Original article:

Neonatal Acute Kidney Injury: Presentation and Outcome

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Abstract

Introduction: Various studies suggest that neonatal acute kidney injury (AKI) is associated with poor outcomes. This study was undertaken to study the presentation and outcome of acute kidney injury in hypernatremic dehydration in a rural tertiary care hospital.

Materials and methods: Retrospective descriptive study of case records of ten neonates admitted in the outborn NICU of a rural tertiary care hospital during the period of April-May 2019 with deranged renal function and documented hypernatremia was done. Exclusion criteria included congenital heart disease, congenital anomalies of kidney and urinary tract, death within 48 hours of admission, diabetes insipidus and babies with hypernatremia without a rise in serum creatinine. AKI was defined using a standardized definition —i.e., serum creatinine rise of ≥0.3 mg/dL or serum creatinine ≥ 2.5 mg/dl or urine output <0.5ml/kg/h.

Results: Out of the ten babies, 40% were boys, 30% were neonates of multiple gestation, 70% were exclusively breastfed and median age was 9 days. Most common presenting complaint was fever, 40% of babies had seizures. Majority infants (80%) had stage III AKI. Mechanical ventilation was required in 30% and 3 out of 10 patients died. Medium BUN was 257 mg/dl, median serum creatinine was 4 mg/dl, mean sodium was 175.63 and mean potassium was 6.9. There was a statistically significant difference in levels of serum sodium in those who survived and died.

Conclusion: Neonatal AKI is a common and independent risk factor for poorer outcomes. Hypernatremia is severe enough to cause AKI in exclusively breast fed babies. Findings of our study suggest that neonates may be impacted by AKI in a manner similar to adult patients but they lack compensatory renal reserve.

Introduction:

There have been significant advancements in the study of acute kidney injury (AKI) in critically ill children. However, the recognition and impact of AKI on morbidity and mortality in neonates was less studied until recent times. Various studies suggest that AKI is common in neonates and it is associated with worse outcomes. [1] [3]

Materials and Methods:

Study was conducted in the out-born NICU of a tertiary care hospital in rural Maharashtra. Ethical committee clearance was taken.

Inclusion criteria

(i) Consecutive babies <1-month age requiring admission during the above-mentioned period

(ii) Documented hypernatremia and deranged renal function were included in the study.

Exclusion criteria

(i) Congenital heart disease

(ii) Congenital anomalies of kidney and urinary tract

(iii) Death within 48 hours of admission

(iv) Diabetes insipidus

(v) Babies with hypernatremia without a rise in serum creatinine.

All cases were subjected to full history taking - name, age, sex, weight at admission, gestational age, mode of delivery, maternal risk factors, presenting complaints, type of feeding, associated comorbidities and clinical outcome. Serum creatinine, BUN, serum sodium, potassium, calcium, complete blood count, C-reactive protein, arterial blood gases if indicated.

Definition of acute kidney injury

All serum creatinine values obtained during the study period were recorded apart from 24-hour urine output. Either diaper weight or catheterised urine collection was used. Infants were classified as having AKI if they met either the serum creatinine or urinary output criteria. Kidney Disease: Improving Global Outcomes (KDIGO) workgroup AKI definition modified for neonates was used [1]

Stage	S. Cr.	Urine output
0	No change in SCr or rise <0.3 mg/dL	≥ 0.5 mL/kg/h
1	SCr rise ≥ 0.3 mg/dL within 48 h or SCr rise ≥1.5–1.9 × reference SCr[a] within 7 d	<0.5 mL/kg/h for 6 to 12 h
2	SCr rise ≥2.0–2.9 × reference SCr[a]	<0.5 mL/kg/h for ≥ 12 h
3	SCr rise ≥3 × reference SCr[a] or SCr ≥2.5 mg/dL[b] or Receipt of dialysis	<0.3 mL/kg/h for ≥24 h or anuria for ≥12 h

Results:

Ten babies were included. Overall, 40% of neonates were boys, 30% were neonates of multiple gestation. 70% were exclusively breastfed. Median age at admission was 9 days ranging from 3-25 days.

Most common presenting complaint was fever followed by poor feeding. Two babies had history of seizures at admission however during subsequent course seizures occurred in 2 more babies, so that 40% of all had seizures.

At the time of admission, none of the mothers complained about decreased urine output but after admission on monitoring, oliguria was observed in all babies except two. Majority of the young infants i.e., 80% had stage III AKI as per neonatal RIFLE criteria.

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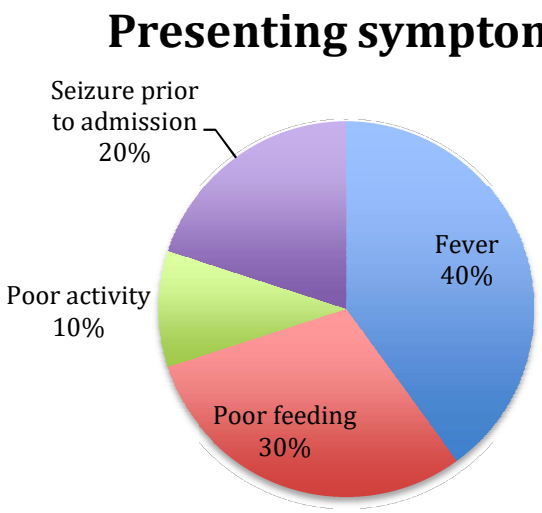

Mechanical ventilation and vasopressor support was required in 30%. Three out of ten patients died.

Blood urea ranged from 144mg/dL to 746 mg/dl with median value of 257 mg/dL. Serum creatinine ranged from 2.1 to 7.6 mg/dL with median value of 4 mg/dL. Serum sodium values ranged from 152 mEq/L to as high as 193 meq/L with mean value being 175.63. Serum potassium levels varied from 5.4 to 8 meq/L with mean being 6.9.

Presence of seizures and presence of stage 3 AKI did not vary statistically between those who survived and those who died, p=0.06 and p=0.9 respectively (Chi square test)

There was a statistically significant difference in levels of serum sodium and in those who survived and died, p=0.001. Mean serum sodium in those with stage 2 AKI was 171.66 and those with stage 3 was 177.32. This was statistically significant p=0.006 (t test)

Serum sodium (meq/L)			P value
Outcome	Discharged alive (n=7)	Died (n=3)	P=0.001
	177.43	179.9	
Stage of AKI	Stage 2 (n=3)	Stage 3 (n=7)	P=0.006
	171.66	177.32	

Discussion

Development of the kidneys begins at the fifth week of gestation and continues until 34 to 36 weeks. An average adult has about 2 million nephrons; this varies, depending on age and sex. Nephrogenesis is influenced by prematurity, intrauterine growth restriction, and AKI. Small studies suggest that the extrauterine environment is detrimental to optimal nephrogenesis.

There are significant changes in renal blood flow after birth. In comparison with the 20% to 25% of cardiac output received by the adult kidney, neonatal kidneys receive 2.5% to 4.0% of the cardiac output at birth, which slowly increases over time. Renin-angiotensin system is critical to normal renal

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development and blood flow. In term infants, the GFR improves from 10 to 20 mL/min/1.73 m^2 during the first days of life to 30 to 40 mL/min/1.73 m^2 by 2 weeks of life and nears adult GFR by 2 years. The immaturity of the neonatal kidneys has important implications for the diagnosis and management of AKI as neonates rely on the clinician to appropriately manage the fluid and electrolyte balance. [2]

AKI is classically defined as a sudden decrease in kidney function resulting in derangements in fluid balance, electrolytes, and accumulation of waste products.[31] Currently, the diagnosis of AKI is dependent on a rise in serum creatinine (SCr) or decrease in urine output. SCr poses unique challenges in the neonatal population due to the presence of maternal creatinine, varying levels of creatinine reabsorption in the proximal tubules, relatively lower GFRs and different maturational age.

The overall incidence of AKI in neonates enrolled in the AWAKEN study was 30%, and infants with AKI had four- times higher independent odds of death and longer independent hospital length of stay than those without AKI.[4] In a study done in Egypt frequency of occurrence of AKI was 10.8% with the pre-renal form being the most common. [3]

In the AWAKEN study infants with AKI had higher mortality than those without AKI and longer length of hospital stay. This was in contrast to our study. However outcome and serum sodium levels in our study were found to be significant related. In a study on hypernatremia and acute kidney injury in exclusively breastfed babies in India by Shobha Sharma et al, it was found that hypernatremia is severe enough to cause AKI in exclusively breast fed babies.

Limitations

1) Small sample size
2) Being a retrospective study, we relied on serum creatinine and urinary output data available in the medical records; therefore, AKI cases could have been missed
3) Neonatal AKI definition used for this study is an empirical one.
4) Given the difficulty in placement of urinary catheters in neonates, and to minimize catheter-associated urinary tract infections, weighing of diapers was used as an alternative, however it may not be accurate due to mixing with stools.

Conclusion

Our findings are consistent with studies in other critically ill populations, emphasizing that the kidney is not just an innocent bystander in critical illness. It is like a canary in a coalmine, indicating poorer outcomes and plays an important role in morbidity and mortality.

Low nephron numbers can predispose infants to AKI because they might not have compensatory renal reserve at the time of stress. Hypernatremia is severe enough to cause AKI in exclusively breast fed babies is difficult to recognize clinically. Thus improved understanding of the burden of neonatal AKI should be a priority.

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