Hyperglycemia in transported neonates: A tertiary care experience

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ABSTRACT

Introduction: Hyperglycemia is common in low birth weight and sick neonates which affect them adversely due to hyperosmolarity. As these neonates need often referral to higher setup, maintenance of euglycemia during transport should be emphasized. **Objective:** To know the prevalence of hyperglycemia on admission among outborn neonates and analyze the association of different transport variables and other clinical parameters with it. **Methods:** An observational, analytical, and cross-sectional study was designed and conducted on outborn neonates, enrolled by simple consecutive sampling from November 2014 to October 2016. All data were analyzed using SPSS version 24 and Microsoft Excel version 16 software. **Results:** Out of 394 outborn neonates, 33.75% were hyperglycemic. 76.4% newborns were transported by ambulance, 94.9% were stabilized before referral, 61.2% had accompanying paramedics, 86.5% neonates given intravenous fluid (IVF) during transport, 61.4% transported by moderately equipped, and 38.6% by poorly equipped vehicle. Admission hyperglycemia was significantly associated with variables such as gestational age, birth asphyxia, type of transport vehicle, duration of transport, IVF during transport, hypoxic ischemic encephalopathy, and neonatal jaundice with $p<0.05$. Logistic regression model taking variable which shows a strong association, we can predict 70.3% time correctly the hyperglycemia on admission. **Conclusion:** Prevalence of hyperglycemia found to be quite common in referred neonates. Although there is quite improvement in neonatal transport due to the implementation of various government transport schemes for patients, specialized neonatal transport service with accompanied skill personnel and care during transport is a long way to go.

Key words: *Birth asphyxia, Gestational age, Hyperglycemia, Intravenous fluid, Neonatal transport, Outborn*

Hyperglycemia is not only encountered in low birth weight, small for gestational age, and premature infants receiving parenteral glucose but also is seen in other infants who are sick. Major clinical problems associated with hyperglycemia are hyperosmolarity and osmotic diuresis. Subsequent dehydration may occur rapidly in small premature infants with large insensible fluid loss [1]. Hyperglycemia also may lead to increased brain lactate, damage to cellular integrity, cerebral edema, or further disturbance in the vascular autoregulation which is deleterious to hypoxic brain. Thus, maintenance of glucose homeostasis during transport is one of the important components in the management of these neonates [1].

On the other hand, these sick asphyxiated or premature neonates often require referral to a tertiary care setup. Now, it is needless to say that euglycemia should be maintained in these neonates which is also emphasized in various neonatal transport models such as STABLE: Sugar, temperature, airway, blood pressure, laboratory workup, and emotional support [2], SAFER: Sugar, arterial circulatory support, family support, environment, respiratory support [3], and TOPS: Temperature, oxygenation (airway and breathing), perfusion, sugar [4].

The present scenario of neonatal transport in India is not encouraging [5]. Currently, there is limited or no dedicated neonatal transport service provided in India. It is well established that transport with well-equipped vehicle, accompanying skilled personnel and proper care during transport decreases the chance of adverse events and altered parameters on arrival. Although previous studies on neonatal transport have described the prevalence of hypoglycemia on admission, few of them report the prevalence of hyperglycemia in these neonates. Our study carried out at tertiary care setup to know the prevalence of hyperglycemia in outborn neonates at admission and association of different transport variables and birth parameters with it.

METHODS

An observational, analytical, and cross-sectional study was conducted at neonatal intensive care unit (NICU) of a tertiary care teaching hospital of Odisha within a study period of November 2014-October 2016. Prior approval from the Institutional Ethics Committee was obtained from all participants. All the outborn neonates referred to our institute were included in our study excluding neonates having lethal congenital malformations and acute surgical emergencies such as tracheoesophageal fistula or congenital diaphragmatic hernia. Taking prevalence of

hyperglycemia of referred neonates as 20.5% from a study on long distance neonatal transport [6], absolute precision level 4%, confidence interval 95%, and assuming the power of the study to be 80%, minimum sample size estimated was 391 using N master version 2.0 software.

After taking informed consent, 394 outborn neonates meeting inclusion and exclusion criteria were enrolled in the study by simple consecutive sampling. Respondents of each neonate were subjected to interview schedule. Vitals and general examinations were done by admitting physician. Random blood sugar was measured from capillary blood glucose by heel prick method using reagent strip method (bioamperometry) using glucometer (ROMSONS, model-TD4230).

Hyperglycemia was taken as blood glucose more than 126 mg/dl, using reagent strip [7]. Axillary temperature was measured by a digital thermometer (model-YB-009) reading as low as 32°C with an accuracy of ±0.1°C and observed temperature was graded as per the standard guidelines of the WHO [8]. Delayed capillary filling time was taken as more than 3 s [9]. Respiratory distress was defined as respiratory rate more than or equal to 60/min, in a quite neonate associated with deep lower chest wall in drawing with or without nasal flaring and/or expiratory grunt [10]. Peripheral cyanosis means the presence of dusky soles with peri-oral cyanosis and not the cyanosis of mucosa. Birth weight and history of birth asphyxia were obtained from referral case sheet. History and clinical examination was done by admitting physician and entered into the interview schedule. Maternal antenatal and intranatal events were obtained from the previous medical records, Janani–Shishu Suraksha Karyakram card, and referral sheet of the neonates. Socioeconomic status was classified according to modified Kuppuswamy's scale. Information regarding maternal literacy obtained from interview schedule with the accompanying person. Transport parameters of the referred neonates were obtained through interview schedule with the accompanying person. Status of pre-referral stabilization was obtained from referral slip. Referred by "SELF" (in observation table) means neonate directly came to our setup without being referred from any other health facility. Neonate transported with "OTHER" mode of means vehicles except 108, 102, Government ambulance (other than 108, 102), and private ambulance, which includes auto, motorcycle, private jeep, taxi, bus, train, or walking as such. As all transport vehicles have not same equipment and accompanying health care personnel, these were categorized differently to find any association with our study parameter. Drugs during transport mean other medications except intravenous (IV) fluid and oxygen. Classification of vehicles used for transport was based on available equipment and drugs as per National Neonatology Forum guidelines for neonatal transport. Highly equipped vehicle means a vehicle having more than 60% of equipment and drugs, moderately means 25-60%, and <25% means poorly equipped. Accompanied person trained in neonatal care means whether person had working experience in NICU for ≥6 months/trained in Neonatal Advanced Life Support/neonatal resuscitation course in the past 6 months. During transport, neonate carried with "OTHER" mode means except mother's lap, incubator, or open cradle which includes accredited social health activist, grandmother, or any other relatives. In provisional diagnosis, other includes hyaline membrane disease, meconium aspiration syndrome, birth injury, and congenital anomalies. All the qualitative and quantitative data were imported to the excel sheet, and various correlation/charts/graphs/tables were displayed using Microsoft SPSS version 24.

RESULTS

Out of 394 referred outborn neonates, 98% deliveries were conducted at health-care facilities. Out of all institutional deliveries, 79.9% delivered vaginally whereas 20.1% were delivered by cesarean section. 52.8% cases had antenatal ultrasonography done once or more than once. Other birth variables are shown in Table 1.

As shown in Table 2, gestational maturity and neonates having birth asphyxia had a significant association with hyperglycemia on admission ($p<0.05$) but other variables such as birth weight, weight on admission, and gestational age were not associated with hyperglycemia on admission.

As evident in Table 3, a maximum number of referred neonates were provisionally diagnosed as hypoxic ischemic encephalopathy (HIE) followed by prematurity, but association with admission hyperglycemia was found to be significant only with HIE neonates and neonates referred for neonatal jaundice ($p<0.05$).

In our study, 48.2% referred neonates were within 2-7 days of life, 35.8% <24 h of age, and 15% were of more than 7 days

Table 1: Descriptive statistics of referred neonate

Variables	Outborn n=394 (%)
Sex	
Male	240 (60.9)
Female	154 (39.1)
Birth weight (kg)	
≥2.5	179 (45.4)
1.5-2.5	150 (38.1)
1-1.5	59 (15)
<1	6 (1.5)
Weight/gestational age	
SGA	163 (41.44)
AGA	231 (58.6)
LGA	0 (0)
Maturity at birth (weeks)	
Term (>37)	286 (72.6)
Preterm (28 to <37)	105 (26.6)
Extreme immaturity (<28)	3 (0.8)
Glycemic status on admission	
Hyperglycemia	133 (33.8)
No hyperglycemia	261 (66.2)

SGA: Small for gestational age, AGA: Appropriate for gestational age, LGA: Low birth weight

and 96.2% were referred by doctor, 1% by nurse, and 3.8% were directly from home without referred from any health facility. In 94.9% referred neonates, pre-referral stabilization had been done, and 5.1% cases had not undergone any pre-referral stabilization. Other transport parameters are shown in Table 4.

From Table 4, the transport parameters showing significant association with hyperglycemia ($p<0.05$) and other birth variables showing significant association from Table 2. Logistic regression analysis was done which is shown in Tables 5 and 6.

Excluding the variables which are not showing significant association in Table 5 and another logistic regression for hyperglycemia is shown in Table 6.

Hyperglycemia was significantly associated with birth asphyxia, prolonged duration of transport (4-6 h), and gestational age.

Table 2: Statistical association between birth variables and admission hyperglycemia

Variables	Hyperglycemia n=133 (%)	No hyperglycemia n=261 (%)	Statistical association
Birth weight			
Normal (n=179)	58 (43.6)	121 (46.4)	χ^2 (3)=3.346, p=0.341
LBW (n=150)	47 (35.3)	103 (39.5)	
VLBW (n=59)	26 (19.5)	33 (12.6)	
ELBW (n=6)	2 (1.5)	4 (1.5)	
Maturity			
Term	85 (63.9)	201 (77)	χ^2 (2)=7.771, p=0.021
Preterm	47 (35.3)	58 (22.2)	
Extreme prematurity	1 (0.8)	2 (0.8)	
Weight/GA			
SGA	56 (42.1)	107 (41)	χ^2 (1)=0.833, p=0.830
AGA	77 (57.9)	154 (59)	
LGA	0 (0)	0 (0)	
Birth asphyxia			
Present (n=189)	85 (63.9)	104 (39.8)	χ^2 (2)=23.177, p=0.000
Absent (n=205)	48 (36.1)	157 (68.2)	

LBW: Low birth weight, VLBW: Very low birth weight, ELBW: Extremely low birth weight, SGA: Small for gestational age, AGA: Appropriate for gestational age, LGA: Low birth weight

DISCUSSION

In the present study, 34% out of 394 referred neonates were hyperglycemic which is very high as compared to a previous study done in 2008, in which 11.2% neonates were hyperglycemic in specialized transport team group and 20.5% neonates were hyperglycemic in self-transport group [6]. The higher percentage in the present study may be due to IV fluid given in a rapid rate during transport or other stress factors involved in the transport. Most of these referred neonates had birth asphyxia (48%) and were found to have a significant association of hyperglycemia on admission. Hence, there should be cautious IV fluid management of these neonates preferably through infusion pump and regular monitoring of blood sugar during transport. Prematurity was the next common diagnosis on admission, and it was also associated significantly with admission hyperglycemia. Therefore, strict monitoring of IV fluid and blood sugar should be emphasized during transport. As there is a paucity of the studies to compare these results, we believe that this association is mostly contributed by the transport status of the outborn neonates. However, this high prevalence of hyperglycemia in our study is worrying as it is deleterious in case of premature and asphyxiated neonates.

On observing the transport characteristics (Table 4), there has been significant increase in the number of newborns transported by ambulance (76.4%), stabilizations before referral (94.9%), accompanying paramedics (61.2%) with transportation than similar previous study where 47.3% newborns transported by the ambulance, 37.6% stabilized before referral, and 44.3% had accompanying paramedics with transportation [11]. However, no improvement was found with respect to the communication to the referred hospital (as only 6 out of 394 cases had informed to our hospital before referral over phone) as compared to a similar study (28%) [11]. The increase in ambulance transport largely attributed to the implementation of various programs such as 108 and 102, especially for pregnant mothers and infants. Furthermore, in this study, none of the neonates were transported with specialized transport ambulance for neonate and all transport vehicles were either moderately or poorly equipped.

In this study, significant association with hyperglycemia was observed with transportation with ambulance (108), other modes of transport, moderate and poorly equipped vehicle, IV fluid during transport, and enteral feeding irrespective of IV fluid. This is because as most of these neonates were stabilized pre-referral with IV fluid,

Table 3: Provisional diagnosis and hyperglycemia association

Provisional diagnosis[$]	Hyperglycemia n (%)	No hyperglycemia	Statistical association Pearson Chi-square test i.e., $\chi 2(1)$
Prematurity (22.3)	34 (25.6)	54 (20.7)	1.207, p=0.306
HIE (45.2)	77 (57.9)	101 (38.7)	13.110, p=0.000
Neonatal sepsis (36.6%)	50 (37.6)	98 (35.5)	0.000, p=1
Neonatal jaundice (7.9%)	2 (1.5)	29 (11.1)	11.18, p=0.001
Others (3%)	1 (0.8)	11 (4.2)	3.557, p=0.067

[$]Neonates having more than one diagnosis were included in both categories. HIE: Hypoxic ischemic encephalopathy

Table 4: Association of hyperglycemia and transport parameters

Transport parameters	Hyperglycemia	No hyperglycemia	Statistical association
Mode of transport			
108	100 (75.2)	139 (53.3)	χ^2 (1)=17.158, p=0.000
102	12 (9)	38 (38)	χ^2 (1)=2.438, p=0.149
Government ambulance other than 108, 102	2 (1.5)	6 (2.3)	χ^2 (1)=0.280, p=0.722
Private ambulance	2 (1.5)	2 (0.8)	χ^2 (1)=0.477, p=0.606
Others	17 (12.8)	76 (29.1)	χ^2 (1)=14.377, p=0.001
Transport duration (h)			
<1	15 (11.3)	41 (15.7)	χ^2 (1)=1.458, p=0.286
1-2	17 (11.8)	47 (18)	χ^2 (1)=1.768, p=0.197
2-4	58 (43.6)	118 (45.2)	χ^2 (1)=0.091, p=0.830
4-6	16 (12)	9 (34)	χ^2 (2)=13.010, p=0.001
>6	26 (19.5)	43 (16.5)	χ^2 (2)=2.595, p=0.273
IVF	123 (92.5)	218 (83.5)	χ^2 (2)=6.070, p=0.013
Enteral feeding irrespective of IVF	3 (2.3)	27 (10.3)	χ^2 (1)=8.196, p=0.004
Equipment available in transport vehicle			
Highly equipped	0 (0)	0 (0)	*****
Moderately equipped	99 (74.4)	143 (54.8)	χ^2 (1)=14.352, p=0.000
Poorly equipped	34 (25.6)	118 (45.2)	χ^2 (1)=14.352, p=0.000

IVF: Intravenous fluids

and poor monitoring of IV fluid during transport might contribute to hyperglycemia on admission. A regression model, formulated by considering these variables, showed highly significant association with the admission hyperglycemia (Table 6).

Strengths of this study are the study setting which reflects the condition of the most rural scenario of the neonatal transport, adequate sample size, and thorough interview schedule to obtain the accuracy of data regarding transport characteristics. Limitations are demography of this study cannot be generalized to a larger level, particularly urban areas. Second, sample size could have been more, and study design could be a matched case–control study with inborn neonates to minimize the confounding factors. Finally, these neonates could have been followed up for survival and neurodevelopmental outcomes. Retrospectively, we also feel that we could have cross-checked the actual status of the transport vehicle to know ground reality of transport vehicles and could have checked the actual pre-referral status and stabilization over phone from the referral hospital.

CONCLUSION

Maintenance of euglycemia and preventing hyperglycemia is one of the important components of neonatal transport along with other stable vitals during transport. Although there is an increase in percentage of neonates being transported by ambulance, still care during transport, accompanied skilled personnel with the referred neonate, and special neonatal transport vehicle with adequate equipment's might have to go a long way to achieve the standard which might be helpful to improve the status of referred neonates on arrival.

Table 5: Regression model for hyperglycemia

Risk factors	Adjusted odds ratio (95% CI)	p-value
Birth asphyxia	2.837 (1.292-6.228)	0.009
HIE	0.981 (0.446-2.158)	0.969
IV fluid during transport	1.159 (0.439-3.056)	0.766
Feeding irrespective of IV fluid during transport	0.624 (0.128-3.035)	0.559
Neonatal jaundice	0.293 (0.058-1.486)	0.138
Transport duration <1 h	0.658 (0.305-1.420)	0.287
Transport duration 2-4 h	0.807 (0.481-1.353)	0.416
Transport duration 4-6 h	3.948 (1.471-10.595)	0.006
Transport by 102	0.723 (0.319-1.637)	0.437
Transport by 108	0.837 (0.433-1.617)	0.595
Transport by other than ambulance	0.857 (0.404-1.817)	0.688
Gestational age	1.126 (1.037-1.223)	0.005
Moderately equipped vehicle	1.318 (0.076-22.924)	0.850
Poorly equipped vehicle	0.763 (0.044-13.021)	0.853

HIE: Hypoxic ischemic encephalopathy, CI: Confidence interval, IV: Intravenous

Table 6: Corrected regression model

Risk factors	Adjusted odds ratio (95% CI)	p-value
Birth asphyxia	3.676 (2.231-6.058)	0.000
Duration of transport 4-6 h	3.953 (1.648-9.480)	0.002
Gestational age	1.134 (1.050-1.225)	0.001

CI: Confidence interval

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