

# A Study of Acute Kidney Injury in Neonates and its Outcome following Peritoneal Dialysis

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**Abstract:** **Background:** Acute Kidney Injury (AKI) is a common clinical condition encountered in NICU. It presents with diminished urinary output and/or retention in elevation of serum urea and creatinine, alteration in ECF volume, electrolytes and acid base homeostasis<sup>1</sup>. Sepsis and asphyxia are most common causes<sup>2</sup>. Peritoneal dialysis is generally regarded as optimal treatment modality in neonates with AKI who do not respond to medical treatment. It is technically a simple treatment modality which is constantly performed in neonates hospitalized in NICUs<sup>3</sup>. **Objectives:** 1) To study etiological profile of AKI in neonates admitted in Neonatal Intensive Care Unit (NICU). 2) To study Outcome of AKI in neonates following Peritoneal dialysis in NICU. **Methods:** This prospective interventional study was done in our MR medical college Hospital from October 2018 to April 2020. This study included 32 neonates admitted in NICU diagnosed with acute kidney injury and considered for peritoneal dialysis were considered for this study. Clinical history was taken and relevant investigations were performed to determine cause of AKI and peritoneal dialysis was performed, outcomes and complications related to PD were analysed. **Statistical analysis used:** Descriptive and inferential statistical analysis has been carried out in the present study. The results were analysed by using SPSS version 20.0. Results on continuous measurements were presented on Mean±SD (Min-Max) and results on categorical measurements were presented in Frequency (Percentage). Inferential statistics like Mann-Whitney U test was used to check difference between two groups. **Results:** Out of 32 neonates with AKI, 53.1% were males and 46.9% were females. While a normal birth weight was observed in 40.6% cases, 59.4% had low birth weight. Frequency of oliguric kidney injury was 71.9% and non-oliguric was 28.1%. Sepsis (78.1%) was the most common cause and followed by dehydration fever (50.0%). On peritoneal dialysis, complete recovery seen in 78.1% and mortality in 21.9% of neonates. PD related complications was seen in 46.8% neonates, most common being hypokalemia (12.5%), difficult drainage due to catheter block (12.5%) followed by hypoglycemia (9.4%). **Conclusion:** Acute kidney injury in neonates and infants is not uncommon and needs frequent renal function monitoring. Sepsis, dehydration fever and birth asphyxia are common predisposing factors for AKI. Peritoneal dialysis is an effective route of renal replacement therapy in the neonatal period for management of metabolic disturbances as well as renal failure. Although major complications of the procedure are uncommon, these patients still have a high mortality rate due to serious nature of the underlying primary causes.

**Keywords:** Acute Kidney Injury, Peritoneal dialysis, Sepsis, Dehydration, fever, Birth asphyxia

## 1. Introduction

Acute kidney injury (AKI), previously termed Acute Renal Failure (ARF), is defined as an abrupt decrease in glomerular filtration rate. The condition often presents with diminished urinary output and/or retention in nitrogenous waste products resulting in elevation of serum urea and creatinine, alteration in ECF volume, electrolytes and acid base homeostasis<sup>1</sup>. It affects 8 to 24% of critically ill neonates<sup>1</sup>.

Common conditions contributing to kidney injury in neonates according to various studies are perinatal asphyxia, neonatal sepsis, hypernatremic dehydration, respiratory distress syndrome, dehydration, heart failure, nephrotoxic drug medication and urological anomalies<sup>2</sup>.

Asphyxia and sepsis are most common causes<sup>2</sup>.

Peritoneal dialysis is generally regarded as optimal treatment modality in neonates with AKI who do not respond to medical treatment. It is technically a simple treatment modality which is constantly performed in neonates hospitalized in NICUs. It facilitates slow removal of fluids and solutes while preventing hemodynamic instability and it is effective for management of AKI and metabolic disturbances<sup>3</sup>.

Advantages of Peritoneal Dialysis being requirement for less specialized expertise, fewer equipment sources, lower costs and fewer complications. National Kidney Foundation recommends Peritoneal Dialysis over hemodialysis in children younger than 6 years<sup>4</sup>.

Complications of Peritoneal Dialysis include peritonitis, catheter related complications like bleed, catheter blockade, dialysate leak, bowel perforation and minor metabolic disturbances like hyperglycemia and hypokalemia<sup>4</sup>.

## 2. Material and Methods

This is a prospective interventional study conducted in the Department Of Pediatrics, M R Medical college Hospital Kalaburgi. Patient's attenders were informed about the purpose of the study and written consent was taken before start of the study. Ethical clearance was obtained by ethical clearance committee of the institution. The study was conducted from October 2018 To April 2020.

### Inclusion criteria:

- 1) All the Neonates admitted in NICU diagnosed with AKI of either sex.
2. Neonates in NICU with AKI performed Peritoneal Dialysis.

**Exclusion criteria**

- 1) Recent abdominal surgery
- 2) Abdominal wall defects like gastroschisis and omphalocele In these conditions, peritoneal dialysis is contraindicated.

**Method of Collection of Data**

All neonates admitted in NICU diagnosed with acute kidney injury and considered for peritoneal dialysis are included in this study. Gestational age, birth weight, relevant maternal and neonatal history, examination findings and investigations are noted in predesigned proforma.

Based on history investigations, neonate is categorized into prerenal, renal and postrenal AKI and possible cause of AKI is determined.

Peritoneal dialysis is performed and PD related complications, outcome after PD is determined.

Lab Investigations done include CBC, CRP, RFT, S. Electrolytes, Urinary indices: Urine Sodium, urine creatinine to measure Fractional Excretion of Sodium (FeNa), Blood Culture and radiological evaluation include ultrasound abdomen with doppler.

**Statistical Analysis**

Descriptive and inferential statistical analysis has been carried out in the present study. The results were analyzed by using SPSS version 20.0 (IBM Corporation, SPSS Inc., Chicago, IL, USA).

Results on continuous measurements were presented on Mean $\pm$ SD (Min-Max) and results on categorical measurements were presented in

Frequency (Percentage). Inferential statistics like Mann-Whitney U test was used to check difference between two groups. p value less than 0.05 was considered statistically significant.

**3. Results**

In study of 32 neonates,

**1) Age wise distribution of cases:**

Majority of them (65.62%) presented within first 5 days of birth. Mean age of presentation is 6.09 days  $\pm$ 4.98 SD.

Age (in days)	Frequency	Percentage
<5	21	65.62
6-10	06	18.76
>11	05	15.62
Total	32	100
Mean	6.09 $\pm$ 4.98	
Range	1-19 days	

**2) Gender wise distribution of cases:**

Out of 32 neonates, 17 (53.1%) were males and 15 (46.9%) were females.

Gender	Frequency	Percentage
Female	15	46.9
Male	17	53.1
Total	32	100

**3) Birth weight distribution:**

Normal birth weight was observed in 40.6% cases, 59.4% had low birth weight.

Birth weight (kg)	Frequency	%
<2.5	19	59.4
>2.5	13	40.6
Total	32	100.0
Mean: 2.39 $\pm$ 0.42		
Range: 1.28-3.25		

**4) Gestational age distribution:**

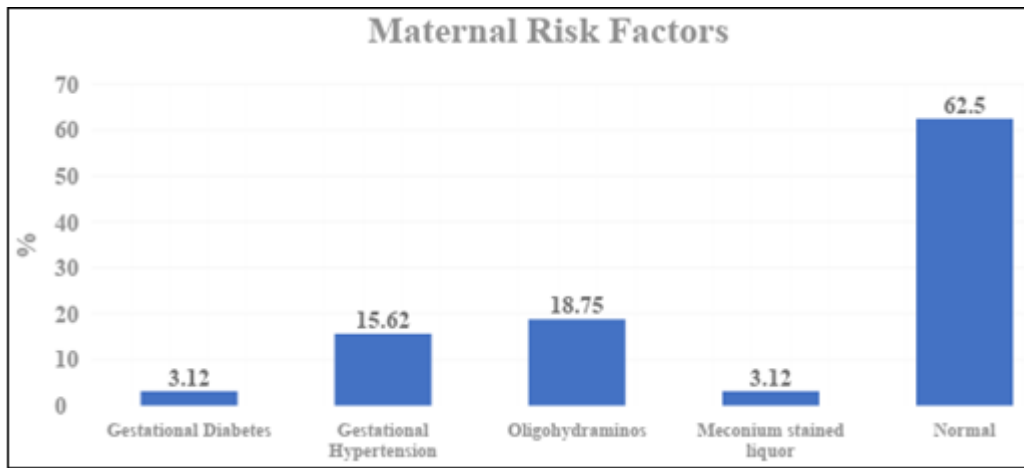
Based on gestational age, majority of them were term babies (81.3%), followed by preterm (15.6%) and postterm (3.1%) cases.

Gestation	Frequency	Percentage
Preterm	05	15.6
Term	26	81.3
Post term	01	3.1
Total	32	100

**5) Maternal Risk Factors**

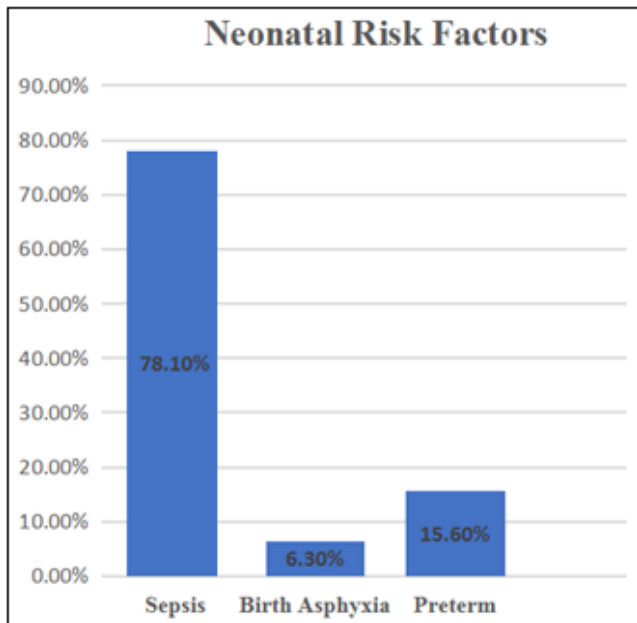
Maternal risk factors associated with AKI in neonates include most common being oligohydramnios 6(18.75%) cases followed by gestational hypertension 5(15.62%) cases.

Maternal Illness	Frequency	Percentage
Gestational Diabetes	01	3.12
Gestational Hypertension	05	15.62
Oligohydramnios	06	18.75
Meconium stained liquor	01	3.12
Nil	20	62.50



6) Neonatal Risk Factors

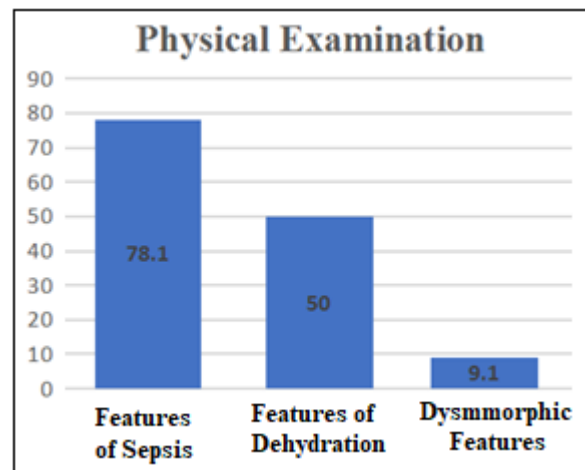
Neonatal Risk Factors	Frequency	%
Sepsis	25	78.1
Birth Asphyxia	2	6.3
Preterm	5	15.6



Neonatal risk factors associated with AKI include most common being sepsis in 25(78.1%) cases, followed by preterm in 5(15.6%) cases and birth asphyxia in 2(6.3%) cases.

7) Physical Examination in AKI neonates

Physical Examination	Frequency	%
Features of Sepsis	25	78.1
Features of Dehydration	16	50.0
Dysmorphic Features	3	9.4



8) Urine output:

Frequency of oliguric kidney injury was 71.9% and non-oliguric was 28.1%.

Urine Output	Frequency	Percentage
Low	23	71.9
Normal	09	28.1
Total	32	100

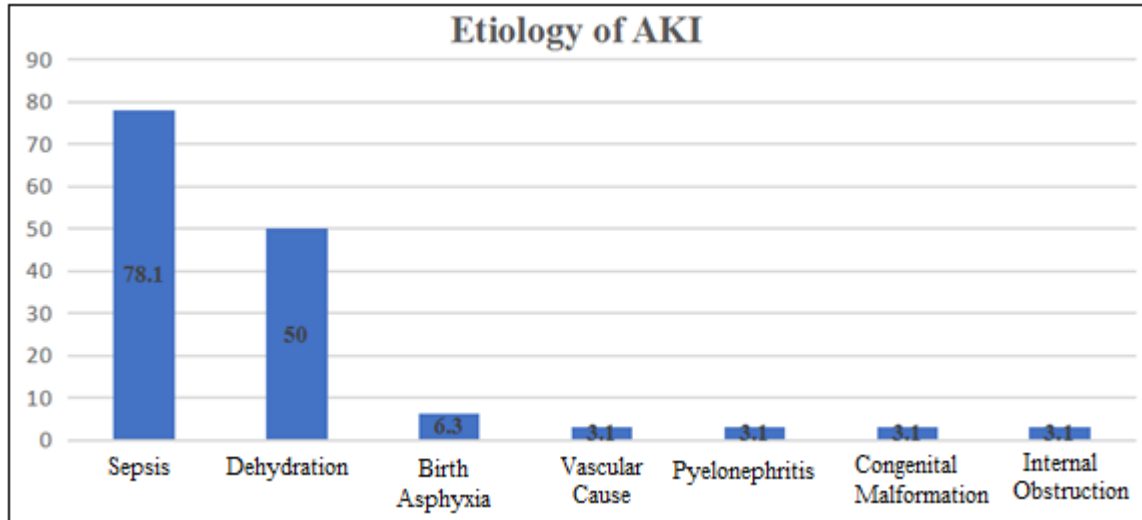
9) USG finding in AKI Neonates:

USG abdomen with Doppler	Frequency	Percentage
B/I hydroureteronephrosis with vesicoureteral reflux	01	3.12
Bilateral medullary nephrocalcinosis	01	3.12
Renal vein thrombosis	01	3.12
Grade I nephropathy	02	6.25
Grade II nephropathy	04	12.50
Hypoplastic horseshoe kidney with polycystic changes	01	3.12
Signs of Pyelonephritis	01	3.12
Normal	21	65.62
Total	32	100

10) Etiology of AKI

Sepsis (78.1%) was the most common cause of AKI followed by dehydration fever (50.0%) and birth asphyxia (6.3%). Few of them had overlapping causes. The various etiologies leading to acute kidney injury in our study include:

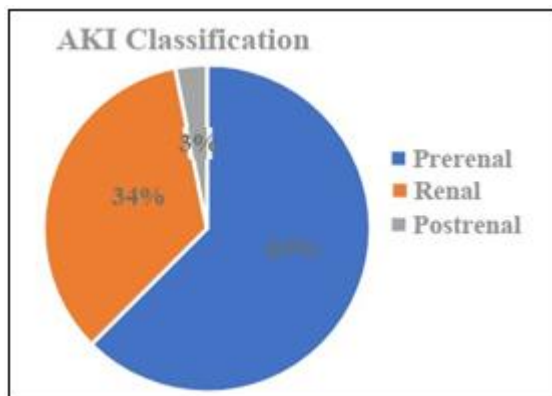
Diagnosis	Frequency	Percentage
Sepsis	25	78.1
Dehydration fever	16	50.0
Asphyxia	02	6.3
Pyelonephritis	01	3.1
Vascular cause (Renal Vein Thrombosis)	01	3.1
Congenital malformation (VACTERL anomaly)	01	3.1
Intrarenal obstruction (Nephrocalcinosis)	01	3.1



**11) Classification of AKI:**

Among classification, prerenal type (62.5%) of AKI was most common.

Etiology of AKI	Frequency	Percentage
Prerenal	20	62.50
Renal	11	34.37
Postrenal	01	3.13
Total	32	100



**12) Prerenal causes of AKI:**

Among Pre renal cause, Sepsis contributes to 15 (75%) cases and dehydration contributes to 12 (60%) cases.

Diagnosis	Frequency	Percentage
Sepsis	15	75
Dehydration	12	60

**13) Renal causes of AKI:**

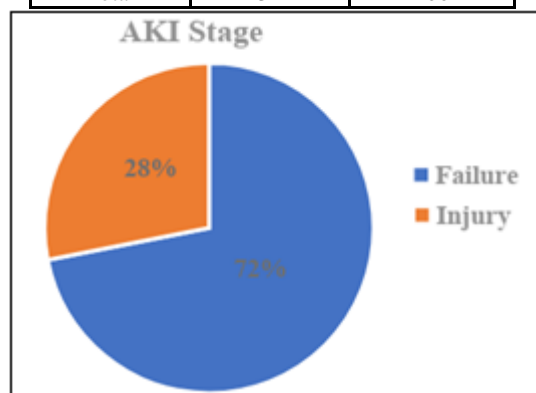
Among Renal cause, Sepsis contributes to majority 10 (90.9%) cases and followed by asphyxia which contributes to 2 (18.18%) cases.

Diagnosis	Frequency	Percentage
Sepsis	10	90.9
Asphyxia	02	18.18
Pyelonephritis	01	9.09
Vascular cause	01	9.09
Congenital malformation	01	9.09
Intrarenal obstruction	01	9.09

**14) AKI Staging at time of Dialysis (RIFLE Criteria):**

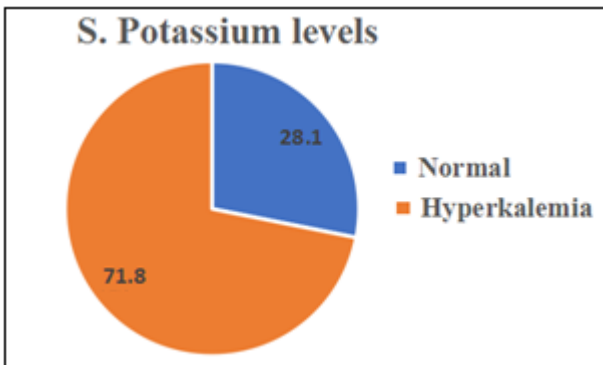
On classifying 32 neonates based on RIFLE criteria, 23 (71.9%) cases fall into 'failure stage' and 9 (28.1%) into 'injury stage'.

AKI Stage	Frequency	Percentage
Failure	23	71.9
Injury	09	28.1
Total	32	100



**15) Serum Potassium levels**

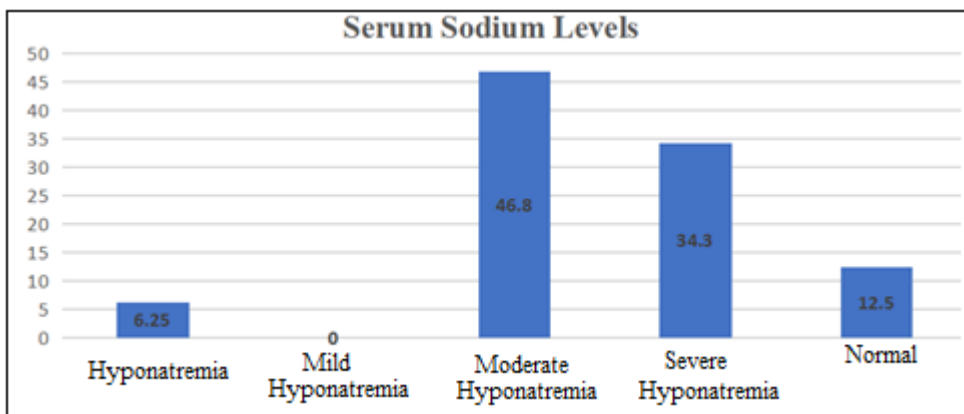
S. Potassium level (mEq/L)	Frequency	Percentage
Normal (3.5-6)	9	28.1
Hyperkalemia (>6)	23	71.8



Serum sodium levels measured in 32 AKI neonates shows hyperkalemia in 23 (71.8%) cases and normal levels in 9 (28.1%) cases.

16) Serum Sodium Levels<sup>5,6</sup>

Serum Sodium Level (mEq/L)	Frequency	Percentage
Hyponatremia (<135)	2	6.25
Hyponatremia mild (146-149)	0	0
Hyponatremia moderate (150-169)	15	46.8
Hyponatremia severe (>170)	11	34.3
Normal (135-145)	4	12.5

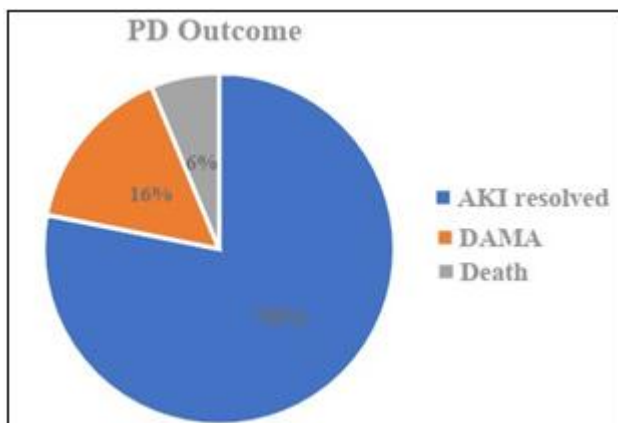


Serum sodium levels measured in 32 AKI neonates shows hyponatremia in 2 (6.25%) cases, normal in 4 (12.5%), moderate hyponatremia in 15 (46.8%) and severe hyponatremia in 11 (34.3%) cases.

17) Peritoneal Dialysis (PD) OUTCOME

AKI resolved in 78.1% of cases and death occurred in 6.3% cases. Patients who went DAMA (Discharge against medical advice) were critically ill. No death occurred due to complications related to PD.

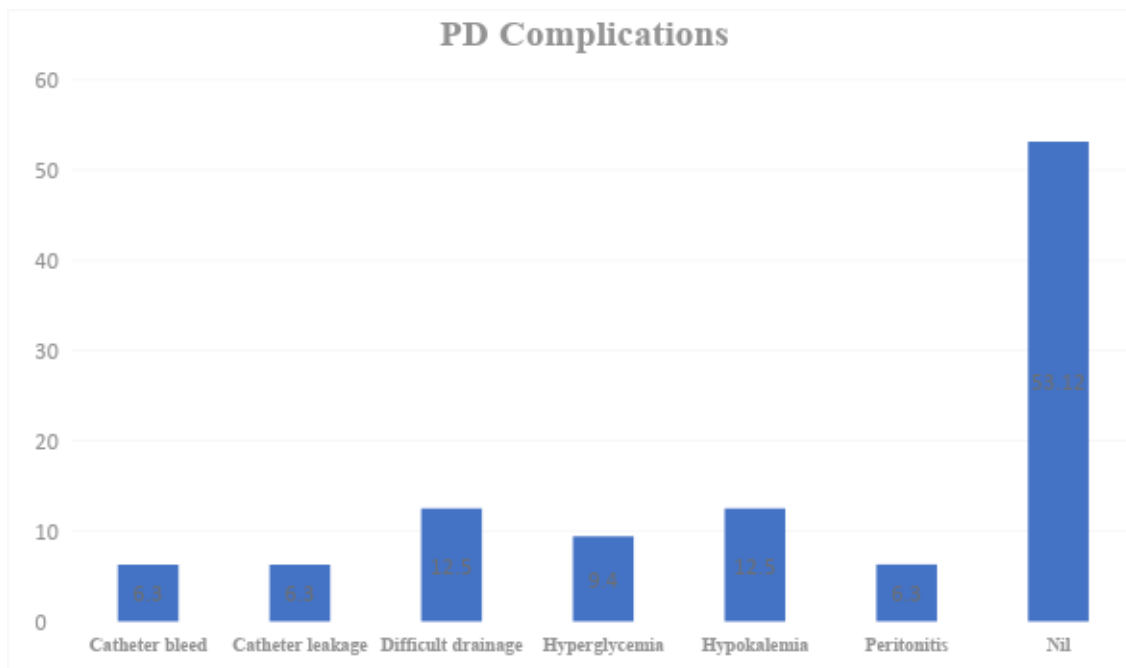
PD Outcome	Frequency	Percentage
AKI resolved	25	78.1
DAMA	05	15.6
Death	02	6.3
Total	32	100



18) PD Complications

Complications related to PD occurred in 46.8% cases. Metabolic complications are most commonly seen include hyperglycemia (9.4%), hypokalemia (12.5%), difficult drainage due to catheter block (12.5%)

PD Complications	Frequency	Percentage
Catheter bleed	02	6.2
Catheter leakage	02	6.2
Difficult drainage due to catheter block	04	12.5
Hyperglycemia	03	9.4
Hypokalemia	04	12.5
Peritonitis	02	6.2
Nil	17	

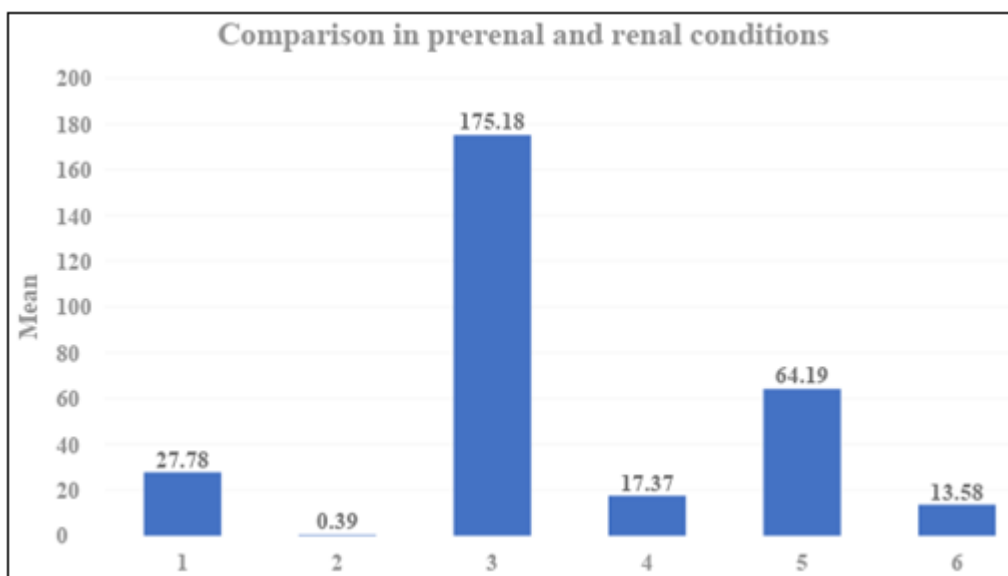


19) Mean±SD of Variables:

Variables	Minimum	Maximum	Mean	SD
Birth weight (Kgs)	1.280	3.250	2.39	0.42
S Urea	40.0	465.0	272.49	135.04
S Creatinine	3.20	9.10	5.06	1.48
S Sodium	130.0	189.0	161.47	13.74
S Potassium	4.73	8.60	6.80	1.06
S Urea creatinine ratio	10.60	101.00	54.16	25.65
Urine sodium	14.00	256.80	89.24	84.88
Fractional excretion of sodium	0.19	95.400	10.70	19.74

20) Comparison of variables in prerenal and renal conditions:

Variables	N	Minimum	Maximum	Mean	SD	P value
Fractional Excretion of Sodium						
Prerenal	12	6.01	95.4	27.78	24.28	0.001*
Renal	19	0.19	0.8	0.39	0.15	
Urine Sodium						
Prerenal	14	65	256.8	175.18	54.76	0.001*
Renal	09	14	19.50	17.37	1.92	
S Urea Creatinine Ratio						
Prerenal	25	34.2	101	64.19	18.98	0.001*
Renal	4	10.6	18.21	13.58	3.25	



4. Discussion

Present study was undertaken to study etiology of acute kidney injury in neonates and their outcome following peritoneal dialysis.

Mean age of presentation with AKI was 6.09±4.98 days. Mean birth weight was 2.39±0.42 kg. Male to female ratio

was 1.13.

Among 32 neonates, 59.4% of neonates had low birth weight (<2.5 kg) and 40.6% had normal birth wt (>2.5kg).

This was comparable to study by SK Pradhan et al on prevalence and factors affecting prognosis in neonates with AKI published in Journal of Clinical Neonatology 2018



where 60.2% of neonates had low birth weight (<2.5 kg) and 39.8% had normal birth wt (>2.5kg)<sup>7</sup>.

Preterm is risk factor for neonatal AKI. Immature renal system and being at a higher risk for ischemia, hypovolemia and hypotension, they will be more prone to acute kidney injury.

In present study, 15.6% of them were preterm neonates. This was comparable to study by S Halder et al on Acute Kidney Injury in Sick Neonate: Incidence and Outcome published in Journal of Bangladesh College of Physicians and Surgeons 2017 where preterm neonates accounted for 28.5% neonates<sup>8</sup>.

In our study, neonatal sepsis was the most common cause of AKI accounting for 78.1% of cases followed by dehydration fever in 50% of cases and birth asphyxia in 6.3% of cases.

Because of hot and humid temperature noted in North Karnataka region, neonates are more prone for hypernatremic dehydration seen mainly during summer months. Hence, 50% of cases of AKI are secondary to dehydration fever.

A study conducted by Prasad G, Anjani A on neonates and infants admitted with acute kidney injury published in International Journal of Science and Research 2015, neonatal sepsis was most common (50%) cause of AKI followed by pneumonia (16.6%)<sup>9</sup>.

In our study, peritoneal dialysis done on 32 AKI neonates, 78.1% neonates recovered from AKI, 15.6% neonates went DAMA and 6.3% neonates died. Patients who went DAMA were critically ill. Non survivors died due to septic shock and all required mechanical ventilation and inotropic support.

This was comparable to study done by Yildiz et al on Acute Peritoneal dialysis in neonates with AKI and hypernatremic dehydration published in Peritoneal Dialysis International in 2013, 73.3% of neonates recovered and 26.7% died during peritoneal dialysis. Non survivors died due to sepsis and multiorgan failure<sup>10</sup>.

In our study, complications related to PD occurred in 46.8% cases. Metabolic complications are most commonly seen include hyperglycemia (9.4%), hypokalemia (12.5%), difficult drainage due to catheter block (12.5%), peritonitis (6.2%), catheter bleed (6.25%) and catheter leakage (6.2%). No complication was noted during catheter insertion.

In study done by Yildiz et al, Complications related to PD occurred in 46.7%. Most common being peritonitis (26.7%). Isolated micro-organisms included methicillin resistant Staphylococcus aureus, Klebsiella, and Candida albicans. Others include dialysate leak (13.3%), exit-site bleeding (3.1%), catheter migration(3.1%) and catheter blockade by fibrin or omentum (20%). Peritoneal dialysis-related complications were managed successfully, and no deaths attributable to PD-related complications<sup>10</sup>.

## 5. Conclusion

This hospital based prospective study included 32 neonates admitted in NICU and diagnosed with AKI and planned for peritoneal dialysis.

Among the study group, most of neonates presented to hospital in 1st 5 days of postnatal life. Majority of them were males. Common Causes for AKI: Sepsis was most common followed by dehydration and birth asphyxia. Among causes, Prerenal etiology is commonly seen.

Depending on Indications, Peritoneal dialysis is done. PD is a simple safe and optimal procedure for neonates. Early initiation of PD is recommended as it reduced mortality, recovered renal function early, reduced duration of mechanical ventilation and decreased length of hospital stay.

Common complications related to PD include: difficult drainage due to catheter block, peritonitis, catheter bleed and catheter leakage and hyperglycemia, hypokalemia.

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