Original Article

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Paediatrics Section

Aetiological Profile and Outcomes of Acute Kidney Injury among Neonates Admitted in a Neonatal Intensive Care Unit at a Tertiary Care Hospital, Northeast India: A Prospective Cohort Study

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ABSTRACT

Introduction: Acute Kidney Injury (AKI) affects approximately 8%-24% of critically ill neonates, with a mortality rate ranging from 10%-61%. Groups of newborns at higher risk for AKI include those with perinatal hypoxia, Respiratory Distress Syndrome (RDS), premature and very low birth weight infants, and newborns with sepsis. AKI is associated with poor short-term and long-term outcomes and has a multifactorial aetiology.

Aim: To evaluate the aetiological profile and short-term outcomes of AKI in neonates admitted to the Neonatal Intensive Care Unit (NICU).

Materials and Methods: A prospective cohort (descriptive) study was conducted in the NICU at Gauhati Medical College and Hospital, Guwahati, Assam, India, over a period of one year, from September 1, 2021, to August 31, 2022. A total of 100 neonates exhibiting signs and symptoms of AKI according to Acute Kidney Injury Network (AKIN) criteria. Detailed neonatal history, including neonatal resuscitation, history of perinatal asphyxia, signs and symptoms of sepsis, Respiratory Distress Syndrome (RDS), or any other symptoms, were recorded. The course and outcome of the neonates during their NICU stay were noted. Data were presented in terms of frequency (n) and percentages (%).

Results: Among the 100 AKI neonates, 58 were males and 42 were females, with a male-to-female ratio of 1.38:1. Out of 100 neonates, birth asphyxia constituted 40 (40%) cases, of cases, followed by sepsis in 30 (30%), RDS 27 (27%), dehydration 2 (2%), and obstructive uropathy in 1 (1%) case. Among the 100 AKI neonates, 64 (64%) cases were discharged, 35 (35%) expired, and 1 (1%) were transferred to the paediatric surgery department.

Conclusion: Neonatal AKI is an independent contributor to morbidity and mortality. Therefore, early identification and prompt management are crucial for improving outcomes and prognosis.

Keywords: Mortality, Newborn, Oliguria, Perinatal asphyxia, Sepsis

INTRODUCTION

The AKI is characterised by diminished urine output (oliguria), an increase in serum creatinine and blood urea, and alterations in serum electrolytes. It also affects extracellular fluid volume and the acid-base homeostasis of the body [1]. AKI is a significant contributor to neonatal mortality and morbidity. The prevalence of AKI varies in different NICUs. Various researchers in different parts of the world have estimated the prevalence of AKI to be in the range of 8% to 24% [1-3]. Newborns are more vulnerable to AKI than older children due to their functionally immature kidneys [4]. Moreover, critically ill neonates are at an even higher risk due to exposure to several additional risk factors such as prematurity, pregnancy-induced hypertension, prolonged rupture of membranes, and meconium-stained amniotic fluid, etc., [5,6]. In the neonatal period, AKI is more common in the first week of life due to hypovolaemia, hypertension, ischaemia, and less commonly due to primary kidney disease [7]. The cause of AKI in neonates is multifactorial, and there are usually one or more associated contributing factors. The origin of AKI in newborns may arise in the prenatal, perinatal, and postnatal periods, or it can be due to a combination of causes. Various studies have mentioned that perinatal asphyxia and neonatal sepsis are the most common causes. Other associated conditions include RDS, dehydration, heart failure, nephrotoxic drugs, and urological anomalies [8-11]. Neonatal AKI is an under-recognised morbidity in neonates. Neonatal AKI is associated with high mortality, and various researchers have reported mortality rates ranging from 32% to 44% in different NICUs [12-15]. Many studies have been conducted by researchers in different parts of the world to study AKI among neonates and evaluate the risk factors, aetiological factors, and outcomes over time [10-20]. However, to the best of the authors knowledge, no similar type of study on AKI in neonates has been conducted in the state of Assam. Nevertheless, two studies were conducted on AKI in older children in the state of Assam in 2017 and 2018 [21,22]. Hence, under this background, the present study was conducted to evaluate the aetiological profile and short-term outcome of AKI in neonates in the NICU.

MATERIALS AND METHODS

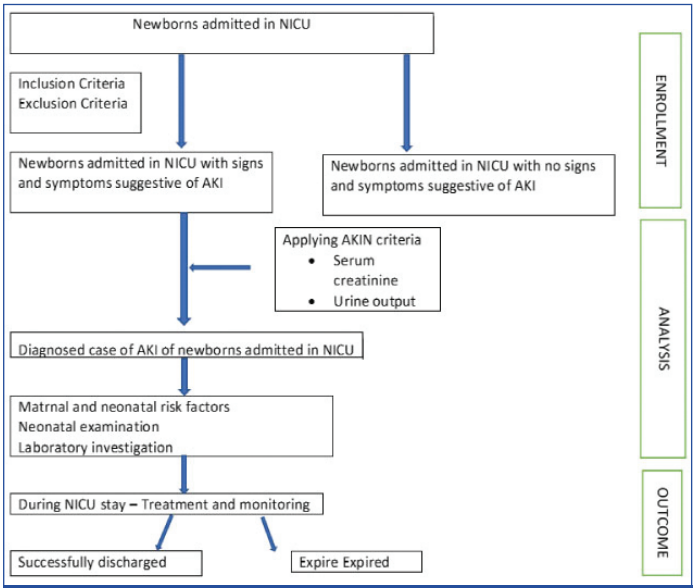
A prospective cohort (descriptive) study was conducted in the NICU at Gauhati Medical College and Hospital, Guwahati, Assam, India, over a period of one year, from September 1, 2021, to August 31, 2022. The study was approved by the Institutional Ethics Committee (IEC) of Gauhati Medical College and Hospital, Guwahati (Ethical approval no: MC/190/2007/pt-11/july2021/TH-22 Dated 26/07/2021). Informed written consent was obtained from the parents of the neonates enrolled in the study in their native language.

Inclusion criteria: Newborns with a gestational age of 28 weeks or more and birth weight of more than 1 kg, admitted to the NICU, diagnosed with AKI, of either sex were included in the study.

Exclusion criteria: Neonates with a gestational age less than 28 weeks and a birth weight less than 1 kg. Neonates with major congenital malformations or life-threatening anomalies were excluded from the study.

Study Procedure

The study population comprised neonates admitted to the NICU with signs and symptoms suggestive of AKI, who fulfilled the inclusion and exclusion criteria, and were diagnosed based on the AKIN criteria [9,20], using serum creatinine level and urine output as shown in [Table/Fig-1,2]. These laboratory-confirmed cases of AKI were enrolled in the study. Thus, a total of 100 consecutively diagnosed neonates with AKI were included. Detailed neonatal history, including neonatal resuscitation, history of perinatal asphyxia, signs and symptoms of sepsis, RDS, or any other symptoms, were recorded. The neonates' gestational age was determined using the New Ballard scoring system [6]. A thorough clinical examination was performed, and general physical examination and vitals of the newborns were recorded. Renal function tests (serum creatinine, blood urea) and serum electrolytes (sodium, potassium) were performed for all cases. Other laboratory tests, such as sepsis screen and blood culture for suspected neonatal sepsis, chest X-ray for RDS, and abdominal ultrasonography, were conducted if renal anomaly was suspected. The babies with AKI were managed through supportive care, fluid adjustment, medication dose adjustments based on renal function, and peritoneal dialysis. Electrolyte disturbances were treated according to standard protocol. The course and outcome of the neonates during the NICU stay and details of the treatment history were noted.



[Table/Fig-1]: Plan of the study: Flow diagram.

Stage	Serum creatinine	Urine output criteria
1	Increase in serum creatinine of more than or equal to 0.3 mg/dL or 1.5-1.9 times the baseline value.	Less than 0.5 mL/kg/hour for 6-12 hours.
2	2.0-2.9 times the baseline value.	Less than 0.5 mL/kg/hour for >12 hours.
3	3.0 times the baseline value or serum creatinine of more than or equal to 4.0 mg/dL.	Less than 0.3 mL/kg/hour for >24 hours or anuria for >12 hours.

[Table/Fig-2]: Acute Kidney Injury Network (AKIN) criteria.

STATISTICAL ANALYSIS

The data collected from the patients were formatted into Microsoft Excel sheets to generate master charts and tables. The data were expressed in terms of frequency and percentage.

RESULTS

Out of 1130 admitted neonates in the NICU screened for AKI, 100 cases were diagnosed as AKI during the study period, constituting 8.8%. Among the 100 AKI neonates, 58% were males and 42% were females, with a male-to-female ratio of 1.38:1. Regarding the distribution of birth weights, neonates weighed 1 to 1.5 kg (22%), 1.5 kg to 2.5 kg (60%), and above 2.5 kg (18%), with an average birth weight of 2240±730 g. According to gestational maturity, 33% were preterm, 53% were term, and 14% were post-term neonates [Table/Fig-3].

Gestational age	Frequency (n)	Percentage (%)
Preterm	33	33
Term	53	53
Post-term	14	14
Mean gestational age: 37.42+3.2 weeks		

[Table/Fig-3]: Distribution of cases according to gestational age (N=100).

In the current study, it was observed that out of 100 neonates with in 40 (40%) cases, were due to perinatal asphyxia, followed by neonatal sepsis in 30 (30%) and RDS in 27 (27%) cases [Table/Fig-4]. The analysis of renal function tests and serum electrolytes showed that the mean creatinine was 2.24±0.59 mg/dL, and the mean urea was 118.61±19.28 mg/dL [Table/Fig-5].

Primary aetiology	Frequency (n)	Percentage (%)
Perinatal asphyxia	40	40
Neonatal sepsis	30	30
RDS	27	27
Dehydration	2	2
Obstructive uropathy (posterior urethral valve)	1	1

[Table/Fig-4]: Primary aetiological factor of AKI (N=100).
RDS: Respiratory distress syndrome

Variables	Values
Mean serum creatinine (mg/dL)	2.24±0.59
Mean blood urea (mmol/dL)	118.61±19.28
Mean serum sodium (mmol/dL)	135.56±19.28
Mean serum potassium (mmol/dL)	6.58±1.08

[Table/Fig-5]: Depicts laboratory results of Acute Kidney Injury (AKI) cases.

The present study showed that according to the site of injury, pre-renal causes constituted 41%, renal causes constituted 58%, and post-renal causes constituted 1% of cases. Peritoneal dialysis was performed in 15 out of 100 neonates with AKI. Among these 100 neonates, 64 (64%) were successfully discharged from the NICU, and 35 neonates (35%) expired. One newborn diagnosed with posterior urethral valve was transferred to the paediatric surgery ward for further management [Table/Fig-6].

Outcome of AKI neonates	Frequency (n)	Percentage (%)
Discharged	64	64
Expired	35	35
Shifted	1	1

[Table/Fig-6]: Outcome of neonates with AKI (N=100).

DISCUSSION

The incidence of AKI in various studies ranged from 8% to 24% [1-3]. The neonatal kidney is particularly more vulnerable to AKI than older children due to their functionally immature kidneys. Renal blood flow in newborns is compromised due to high renal vascular resistance and plasma renin activity [4,6]. The incidence of AKI in our NICU was 8.8% during the study period. Kapoor K et al., and Youssef D et al., reported incidences of 9.6% and 10.8%, respectively [5,15]. However, Gallo D et al., reported a low incidence of 1.5%, and Bansal SC et al., reported an incidence of 4.24% in their studies [12,16]. This wide variability in the incidence of AKI in the available data from different units may be due to different definitions of AKI {AKIN criteria, pRIFLE (Pediatric Risk, Injury, Failure, Loss, End Stage Renal Disease) criteria etc.} or the exclusion and inclusion criteria being used.

The gender distribution of AKI neonates revealed that male neonates (58%) were commonly affected compared to female neonates

(42%). When comparing this result with a few other studies, Kapoor K et al., reported a male-to-female ratio of 2.6:1, Mortazavi F et al., reported a ratio of 2:1, and Gallo D et al., reported a ratio of 1.8:1, respectively [5,8,12]. All these researchers observed a higher incidence of AKI in male neonates. The reason for the high incidence of AKI in male neonates may be due to a higher number of admissions of male neonates during this period. In the present study, most common cause of AKI was perinatal asphyxia (40%), followed by neonatal sepsis (30%) and RDS (27%). Many researchers have reported the association of perinatal asphyxia and neonatal AKI. The most common aetiological factor of AKI was found to be perinatal asphyxia in the studies conducted by Gallo D et al., (72%) and Nandhagopal N et al., (74%), respectively [12,18].

Furthermore, Kaur S et al., also reported an incidence of 41.67% of AKI, and Selewski DT et al., reported that 38% of AKI cases were due to perinatal asphyxia [4,9]. Mangshetty R et al., reported a low incidence of AKI (6.3%) in perinatal asphyxia [17]. Neonatal sepsis has consistently been associated with the development of AKI in neonates [7,8,10,19,20]. The current study showed that neonatal sepsis was present in 30% of AKI cases. Timovska SN et al., reported neonatal sepsis in 28% of cases, while Mangshetty R et al., reported a very high incidence of AKI (78%) [13,17]. Neonatal sepsis is a predisposing factor for AKI due to the dual effect of hypotension secondary to sepsis and a direct damaging effect on renal microvasculature [13,16]. In the present study, the analysis of the outcome of the AKI neonates revealed a mortality rate of 35%. The present study's finding was similar to the results obtained by Momtaz HE et al., (36.5%), Gallo D et al., (35%), Timovska SN et al., (32%), and Bolat F et al., (23.8%) [11-14]. The highest mortality rate of AKI in neonates was found in the study conducted by Youssef D et al., which was 44.4% [15].

Limitation(s)

There were several limitations to the present study. Firstly, it was an observational study with a small sample size and was conducted in a short period of time. Secondly, the data was collected from a single centre, which reduces generalisability. Additionally, there is variability in the diagnosis criteria of AKI in neonates, and authors used AKIN criteria in the current study. Therefore, the frequency of AKI may be different if other criteria are applied. While evaluation the outcome of AKI, the neonates were divided into two groups - survival and mortality. Neonates who progressed to chronic kidney disease were included in the survival group. However, authors did not conduct long-term follow-up of the cases, so could not be commented on delayed renal sequelae. Further studies are needed in this region for a longer period to evaluate the aetiological profile and outcome of newborns with AKI.

CONCLUSION(S)

The identified aetiological factors for neonatal AKI in the present study were perinatal asphyxia (40%), followed by neonatal sepsis (30%) and RDS (27%). It is important to appropriately manage these risk factors in the NICU to prevent complications. The analysis of the short-term outcome of the AKI neonates in the study revealed a mortality rate of 35%. AKI is a reversible cause of neonatal mortality if detected in the early stage, highlighting the importance of prompt treatment for good outcomes.

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