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Incidence, Risk Factors, and Outcome of Acute Kidney Injury in Hospitalized Neonates

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ABSTRACT
Background: Acute Kidney Injury is one of the most common diseases among the neonates hospitalized in neonatal intensive care units and is associated with increased risk of morbidity and mortality. The true incidence of Acute Kidney Injury in neonates is not well known.
Objective: The study aimed to determine the incidence of neonatal AKI, risk factors predisposing to neonatal AKI, and outcome in neonates with AKI.
Methods: This was a hospital based observational study conducted in the Department of Paediatrics, Silchar Medical College & Hospital over a period of year starting from 1st June 2021 to 31st May 2022. A total of 140 neonates were included based on the inclusion and exclusion criteria. Detailed ante-natal, natal and post-natal history with examination and relevant investigations were done. Neonates were closely monitored for the occurrence of AKI based on rising creatinine values or decreasing urine output.
Results: The incidence of neonatal AKI was 25.70% (36 out of 140 neonates). The mean birth weight and gestational age among the enrolled neonates were 2.20 kg (standard deviation of 0.62 kg) and 36.4 weeks (standard deviation of 2.9 weeks). By applying KDIGO criteria, 22 neonates, 12 neonates and 2 neonates fell into stage 1, stage 2 and stage 3 respectively. Out of 36 neonates with AKI, 15 neonates expired (41.70%) and 21 were discharged and followed up till 3 months of age. Prematurity, low birth weight, PIH, PPROM, ante-natal steroids, birth asphyxia, sepsis, shock, umbilical catheterization and mechanical ventilation were significantly associated ($p < 0.05$) with occurrence of neonatal AKI.
Conclusion:AKI in the newborn is a common problem in the neonatal intensive care unit. The presence of AKI increases the risk of mortality in the newborn. PPROM, Birth asphyxia, shock, umbilical venous catheterization, use of mechanical ventilation, oliguria and presence of AKI were significant risk factors for mortality. Early diagnosis and timely intervention in neonates can prevent the progression of AKI and thus improve prognosis.
Key words:AKI, KDIGO, risk factors, mortality

I. INTRODUCTION

AKI is commonly encountered complications in newborns admitted to the neonatal intensive care units (NICUs).The exact prevalence in the newborn population is still unknown, the data available reveals varying incidence of AKI in the Newborn Intensive Care Units (NICUs) around the world, ranging from 6-24%.[1,2]
AKI, is defined as an abrupt (within 7 days) reduction in kidney function currently defined as an absolute increase in serum creatinine of more than or equal to 0.3 mg/dL (>26.4 micromol/L), a percentage increase in serum creatinine of more than or equal to 50% (1.5-fold from baseline) or a reduction in urine output (documented oliguria of <1ml/kg per hour over 24 hours).[3,4]

AKI development may be influenced by a number of underlying risk factors, including asphyxia, respiratory distress syndrome, preterm, sepsis, umbilical artery catheterization, early medication administration, particularly aminoglycosides, volume depletion, and urogenital abnormalities.[5,6,7,8,9]
This study was done to identify the incidence of AKI in admitted neonates and to evaluate their outcome and explore the risk factors for the development of AKI.

II. MATERIALS AND METHODS

The local ethics committee accepted this study. A total of 140 neonates admitted in NICU, SMCH with risk factors and symptoms of AKI either at admission or during the course of treatment were included in the study as per the inclusion criteria and exclusion criteria until the required study population achieved over a period of 1 year.

- Inclusion criteria:

❖ Neonates with peri-natal asphyxia, respiratory distress syndrome, sepsis, prematurity, mechanical ventilation, dehydration, umbilical

catheterization, maternal use of ACE inhibitors, congestive heart failure.

- Exclusion criteria:

❖ Neonates who died within 24 hrs of admission, with maternal history of azotemia, with congenital anomalies of urinary system, with post operative AKI, on drugs altering GFR.

The diagnosis of AKI was established by measuring the serum creatinine level or urine output. In babies, who fulfilled the criteria for AKI, repeat estimations of serum creatinine were done every 48 h (or earlier if indicated) till it was normalized or the baby was discharged from the hospital.Normal serum creatinine values used for this study were 0.3–1.0 mg/dl.The elevation of serum creatinine value by 1.5, 2, and 3 times from the baseline values was considered as Stage 1, 2, and 3 of renal failure, respectively. Similarly, urine output ≤1.5 ml/kg/h for 24 h, <1ml/kg/h for 24 h, and <0.7 ml/kg/h for 24 h or anuria for 12 h was defined as Stages 1, 2 and 3 oliguric renal failure, respectively. (Based on KDIGO and nRIFLE criteria).[7]

III. STATISTICAL ANALYSIS

Sample size calculated was 140.(p =0.21, d= 0.07)Data were compiled using MS excel and analyzed using IBM SPSS ver. 26 software.Mean and standard deviation were calculated for continuous variables. The Chi square test and Fischer exact test were used to compare categorical variables, and unpaired t test was used for comparing continuous variables. A P value less than 0.05 was considered statistically significant.

IV. RESULTS

A total of 140 neonates admitted in Neonatal Intensive Care Unit, Department of Paediatrics of Silchar Medical College and Hospital between 1st June 2021 to 31st May 2022 were taken up for this study based on the previously mentioned inclusion and exclusion criteria.

The incidence of AKI in our study 25.70% (36 neonates out of 140enrolled neonates). In our study male neonates with AKI show slight predominance over female neonates with AKI (22 male, 14 female, ratio of 1.57:1). The mean gestational age of AKI in our study was 36.39 weeks with standard deviation (SD) of 3.42. In our study premature neonates were more prone to the development of AKI (63.9%) in compare to term neonates (36.1%). The mean birth weight of occurrence of AKI in our study was 2150 grams with standard deviation (S.D.) of 662.5 grams. In our present study, majority of neonates with AKI were low birth weight i.e., 69.4% whereas only 30.6% of normal birth weight neonates developed AKI.In our study inborn neonates had higher incidence of AKI (61.1%) when compared to outborn neonates (38.9%) and it was statistically significant.Majority of the neonates in our study were delivered by normal vaginal delivery (63.9%) while 36.1% neonates were delivered through LSCS.Among 140 neonates, maternal Pregnancy Induced Hypertension (PIH) was seen in 26 neonates (18.6%). Out of 36 neonates with AKI, 11 neonates (30.6%) had PIH as a risk factor for the occurrence of AKI.Out of 140 enrolled neonates, PPROM was seen in 30 neonates (21.4%) and out of 36 neonates with AKI, 12 neonates (33.3%) had PPROM as a risk factor for the occurrence of AKI.Among 140 neonates in our study, there were 17 neonates (12.1%) whose mother received ante-natal steroid. Out of 36 neonates with AKI, 8 neonates (22.2%) had ante-natal steroid as a risk factor.Other maternal factors considered to be risk factors were: maternal GDM (in 6.4% of 140 neonates), chorioamnionitis (in 5% of 140 neonates), APH (in 13.6% of 140 neonates) and maternal anti-hypertensives (in 10% of 140 neonates).

In our study, 55 neonates (39.3%) out of 140 enrolled neonates had birth asphyxia. Out of 36 neonates with AKI, 21 neonates (58.3%) had birth asphyxia.Out of 140 neonates in our study, 46 neonates (33.1%) went into shock. Out of 36 neonates with AKI, 17 neonates (47.2%) had shock as a risk factor.Among 140 neonates in our study, 36 neonates (25.7%) had sepsis. Out of 36 neonates with AKI, 15 neonates (41.7%) had sepsis as a risk factor.In 140 enrolled neonates in our study, umbilical vein catheterization was done in 23 neonates (16.4%). Out of 36 neonates with AKI, 10 neonates (27.8%) had umbilical vein catheterization as a risk factor.Out of 140 neonates, 20 neonates (14.3%) were on mechanical ventilation. Out of 36 neonates with AKI, 12 neonates (33.3%) were on mechanical ventilation.Other neonatal factors considered to be risk factors were: respiratory distress (27.9% in 140 neonates), dehydration (12.9% in 140 neonates), and congestive heart failure (5% in 140 neonates).Among 140 neonates in our study, 11 neonates (7.9%) had oliguria. Among 36 neonates with AKI, 11 neonates (30.6%) had oliguric AKI, whereas 25 neonates (69.4%) had non-oliguric AKI.

In our study, 22 neonates (61.1%) reached stage 1 AKI, 12 neonates (33.3%) reached stage 2 AKI, and 2 neonates (5.6%) reached stage 3 AKI.

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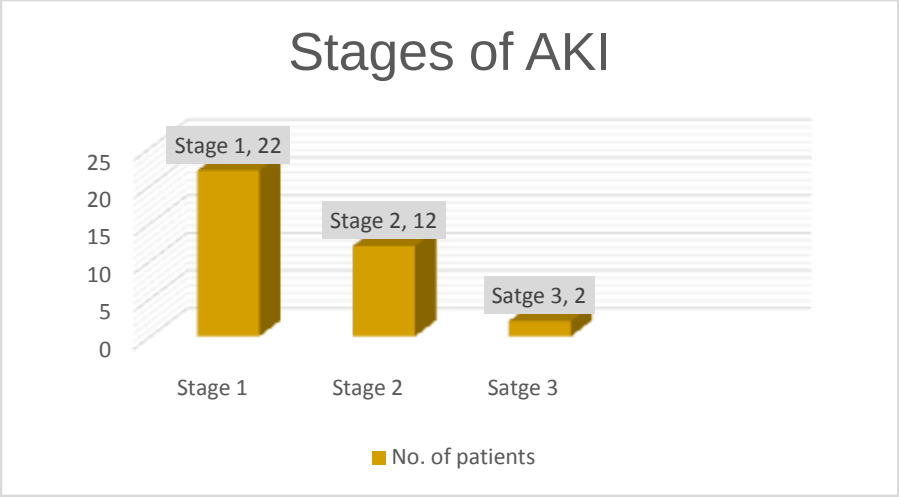
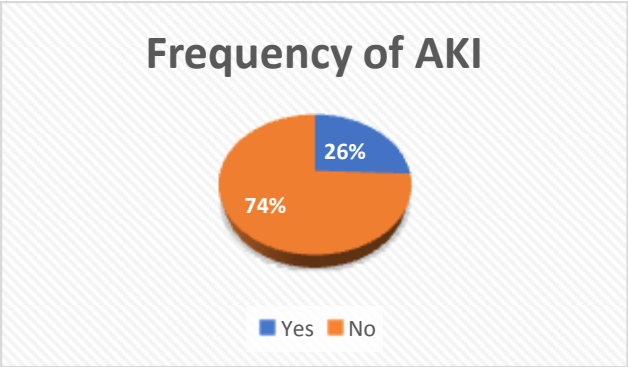
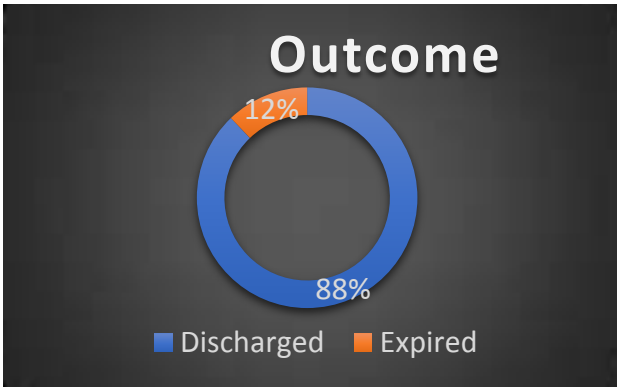
Among 140 enrolled neonates in our study, 17 neonates (12.1%) expired. Out of 36 neonates with AKI,15 neonates (41.7%) expired and rest all got discharged.

Among 15 expired neonates, 6 (27.3%) neonates were in stage 1 AKI, 7 neonates (58.3%) were in stage 2 AKI, and 2 neonates (100%) were in stage 3 AKI.







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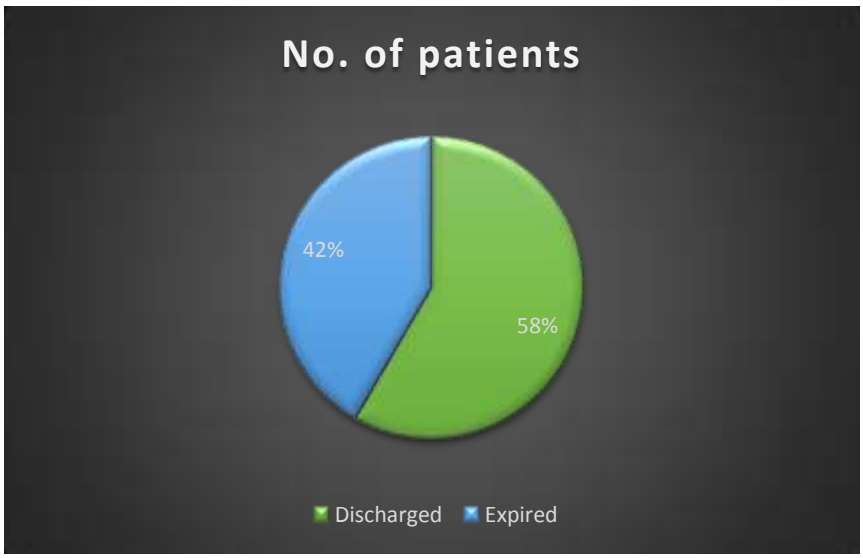

Risk factors of AKI		AKI				Total		P	OR	95% CI of OR
		Yes		No						
		N	%	N	%	N	%			
Gestational age	<37 weeks	23	63.9	43	41.3	66	47.1			
	≥37 weeks	13	36.1	61	58.7	74	52.9	0.014	2.51	1.15-5.5
Birth weight	Low birth weight	25	69.4	52	50	77	65			
	Normal	11	30.6	52	50	63	45	0.043	2.27	1.01-5.09
Site of delivery	Inborn	22	61.1	42	40.4	64	45.7			
	Out born	14	38.9	62	59.6	76	54.3	0.031	2.32	1.07-5.04
PIH	Yes	11	30.6	15	14.4	26	18.6			
	No	25	69.4	89	85.6	114	81.4	0.032	2.61	1.07-6.39
PPROM	Yes	12	33.3	18	17.3	30	21.4			
	No	24	66.7	86	82.7	110	78.6	0.043	2.39	1.01-5.64
Steroids	Yes	8	22.2	9	8.7	17	12.1			
	No	28	77.8	95	91.3	123	87.9	0.032	3.02	1.06-8.55

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Volume 5, Issue 2, Mar - Apr 2023 pp 1000-1007 www.ijdmsrjournal.com ISSN: 2582-6018

Birth asphyxia	Yes	21	58.3	34	32.7	55	39.3	0.007	2.88	1.32-6.28
	No	15	41.7	70	67.3	85	60.7			
Sepsis	Yes	15	41.7	21	20.2	36	25.7	0.011	2.82	1.25-6.39
	No	21	58.3	83	79.8	104	74.3			
Umbilical catheter	Yes	10	27.8	13	12.5	23	16.4	0.033	2.69	1.06-6.84
	No	26	72.2	91	87.5	117	83.6			
Mechanical ventilation	Yes	12	33.3	8	7.7	20	14.3	<0.001	6.00	2.2-16.31
	No	24	66.7	96	92.3	120	85.7			
Oliguria	Yes	11	30.6	0	0	11	7.9	<0.001	∞	
	No	25	69.4	104	100	129	92.1			
Shock	Yes	17	47.2	29	27.9	46	33.1	0.028	2.31	1.06-5.06
	No	19	52.7	75	72.1	94	66.9			

Table 1:Independent risk factors for acute kidney injury among study subjectson logistic regressionanalysis

		MORTALITY						P	OR	95% CI of OR
		YES		NO						
		N	%	N	%	N	%			
Maternal age	<25 years	10	58.8	66	53.7	76	54.3	0.689	1.23	0.44 - 3.45
	≥25 years	7	41.2	57	46.3	64	45.7			
Gestational age	<37 weeks	8	47.1	58	47.2	66	47.1	0.994	1	0.36 - 2.75
	≥37 weeks	9	52.9	65	52.8	74	52.9			
Birth weight	LBW	13	76.5	64	52	77	55	0.058	3.0	0.93 -9.70
	Normal	4	23.5	59	48	63	45			
Sex	Male	11	64.7	72	58.5	83	59.3	0.627	1.3	0.45 - 3.74
	Female	6	35.3	51	41.5	57	40.7			
Site of delivery	Inborn	10	58.8	54	43.9	64	45.7	0.247	1.83	0.65 - 5.11
	Out born	7	41.2	69	56.1	76	54.3			
Mode of delivery	LSCS	7	41.2	50	40.7	57	40.7	0.967	1.02	0.37 - 2.87
	NVD	10	58.8	73	59.3	83	59.3			

International Journal Dental and Medical Sciences Research
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PIH	Yes	3	17.6	23	18.7	26	18.6			
	No	14	82.4	100	81.3	114	81.4	0.917	0.93	0.25 - 3.51
PPROM	Yes	7	41.2	23	18.7	30	21.4			
	No	10	58.8	100	81.3	110	78.6	0.034	3.04	1.05 - 8.85
GDM	Yes	0	0	9	7.3	9	6.4		0	
	No	17	100	114	92.7	131	93.6	0.249		
Chorioamnionitis	Yes	2	11.8	5	4.1	7	5			
	No	15	88.2	118	95.9	133	95	0.172	3.15	0.56 -17.67
APH	Yes	3	17.6	16	13	19	13.6			
	No	14	82.4	107	87	121	86.4	0.274	1.43	0.37 – 5.54
Steroids	Yes	4	23.5	13	10.6	17	12.1			
	No	13	76.5	110	89.4	123	87.9	0.125	2.6	0.74 - 9.17
Antihypertensives	Yes	1	5.9	13	10.6	14	10			
	No	16	94.1	110	89.4	126	90	0.546	0.53	0.07 - 4.32
Birth asphyxia	Yes	11	64.7	44	35.8	55	39.3			
	No	6	35.3	79	64.2	85	60.7	0.022	3.29	1.14 - 9.51
Shock	Yes	11	68.8	35	28.5	46	33.1			
	No	5	31.3	88	71.5	93	66.9	0.001	5.53	1.79 -17.08
Sepsis	Yes	6	35.3	30	24.4	36	25.7			
	No	11	64.7	93	75.6	104	74.3	0.335	1.69	0.58 - 4.96
Respiratory distress	Yes	6	35.3	33	26.8	39	27.9			
	No	11	64.7	90	73.2	101	72.1	0.466	1.49	0.51 - 4.34
Dehydration	Yes	0	0	18	14.6	18	12.9		0	
	No	17	100	105	85.4	122	87.1	0.091		
Umbilical catheter	Yes	6	35.3	17	13.8	23	16.4			
	No	11	64.7	106	86.2	117	83.6	0.025	3.4	1.11 - 10.41
Mechanical ventilation	Yes	10	58.8	10	8.1	20	14.3			
	No	7	41.2	113	91.9	120	85.7	<0.001	16.1	5.05 - 51.62
Congestive heart failure	Yes	2	11.8	5	4.1	7	5			
	No	15	88.2	118	95.9	133	95	0.172	3.15	0.56 - 17.67
Oliguria	Yes	8	47.1	3	2.4	11	7.9			
	No	9	52.9	120	97.6	129	92.1	<0.001	35.56	8.01-157.73
AKI	Yes	15	88.2	21	17.1	36	25.7			
	No	2	11.8	2	82.9	104	74.3	<0.001	36.4	7.75 -171.35

Table 2: Association of risk factors with mortality in neonates with AKI

V. DISCUSSION

The incidence of AKI in our study was 25.70%(36 neonates) which is similar to findings of AWAKEN study[10] and various previous studies.The mean and standard deviation age of occurrence of AKI in our study was 1.86 ± 2.52 days.The mean and standard deviation gestational age of occurrence of AKI in our study was 36.39 ± 3.42 weeks.The mean and standard deviation birth weight of occurrence of AKI in our study was 2150.0 ± 662.5 grams.

Prematurity, low birth weight, maternal PIH, PPROM, ante-natal steroids were maternal factors which were significantly associated with occurrence of neonatal AKI in our study which is similar to finding of Bolat et al[11] and various previous studies.

Birth asphyxia, sepsis, shock, umbilical catheterization, presence of oliguria and use of mechanical ventilation were neonatal factors which were significantly associated with neonatal AKI in our study which is similar to finding of Ramesh et al[12], Ghoiya P et al[13], and various previous studies.

Oliguria and raised serum creatinine was significantly associated with occurrence of AKI which is similar to findings of Youseef et al[14].

Significant risk factors for mortality were: PPROM, Birth asphyxia, shock, umbilical venous catheterization, use of mechanical ventilation, oliguria and presence of AKI.

Out of 36 neonates with AKI, 15 neonates expired which is similar to findings of Youseef et al[14], Nandhgopal et al[15].

Among 15 expired neonates with AKI, 6 (27.3%) neonates were in stage 1 AKI, 7 neonates (58.3%) were in stage 2 AKI, and 2 neonates (100%) were in stage 3 AKI.

VI. CONCLUSION

AKI in the newborn is a common problem in the neonatal intensive care unit. The presence of AKI increases the risk of mortality in the newborns. Most of the sick neonates are likely to develop lower stages of AKI, so they need close monitoring. The cutoff of 1.5 mg/dl for serum creatinine for defining AKI has chance to miss most of the cases of AKI. Prematurity, low birth weight, maternal PIH, PPROM, ante-natal steroids, birth asphyxia, sepsis, shock, umbilical vein catheterization and mechanical ventilation are common predisposing factors for AKI in neonates. AKI was predominantly non-oliguric. AKI increases the mortality rate in neonates. PPROM, Birth asphyxia, shock, umbilical venous catheterization, use of mechanical ventilation, oliguria are risk factors for mortality in neonates with AKI. It is important to prevent AKI by rapidly diagnosing the patients with predisposing factors and effectively treating the neonates with AKI.

LIMITATIONS

Sample size was smaller.No Control group was taken for comparative analysis of the efficacy.Long term follow-up needed to look for development of CKD in neonates with AKI.

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