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# Acute Renal Failure in Neonates:Clinical and Laboratory Profile

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**Abstract:- Pre-renal failure is the most common cause of neonatal acute renal failure (ARF), which is a significant disruption of glomerular filtration and tubular function in infants. It is brought on by intra-abdominal compartment syndrome, decreased effective blood volume, increased capillary leak, inadequate cardiac output, and renal hypoperfusion. Renal failure is a major problem that results in co-morbidities and a prolonged hospital stay in neonates who have been asphyxiated. According to the National Neonatal Perinatal Database of India, 2003, 2.5% of intramural deliveries required bag and mask ventilation, 1% required cardiac compressions, and 9% had Apgar scores below 7 at 1 minute. Perinatal asphyxia caused 23% of all neonatal fatalities, and 1.5% of all babies had symptoms of HIE. Currently, 13.12% of cases of ARF occur. In this study, sepsis was the most common cause of acute renal failure (ARF), which is comparable to earlier studies. Only 21.2% of patients were oliguric, according to Gupta et al., and there was no appreciable difference in urine output between the control and study groups. A 15% incidence of oliguria in sepsis was found by Mathur et al. and was attributable to prompt shock therapy. ARF was more common in premature infants, occurring in 79% of VLBW neonates. Another diagnosis that was anticipated was prematurity. A less severe decline in GFR and the preservation of tubular function may be the results of rapid therapy for shock with intravenous fluids and inotropic support. 38 newborns with HIE characteristics were examined by Gupta et al., who discovered that the concentration of creatinine rose as the HIE stage proceeded. 28 of the 45 ARF cases had birth asphyxia, and 7, 12, and 9 of those instances were HIE I, II, and III cases. The most common cause of ARF is sepsis, which can be identified and treated with the use of monitoring urine output, sepsis, serum creatinine, and FENa screening. Male newborns are more prone to develop ARF, and there is a positive relationship between prerenal ARF and HIE stage. Rapid management of stress may lower the likelihood that it may advance to tubular injury and, ultimately, intrinsic ARF.**

***Keywords***:- *Renal Failure, Prerenal ARF, New Borns, Study, Sepsis.*

## I. INTRODUCTION

When serum creatinine is greater than 1.5 mg/dl, regardless of the rate of urine production, neonatal acute renal failure, which is characterised as a rapid, severe disruption of glomerular filtration and tubular function, is identified[1]. Pre-renal failure is the most frequent cause of ARF in newborns and, if left untreated, may progress to intrinsic kidney failure[2]. Prerenal ARF accounts for more than 70% of these cases, with the other cases being intrinsic or obstructive. Prerenal ARF is brought on by renal hypoperfusion, which is brought on by decreased effective blood volume, increased capillary leak, inadequate cardiac output, drug side effects, and intra-abdominal compartment syndrome. Intrinsic renal failure[2] may result from this syndrome if it is very severe or persists for a long time. ARF occurs in as many as 8% of infants in NICU[3].

In asphyxiated newborns, renal failure is a serious issue that contributes to co-morbidities and an extended hospital stay. In most centers, the incidence of birth asphyxia is between 1 and 1.5% of live births, and it is inversely related to gestational age and birth weight, being significantly lower in later gestations. The kidneys are the primary target organs of perinatal asphyxia, accounting for 50% of instances, followed by the central nervous system in 28% of cases, the cardiovascular system in 25% of cases, and the lungs in 23% of cases.[4]

Indian data: According to the National Neonatal Perinatal Database of India, 2003, which compiled information from 17 tertiary neonatal critical care facilities in India, 9% of all intramural deliveries had Apgar scores below 7 at 1 minute (which includes mild and severe hypoxia). At five minutes old, 2.5% of infants still had Apgar scores of seven. 4.5% of newborns required bag and mask ventilation, and 1% required cardiac compressions and/or medicines for resuscitation at birth. 23% of all neonatal deaths were brought on by perinatal asphyxia. HIE symptoms were present in roughly 1.5% of all newborns. The most frequent reason for stillbirths, accounting for one-third of all such instances, was perinatal asphyxia[5]. The incidence of AKI in newborns in a developing country is 3.9/1,000 live births and 34.5/1,000 newborns admitted to the neonatal unit[9].

ISSN No:-2456-2165

## II. MATERIALS AND METHODS

➢ *Methods of Recruitment of Subject:*

Study population will include all babies (inborn or outborn) admitted to newborn unit irrespective of birth weight, gestational age, and cause for admission except the exclusion criteria.

All the babies meeting inclusion criteria will be included in the study sample.

After 72 hours of birth after obtaining informed consent from the parents, 3ml blood is drawn under aseptic precautions. This is evaluated for serum creatinine (Jaffe's test) and electrolytes-$Na^+$, $K^+$, $Cl^-$, $Ca^{+2}$, $HCO3^-$ (colorimetric method)

Serum creatinine is the current criterion standard for the diagnosis of ARF. However, important limitations are noted.

- Creatinine levels can vary widely with age, gender, lean muscle mass, muscle metabolism, and hydration status
- Serum creatinine levels may not change until 50% of kidney function is lost.
- When the GFR is lower, the amount of creatinine secreted by the tubules causes an overestimation of renal function.

The serum creatinine does not accurately represent renal function after acute alterations in glomerular filtration until steady state equilibrium has been attained, which may take several days.

The capacity to detect AKI early in the illness process may be improved by recent research of serum and urine biomarkers. Examples of markers that have been demonstrated to predict which neonates undergoing cardiopulmonary bypass will experience an increase in SCr level by higher than 0.5 mg/dL include urine and serum neutrophil gelatinase-associated lipocalin, urine interleukin-18, kidney damage marker 1, and others.

Jaffe's Test: When creatinine and picric acid are combined in an alkaline media, a quantifiable orange colour is produced. The colour is measured at 520 nm after a 15-minute incubation period at room temperature for colour development.

Colorimetric Test: Based on a modified Maruna and Trinder approach, sodium is calculated using a colorimetric method. Magnesium Uranyl Acetate precipitates sodium and proteins as a Uranyl salt, which then interacts with potassium ferrocyanide to give off a reddish hue. When measured photometrically at 505 nm, the colour's intensity is inversely proportional to the specimen's sodium content.

We measured urine sodium and creatinine.

Neonatal patients with ARF were catheterized under strict aseptic conditions in order to keep the 24 hour input and outflow chart. These newborns underwent a 30-minute fluid challenge with 10 ml/kg of ordinary saline while having their clinical parameters and urine output tracked. It was followed by injecting 1 mg/kg of Lasix if urine production was less than 1 ml/kg/hr. Additionally, intrinsic renal failure is diagnosed if urine production is still less than 1ml/kg/hr.

The following statistical techniques were used to analyse the findings:

➢ *Statistical Methods:*

Data will be analysed by following statistical methods:

- Descriptive Cross Section Statistics
- Univariate Analyses
- One way Anova test

In the current investigation, a descriptive cross-sectional study was done. findings for categorical measurements are reported as number%, whereas findings for continuous measurements are presented as mean+/-SD. The 5% level of significance is used to determine significance. Finding the relevance of study parameters on a continuous scale among three groups has been done in part using an Anova.

## III. RESULTS AND ANALYSIS

The goal of this descriptive cross-sectional study was to determine the prevalence, cause, and effects of birth asphyxia on ARF in the Neonatal ICU at the Meenakshi Mission Hospital and Research Centre in Madurai.

The results are shown in the tables and graphs below.

Table 1 Gestation Wise Distribution of Cases

| Gestation | f | % |
|---|---|---|
| Pre term | 22 | 48.89 |
| Term | 23 | 51.11 |
| Total | 45 | 100 |

In our study out of 45 patients, 23 were term and 22 were preterm

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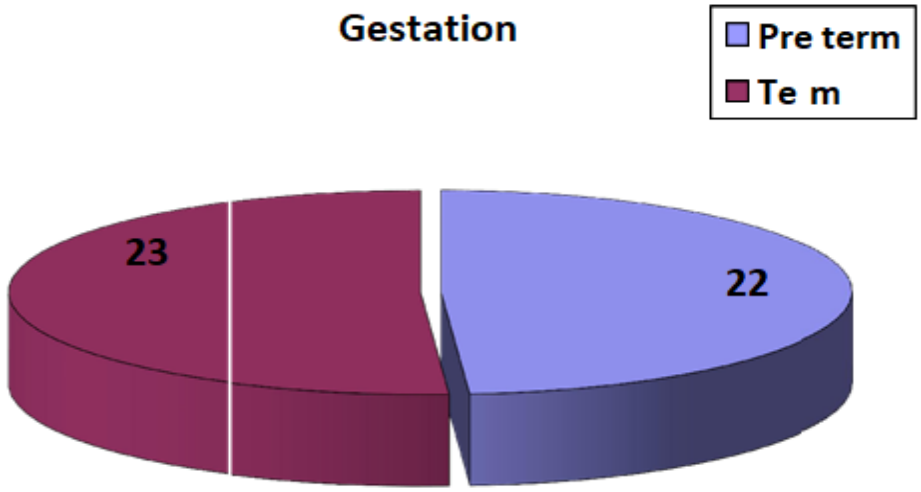


Fig 1 Gestation Wise Distribution of Cases

Table 2 Mode of Delivery Wise Distribution of Cases

| Mode of Delivery | F | % |
|---|---|---|
| CS | 24 | 53.3 |
| FD | 3 | 6.67 |
| NVD | 17 | 37.78 |
| VE | 1 | 2.22 |
| Total | 45 | 100 |

In present study, caesarean section was the predominant mode of delivery followed by normal vaginal delivery

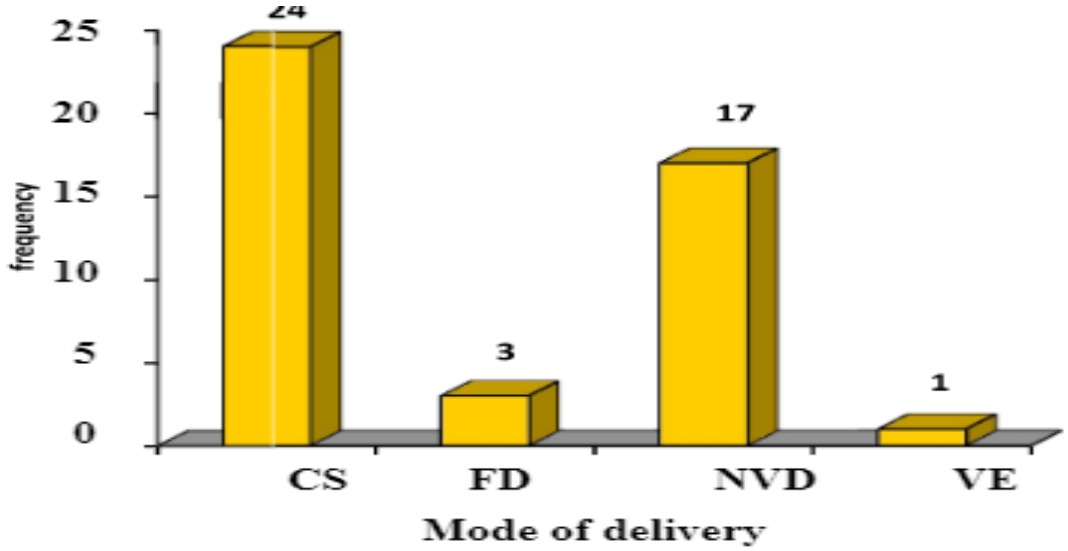


Fig 2 Mode of Delivery Wise Distribution of Cases

Table No. 3 Sex wise distribution of cases

| Sex | f | % |
|---|---|---|
| Male | 31 | 68.89 |
| Female | 14 | 31.11 |
| Total | 45 | 100 |

In present study, ARF was more common in male babies than female babies

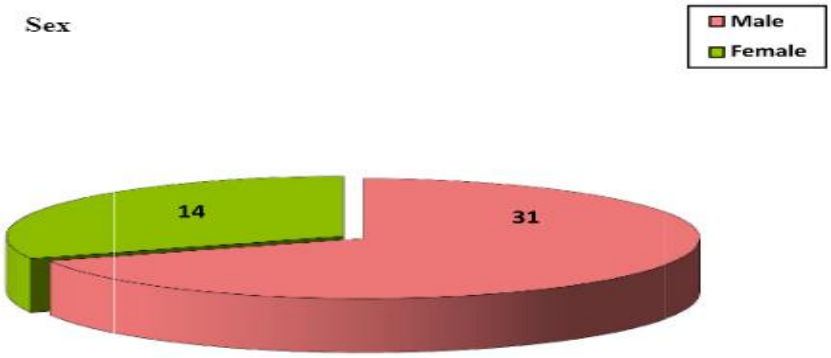


Fig 3 Sex wise Distribution of Cases

Table 4 Birth Weight VS ARF

| Birth weight | f | % |
|---|---|---|
| 1-1.5kgs | 9 | 20 |
| 1.5-2.5kgs | 18 | 40 |
| >2.5kgs | 18 | 40 |
| Total | 45 | 100 |

In present study, incidence of ARF was highest in low birth weight babies

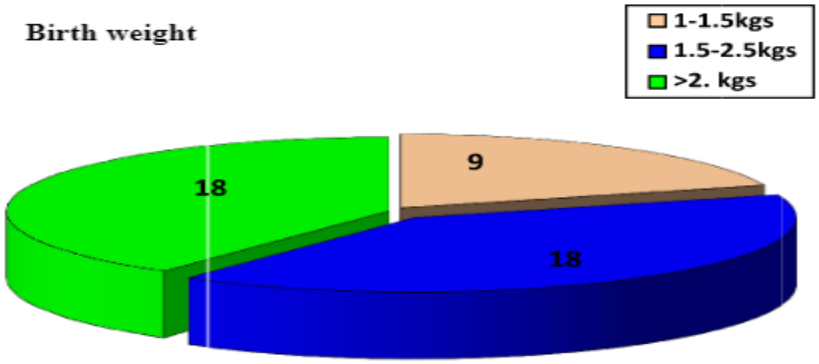


Fig 4 Birth wight VS ARF

Table 5 HIE Wise Distribution of Cases

| HIE | f | % |
|---|---|---|
| I | 7 | 15.56 |
| II | 12 | 26.67 |
| III | 9 | 20.00 |
| Nil | 17 | 37.78 |
| Total | 45 | 100 |

In present study, out of all birth asphyxia cases, majority of the babies had HIE stage II

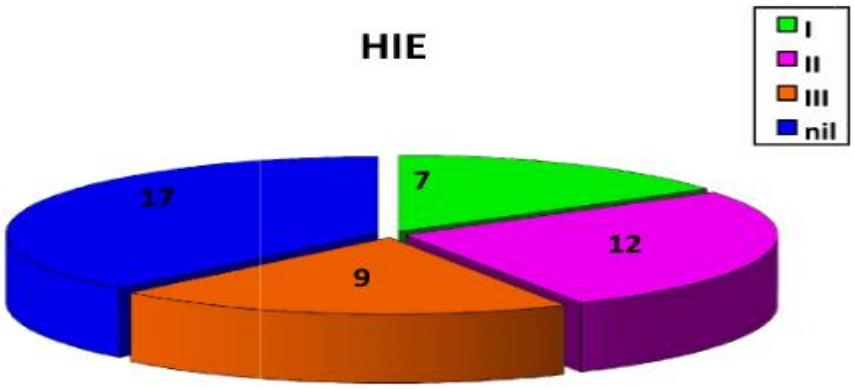


Fig 5 HIE Wise Distribution of Cases

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Table 6 CRP VS ARF

| CRP | f | % |
|---|---|---|
| Yes | 21 | 46.67 |
| No | 24 | 53.33 |
| Total | 45 | 100 |

In present study, out ofpositive ARF cases, 21 babies were found to be CRP.

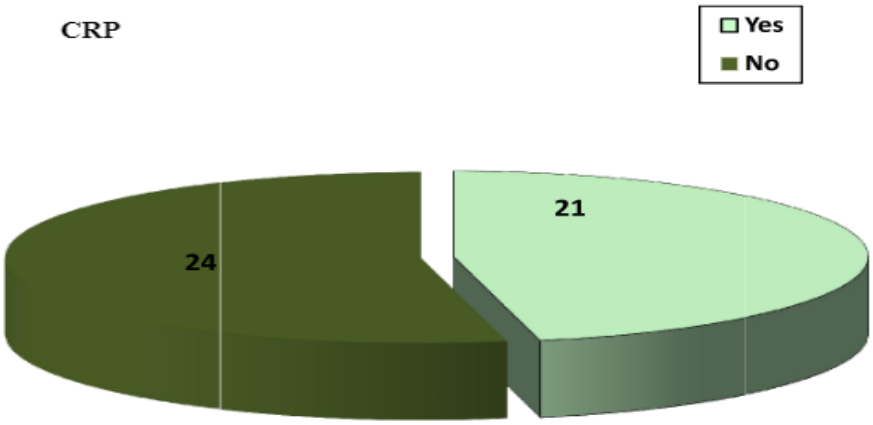


Fig 6 CRP VS ARF

Table 7 Hyaline Membrane Disease Wise Distribution of Cases

| Hyaline membrane disease | f | % |
|---|---|---|
| Yes | 23 | 51.11 |
| No | 22 | 48.89 |
| Total | 45 | 100 |

In present study, out of 45 ARF cases, 23 babies had hyaline membrane disease

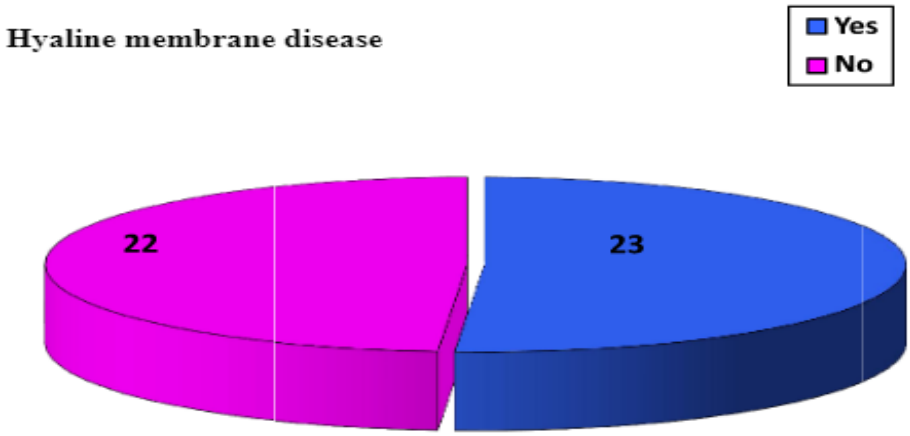


Fig 7 Hyaline Membrane Disease Wise Distribution of Cases

Table 8 Congenital Heart Disease Wise Distribution of Cases

| Congenital heart disease | f | % |
|---|---|---|
| Yes | 16 | 35.35 |
| No | 29 | 64.44 |
| Total | 45 | 100 |

In present study, incidence of congenital Heart Disease in ARF cases was 35.35%

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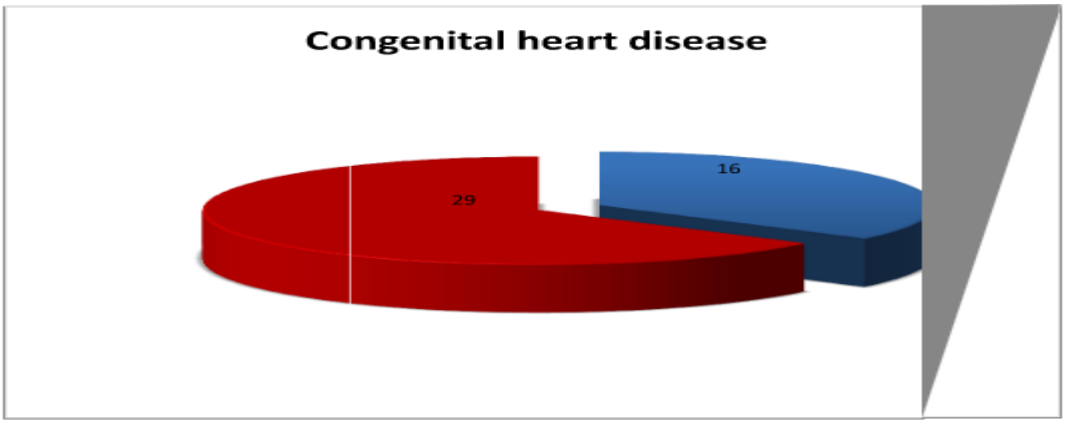


Fig 8 Congenital Heart Disease Wise Distribution of Cases

Table 9 Oliguric ARF vs Non-oliguric ARF

| Urine output | f | % |
|---|---|---|
| Oliguric ARF | 9 | 20 |
| Non Oliguric ARF | 36 | 80 |
| Total | 45 | 100 |

In present study, non-oliguric ARF was the predominant form of ARF

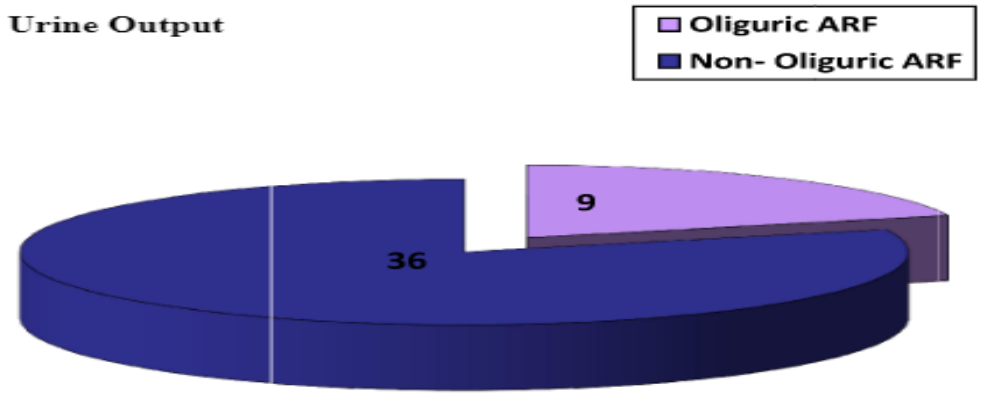


Fig 9 Oliguric ARF VS Non-Oliguric ARF

Table 10 USG Abdomen-Obstructive VS Non Obstructive ARF

| Abnormal USGAbdomen | f | % |
|---|---|---|
| BL HUN | 2 | 20 |
| BL MRD | 8 | 80 |
| Total | 10 | 100 |

In our study out of 10 ARF cases with abnormal USG abdomen, 2 were found to have bilateral hydroureteronephrosis

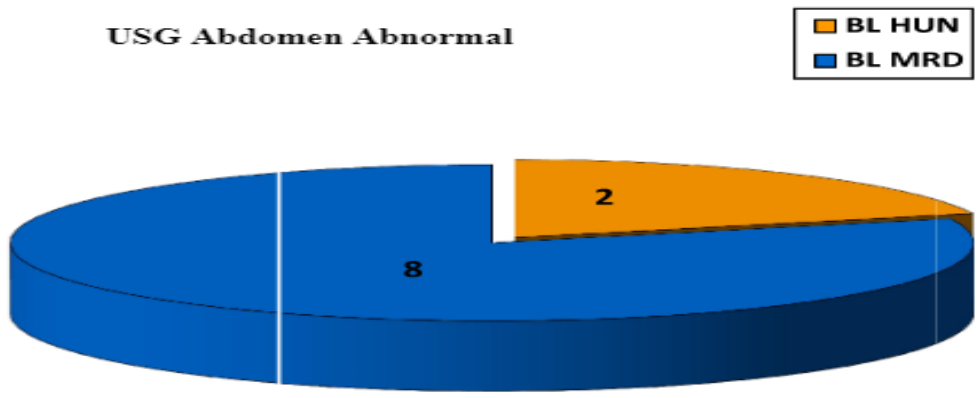


Fig 10 USG Abdomen-Obstructive VS Non Obstructive ARF

Table 11 Pre-renal VS Renal ARF Based on FENa

| FENa | f | % |
|---|---|---|
| ≤2 | 26 | 57.8 |
| >2 | 19 | 42.2 |
| Total | 45 | 100 |

In present study, based on FENa, Pre-renal ARF was the predominant form, constituting 57.8% of the cases

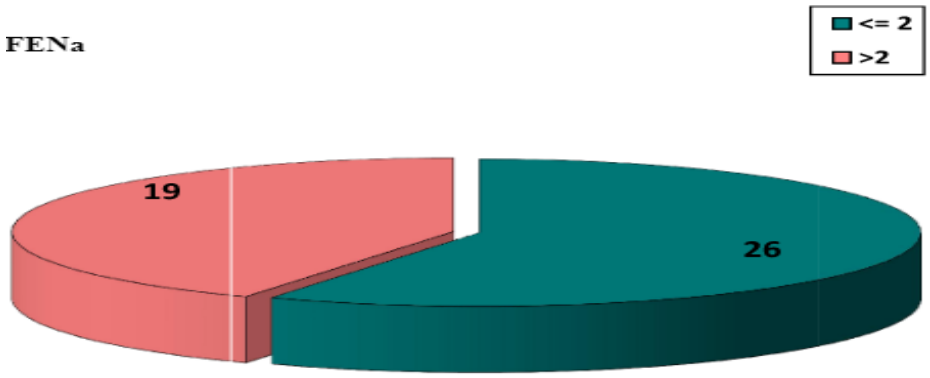


Fig 11 Pre-renal VS Renal ARF Based on FENa

Table 12 Low Birth Weight VS ARF

| Birth Weight | f | % |
|---|---|---|
| ≤2.5kgs | 27 | 60 |
| >2.5kgs | 18 | 40 |
| Total | 45 | 100 |

In present study, incidence of Low Birth Weight in ARF cases is 60%

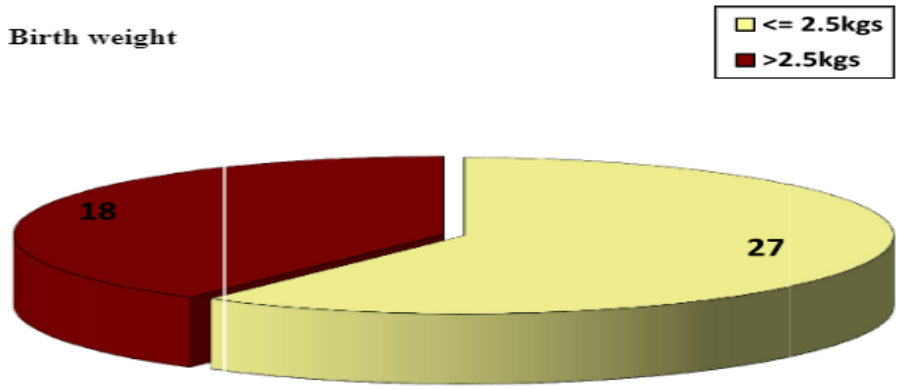


Fig 12 Low Birth Weight VS ARF

Out of total 343 newborns admitted during the study period, 45 babies developed ARF as per inclusion criteria. Hence, Incidence of ARF in present study= 13.12%

Table 13 Etiology of ARF in Present Study

| Etiology | f | % | Total | % |
|---|---|---|---|---|
| **Birth asphyxia** : | | | | |
| HIE-I | 7 | 15.6 | | |
| HIE-II | 12 | 26.7 | 28 | 62.2 |
| HIE-III | 9 | 20 | | |
| **Sepsis:** | | | | |
| **CRP** | 21 | 47 | | |
| **Bloodculture** | 8 | 17.8 | 31 | 68.9 |
| **Urine culture** | 2 | 4.4 | | |
| **Hyaline Membrane Disease** | 23 | 51.1 | 23 | 51.1 |
| **Congenital Heart Disease** | 16 | 35.6 | 16 | 35.6 |

| | | | | |
|---|---|---|---|---|
| **Obstructive Uropathy** | 2 | 4.4 | 2 | 4.4 |

In present study, sepsis is the commonest cause of ARF followed by birth asphyxia, Hyaline membrane disease, congenital heart disease and obstructive uropathy.

Table 14 Distribution of Laboratory Values of ARF Cases

| Variables | Range | Mean±SD | Median |
|---|---|---|---|
| Serum Creatinine | 1-5.4 | 1.704±0.83 | 1.5 |
| Urine Sodium | 10-172 | 58.88±37.34 | 51 |
| Urine Creatinine | 4-126 | 34.74±27.69 | 24 |
| Serum sodium | 95-177 | 136.96±12.95 | 138 |
| FENa | 0.15-15.6 | 3.89±4.31 | 1.7 |

Table 15 Correlation of HIE with Serum Creatinine

| HIE | Serum Creatinine | p-value |
|---|---|---|
| | Mean±SD | |
| HIE-I | 1.05±0.078 | 0.0275* |
| HIE-II | 1.575±0.379 | |
| HIE-III | 2.57±1.38 | |

In the current investigation, there is a strong link between serum creatinine levels and the stage of HIE. As neonates' HIE staging advanced, a growing trend in serum creatinine was seen, and newborns with HIE stages 1 and 2 and those with HIE stage 3 showed a statistically significant difference.

## IV. DISCUSSION

Neonatal patients in critical condition are more likely to experience acute kidney injury or, more accurately, acute renal failure. ARF can occur with an incidence of 8% to 24% and a death rate of 10% to 61%. ARF frequently develops as a result of a systemic disease. The disease process can be stopped with early detection of the type and causes of ARF. The current study focuses on important issues like renal failure severity in connection to serum creatinine, incidence of ARF, forms of ARF like pre-renal and renal, and types of ARF like pre-renal and renal.

ARF incidence is 13.12% in the current situation.

Table 16 Comparison with the Other Studies

| Study | Study Design | Incidence | Etiology / Comments |
|---|---|---|---|
| Airede etal, 1997 | Prospective study. Inborn, outborn | 3.9% | Causes : Asphyxia: 53.4%,Sepsis: 32.6%, Obstructive |
| Abu etal, 1998 | Retrospectivestudy, inborn | 8% | Causes: Asphyxia: 42%, Drugs: 14%, Sepsis: 15.7%, Urinary anomalies: 9.3%, Misc.: 4.7% |
| Agras, 2004 | retrospective | 3.4% | Causes: Asphyxia: 40%, Sepsis: 22.2%, Feeding Problems: 17.8%. |
| Gupta etal, 2005 | Prospective Case control, inborn, asphyxiated | 47.1% | Oliguria, hyponatremia andabnormal sonographic scan are bad prognostic signs in ARF secondary to asphyxia |
| Mathur etal, 2005 | Prospective Casecontrol, outborn | 26% | Those with AKImore likely to have shock, DIC, meningitis and prematurity |
| Viswanath etal,2012 | Retrospective casecontrol study. Inborn ELBWneonates | 12.5% | Associated with anincreased mortality, especially in presence of oliguria. |
| Kapil Kapoor etal, 2013 | Retrospective,outborn | 9.6% | Septicemia61.3%, asphyxia22.7%,RDS9%, genitourinary anomalies6.8% |
| Present study,2013 | Descriptive crosssectional inborn/outborn | 13.12% | Septicemia68%,Asphyxia62%, HMD51%, CHD35.6% Urogenital Anomaly4% |

The incidence of ARF in this study is comparable to that in other investigations, as shown in the table above. The most frequent cause of ARF was sepsis, which is consistent with research by Kapil Kapoor et al. However, this patient group shared characteristics with other etiological groups. Even the patients in the other group exhibited signs of septicemia. This might be because we get referrals for outborn patients. At the time of admission, the majority of the newborns were ill and infected.

Additionally, poor supportive care (hypothermia, hypoxia, and hypoglycemia) during neonatal transit may further put them at risk for ARF.

Table 17 Comparative Study Showing Oliguric VS Non-Oliguric ARF

| Study | Year | Arf | Oliguric | Nonoliguric |
|---|---|---|---|---|
| Gupta etal | 2005 | 47.14% | 21.2% | 78.8% |
| Agarwal et al | 2005 | 56% | 42% | 58% |
| Karlowicz etal | 1995 | 61% | 40% | 60% |
| Jayasree etal | 1991 | 43.3% | 69.8% | 30.2% |
| Mathur etal | 2005 | 26% | 15% | 85% |
| Kapil kapoor | 2013 | 9.6% | 65.9% | 34.1% |
| Present study | 2013 | 13.12% | 20% | 80% |

In their investigation, Gupta et al. demonstrated that only 21.2% of patients were oliguric. Only 7 of the 70 asphyxiated neonates had considerable oliguria, and there was no discernible difference in urine output between the control and study groups. Additionally, the amount of pee produced did not correspond to the degree of asphyxia.
Compared to earlier studies, Mathur et al. identified a 15% incidence of oliguria in sepsis. This was ascribed to quick shock management.

Oliguric ARF incidence was 69.8%, according to Jayasree et al. They made an effort to validate it as a predictive factor. When compared to people who were not oliguric, oliguria significantly increased mortality.
The incidence of oliguric ARF in the current study is lower than in the earlier investigations. Rapid therapy of shock with intravenous fluids and inotropic support may result in a less drastic drop in GFR and preserve tubular function. As a result, intrinsic renal failure does not advance.

Table 18 Comparative Study Showing Preterm VS ARF

| Study | Year | Study Population | Preterm% |
|---|---|---|---|
| Cataldi Etal | 2005 | Preterm | 79% |
| Present | 2013 | Term/Preterm | 48.8% |

Preterm newborns had a greater incidence of ARF, according to Cataldi et al. According to a case-control study including 172 premature infants born at 37 weeks, 79% of ARF cases were found in VLBW neonates. These newborns' mothers took more medications both during pregnancy and birth.

Since our NICU is a tertiary facility, we receive both preterm and term cases in the current study. The majority of preterm infants, whether they were inborn or outborn, experienced co-morbid conditions like hyaline membrane disease, shock, and heightened susceptibility to infections. Prematurity was predicted as another diagnosis in our investigation, as is only natural. Prematurity is a distinct risk factor for the development of ARF, according to earlier research.

Table 19 Comparison of Creatinine Among Stages of HIE

| Study, Year | HIE I | HIE II | HIE III |
|---|---|---|---|
| | Serum Cr. | Serum Cr. | Serum Cr. |
| Gupta Etal, 2005 | 1.1 ± 0.4 | 1.3 ± 0.8 | 1.4 ± 0.6 |
| Present, 2013 | 1.05±0.078 | 1.575±0.379 | 2.57±1.38 |

38 infants with HIE characteristics were among the 70 asphyxiated cases that Gupta et al. investigated. It was discovered that the concentration of creatinine increased as the HIE stage advanced and that there was a statistically significant difference between having no HIE and having HIE III.

28 of the 45 ARF cases in the current study experienced birth asphyxia. 7,12,9 of them were HIE I, II, and III, respectively. As the HIE stage advanced, there was a growing trend in the creatinine concentration. Between HIE I and III, there was a statistically significant difference.

## V. CONCLUSION

13.12% of the ill newborns in our NICU have ARF. Sepsis is the most frequent cause of ARF, and it is followed by obstructive uropathy, birth asphyxia, HMD, CHD, and HMD.

Monitoring of urine output, sepsis, serum creatinine, and FENa Screening aids in the identification and treatment of renal failure. Even non-oliguric newborns with birth hypoxia exhibited ARF. Therefore, monitoring merely urine output is insufficient to diagnose ARF; renal biochemical markers also need to be kept an eye on.

Babies with low birth weights are more likely to get renal failure.

ARF is more likely to affect male infants. More frequently than intrinsic renal ARF, prerenal ARF and HIE

staging have a significant positive connection in cases of birth asphyxia.

Prompt management of shock may reduce chances of progression totubular damage and thus intrinsic ARF.

## RECOMMENDATIONS

- Early and precise diagnosis and care are essential for a successful outcome in acute renal failure in neonates since it is potentially lethal yet reversible in the early stages.
- Identify pre-renal ARF early and effectively manage it to stop the development of intrinsic ARF
- Controls for sepsis should be used in both the delivery room and the NICU.
- Prenatal screening should be performed for every pregnancy. Genitourinary anomalies should be treated as soon as they are identified for effective management.
- Serum creatinine does not correctly reflect renal function during acute alterations in glomerular filtration until steady state equilibrium has been attained, which may take several days. Thus, there is a need for urinary and serum biomarkers of AKI to improve our ability to diagnose AKI early in its disease process. . For example, urine and serum neutrophil gelatinase-associated lipocalin, urine interleukin-18, kidney injury marker 1, and others.

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