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Acute Kidney Injury Among Neonates

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Abstract:

- ***Introduction:***

Acute kidney injury (AKI) is among the major tasks in neonatology globally. Its incidence has wide range globally. The mortality and the risk factors for death due to AKI signifies one of the foremost reasons of death among neonatal period.

- ***Aim:***

To identify the incidence of AKI among neonates in neonatal intensive care (NICU) and to determine its causes and the risk factors of mortality among neonates with AKI.

- ***Methodology:***

It is a retrospective hospital-based study conducted in the NICU of AL- Sabeen hospital for Maternity and Childhood (SHMC) over a year. Epi-Info program No. 7 was used to analyse the data that retrieved from the hospital's records of the enrolled patients using a pre-designed questionnaire.

- ***Results:***

The rate of AKI among the 1086 NICU admissions was 5.3% and the mortality rate among neonates with AKI was 41%. Gestation age <37 weeks, the need for mechanical ventilation (M.V.) and hospitalization days > 3 days were the significant independent factors for death among neonates with AKI.

- ***Conclusion:***

Preventing AKI and decreasing mortality among them may be achieved by early identification of risk factors and prompt treatment of underlying disease.

Keywords: *Neonate, Acute kidney Injury, Mortality Rate, Risk Factor, Sana'a.*

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I. INTRODUCTION

- *Background:*

AKI is a considerable dilemma in neonates, but the evidence is infrequent (1, 2, 3, 4). Neonates are more prone to AKI because their kidneys are functionally immature (5). Furthermore, the physiological characteristics of neonates render them liable to a reduction in sodium reabsorption from the kidneys as a result of increased activity of plasma renin due to hypo-perfusion (6).

AKI is defined as a abrupt reduction in glomerular filtration rate (GFR) that results in the advanced retention of creatinine and nitrogenous products and the incapability to adjust fluid and electrolyte homeostasis (7,8,9).

The definition of AKI in neonates is less accurate since the serum creatinine soon after birth reflects the renal function of the mother.

Among all neonates who admitted to NICUs, AKI develops in about 8%-24% (10). In a meta-analysis study, the frequency of any stage AKI was 30%, and that of severe AKI was 15% (11). The prevalence of AKI is not known globally.

The presentation of AKI ranges from mild injury to complete renal failure. Many cases will be missed because AKI in newborns usually asymptomatic if related investigations are not conducted. The most straightforward and broadly used biomarker of newborn renal function is blood creatinine level (12,13).

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An empirical working AKI definition was proposed in 2004, The RIFLE (risk, injury, failure, loss, and end stage renal disease) classification has been studied in adult population. These studies have not been reproduced in critically sick neonate (14).

A staging scheme which uses mild AKI (stage 1), moderate AKI (stage2) and sever AKI (stage3) in very similar to the risk, injury and failure categories in RIFL was proposed (15). These cataloging systems to define AKI in neonate population have not performed. Table 1 represents the first modification of acute kidney injury network AKI definition and subsequently the kidney disease improving Global outcome (KDIGO) (16), and has serve as the consensus definition that should be applied in research and clinically to identify and phase AKI

Table 1 Neonatal AKI KDIGO Classification

Stage	S. creatinine (Scr)	Urine output
0	No change in Scr or rise < 0.3 mg/dl	≥5 ml/kg/h
1	Scr rise ≥0.3 mg/dl within 48 hr or Scr rise ≥1.5-1.9 X reference Scrα within 7 days	< 0.5 ml/kg/hr for 6 to 12 hr
2	Scr rise ≥ 2.0 − 2.9 X reference Scrα	< 0.5 ml/kg/hr for ≥12 hr
3	Scr rise ≥3X reference Scrα or Scr ≥ 2.5mg/dlβ or receipt of dialysis	< 0.3 ml/kg/hr for ≥24 hrs or anuria for ≥ 12hrs

Differences between the proposed neonatal AKI definition and the KDIGO include the following:

α= Reference of Scr will be defined as the lowest previous Scr value

β = Scr value of 2.5 mg/dl represents < 10 ml/min/1.73m²

AKI plays a noteworthy role in morbidity and death among the neonatal population. It was reported that the mortality rates due to AKI amid neonates are between 10% and 61% (17,18,1).

The etiology of AKI in neonate is multi factorial, and has one or more linked contributing factors such as prematurity, low birth weight, intubation, respiratory distress, pulmonary hypertension, and hyperbilirubinemia (6, 18-25).

➢ *Risk factors that lead to mortality among neonates with AKI*

It was found that necrotizing enterocolitis, perinatal asphyxia, sepsis, nephrotoxic medications, patent ductus arteriosus, were weighty risk factors for AKI in a meta-analysis of about 201 studies from 45 countries involving 98228 participants (11).

Aims: To determine:

- The frequency of AKI among neonates in NICU setting.
- The etiologies of AKI among neonates
- The risk factors of mortality among neonates with AKI.

II. RESEARCH METHODOLOGY

➢ *Study Design*

It is a retrospective hospital-based study, conducted in the NICU of SHMC from 1st October 2021 to 31st October 2022. SHMC is a referral tertiary hospital with a capacity of 85 incubators that distributed over three units. One unit for neonates who born inside the hospital with a capacity of 30 incubators, a second unit with 25 incubators for neonates who born outside the hospital and the third unit where the study was conducted, the NICU that has a capacity of 30 incubators.

➢ *Study Population*

The study population were neonates at an age of 3-28 days who met the criteria for AKI which is a serum creatinine level equal or more than 1.5 mg/dl or increase in creatinine by 0.3 mg/dl/48 hours. The following were excluded: those who referred to from other hospitals and those whose investigation were not complete.

➢ *Methodology:*

The following variables were collected in a predesigned questionnaire such as demographic characteristics, weight, sex, abdominal ultrasound report, outcome including (death and improvement or discharge against medical advice [DAMA]) and length of hospitalization were obtained

➢ *The Sample size:*

Based on a previous study (11) the expected frequency of AKI among neonatal population was 3/1000, STAT Cal Epi Info program version 7.2.5.0 was used to calculate the sample size. It was found that the sample size is 45 children with 5% acceptable margin of error and a confidence interval of 95%. To avoid 2% dropout, 55 children will be enrolled.

➢ *Statistical Analysis*

Statistical analysis was performed using Epi-info No7. T- student test was used to analyse normally distributed numerical data that were shown as means and averages while chi squire test was used to analyse categorical data that were shown as proportions and percentages. Univariate and multiple logistic regression analysis were used to anlyse the risk factors for mortality among neonates with AKI. The level of significance (p value <0.05) was used by calculating the odd ration or the adjusted odd ratio.

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➢ *Ethical considerations:*

The approval of the ethical committee of the hospital was obtained. The data of the patient will be kept in confidential state and the names will not be disclosed.

➢ *Results*

During the study period, 1086 neonates were admitted to the NICU. Fifty-eight neonates were enrolled in the study. The frequency of AKI was 5.3% in the NICU. The mean gestational age of the study population was 35.3 weeks with a range of 29-37 weeks. The mean of their weight was 2.45 Kg and a range of 0.9-4.5Kg. The mean age at diagnosis was 7.2 days. The neonates who diagnosed with AKI were hospitalized for an average of 9.4 days. Their mean creatinine level was 2mg/dl, with a range of 1-5mg/dl. The fatality rate among neonates with AKI was found to be 24 neonates (41%).

The percentage of diagnosis among the study population according to their order of frequency, were multiple congenital anomalies and sepsis 24.14% for each, followed by hypoxic ischemic encephalopathy (HIE) in 20.69%, respiratory distress syndrome (RDS) in12.07% Jaundice and dehydration in 6.9% for each, birth asphyxia, twin and tetanus in 1.72 % for each (table 3).

➢ *The Risk factors of mortality among study population using univariate and multivariate analysis.*

In the present study the mortality rate among the study population study was 41%. The independent risk factors for mortality that were significantly identified were: gestational age less than 37weeks, a duration of hospital stay > 3 days and the need for M.V, these factors were significantly increased the risk for mortality with an AOR of 0.02, 0.02 and 0.009 respectively (table 5).

III. DISCUSSION

This study provides a evocative outline of AKI in neonates admitted to NICU in a tertiary hospital in Sana'a, Yemen. The incidence of AKI in at risk neonates was 5.3 % in this study.

This frequency is less than what was reported in Turkey by Bolat et al (26) who reported a prevalence of 8.4% and more less (13.3%) than a study by Memon (2021), (27) and by Gohiya et al in India who reported an incidence of 21% (10). however, it was 56% by Shalaby et al (2018) in Saudi (28). But We found the frequency of mortality of the study population was 41%, that was higher than what was stated by Desalew et al in Ethiopia (20%) (29) and by Bolat et al in Turkey (28.3%) (26).

In the current study the gestation age <37 weeks was a significant independent risk factor of mortality with a frequency of 33%, that was higher to what was described by Branagan et al, in their study, the preterm group, extreme low birth weight (ELB) neonates had a higher incidence of AKI (48%) in comparison to neonates born at 29-36 weeks gestation (28%) and any episode of AKI in neonates amplified the risk for mortality by three times compared to age matched controls without an AKI (30).

The higher rate of death among premature neonates due to AKI could be explained by the fact that they may suffer from many insults during their intrauterine life because of placental insufficiency, infection, intrauterine growth retardation and maternal medication. Postnatally, premature infants' lives are frequently complicated by hypovolemia, sepsis, hypotension and ischemia. In addition, premature neonates have an increased risk of death due to incomplete nephrogenesis that led to lower nephron numbers. Sixty percent of nephrogenesis occurring in the third trimester and the concluding nephron number is highly flexible.

In the present study, the neonate being on M.V was found to be a significant risk factor of mortality with a frequency of 50% like other studies. In a Turkish study, M.V is one of the determinants of mortality in neonate, it was associated with increased mortality and length of stay (26).

The signal has shown that M.V may contribute to pathogenesis of AKI. AKI is caused by numerous mechanisms rather than by one. A probable one is a pulmonary inflammatory reaction with release of inflammatory mediators and induction of a systemic inflammatory reaction. Another possibility is the compromise of renal blood flow by hypercapnia or hypoxemia, which may disturb the vascular dynamic via activation or inactivation of vasoactive factors such as nitric oxide, angiotensin 2, endothelin and bradykinin.

In the current study the frequency of hospital stay >3 days was 54% among dead neonates, which opposite to other studies (28) but similar to other studies (26, 28, 4)

IV. CONCLUSION

The rate of AKI among NICU admissions was 5.3% and the mortality frequency in neonates with AKI was 41%. The independent risk factors of mortality were gestation age <37 weeks, the need for M.V. and hospitalization days > 3 days. Preventing AKI and decreasing mortality among them may be done by early identification of risk factors and prompt treatment of underlying disease

RECOMMENDATIONS

Using KDIGO criteria for diagnosis AKI can help early identification and prevents progression of AKI, thus improve prognosis. The knowledge of the risk factors of mortality will help early intervention to reduce the mortality rate.

➢ *Study Limitations:*

The study was a retrospective that may lead to shortage of more information and thus the need for prospective studies is indeed important.

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