

**ETIOLOGICAL AND EEG PROFILE OF NEONATAL SEIZURE AMONG NEWBORN ATTENDING IN NICU**

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**ABSTRACT**

**Background:** Incidence of seizures is highest during the neonatal period, but clinical diagnosis is often difficult, thereby making it difficult to estimate the true incidence of neonatal seizures. Electroencephalography (EEG) provides a useful noninvasive test to diagnose neonatal seizures and evaluate degree of perinatal damage to brain and long-term prognosis. **Objective:** To evaluate the clinical, etiological and EEG profile of neonatal seizures. **Methods:** This cross-sectional study was carried out in NICU of the department of Paediatrics, ICMH, Matuail, Dhaka. The neonates admitted in the NICUs (inborn and out born) from July 2018 to June 2019 were enrolled. A total of 50 neonates who either have seizures during the NICU stay or had seizures which were noticed by other doctors and referred from outside were included in the study. Details history of each baby with a complete description of the seizure, day of onset, duration and frequency were noted. Complete newborn examination was done. Essential and relevant investigations were done such as blood glucose, serum calcium, serum electrolyte, CSF study and USG brain. EEG was done in all the subjects. Statistical analyses was done by using SPSS, version 22. **Results:** In this study it was observed that 29(58.0%) were male and 21(42.0%) were female majority (94.0%) neonates were term. Almost three fourth neonate (72%) neonate had history of delayed crying. The age of onset of seizure within first 24 hours of life were the commonest and contributed to 74% of the total seizures. More than three fourth (78.0%) neonates had seizure frequency of 1-5 per day before admission. More than three fourth (70.0%) neonate duration seizure (each episode) had >5 min. On the basis of examination findings related to etiology it was observed that all (100%) of the neonates were lethargic and majority (82%) of them had poor primitive reflexes and 88% were hypotonic. The study found that Subtle seizures 25 (50%) were the most common type of seizure followed by clonic 17(34%), tonic 6(12.0%) and focal 2(4%). Regarding the seizure etiology, perinatal asphyxia was the major (74%) contributing factor of neonatal seizure, Hypocalcaemia 15(30%) was the next common cause. CNS infection (meningitis) also found in 15(30%) and hyponatremia in 9(18%), hypernatremia in 5(10%) and hypoglycemia 6(12%) of the total seizures. **Conclusion:** Subtle seizures were the most common type of seizure followed by clonic, tonic and focal. Perinatal asphyxia is the most frequent cause of neonatal seizure, hypocalcemia and CNS infection were the next most common causes followed by metabolic and electrolyte derangement. Almost two third neonates had abnormal background activities. There was no significant association between EEG findings with etiology and clinical type of neonatal seizure. However further study with large sample is recommended.

**KEYWORDS:** Neonatal seizure, Electroencephalography, clinical type of seizure, etiology.

**INTRODUCTION**

The immature brain seems more prone to seizures than the more mature brain. Seizures are more common in

neonatal period than any other life time. The prevalence of neonatal seizures is 2-3/1000 live births in term and 10-15 /1000 in preterm deliveries.<sup>[1]</sup> Seizures are often

the first sign of neurological dysfunction in newborn but their clinical expression at this age is quite variable, poorly organized and often subtle. Neonatal seizure can have variable clinical manifestations. According to clinical presentations, neonatal seizures are classified as a) Subtle seizures: Occurs both in term and preterm infants. Subtle means the clinical manifestations are mild and frequently missed.<sup>[2]</sup> They constitute 50% of all seizures. b) Clonic Seizures c) Tonic seizures, they are seen in preterm infants and d) Myoclonic Seizures. Causes of Neonatal Seizures include.<sup>[2,3,4,5,6]</sup> Hypoxic-ischemic encephalopathy (HIE), secondary to perinatal asphyxia is the commonest cause of seizure in neonates, especially in developing countries, constituting 50-65% of all seizures. Most seizures (50-65%) due to HIE start within 12 hrs of birth, remaining have an onset within 24-48 hours. Metabolic causes are hypoglycemia, hypocalcaemia, hypomagnesaemia, hyponatremia, hypernatremia and rarely pyridoxine deficiency, pyridoxine dependency, amino acid, organic acid and urea cycle disorders, mitochondrial and peroxisomal disorders and other inborn errors. Infections such as meningitis, Intrauterine infection (TORCH, HIV, syphilis) causing seizure in neonatal period. Intraventricular hemorrhage, cerebral infarcts, developmental brain defects, neuronal migration disorder and neonatal epileptic syndromes are rare causes of seizure in the neonatal period. Regardless of the etiology, neonatal seizures may cause damage to the brain and lead to developmental delay, learning disability and epilepsy in later life. Neonatal seizures are difficult to investigate and consequently determination of etiology

## METHODOLOGY

| Type of study      | Cross sectional study.  |
|--------------------|---|
| Place of study     | Neonatal intensive care unit (NICU) of the Department of Paediatrics, Institute of Child and Mother Health (ICMH), Matuail, Dhaka-1362. |
| Study period       | One year (July 2018 to June 2019).  |
| Study population   | Newborn age less than 28days  |
| Sampling technique | Purposive sampling  |

### Inclusion criteria

- Newborn age  $\leq$  28 days admitted with any seizure (reported by mother/care giver/emergency doctor/admitting doctors).
- Both term and preterm.

### Exclusion criteria

- Major congenital anomaly.

**Research instrument:** A pretested semi structured questionnaire was used to collect data.

### Study Procedure

The neonates admitted in NICU with seizure fulfilled the inclusion criteria were enrolled in the study. Written informed consent was taken from the parents. A total of 50 neonates who either have seizures during the NICU stay or had seizures which were noticed by other doctors and referred from outside were included. Details history

and initiation of therapy may be delayed which results in poor neurological outcome. Electroencephalography (EEG) is ordered in almost all neonate with seizures. Interpretation of neonatal EEGs requires an understanding of developmental changes in EEG and is best done by an expert neuro electro physiologist.

However, all seizures do not have abnormal EEG pattern, because of immaturity of the brain and inter ictal scalp recording may fail to pick up seizure activity. There is often poor correlation between the electrographic and clinical manifestations of neonatal seizures.<sup>[7]</sup>

The risk of recurrence increases in the presence of persistent EEG abnormality or slowly resolving EEG. Electrical seizure activity in neonatal period is rare before 34 to 35 weeks. Seizure discharges of the depressed brain are typically low in voltage, long in duration & highly localized. Alpha seizure activity indicates severe encephalopathy. Burst suppression pattern is suggestive of severe epileptic encephalopathy.

## OBJECTIVES

### General Objectives

To determine the etiological and EEG profile of neonatal seizures.

### Specific Objectives

1. To identify the clinical type and etiology of neonatal seizure.
2. To find out pattern of EEG in different types of seizures.

of each baby with a complete antenatal, natal and perinatal history were recorded a history of seizures associated with poor feeding, lethargy, recurrent vomiting, with family history of consanguinity and/or neonatal seizure with early fetal and neonatal death is taken to rule out inborn errors of metabolism. A complete description of the seizure, age of onset, duration and frequency were noted. A complete newborn examination with neurological examination, any congenital malformation and cutaneous markers were examined and were done. Sarnat and Sarnat score was considered for HIE grading. Gestational age was measured by New Ballard score. Investigations such as CBC, Serum C reactive protein, random blood sugar, serum calcium, serum electrolyte, serum creatinine, serum bilirubin, blood culture and sensitivity, cerebrospinal fluid (CSF) examination, USG were done. Neonatal montages were used and 16 leads were used as against the standard of 23 leads in the adult. Each EEG

was recorded for 30-40 minutes in order to bring out the sleep and awake cycles in each case. EEG were reported by pediatric neurophysiologist in the center.

#### Data analysis

Data were checked and cleaned before incorporating into statistical software (SPSS- version 22) and analyzed. Descriptive statistics were expressed as percent, mean &

standard deviation. For categorical variables Chi-square test was done to find out the association. Continuous variables were compared by unpaired t-test. In all tests of significance P below <0.05 was considered as significant. Logistic regression –predicts a single dependent or response variable using a number of independent variables.

## RESULT

**Table I: Socio demographic characteristics of the study subject (n=50).**

| Socio demographic characteristics         | Number of neonate | Percentage |
|---|-------------------|------------|
| <b>Age group (in days)</b>                |                   |            |
| 1-5                                       | 42                | 84.0       |
| 6-10                                      | 4                 | 8.0        |
| 11-15                                     | 3                 | 6.0        |
| >15                                       | 1                 | 2.0        |
| Mean±SD                                   | 3.58              | ±3.87      |
| Range(min-max)                            | 1                 | -18        |
| <b>Sex</b>                                |                   |            |
| Male                                      | 29                | 58.0       |
| Female                                    | 21                | 42.0       |
| <b>Religion</b>                           |                   |            |
| Muslim                                    | 47                | 94.0       |
| Hindu                                     | 3                 | 6.0        |
| <b>Residence</b>                          |                   |            |
| Urban                                     | 31                | 62.0       |
| Rural                                     | 19                | 38.0       |
| <b>Fathers education</b>                  |                   |            |
| Primary                                   | 12                | 24.0       |
| Secondary                                 | 29                | 58.0       |
| Above secondary                           | 9                 | 18.0       |
| <b>Mothers education</b>                  |                   |            |
| Below primary                             | 1                 | 2.0        |
| Primary                                   | 21                | 42.0       |
| Secondary                                 | 23                | 46.0       |
| Above secondary                           | 5                 | 10.0       |
| <b>Fathers occupation</b>                 |                   |            |
| Service                                   | 13                | 26.0       |
| Self employment                           | 8                 | 16.0       |
| Business                                  | 29                | 58.0       |
| <b>Mothers occupation</b>                 |                   |            |
| House wife                                | 38                | 76.0       |
| Service                                   | 12                | 24.0       |
| <b>Monthly income category (tk/month)</b> |                   |            |
| <10,000                                   | 12                | 24.0       |
| 10,000-20,000                             | 28                | 56.0       |
| >20,000                                   | 10                | 20.0       |

Table I shows the socio demographic characteristics. It was observed that majority (84.0%) neonate belonged to age group 1-5 day. The mean age was 3.58±3.87 days with ranged from 1 to 18 days. More than half (58.0%) neonate were male and 21(42.0%) were female. Majority (94.0%) neonate were Muslim and 3(6.0%) were Hindu. Almost two third (62.0%) neonate came from urban area and 19(38.0%) in rural area. More than half (58.0%) babies' father education level was secondary followed 12(24.0%) in primary and 9(18.0%) in above secondary.

Almost half (46.0%) babies' mother education level was secondary followed by 21(42.0%) in primary, 5(10.0%) in above secondary and 1(2.0%) in below primary. More than half (58.0%) babies' father occupation was business followed by 13(26.0%) in service and 8(16.0%) in self-employment. More than three fourth (76.0%) babies' mother was house wife and 12(24.0%) in service. More than half (56.0%) babies' monthly family income was 10,000-20,000 taka followed by 12(24.0%) in <1000 taka and 10(20.0%) in >20000 taka.

**Table II: Distribution of the studied neonate by antenatal and perinatal history (n=50).**

| <b>Antenatal and perinatal history</b>                                | <b>Number of neonate</b> | <b>Percentage</b> |
|---|--------------------------|-------------------|
| <b>Gestational age</b>  |                          |                   |
| Term  | 47                       | 94.0              |
| Preterm   | 3                        | 6.0               |
| <b>Prolonged rupture of membrane</b>                                  |                          |                   |
| Yes   | 17                       | 34.0              |
| No  | 33                       | 66.0              |
| <b>Prolonged labor</b>  |                          |                   |
| Yes   | 36                       | 72.0              |
| No  | 14                       | 28.0              |
| <b>Febrile illness in the mother within 2 weeks prior to delivery</b> |                          |                   |
| Yes   | 1                        | 2.0               |
| No  | 49                       | 98.0              |
| <b>Foul smelling or meconium stained liquor</b>                       |                          |                   |
| Yes   | 3                        | 6.0               |
| No  | 47                       | 94.0              |
| <b>Vaginal examination: Single unclean or &gt;3sterile</b>            |                          |                   |
| Yes   | 17                       | 34.0              |
| No  | 33                       | 66.0              |
| <b>Maternal/gestational diabetes mellitus</b>                         |                          |                   |
| Yes   | 1                        | 2.0               |
| No  | 49                       | 98.0              |
| <b>Mode of delivery</b>   |                          |                   |
| NVD   | 20                       | 40.0              |
| LUCS  | 30                       | 60.0              |
| <b>Delivery attended by</b>   |                          |                   |
| Untrained Dai   | 11                       | 22.0              |
| Trained Dai   | 4                        | 8.0               |
| Trained nurse   | 4                        | 8.0               |
| Doctor  | 31                       | 62.0              |
| <b>Place of delivery</b>  |                          |                   |
| Home  | 14                       | 28.0              |
| Hospital  | 31                       | 62.0              |
| Clinic  | 5                        | 10.0              |
| <b>History of delayed crying</b>                                      |                          |                   |
| Yes   | 36                       | 72.0              |
| No  | 14                       | 28.0              |
| <b>Consanguinity</b>  |                          |                   |
| Yes   | 3                        | 6.0               |
| No  | 47                       | 94.0              |

Table II shows the distribution of the studies neonate by antenatal and perinatal factors. It was observed that majority (94.0%) neonate had term and 3(6.0%) in preterm. More than (34.0%) neonate had prolonged rupture of membrane. Almost three fourth (72.0%) neonate had prolonged labour. One (2.0%) neonate had febrile illness in the mother within 2 weeks prior to delivery. Three (6.0%) neonate had foul smelling or meconium stained liquor. More than one third (34.0%) neonate had vaginal examination: Single unclean or >3sterile. One (2.0%) neonate had maternal/gestational diabetes mellitus. Almost two third (60.0%) neonate had LUCS and 20 (40.0%) in NVD. Almost two third

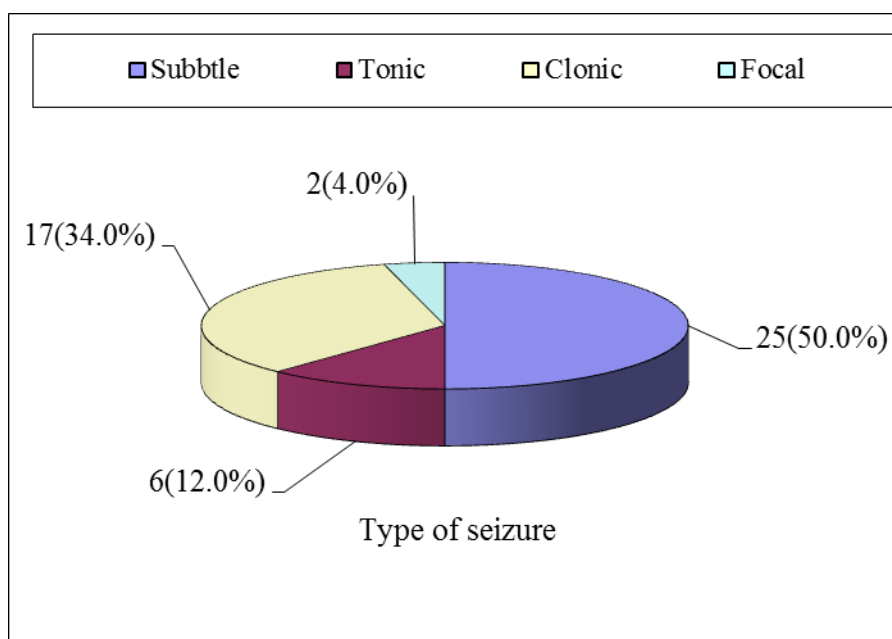
(62.0%) neonate had delivery attended by doctor followed 11(22.0) in untrained dai, 4(8.0%) in trained dai and 4(8.0%) in trained nurse. Almost two third (62.0%) neonate place of delivery had hospital followed by 14(28.0%) in home and 5(10.0%) in clinical. Almost three fourth (72.0%) neonate had history of delayed crying. Three (6.0%) neonate had consanguinity.

**Table III: Distribution of the studied newborn by characteristics of seizure (n=50).**

| Characteristics of seizure                             | Number of neonate | Percentage |
|--|-------------------|------------|
| <b>Onset of seizure</b>                                |                   |            |
| Within 24hrs   | 37                | 74.0       |
| 24-48hrs   | 1                 | 2.0        |
| >48- 72hrs or more                                     | 12                | 24.0       |
| <b>Frequency of seizure before admission (per day)</b> |                   |            |
| 1-5  | 38                | 78.0       |
| 6-10   | 10                | 20.0       |
| >10  | 1                 | 2.0        |
| <b>Duration of seizure (each episode)</b>              |                   |            |
| 1-5 min  | 15                | 30.0       |
| >5 min   | 35                | 70.0       |

Table III shows the distribution of the studied neonate by characteristics of seizure. It was observed that almost three fourth (74.0%) neonate onset of seizure had within 24hrs followed 12(24.0%) in >48- 72hrs or more and 1(2.0%) in 24-48 hrs. More than three fourth (78.0%)

neonate belonged to frequency of seizure before admission 1-5 per day followed by 10(20.0%) in 6-10 per day and 1(2.0%) in >10 per day. More than three fourth (70.0%) neonate duration of seizure (each episode) had > 5 min and 15(30.0%) in 1-5 min.



**Figure 1: Pie chart showing type of seizure of the studied neonate.**

**Table IV: Distribution of the studied neonate by examination findings related to etiology (n=50).**

| Examination findings related to etiology | Number of neonate | Percentage |
|--|-------------------|------------|
| <b>Appearance</b>                        |                   |            |
| Lethergic                                | 50                | 100.0      |
| <b>Pallor</b>                            |                   |            |
| Yes                                      | 2                 | 4.0        |
| No                                       | 48                | 96.0       |
| <b>Jaundice</b>                          |                   |            |
| Yes                                      | 6                 | 12.0       |
| No                                       | 44                | 88.0       |
| <b>Heart rate (1 min)</b>                |                   |            |
| <160                                     | 37                | 74.0       |
| 160-180                                  | 13                | 26.0       |
| <b>Respiratory Rate (1min)</b>           |                   |            |
| ≥60                                      | 31                | 62.0       |
| <60                                      | 19                | 38.0       |

|   |    |       |
|---|----|-------|
| <b>Temperature</b>                                      |    |       |
| Normothermic (97.5 <sup>0</sup> to 99.5 <sup>0</sup> F) | 25 | 50.0  |
| Hypothermic (< 97.5 <sup>0</sup> F)                     | 10 | 20.0  |
| Hyperthermic (> 99.5 <sup>0</sup> F)                    | 15 | 30.0  |
| <b>Weight of the infant in gram</b>                     |    |       |
| AGA (2500 to 4000gm)                                    | 44 | 88.0  |
| LBW (<2500 gm)  | 5  | 10.0  |
| LGA   | 1  | 2.0   |
| <b>OFC in cm</b>  |    |       |
| Normal (33 to 37cm)                                     | 50 | 100.0 |
| <b>Anterior fontanallae</b>                             |    |       |
| Normal  | 44 | 88.0  |
| Bulged  | 6  | 12.0  |
| <b>Sclerema</b>   |    |       |
| Present   | 2  | 4.0   |
| Absent  | 48 | 96.0  |
| <b>Capillary refill time</b>                            |    |       |
| >3 Seconds  | 27 | 54.0  |
| <3 Seconds  | 22 | 44.0  |
| 3 Seconds   | 1  | 2.0   |
| <b>Primitive reflexes</b>                               |    |       |
| Good  | 1  | 2.0   |
| Moderate  | 8  | 16.0  |
| Poor  | 41 | 82.0  |
| <b>Muscle tone</b>                                      |    |       |
| Normal  | 5  | 10.0  |
| Hypotonic   | 44 | 88.0  |
| Hypertonic  | 1  | 2.0   |
| <b>Any congenital anomaly</b>                           |    |       |
| Present   | 2  | 4.0   |
| Absent  | 48 | 96.0  |

Table IV shows the distribution of the studied neonate by examination findings related to etiology. It was observed that all (100.0%) of the neonate were lethargic. Two (4.0%) neonate had pallor. Six (12.0%) neonate had jaundice. Almost three fourth (74.0%) neonate had belonged to heart rate (1 min) <160 and 13(26.0%) in 160-180. Half of the neonate (50.0%) neonate were normothermic (97.5<sup>0</sup> to 99.5<sup>0</sup> F) followed by 15(30.0%) in hyperthermic (> 99.5<sup>0</sup> F) and 10(20.0%) in hypothermic (< 97.5<sup>0</sup> F). Majority (88.0%) neonate had AGA (2500 to 4000gm) followed by 5(10.0%) in LBW

(<2500 gm) and 1(2.0%) in LGA. All (100.0%) of the neonate had OFC normal (33 to 37cm). Six (12.0%) neonate anterior fontanallae had bulged. 2(4.0%) neonate had sclerema. More than half (54.0%) neonate capillary refill time had >3 seconds followed by 22(44.0%) in <3 seconds and 1(2.0%) in 3 seconds. Majority (82.0%) neonate primitive reflexes had poor followed by 8(16.0%) in moderate and 1(2.0%) in good. Majority (88.0%) neonate muscle tone had hypotonic followed by 5(10.0%) in normal and 1(2.0%) in hypertonic. Two (4.0%) neonate had congenital anomaly.

**Table V: Distribution of the studied neonate by EEG findings (n=50).**

| EEG findings                                     | Number of neonate | Percentage |
|--|-------------------|------------|
| <b>Age category at 1<sup>st</sup> EEG (days)</b> |                   |            |
| <10  | 22                | 44.0       |
| 10-20  | 17                | 34.0       |
| 21-30  | 11                | 22.0       |
| <b>Background activity</b>                       |                   |            |
| Normal   | 19                | 38.0       |
| Abnormal   | 31                | 62.0       |
| <b>Seizure activity</b>                          |                   |            |
| Present  | 15                | 30.0       |
| Absent   | 35                | 70.0       |

Table VI shows the distribution of the studied neonate by EEG findings. It was observed that almost half (44.0%) neonate belonged to age at 1<sup>st</sup> EEG <10 days followed by 17(34.0%) in 10-20 days and 11(22.0) in 21-30 days.

Almost two third (62.0%) neonate background activities had abnormal. Almost one third 15(30.0%) neonate had seizure activity.

**Table VI: Distribution of the studied neonate by etiology (n=50).**

| Etiology      | Number of neonate | Percentage |
|---------------|-------------------|------------|
| PNA with HIE  | 37                | 74.0       |
| Meningitis    | 15                | 30.0       |
| Hypocalcemia  | 15                | 30.0       |
| Hyponatremia  | 9                 | 18.0       |
| Hypoglycemia  | 6                 | 12.0       |
| Hypernatremia | 5                 | 10.0       |

\*Multiple response

Table VII shows the distribution of the studied neonate by etiology. It was observed that almost three fourth (74.0%) neonate had PNA with HIE followed by 15(30.0%) in meningitis, 15(30.0%) in hypocalcemia, 9(18.0%) in hyponatremia, 6(12.0%) in hypoglycemia and 5(10.0%) in hypernatremia.

## DISCUSSION

This study was carried out with an aim to find out the clinical, etiological and EEG profile of neonatal seizures. A total of 50 neonates with seizure or history of seizure were enrolled in this study. From the age distribution of cases of this study, mean age of neonates was found  $3.58 \pm 3.8$  days and majority belongs to age group of 1-5 days. It was observed that 29(58.0%) were male and 21(42.0%) were female. Comparable result was shown by Eghbalian *et al.*, (2007) with a male female ratio of 3:1.<sup>[10]</sup> Regarding other socio-demographic characteristics of the studied neonates, majority (94%) neonate were Muslim. Almost two third 31(62%) neonates came from urban area. Fathers and Mothers education at secondary level were found 29(58%) and 23(46%) respectively. More than half (58%) of baby's fathers were businessman and maximum mothers were house wife. More than half of this families had their monthly income within 10,000-20,000 taka. While considering the characteristics of seizure this study observed that the age of onset of seizure within first 24 hours of life were the commonest and contributed to 74% of the total seizures. Nearly similar findings were observed by where in 64% of neonate seizure occurred within first 24 hours of life.<sup>9</sup> Also had similar finding with (Shwetal Bhatt *et al.*, 2013) in their study, they found 81% of the neonatal seizure were found to be early onset <48 hours of life and the rest 19% were late onset >48 hours.<sup>10</sup> More than three fourth (78.0%) neonates had seizure frequency of 1-5 per day before admission. More than three fourth (70.0%) neonate duration seizure (each episode) was >5 mins. In current study examination findings related to etiology showed that all (100%) of the neonate were lethargic, six (12%) had jaundice, 13(26%) had heart rate <160b/m, more than half had respiratory rate >60 breath/min and 15(30%) had hyperthermia and 10(20%) had hypothermia. Majority (88%) were AGA and 6(12%) were LBW/SGA.

More over unlike older infants, neonate rarely have well organized generalized tonic-clonic seizures. In this study, Subtle seizures were commonest 25 (50%) variety followed by clonic 17(34%), tonic 6(12.0%) and focal 2(4%). Mizrahi *et al.* 1987 and Scher *et al.*, 1993) reported similar findings with subtle seizure being the most common type of neonatal seizure in their studies.<sup>[11,12]</sup>

Ruma Parvin *et al.*, (2014) mention that about half (43.1%) of the EEG findings were abnormal. In background abnormality, 23.5% had low voltage; very low voltage was in 11.8%.<sup>[13]</sup> In area of involvement of the discharges, it was mostly focal (31.4%), multifocal 3.9%. Ronit M, Pressler, (2003) describe neonatal seizures have a focal onset, whereas a generalized onset spike and wave seizure discharge is extremely rare.<sup>[14]</sup> So these findings were well consistent with current study. Abnormal background activity is associated with an increased risk of seizures LAROA N *et al.*, (1998) and GLASS HC *et al.*, (2011) and poor neurodevelopmental outcome.<sup>[16]</sup>

In hypoglycemic seizure, EEG produces multifocal discharge. However, this study found 4(12.9%) had abnormal background and 2(13-3%) had seizure activity in EEG with hypoglycemia. In electrolyte disturbance EEG patterns are usually unspecific including various degree of diffuse slowing, epileptiform discharge, intermittent rhythmic slow activity, occurrence of triphasic waves which are usually reversible after treatment of the underlying causes by (Watanabe K *et al.*, 1980) and (Mariani E *et al.*, 2008).<sup>[17,18]</sup>

## CONCLUSIONS

Subtle seizures were the most common seizure type followed by clonic, tonic and focal. Perinatal asphyxia was the most frequent cause of neonatal seizure, hypocalcemia and CNS infection were the next most common causes. Almost two third neonates had abnormal background activities in EEG. Most of the background abnormalities were unusual low voltage and nonspecific fast and low amplitude. Almost one third neonates had seizure activity in EEG and most frequent findings were nonspecific, asymmetric waves.

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