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Relationship Between Glycemic Levels and Treatment Outcome Among Critically ill Children

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Abstract

Objective: To study relationship between blood glucose level and mortality, morbidity and length of picu stay in critically ill children ≥ 1 month to ≤ 10 years of age.

Methods: Glycemia was determined using Accu-Chek (Roche Inc., Manheim, Germany) at the bedside, with blood being usually collected by finger prick. Glycemia results were provided either in mmol/L or mg/dL units. To simplify the analysis, all mg/dL values were converted into mmol/L by multiplying them by 0.0555.

Result: Total 200 critically ill children were included in our study, one fourty one patients were having hyperglycemia (70.5%), ten were having hypoglycaemia (5%), fourty nine were having normoglycemia (49%).

Conclusion: We demonstrated that hyperglycemic patients were more prevalent among critically ill children and are at higher risk for mortality, increased length of PICU stay, high PRISM SCORE III.

Keywords: Glycemic Levels; Treatment; Critically ill Children.

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Introduction

Critically ill-children constitutes a heterogenous group of acutely ill children such as those convulsing, unconscious, cyanosed, lethargic or floppy and those with severe chest indrawing, dehydration (severe), petechiae or purpura, stridor, hypoxemia, hypothermia and hyperpyrexia[1-3] which are seen in most serious medical cases like meningitis, acute respiratory infections (ARIs), septic shock, febrile convulsions, diarrheal diseases etc. Disruption of blood glucose are common in critically ill hence it is important to assess glycemic

level along with maintain airway tract, breathing and circulation.In healthy state body is able to maintain glycemic level within a narrow range, in acute illness this homeostasis is deranged and result in hypoglycaemia or hyperglycemia.[4]

In critically ill children metabolism is deranged and hypergycemia represents an acute response to stress in 90% of patients admitted to an intensive care unit (icu) irrespective of a previous diagnosis of diabetis. Hyperglycemia is due to the combined effects of insulin resistance, glucose intolerance, increased gluconeogenesis, counter-regulatory hormone release (epinephrine norepinephrine, glucagon,cortisol, growth hormone) and cytokines (tumor necrosis factor-α [TNF-α], interleukin1 [IL-1 interleukin-6 [IL-6]).[5, 6, 7]

On the other side of the spectrum, hypoglycemia is also a common and life-threatening complication of several diseases such as severe malaria, bacterial sepsis, severe malnutrition, and neonatal illness, among others.[8-12] During critical illness there is increased glucose utilization, inadequate nutrition, and decreased endogenous glucose production.[13] Body tries to defend against hypoglycaemia as it the main source of glucose to brain.The brain is quite sensitive to acute hypoglycemia, but less so to chronic glucose deprivation where it can metabolize ketones for up to 60% of its energy requirements.[14] Although the brain contains enzymes that can metabolize alternate sources of fuel (e.g., lactate and ketones) when arterial BG falls below 54 mg/dl, cerebral metabolism and function decline.The developing brain of neonates is more prone to adverse effects of hypoglysemia which can cause altered consciousness, seizures , coma and death.

Aims and Objective

1. To find the incidence of hyperglycemia (blood glucose [BG] ≥ 150 mg/dl), hypoglycemia (BG ≤ 60 mg/dl) and euglycemia in critically ill children at the time of admission.
2. To study relationship between blood glucose level and mortality,morbidity and length of picu stay.

Study Duration

Study was carried out from december 2017 to october 2019.The relevant and required information pertaining to the study was collected using self designed proforma.

Study Setting

Study was conducted in tertiary medical college.

Study Design

Cross sectional observation study

Study Subjects

200 patients aged ≥ 1 month to ≤ 10 years admitted in picu was selected for study from our institute with the following inclusion and exclusion criteria

Inclusion Criteria

1. All critically Ill children ≥ 1 month to ≤ 10 years of age who presented with convulsion, unconsciousness, cyanosed, lethargic or floppy, those with severe chest indrawing, severe dehydration, petechiae or purpura, stridor, hypoxemia, hypothermia and hyperpyrexia, and had at least one blood glucose measurement on admission before commencement of intravenous fluid or antibiotics were consecutively recruited.
2. All children in the study were studied from day of admission and followed up till discharge or death.

Exclusion Criteria

Include those children whose parent(s)/caregiver did not consent, all diabetics, all children who received intravenous fluid, steroids, vasopressors or antibiotics prior to presentation and all children who did not present with the features mentioned above.

Methods

Glycemia was determined using Accu-Chek (Roche Inc., Manheim, Germany) at the bedside, with blood being usually collected by finger prick. Glycemia results were provided either in mmol/L or mg/dL units. To simplify the analysis, all mg/dLvalues were converted into mmol/L by multiplying them by 0.0555.

Statatistical Analysis

The data was coded and entered into Microsoft Excel spreadsheet. Analysis was done using SPSS version 20 (IBM SPSS Statistics Inc., Chicago, Illinois, USA) Windows software program. Descriptive statistics included computation of percentages, means and standard deviations. The analysis of variance (ANOVA) [for quantitative data within three groups] with post hoc Bonferroni test (intra-group comparioson) were used for quantitative data comparison of all clinical indicators. Chi-square test and fisher exact test were used for qualitative data whenever two or more than two groups were used to compare. Level of significance was set at P≤0.05.

Result and Observation

Table no. 1: Prevalence of hyperglycemia, hypoglycaemia, normoglycemia in critically ill children.

Groups	Total no. of Cases	
(Acc. to Blood glucose levels)	No. of Cases	Percentage
Hyperglycemia	141	70.5
Hypoglycaemia	10	5
Normoglycemia	49	24.5
Total	200	

Total 200 critically ill children were included in our study, one fourty one patients were having hyperglycemia(70.5%), ten were having hypoglycaemia(5%), fourty nine were having normoglycemia (49%). (Table 1)

Table No. 2: Association between blood glucose level and mortality.

Groups	Mortality				Total no. of Cases	
(Acc. to Blood glucose levels)	Seen		Not seen			
	No. of cases	Percentage	No. of cases	Percentage	No. of cases	Percentage
Hyperglycemia	41	29.1	100	70.9	141	100
Hypoglycemia	1	10.0	9	90.0	10	100
Normoglycemia	2	4.1	47	95.9	49	100
Total No. of cases	44	22.0	156	78.0	200	100

P value = 0.001 (S)

Total number of death in our study is fourty four, fourty one patients who died were having hyperglycemia (29.1%). We found significant association between hyperglycemia and mortality. (Table 2)

Table No. 3: Association between blood glucose level and length of PICU stay.

Groups (Acc. to Blood glucose levels)	Total No of Cases	Mean	SD	Minimum	Maximum	P value
Hyperglycemia	141	106.87	64.496	12	250	
Hypoglycemia	10	64.70	44.801	20	120	0.001 (S)
Normoglycemia	49	73.80	44.994	19	170	
Total	200	96.66	61.314	12	250	

In our study we observed that patients having hyperglycemia had longest duration of stay in PICU as compared to hypoglycaemia and euglycemic patients. (Table 3)

Table No. 4: Co relation between blood glucose level and PRISM SCORE III

Groups (Acc. to Blood glucose levels	Total No of Cases	Mean	SD	Minimum	Maximum	P value
Hyperglycemia	141	8.8156	5.73411	.00	24.00	
Hypoglycemia	10	8.4000	5.03764	5.00	21.00	0.001 (S)
Normoglycemia	49	4.6531	4.38060	.00	19.00	
Total	200	7.7750	5.66523	.00	24.00	

We demonstrated in our study that PRISM SCORE III was high in hyperglycaemic critically ill patients than non hyperglycaemic. (Table 4)

Incidence of hyperglycemia and hypoglycaemia in our study is 70.5% and 5%; Hirsberg E et. al.[15] study is 56.1% and 9.7% respectively, blood glucose level above 150 was considered hyperglycemia in both the studies, difference in the incidence can be attributed to the sample size and type of study conducted. Difference in incidence compared with other studies is due to the blood glucose level taken as hyperglycemia and hypoglycaemia. (Table 5)

Table 5: Comparison of percentage of hyperglycemia, hypoglycemia with previous studies.

Author and Year	Hyperglycemia Defined as Blood Glucose mg/dl	Incidence of hyperglycemia (%)	Hypoglycemia defined as blood glucose mg/dl	Incidence of hypoglycaemia (%)
Hirshberg E (2008) (15)	>150	56.1	<60	9.7
Andres Palacio* MD (2008) (16)	>180	5.9	<120	75
Rohit R et. al. (2013)(17)	>200	18	<40	3
Yanhong Li (2015)(18)	110-140 140-200 >200	25.4 20.8 19.3	<65	3.6
Nwachinemere Davidson Uleanya1 (2017) (19)	>110	39	<65	20.7
Present Study	>150	70.5	<60	5

(*) **Note:-** In a given study blood glucose <120 is not defined as hypoglycaemia.

Table 6: Key Studies of Association of hyperglycemia and Mortality in Critically Ill Children.

Study (number denotes study reference)	Setting/patient population	Sample size	Definition of hyperglycemias	Odds Ratio Relative risk P VALUE
Srinivasan et. al. (20)	ICU	152	BG >150 mg/dl	Significant (OR 3.4)
Faustino et. al. (21)	ICU	942	BG >150 mg/dl	Significant (RR 2.5)
Wintergerst et. al., (6)	ICU	1094	BG >150 mg/dl	Significant (RR 4.8)
Yung et. al., (22)	ICU	409	BG >126 mg/dl	Significant (OR 3.31)
Hirshberg et al	ICU	863	BG >150 mg/dl	Significant (OR 11.1)
Rohit Rai et. al., (17)	ICU	200	BG>200	Significant (58.33% P=0.000)
Khan S A et. al., (23)	ICU	150	BG>126	Significant (57.3%, p = 0.019)
Patki et. al., (24)	ICU	101	BG>126	Significant (28.6%, p<0.05)
Present study	ICU	200	BG>150	Significant P = 0.001

In our study mortality rate among hyperglycaemic group is higher than non hyperglycaemic, frequency of hyperglycemia in critically ill children was observed in 141 patients out of 200 patients (70.5%). Overall mortality rate was 28.36% among hyperglycaemic which is higher than among non hyperglycaemic group.(%); which is similar to other studies conducted previously. (Table 6)

Table No 7: Association Blood Glucose Level and Length of Picu Stay

Study	Blood Glucose Level(mg/dl)	Length of Picu Stay
Hirshberg E (2008) [15]	>150 mg/dl	p <0.001
Andres P et. al., (16)	>180	p<0.001
Leila Shirzadeh (2014) [25]	>120	P=0.002
Patki et. al., (2014) (26)	>126mg/dl	P< 0.05
Present study	>150	P=0.001

We did demonstrated a significant correlation between the BG level and the length of stay in the pediatric ICU. (Table 7) Hirshberg Eet al[15] and Patki et al, (26) reported the same finding, but it is in contrast to study by Seham A et. al.,[21] the difference in observation can be due to the level of blood glucose taken as hyperglycemia, later study defined hyperglycemia as above 126 mg/dl and former study defined it as as above 180mg/dl. This finding denotes that patients with severe hyperglycemia tend to have prolonged PICU stays for their severe underlying critical illness. (Table 8)

Table No. 8: Association of blood glucose level and prism score III.

Study	Blood Glucose LeveL	Prism Score
Khan S A et. al., (23)	>126	P = 0.001
Seham A et. al., (2018)(21)	>180	P = 0.019
Ballestero et. al.,		
Present study	>150	P = 0.001

BG ≥ 150 mg/dL was significantly associated with higher PRISM III scores (p = 0.001), and BG level was significantly positively correlated with PRISM III score(p = 0.019). These findings agree with those of Ballestero et al., Seham A et al (21), Khan S A et al (23) but they differ from the report by Patki and

Chougule, (24) in which the PRISM score fell just short of statistical significance. In contrast to our results, Bhutia et. al. (22) did not find any association between the severity ofillness at admission and the occurrence of hyperglycemia. The difference could be explained

Discussion

Critically ill-children constitutes a heterogenous group of acutely ill children,it is important to assess glycemic level along with maintain airway tract, breathing and circulation.In healthy state body is able to maintain glycemic level within a narrow range, in acute illness this homeostasis is deranged and result in hypoglycaemia or hyperglycemia. Hence we conducted our study to find the incidence of hyperglycemia in critically ill children admitted in PICU and the treatment outcome.

One fourty one out of two hundread patients have blood glucose above 150mg/dl.Ten patients had hypoglycaemia and fourty patients had euglycemia. Increased occurance of hyperglycemia in our study was comparable with studies Hirshberg E et al.,[15] Andres et. al.,[16] Rohit et. al.,[17] Yanhong Li et. al.,[18] Nwachinemer D et. al.[19]

Conclusion

We demonstrated that hyperglycemic patients were more prevalent among critically ill children and are at higher risk for mortality, increased length of PICU stay, high PRISM SCORE III.Controlling stress hyperglycemia by insulin infusion during PICU stay effect treatment outcome has to be studied.

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