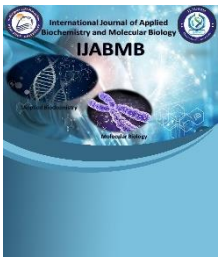
International Journal of Applied Biochemistry and Molecular Biology (IJABMB)



Clinical profile and investigations of acute kidney injury in neonates admitted to NICU

Heba Mustafa Ahmed M.D.[1], Noha A. Doudar M.D.[2], Sara Hosny Ahmed M.B.B.CH.[1*], Osama Ezzat Botrous M.D.[1]

[1] Department of Pediatrics, Faculty of Medicine, Beni-Suef University, Beni-Suef, Egypt.

[2] Department of Clinical and Chemical Pathology, Faculty of Medicine, Beni-Suef University, Beni-Suef, Egypt.

***Corresponding author:**

Sara Hosny Ahmed Abdel Latif

MBBCH, Resident at Department of Pediatrics, Faculty of Medicine, Beni-Suef University, Beni-Suef,

Email: dr.sarahosny@gmail.com

Tel: 01228965333

Published on 1- January-2024

Running Title: Acute kidney injury in neonates admitted to NICU

Abstract:

Background: Recent studies showed that critically ill neonates who were admitted in neonate intensive care unit (NICU) may develop acute kidney injury (AKI) due to several risk factors thus resulting in a high mortality rate.

Purpose: Diagnosis of acute kidney injury in neonates admitted to Neonatal Intensive Care Units.

Patients and Methods: This was a case-control study. Conducted at the NICU, Faculty of Medicine Beni-Suef University Hospital from August 2020 to March 2021. The current study was conducted on 55 neonates (35 critically ill neonates and 20 healthy neonates admitted for phototherapy as a control group)

Results: The gestational age didn't show significant differences between cases and controls. Body weight showed a significant decrease in neonates with sepsis in comparison with controls. The respiratory rate (RR) and systolic blood pressure (BP) were significantly elevated in cases compared to control. Hemoglobin and platelets were significantly lower in cases than controls while white blood cells were significantly increased in cases compared to controls. Plasma creatinine level was significantly elevated in cases compared to controls

Conclusion: 30% of neonates admitted to NICU developed AKI specially with the risk factors as high RR, high systolic BP, anemia and thrombocytopenia

Keywords: Neonatal AKI, NICU

Introduction:

Acute kidney injury (AKI), is a sudden loss of renal functions that leads to accumulation of waste products in the body in addition to unbalanced body fluids (1) . It is increasing problem in the neonatal intensive care units (NICU) (2). The causes include sepsis, asphyxia, hypovolemia, RDS, HF, necessity for inotropic drugs and Mechanically Ventilated babies (2). It's accompanied by increased morbidity & mortality in neonatal age **(3).** There are some limitations for Cr use as a marker for renal functions like the slow increase following kidney injury, variations in muscle mass among individuals and being secreted by the renal tubules (**4).** Thus, the diagnostic sensitivity & specificity of AKI according to SCr and urine volume is weak and might result in delayed diagnosis & management ***(5)*** The incidence of neonatal AKI shows great variability. VLBW a low 5 min Apgar score, maternal drug intake, intubation at birth, RDS, PDA, sepsis, phototherapy and neonatal medications (NSAIDs, Antibiotics, diuretics) are the commonest documented factor that predispose AKI in neonatal period. ***(6).*** Pre-renal causes are responsible for eighty-five per cent of all AKI in this age group. Intrinsic renal and post-renal failure is less common in this age group, being responsible for eleven and three per cent, respectively, of all cases (**7**). AKI is in particular frequent among critically ill babies in the ICUs and is a pivotal determinant of morbidity & mortality in those babies, multiple of whom were born with LBW or were premature ***(8).*** MV participates in AKI development, that might be accompanied by ABG or lung injury due to ventilation promoted production of inflammatory factors. **(9).**

Patients and Methods:

The current study was conducted at the NICU, Faculty of Medicine Beni-Suef University Hospital from August 2020 to March 2021. It included 35 critically ill neonates and 20 healthy neonates admitted for phototherapy as a control group. Exclusion criteria: Neonates with congenital renal diseases**,** neonates with multiple congenital anomalies**,** neonates with suspected or proved metabolic disorders. All neonates included in the research have had their parents notified of the study's protocols and made aware of their right to forbid their participation or remove them from the study without providing an explanation. The study was approved by the research ethics committee's (REC) clearance from the medical school at Beni-Suef University. Approval number (FMBSUREC/03112020/Abdel Latif).

All patients were subjected to the following: Careful history taking stressing on gestational age, maternal medical disorders or drugs used, PROM and mode of delivery. Age and gender documentation. Full clinical examination that included general, cardiac, abdominal, neurological and chest examination. Daily follow up that included vital signs monitoring, UOP, general examination, medications administered to included babies (nephrotoxic antibiotics, inotropic agents type & dose), need for MV, duration of admission and outcomes (discharge or death). Laboratory *Investigations:* CBC using coulter B66, Miami, Florida, USA., CRP was carried out as needed. Evaluation of serum creatinine (SCr) level and UOP estimation. KDIGO classification was done as shown in Table 1.

Table 1. KDIGO classification (kdigo.org, 2012)

Stage	Serum creatinine criteria	Urine output criteria
One	Increase in Scr ≥ 0.3 mg/dlor increase ≥ 1.5 to 1.9-fold from baseline	Less than 0.5 ml/kg perhour for 6-12 hours
Two	increase > 2 to 2.9-fold from baseline	Less than 0.5 ml/kg perhour for more than or equal to 12 hours
Three	increase = 3-fold from baseline or Scr ≥ 4.0 mg/dlor initiation of replacement therapy or decrease in eGFR < 35 ml/min per 1.73 m^2 in patients less than 18 years	Less than 0.3 ml/kg per hour for more than or equal to 24 hours or anuriafor more than or equal to 12 hours

Statistical analysis

Statistical Package for the Social Sciences (SPSS) was utilized for entering and coding of data on an IBM-PC compatible computer (version 22). To detect statistical significance, a P value of < 0.05 was used. Associative variables for categorical data were tested via Chi-Square test x^2. Table with values < 5 was subjected to the Fisher's exact test. The statistical significance of the difference between 2 population means was evaluated via the student's t-test in a study with independent samples. Statistically significant difference between > 2 means {difference between 3 or 4 groups} was tested via a one-way ANOVA test.

Results:

Table 2 showed that weight and length were significantly lower in cases than controls. Table 3 showed that RR and systolic BP were significantly higher in cases than controls. Table 4 showed that Hb and PLTs were significantly lower in cases than controls while WBCs, creatinine, levels were significantly higher in patients than controls groups. Table 5 showed that there were no significant differences between the two groups as regards UOP and creatinine at admission.

Table 2. Comparison between controls and cases as regard age and anthropometric measurements.

	Controls (n=20)	**Cases (n=35)**	**P**
Gestational age (weeks)	36.90± 1.68	35.37± 3.80	0.095
Age (days)	4.80± 2.09	6.91± 6.71	0.177
Weight (Kg)	3.47± 0.68	2.53± 0.85	<0.001
Length (cm)	47.45± 3.86	42.71± 6.90	0.007

Table 3. Comparison between controls and cases as regard clinical data

	Controls (n=20)	**Cases (n=35)**	**P**
HR (bpm)	135.75± 8.93	139.00± 17.20	0.436
RR/min	48.45± 6.70	56.14± 9.26	0.002
Temperature (^{0} C)	37.25± 0.14	37.48± 0.36	0.07
Systolic BP (mmHg)	59.25± 2.45	70.26± 13.46	0.001
Diastolic BP (mmHg)	39.10± 4.24	34.34± 13.37	0.129
UOP (ml/kg/hr)	2.58± 0.37	2.30± 1.18	0.144

Table 4. Comparison between controls and cases as regard laboratory data

	Controls (n=20)	**Cases (n=35)**	**p**
Hb (gm %)	15.70± 1.19	13.87± 3.82	0.043
WBC x10^3 (cell/cm^3)	7.56± 1.51	18.17± 21.94	0.036
Platelets x10^3 (cell/cm^3)	275.50± 90.21	188.50± 92.29	0.001
Creatinine (mg/dl)	0.32± 0.09	0.49± 0.25	0.004
RBS (mg/dl)	79.15± 7.05	87.17± 23.65	0.146

Table 5. initial clinical and lab data according to AKI course in the patient group

course	**Improving (14)**	**Deteriorating (21)**	**P**
UOP (m/kg/hr)	2.52±1.44	2.3± 0.99	0.341
Creatinine (mg/dl)	0.67± 0.26	0.58± 0.15	0.081

Discussion:

The gestational age didn't show significant differences between the 2 groups (p value 0.09), on the contrary gestational age was significantly decreased in cases in the study of Ladeiras and colleagues (P value 0.006) **(10).**

In the current study the weight & length were significantly lower in cases compared to controls (p value 0.001& 0.007) respectively, similar results were documented by Fatmi and colleagues (11)

The RR was significantly elevated in cases compared to control babies, Risk factors for tachypnea such as RDS, premature babies and sepsis and the usage of MV. Tachypnea is a compensatory mechanism for hypercarbia, hypoxia, or acidosis (**12).**

Systolic BP was significantly elevated in cases compared to controls. The risk factors for neonatal HTN included Antenatal maternal steroid intake, maternal HTN, umbilical arterial catheter, postnatal ARF, PDA, indomethacin use and chronic pulmonary diseases. **(13).**

HB was significantly lower in cases than controls. Neonatal anemia is a common problem in NICU. In such cases, decreased Hb level might increase tissue oxygenation impairment through reducing arterial O_2 level.

PLT was significantly lower in cases compared to control babies, Thrombocytopenia is a frequent and multifactorial phenomenon that happens during sepsis. The principal etiologies are reduced PLT synthesis, hemodilution, platelet consumption, higher sequestration of PLT in micro vessels, and immune-mediated damage of platelets (**14).**

WBCS was significantly increased in cases compared to controls. Leukocytosis is a major sign of infection, bacterial, and clinicians should detect other manifestations of infection. The peripheral WBCs can double within hours following stimuli due to the great storage in the BM and intravascularly marginated pools of neutrophils. Noteworthy, Stress can cause acute leukocytosis **(15).**

Plasma Cr level was significantly elevated in cases compared to controls. In line with Sarafidis, and colleagues who demonstrated that the sCr of 30 asphyxiated babies (1.32 ± 0.43) was significantly elevated compared to control babies (1.02 ± 0.26) with p value of 0.03. **(16)**

Conclusion:

We found that 30% of neonates admitted to NICU developed AKI especially with the risk factors as high RR, high systolic BP, anemia and thrombocytopenia

References:

1. Acute Kidney Injury (AKI). (2019). National Kidney Foundation: https://www.kidney.org/atoz/content/AcuteKidneyInjury
2. Momtaz,HE , Sabzehei MK. , Rasuli B. , Torabian S. (2014). The Main Etiologies of Acute Kidney Injury in the Newborns Hospitalized in the Neonatal Intensive Care Unit. J Clin Neonatol , 2 : 99–102.
3. Asghar. (2018). Association of In-hospital outcome of Acute Kidney Injury (AKI) with etiology among newborns at a tertiary care unit. Pak J Med Sci. , 125-129.
4. Zand F Md, S. G. (2015). Early Acute Kidney Injury based on Serum Creatinine or Cystatin C in Intensive Care Unit after Major Trauma. Iran J Med Sci. , 40(6):485-92.
5. Thongprayoon C, Hansrivijit P, Kovvuru K, et al. (2020). Diagnostics, Risk Factors, Treatment and Outcomes of Acute Kidney Injury in a New Paradigm. Journal of Clinical Medicine, 9(4), 1104.
6. Bakr A, Eid R, Allam NA, et al (2018). Neonatal Acute Kidney Injury: Diagnostic and Therapeutic Challenges. Journal of Nephrology Research; 4(1): 130-134.
7. Viswanathan S, Manyam B, Azhibekov T, et al (2012). Risk factors associated with acute kidney injury in extremely low birth weight (ELBW) infants. Pediatr Nephrol; 27:303–311.
8. Gorga SM, Murphy HJ, Selewski DT (2018). An Update on Neonatal and Pediatric Acute Kidney Injury. Current Pediatrics Reports 6:278–290
9. Fan Y, Ye J, Qian L, et al (2019). Risk factors and outcomes of acute kidney injury in ventilated newborns. Renal Failure, 41(1), 995–1000
10. Ladeiras, R., Flor-De-Lima, F., Soares, H., Oliveira, B., & Guimarães, H. (2019). Acute kidney injury in preterm neonates with ≤30 weeks of gestational age and its risk factors. Minerva Pediatr , 404-414.
11. Fatmi, A., Rebiahi, S., Chabni, N., Zerrouki, H., Elhabiri, Y., et al. (2020). miRNA-23b as a

biomarker of culture-positive neonatal sepsis. Molecular Medicine, 26.

12. Reuter, S., Moser, C., & Baack, M. (2014). Respiratory Distress in the Newborn. Pediatr Rev., 417–429.

13. Seliem, W., Falk, M., Shadbolt, B., & Kent, A. (2007). Antenatal and postnatal risk factors for neonatal hypertension and infant follow-up. Pediatr Nephrol , 2081-2087.

14. Vardon-Bounes, F., Ruiz, S., Gratacap, M.-P., Garcia, C., Payrastre, B., & Minville, V. (2019, July 16). Platelets Are Critical Key Players in Sepsis. International Journal of Molecular Sciences.

15. Riley, L. K., & Rupert, J. (2015, December 1). Evaluation of Patients with Leukocytosis. American Family Physician, pp. 1004-1011.

16. Sarafidis, K., Tsepkentzi, E., Agakidou, E., Diamanti, E., Taparkou, A., Soubasi, V., et al. (2012). Serum and urine acute kidney injury biomarkers in asphyxiated neonates. Pediatric Nephrology, 1575–1582.