respectively. There have been few studies of the risk

factors associated with obstetric AKI. Besides hyperuricemia and oliguria that are classical factors associated with AKI, **Yassamine Bentata et al. (2012)**<sup>(31)</sup> study have found other factors strongly associated with AKI: icterus, sepsis, abruption placentae, severe anemia and thrombocytopenia. These factors correspond to severe clinical and biological situations favoring the appearance of AKI. **Mjahed et al.**<sup>(32)</sup>, while analyzing AKI related to eclampsia in intensive care, identify a number of factors associated with AKI, such as icterus, abruption placentae, HELLP syndrome, obstetric hemorrhage, anemia and thrombopenia (**Mjahed et al. 2004**)<sup>(32)</sup>. On the contrary **Thangaratinam et al. (2006)**<sup>(33)</sup> study in which serum uric acid is a poor predictor of maternal and fetal complications in pregnant women with AKI. Our findings indicate that the majority of women who experienced deterioration of kidney function during late pregnancy and in the peripartum period had substantial preexisting comorbid conditions or complications that could have placed them at risk for renal injury.

#### Conclusions:

In the conclusion, the results of our study may facilitate the recognition of women at increased risk for acute kidney injury in the peripartum period, leading to appropriate surveillance and timely implementation of protective measures to avoid or minimize injuries.

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