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RESEARCH ARTICLE

ELECTROLYTE DISTURBANCES IN CRITICALLY ILL PATIENTS.

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Abstract

Background:- Critically ill child is any child needs supportive treatment for its biological function either by drugs or mechanical ventilation & is usually associated by disturbances in Electrolytes due to different associated factors.

Objective:- The aim of our work is to measuring level of sodium, potassium, and calcium, in critically ill patient

Methods:- The study was conducted at pediatric Intensive Care Units (PICUS) of the Pediatric Department, Benha University Hospitals during the period from February 2015 to April 2015, on females and males equally from 1month to 18 years needing supportive treatment by drugs or mechanical ventilators. Demographic Data were collected & Full examination was done and Blood samples were taken to do Complete blood count, C-reactive protein, Liver function test, Kidney function test, Arterial blood gases & serum electrolytes as serum Ca, Na & K level.

Results:- Hypocalcemia is more common in our PCIU 71.7% of cases with PRISM score mean of (23.0±11.42 (5-47)) with Death prediction of (39.07±23.51 (9-75)), Hypercalcemia is less common 2.5% of cases with PRISM score mean of (43.67±1.53(42-45)) & Death prediction of (75.0±0.0 (75-75)), Hypokalemia is more common 38.8% of cases with PRISM score of (25.04±8.21 (8-38)) and Death prediction of (44.52±20.49 (9-75)), Hyperkalemia is less common 22.5% of cases with PRISM score of (27.44±13.58 (10-47)) and Death prediction of (47.22±24.91 (15-75)), Na level of no significance relation with critically ill children.

Conclusion:- Critically ill children, hypocalcemia& hypokalemia are more common among children but hyperkalemia & hypercalcemia are associated with high level of PRISM score & Death Prediction

Introduction:-

PICU is an important component of tertiary pediatric care services. PICU aims at promoting qualified care for critically ill children. These units are points of major technology transfer and constitute one of the main consumers of hospital budgets **(Qureshi et al., 2007).**

The main purpose of the PICU is to prevent mortality by intensively monitoring and treating critically ill children who are considered at high risk of mortality. The capability to estimate patient risk of death is extremely important because such estimate would be useful in achieving many different goals such as assessing patient's prognosis, ICU

performance, ICU resource utilization and also evaluating therapies, controlling and matching severity of illness in clinical studies**(Bhadoria and Bhagwat, 2008).**

Mortality rates are increased in patients with sepsis & hypocalcemia compared with patients who are normocalcemic **(Forsythe et al., 2008)**

hypercalcemia is seen reatively infrequently in the PICU. When seen,the usual causes include immobilization, iatrogenic causes & malignancies (neuroblastoma) & myeloma **(Alsirafy et al., 2009).**

Severe hyponatremia (< 125 mEq/L) has a high mortality rate. In instances when the serum sodium level is less than 105 mEq/L, the mortality is over 50% **(Singhi and Jayashre, 2009).**

As regard hypernatremia Mortality rates of 30-48% have been shown in patients in ICUs who have serum Na levels exceeding 150 mmol/L **(Darmon et al., 2010).**

Mild potassium abnormalities are common in the PICU. Guidance in monitoring frequencies of potassium abnormalities in pediatric critical care is needed**.** Hypokalemia is more commom than hyperkalemia affected patients at admissions. **(Cummings et al., 2014).**

Aim of the work:- measure the level of sodium, potassium, and calcium, in critically ill patient

Subjects and Methods:-

The study was conducted at PICUS of the Pediatric Department, Benha University Hospitals during the period from February 2015 to April 2015 and all cases girls and boys were take equally from the age of 1m. till 18y and all were subjected to full data like personal, present, past, family, medical, vaccination & neonatal history and underwent full examination like General examination; head & neck, Upper limb, lower limb, Vital Data; Respiratory rate, Hear rate, Blood pressure, Temperature., Regional exam. ; Chest Exam., Cardiac Exam., Neurological Exam., Abdominal Exam. Investiagtions done were Complete blood count, Liver function test, Kidney function test, C-recive protein, Arterial blood gases, Serum Na, K& Ca levels

Statistical Analysis:-

Results will be organized, tabulated and statistically analyzed using SPSS software statistical computer package version 16. For quantitative data, the mean and standard deviation will be calculated. The difference between two means will be statistically analyzed using the student (t) test and Mann-Whitney test. For qualitative data the number and percent distribution will be calculated. Chi square will be used as a test of significance which will be adopted at $p < 0.05$ for interpretation of results of tests of significance**.**

Results:-

Most cases admitted were females with mean age of 22.27m. ±23.03(1-96) , most cases was renal failure, gastroenteritis then CNS infection and chest infection with PRISM score range of 24.02±10.89 (5-47) as shown in Table (1)

Table (1):Demographic & laboratory data of the studied groups:-

	Mean ±SD (Range)
Age	22.27±23.03 (1-96)
Sex no&%	
Male	52(43.3)
Female	68(56.7)
Vital signs	
Systolic Blood Pressure	89.82±25.61 (38-150)
Diastolic Blood Pressure	51.22±21.04 (19-120)
Temperature	38.12±1.22 (35-40)
Respiratory Rate	53.96±14.75 (22-90)
Diagnosis	
Chest infection	21(17.5)
Sepsis	12(10.0)
Gastroenteritis	24(20.0)
CNS infection	21(17.5)
Metabolic disorders	6(5.0)
Renal failure	27(22.5)
Hypocalemic convulsions	15(12.5)
Anemic heart failure	6(5.0)
Renal Tubular Acidosis	11(9.2)
Cerebral Palsy	6(5.0)
Diabetic ketoacidosis	3(2.5)
Hemolytic Uremic Syndrome	3(2.5)
Diabetes Insipidus	1(0.8)
PRISM score	24.02±10.89 (5-47)
Glasscow coma score	6.81±2.05 (3-12)

Number of cases admitted were 120 cases with distributions of electrolytes disturbances according to that shown in the table (2).
Cases admitted were mostly hypocalcemic, normonatremia & normokalemia
But hyponatremia was more than hypernatremia, hypokalemia was more than hypekalemia as shown in table (2)

Table (2): Distribution of cases regarding electrolytes disturbance:

	No	%
Ca		
Hypercalcemia	3	2.5
Hypocalcemia	86	71.7
Normal	31	25.8
Na		
Hypernatremia	14	11.7
Hyponatremia	28	23.3
Normal	78	65.0
K		
Hyperkalemia	27	22.5
Hypokalemia	46	38.3
Normal	47	39.2

ypocalcemia is more common among cases of PICU than hypercalcemia but PRISM score is higher with hypercalcemia with higher Death prediction than hypocalcemia as shown in table (3) .

Table (3): Distribution of ca disturbances regarding PRISM score & Death prediction:

Ca	Hypercalcemia (3)	Hypo calcemia (86)	Normal (31)	FET	P value
PRISM score Mean ±SD (range)	43.67±1.53(42-45)	23.0±11.42 (5-47)	24.94±7.54 (9-42)	F=5.82	0.004**
Death prediction Mean ±SD (range)	75.0±0.0 (75-75)	39.07±23.51 (9-75)	42.94±18.24 (9-75)	4.01	0.021*

And hyponatremia is more common than hypernatremia but hypernatremia is associated with higher PRISM score and Death prediction than hyponatremia as shown in table (4) .

Table (4): Distribution of Na disturbances regarding PRISM score & Death prediction:

Na	Hypernatremia (14)	Hypo natremia (28)	Normal (78)	Test	P value
PRISM score Mean ±SD (range)	28.07±7.5 (22-42)	26.57±12.38 (8-46)	22.38±10.59 (5-47)	F=2.69	0.072
Death prediction Mean ±SD (range)	46.71±16.71 (35-75)	45.07±23.11 (9-75)	38.46±23.18 (9-75)	1.4	0.25

Hypokalemia is also more common than hyperkalemia but hyperkalemia is associated with higher PRISM score and Death prediction than Hypokalemia as shown in table (5) .

Table (5): Distribution of K disturbances regarding PRISM score & Death prediction:-

K	Hyperkalemia (27)	Hypo kalemia (46)	Normal (47)	Test	P value
PRISM score Mean ±SD (range)	27.44±13.58 (10-47)	25.04±8.21 (8-38)	21.06±10.95 (5-46)	F=3.4	0.037*
Death prediction Mean ±SD (range)	47.22±24.91 (15-75)	44.52±20.49 (9-75)	33.89±21.79 (9-75)	4.1	0.019*

Discussion:-

Critically ill child means a child who is in a clinical state which may result in cardiac arrest or severe neurologic complication, if not recognized promptly. This term does not refer to any particular disease, but many diseases can lead onto "critically ill state". Whether a child presents with a primary cardiovascular, respiratory, neurologic, infectious or metabolic disorder, the goal is early recognition of respiratory and circulatory insufficiency **(Kinsella, 1993)**

I used here in my study PRISM score for scoring my patients as it consider the only new one collecting two electrolytes of my study in one score which are potassium and calcium, it also include a lot of criteria of patients admitting to PICU like conscious level (Glasscow coma scale), heart rate, blood pressure, respiratory rate, ABG, bleeding tendency, bilirubin level, bl. Sugar **(Bhadoria and Bhagwat, 2008).**

As regard electrolytes, I talked in my study about sodium, potassium & calcium.
In our results we found that Hypocalcemia is a critical condition that is occurred in about 86 patients in the PICU out of 120 cases entering the PICU over 4 months, with PRISM score about 23.0±11.42 (5-47) & death prediction of 39.07±23.51 (9-75).

This agrees with **Cardenas-Rivero et al., (1989)** the study done at Massa-chusetts General hospital; 49% of critically ill children had low serum calcium values & is associated with greater severity of illness and mortality.

According to **Desai et al., (1988)** who explained that acute illness may lead to hypocalcemia for multiple reasons. In one study, the 3 most common factors identified in patients with hypocalcemia associated with acute illness were hypomagnesemia, acute renal failure, and transfusions, In gram-negative sepsis, there is a reduction in total and ionized serum calcium. The mechanism for this remains unknown, but it appears to be associated with multiple

factors, including elevated levels of cytokines (eg, interleukin-6, interleukin-1, TNF-alpha), hypoparathyroidism, and vitamin D deficiency or resistance**.**

In our results we found that hypercalcemia is not a common clinical pediatric problem as regard my study there are only 3 cases out of 120 patient with PRISM score 43.67±1.53(42-45) & death prediction of 75.0±0.0 (75-75) because of the underlying aetiology which caused this not because hypercalcemia itself.

No recorded cases with convulsion.
Similar to **Alsirafy et al., (2009)** who reported that hypercalcemia is seen reatively infrequently in the PICU. When sreen,the usual causes include immobilization, iatrogenic causes & malignancies (neuroblastoma) & myeloma

In contrast to our results , **Zivin et al., (2001)** who found that mortality rates are increased in patients with sepsis and hypocalcemia, compared with patients who are normocalcemic.

As regard Na: Hyponatremia is a common pediatric problem seen here, in my study there are 28 patients out of 120 patients entering the PICU who are hyponatremic & associated with PRISM score of [26.57±12.38 (8-46)] and death prediction [45.07±23.11 (9-75)] and associated with chest infection, hypocalcemic convulsion, anemic heart failure, cerebral palsy, CNS infection, multiorgan failure, hemolytic uremic syndrome, sepsis& diabetes mellitus.

8 cases out of 28 cases developed convulsion.
As regard searches done by **Gruskin et al., (1982)** hyponatremia is caused by AS regard searches hyponatremia most commonly results from an abnormality in the handling of water. The most common cause of hyponatremia is the PICU is SIADH

Singhi et al., (2009) explained that under normal conditions, renal handling of water is sufficient to excrete as much as 15-20 L of free water per day. Further, the body's response to a decreased osmolality is decreased thirst. Thus, hyponatremia can occur only when some condition impairs normal free water excretion, The incidence of hyponatremia depends largely on the patient population and the criteria used to establish the diagnosis. Among hospitalized patients, 15-20% have a serum sodium level of <135 mEq/L, while only 1-4% have a serum sodium level of less than 130 mEq/L. The prevalence of hyponatremia is lower in the ambulatory setting & Severe hyponatremia (< 125 mEq/L) has a high mortality rate. In instances when the serum sodium level is less than 105 mEq/L, the mortality is over 50%.

Hypernatremia is relatively less than hyponatremia in children of my study; they are about 14 patients out of 120 admitted to our PICU with PRISM score of [28.07±7.5 (22-42)] with death prediction of [46.71±16.71 (35-75)] and it is associated with metabolic disorder, sepsis, gastroenetritis & renaltubular acidosis.

8 cases out of these 14 cases developed convulsion.
And was explained by **Darmon et al., (2010)** considerably higher prevalences of 9-26% are seen in critically ill patients, in whom major risk factors for hypernatremia include mechanical ventilation, coma, and sedation.

Another study done by **Lindner et al., (2007)** found that incidence of hypernatremia at the center's intensive care unit (ICU) was 9% of the total cases. However, it was also found that among those patients with hypernatremia, only 23% already had the condition when admitted to the ICU**.**

Darmon et al., (2010) & Funk et al., (2010) reported that mortality rates of 30-48% have been shown in patients in ICUs who have serum sodium levels exceeding 150 mmol/L**.**

Hyperkalemia in my study is less common than hypokalemia& About 27 cases out of 120 cases admitted were hyperkalemic& is associated with PRISM score of 27.44±13.58 (10-47) and prediction of death of 47.22±24.91 (15-75) & is associated with sepsis, Renal failure (Acute or chronic) Cerebral palsy, gastroenetritis (especially with severe diarrhea)& multiple organ failure & is associated with glasscow coma scale of 6.33±2.04 (3-10) & Urine output of 0.94±1.31 (0.1-4.2) & creatinine of 2.09±0.96 (0.4-3.8) & C-reactive protein of 92.56±69.97 (12-192).
According to **Cummings et al., (2014)** As regard a study done: Potassium abnormalities are common in critically ill patients,who found that one-third had abnormal values. Hypokalemia affected 40% of the admissions. mmol/L) .

Hyperkalemia affected 29% of the admissions. On univariate analysis, severity of hypokalemia was associated with mortality (odds ratio 2.2, P = .003) .

Unlike my study Also in other searches about hyperkalemia they say that hyperkalemia is a life threatening condition that is most often seen in the pediatric ICU , it can be result from increased intake **Hoyt (1986).**

Hypokalemia is more common than hyperkalemia in my study About 46 cases out of 120 cases admitted were hypokalemic with PRISM score of 43.67±1.53(42-45) and death prediction of 75.0±0.0 (75-75) with sepsis, gastroenetritis, CNS infection, chest infection with gastroenetritis, sepsis with gastroenetritis, sepsis with renal tubular acidosis, diabetic ketoacidosis, diabetes insipidus & hemolytic uremic syndrome.

With glasscow coma scale of 7.13±1.63 (3-10), urine output of 2.54±1.29 (0.4-5), creatinine of 0.95±0.90 (0.4-4) & C-reactive protein of 42.15±34.16 (3-97).

Mostly associated with gastroenetritis & sepsis.
About 23 cases developed convulsion out of these 27 cases.

According to **Cummings et al., (2014)** K abnormalities are common in critically ill patients & found that one-third had abnormal values. Similar to our results, hypokalemia affected 40% of the admissions. mmol/L) . Hyperkalemia affected 29% of the admissions. On univariate analysis, severity of hypokalemia was associated with mortality (odds ratio 2.2, P = .003) .

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