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Acute Kidney Injury in Sick Neonate: Incidence and Outcome

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Summary:

Introduction: ***Acute kidney injury (AKI) is an important clinical problem in sick neonate. In most patients, AKI accompanies with a predisposing factor such as sepsis, asphyxia and surgery. The aims of this study were to determine the incidence, associated contributing factors and short term outcome of AKI in hospitalized newborn infants.***

Materials and Methods: ***This prospective cohort study was done in Dhaka Shishu Hospital from March 2011 to September 2011. This study included 300 sick neonates admitted during the study period. AKI was defined when serum creatinine level >1.5 mg/dl and BUN was >20 mg/dl on two separate occasions at 24 hours apart. Oliguria was defined as urine output <1ml/kg/ hr. Medical records of those patients were reviewed and data were analyzed using SPSS software.***

Results: ***Fourteen babies (4.66%) out of 300 sick neonates had AKI, of whom 64.2% were male and 35.7% female. The term and preterm neonates were 71% and 29% respectively. While a normal birth weight was observed in 57% cases, 35% had low birth weight and 7.14% had very low birth weight. Sepsis was the most common (71%) association of AKI, followed by perinatal asphyxia (52%). All patients had more than one predisposing factors. Frequency of oliguric kidney injury was 57% and non-oliguric was 43%. Mortality among the hospitalized neonate with AKI was 21%.***

Conclusion: ***This study showed that in a tertiary care hospital AKI is not uncommon (4.66%) in neonatal care unit. It is associated with some preventable conditions such as sepsis, perinatal asphyxia and shock. Outcome is poor in sick neonates with AKI (21% mortality) in comparison to sick neonates without AKI (10.3%).***

Key words: Acute Kidney Injury, Sick neonate.

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Introduction:

Acute kidney injury(AKI) is a common problem among sick newborns.[1,2] The sick newborns are those who are admitted in a hospital for any morbidities like perinatal asphyxia (PNA), septicemia, necrotizing enterocolitis (NEC), shock, heart failure, respiratory distress syndrome etc. Any critical illness in neonate leads to multiorgan dysfunction and the kidney is one of the organs frequently afflicted .[3,4] AKI previously called acute renal failure is characterized by a reversible increase in the blood concentration of creatinine and nitrogenous waste products and by the inability of the kidney to regulate fluid and electrolyte homeostasis appropriately.[5,6]. It is diagnosed on the basis of clinical history such as decreased urine production (Oliguria), and laboratory findings such as elevated blood urea nitrogen and creatinine. Although non-oliguric neonatal kidney injury is being detected with increasing frequency.[1,7]

Study done by Stapleton FB et al.[1], Gharehbaghi MM[8], Airede A et al.[9] and Andreoli SP[10] found that the incidence of acute kidney injury was 3% to 8% in sick neonate. A wide variety of predisposing factors such as asphyxia (40%), sepsis (22%), feeding problems (18%), heart failure, prematurity and urogenital anomalies are commonly reported causes of AKI in the developed countries.[2,11] Studies done in India showed that AKI was the common sequel of sepsis in neonatal care unit.[3,12]

Mortality among hospitalized neonate due to kidney injury was 20-50% and patient with sepsis had significantly higher rate.[8,13] In Bangladesh, neonatal mortality rate is still high which is more than two third

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of infant mortality rate.[14] The major causes of death in hospitalized neonates are preterm low birth weight and related consequences, asphyxia, infection, trauma etc.[15] To the best of our knowledge, a few studies have been conducted on assessment of renal function in perinatal asphyxia and preterm neonates in Bangladesh.[16] But it seems to be essential for early detection of AKI for planning appropriate fluid and electrolyte therapy and thereby for improved outcome. This study was conducted to see the incidence, predisposing factors of acute kidney injury in sick neonate and their outcome.

Materials and methods:

This prospective cohort study was conducted in Neonatology unit of Dhaka Shishu Hospital from March 2011 to august 2011. During the study period, admitted sick neonates were evaluated for presence of AKI. The sick neonates were those who were admitted for different morbidities like septicemia, perinatal asphyxia with hypoxic ischemic encephalopathy, shock, respiratory distress syndrome, necrotizing enterocolitis and undergone surgical procedure. Neonates of any congenital anomalies like skeletal, renal, urinary tract were excluded from this study. For each patient detailed history was taken and physical examination was done. First blood sample(2-3ml venous blood) was collected at admission and send to the Clinical Pathology and Biochemistry department in Dhaka Shishu Hospital for blood urea, serum creatinine and serum electrolytes values. For an abnormal value, repeat test was done after 24 hrs. Urine was collected by adhesive urine bag.

AKI was defined as serum creatinine concentration >1.5 mg/dl and blood urea nitrogen >20mg/dl on two separate tests 24 hours apart. Oliguria was defined as urine output less than 1ml/kg/h. Statistical analysis was performed using SPSS Version 17. Outcome was compared with the use of the Chi-square test. P value <0.05 was considered statistically significant.

Result:

Three hundred sick neonates were evaluated during the study period. Among them, 66.7% were male and 33.3% were female, 60% were term, 40% were preterm and 46% were normal birth weight and 38% were low birth weight. The newborns were admitted for different morbidities like sepsis (35.3%), perinatal asphyxia (34.6%) (Table-I).

Among 300 sick neonates 14(4.66%) babies developed AKI. Male to female ratio was 1.8:1. Most of the patients with AKI were term (n-10, 71%) and 4 (29%) cases were preterm (Table -2). Oliguric renal injury was found in 8 cases (57%) and non-oliguric was found in 6 cases. Sepsis was found to be the most common cause (71%) followed by perinatal asphyxia (52.8%) (Table II). There were more than one predisposing factors in all patients.

Mortality was significantly higher ($p<0.05$) in neonates with AKI (21%) than in neonates without AKI (10%). (Table-V)

Table-I

Disease pattern of the sick neonates (n=300)

Diagnosis	Frequency	Percentage (%)
Sepsis	106	35.33
Perinatal asphyxia	104	34.67
Neonatal jaundice	71	23.67
Respiratory distress syndrome	14	4.67
Pneumonia	13	4.33
Shock	13	4.33
Heart diseases	12	4
Surgical causes	10	3.33

Table-II

Demographic characteristics of neonates with AKI (n=14)

	Frequency	Percentage (%)
Sex Male	9	64.2
Female	5	35.7
Gestational age		
Term	10	71.4
Preterm	4	28.5
Birth weight		
Normal(2500-4000gm)	8	57
LBW(<2500gm)	6	43

Table-III

Predisposing factors for developing AKI in neonates (n=14)

Diagnosis	Frequency	Percentage (%)
Sepsis	10	71.43
Perinatal asphyxia HIE-III	6	52.86
Surgical causes	3	21.43
Shock	3	21.43
Intrauterine growth retardation	2	14.2
SIADH	3	21.3

Table-IV

Renal function and serum electrolytes values in repeat sample of AKI cases (n=14)

Investigations	1st sample Mean+_SD	2nd sample Mean+_SD
S. creatine (mg/dl)	2.8+_1.25	2.7+_1.15
BUN (mg/dl)	57+_27	47+_16.2
S. sodium (mmol/l)	134+_8.7	132.0+_6.5
S. Potasium (mmol/l)	5.6+_1.3	5.3+_1.2

Table-V

Short-term outcome of the sick neonates

Patients	Mortality (%)
Total sick neonates (300)	31(10.3%)
AKI (14)	3 (21.4%)

p value=<0.05

Discussion:

In this study, it was found that good number of sick neonates developed AKI. Stapleton et al.[1], Ghaebaghi MM et al.[8], Airede A et al.[9] and Andreoli SP[10] found that the incidence of AKI was 3-8% in sick neonates. In several studies[8,9,17] it was found that predominantly male and term babies developed renal impairment. In our study, similar findings were found. The high frequency of AKI in boys may be due to the susceptibility of boys to some perinatal disorders such as sepsis and respiratory distress syndrome.[17]

A wide variety of predisposing factors or prenatal, natal or postnatal events may cause AKI. In this study sepsis (71%) was the most common cause of AKI. Study done in India by Mathur NB[12] found that 26% septic babies developed AKI. The exact pathophysiology of sepsis-induced AKI is not known, however, it is generally accepted that it has a multi-pronged injury pathway. It may be due to ischemia-reperfusion injury, direct inflammatory injury, coagulation and endothelial cell dysfunction, and apoptosis.[3]

Perinatal asphyxia was high in this study. It was 53% in a study done by Airede A et al.[9] and Mortazavi F et al.[18] found 29.8% babies with perinatal asphyxia developed AKI. As kidneys are very sensitive to oxygen deprivation, renal insufficiency may occur within 24 hours of a hypoxic ischemic episode, which if prolonged, may lead to irreversible cortical necrosis.[18]

Other factors responsible for developing AKI were shock (hypovolumia and sepsis) (21%), surgical procedure (21%) and SIADH

(21%). Gharehbaghi MM[8] found that 43.5% neonates developed AKI following surgical procedure.

Serum creatinine and BUN were determined as an indicator of renal function following an initial insult. These laboratory tests are relatively inexpensive and widely available. Obstruction of tubular lumen and back leak mechanism (by damage to the intracellular junctions) contributed to increase in urea and creatinine levels in sick neonates[18,19]. In this study hyperkalemia was the main electrolyte abnormality. Hyperkalemia is a common complication of AKI as the kidney tightly regulates potassium balance and excretes 90% of dietary potassium intake.[20] It was observed that the babies with AKI had higher incidence of hyponatremia. The capacity of sodium reabsorption is limited and if the load of sodium reaching the distal convoluted tubule (DCT) increases significantly, reabsorption does not occur proportionately and sodium load excretes in the urine. Other contributing factors to develop hyponatremia may be occurrence of SIADH secondary to perinatal asphyxia and partial resistance to aldosteron.[21] Here, 7.14% babies with AKI were hypernatremic which might be due to association of poor feeding, VLBW etc.

Mortality rate was also high in sick neonates with AKI in comparison to sick neonates without AKI (10.3%). In

this study, renal function of 11 babies (out of 14) returned to normal and discharged. Gharehbaghi MM et al.[8] and Mortazavi F et al.[17] also reported the mortality rate of 20%, and 20.6% respectively. Mathur NB et al.[12] reported 70% mortality in septic neonates with AKI. The major risk factors for mortality were sepsis, perinatal asphyxia, IUGR, dehydration, electrolyte abnormality and delayed hospitalization.

Conclusion:

Renal function impairment is not uncommon in sick neonates. The predisposing factors for developing AKI are sepsis, perinatal asphyxia, IUGR, shock surgical procedures etc. Mortality of sick neonates with AKI is high in comparison to sick neonates without AKI.

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