EVALUATING MORTALITY RATE CAUSED BY ELECTROLYTE ABNORMALITIES IN PATIENTS HOSPITALIZED

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Abstract- Adjustment of composition of body fluids and electrolytes is one of the most important aspects of patients care. Sodium and Potassium are the most important body cations, the improper adjustment of them will cause sever disorders in neuromuscular, gastrointestinal, respiratory and cardiovascular systems. Acute renal failure indicated by increase in creatinine and nitrogen urea, brings an accumulation of fluids, salts and metabolites of nitrogen in body. This study intends to assess the status of electrolyte abnormalities and mortality rates of the patients hospitalized in ICU wards in our country. This is a descriptive and retrospective study on the records of 378 patients hospitalized in ICU. A questionnaire was prepared and the data were entered in SPSS system. They were statistically analyzed by using chi-square and fisher's Exact test methods. Out of 378 patients hospitalized in ICU, over 2/3 of them were male and over half of them were>45 years old. Frequency distribution of electrolyte abnormalities was as follows: Hyponatremia 59% hypernatremia 23% hypokalemia 37% hyperkalemia 28%, 35% and 21% of patients had respectively BUN and creatinine more than the normal range. 26% of patients hospitalized in ICU had nonsurgical problems and 74% of the patients had surgical problems. Average time of hospitalization in ICU was 85 days and mortality rate was 35%. The most common electrolyte abnormality was related to variation in serum sodium levels in the form of hyponatremia. And the highest prevalence electrolyte abnormality in dead patients was hyponatremia. This study proves that the prevalence of electrolyte abnormalities is directly related to mortality and increase in hospitalization period and those having undergone surgical operations during hospitalization in ICU, manifested more abnormalities.

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Key words: Hyponatremia, hypernatremia, hypokalemia, hyperkalemia, ICU

INTRODUCTION

Stability of fluids and electrolytes is very important for normal people in their physiological and biochemical activities.

This is the aspect that takes a special importance in pathological status especially with the patients hospitalized in ICU.

It may cause disorder in the abilities of body systems for the maintenance of newly-arising needs under pathological conditions. On the other hand, water balance is also maintained mainly through the variations in renal excretion of pure water (1).

Total Body Water (TBW) is an important part of total body fluid components and total body water (TBW) is about 50-60 percent of total body weight of an adult (2). Water in body exists in the form of intra cellular fluids (ICF) and extra cellular fluids

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(ECF). ICF is 2/3 of the water in body and the remaining 1/3 of total body water that is in ECF, consists of two essential components: plasma (25% of ECF) and intercellular fluid (75% of ECF). (3) Average ICF volume is 400-500 ml/kg and about 30 lit out of which 2 lit may be considered as RBC volume, Major metabolic reactions of blood occur inside RBC and hence in ICF (2). Daily oral intake of water and salts is modified by excretion of some elements through gastrointestinal, renal, pulmonary and dermal systems so that the internal environment of body is maintained on the basis of different physiological needs.

In spite of diversity in their combination the elements excreted through the gastrointestinal system are isotonic in nature and they necessarily should be compensated for by using isotonic salty fluids (4). Fluid balance abnormalities are divided into three major categories: Volume abnormality, density abnormality, and combination abnormality. With the most common water and electrolyte abnormality patients suffering from a sudden acute unease, is the deficit in ECF. The most simple form of decrease in volume is deficit of water without reduction in the rate of salts that may be observed in the patients with sever disability that cannot take water, those with higher fever and those with high intangible excretion of water.

Different symptoms such as drowsiness, senselessness, reduction in reflexes and cardiovascular symptoms in the form of some degrees of hypertension, tachycardia, weak pulse and coldness of extremities are commonly observed in such patients and by substituting extra cellular fluid volume such symptoms will considerably modify (5).

Concurrent reduction of volume and electrolytes is another abnormality that happens because of excretion of fluids through gastrointestinal system for instance after using gastric drainage, enteral fistula, enterostomy or diarrhea and also in over using of diuritics, severe sweating and burning. Variations in density: Sodium ions of 90% of the particles with osmotic activities are found in ECF and this takes an important role in the determination of intracellular and extracellular osmolarity. In case of sodium decrease in ECF, transmission of water to ICF shall be continued in order to equalize osmolarity in 2 parts. However, the fluctuations in density of much of other ions in ECF do not cause important variations in osmotic activities but cause a change in combination (3).

Sodium Disorders

Hyponatremia: decrease of sodium to a level which is less than 130meq/l or 135meq/l (2,4).

Such an abnormality may be the result of an increase in sodium excretion. Through sweating, diarrhea, sever vomiting, burning and using diuretics and the more common reason of hyponatremia is increase of TBW.

Symptoms of hyponatremia include: nausea, vomiting, headache, visual disorders, reduction in consciousness, restlessness, confusion, muscular cramps, convulsion and coma (4).

According to Dunn's studies, 85% of hyponatremic patients have neurological symptoms (6).

Hypernatremia

It is an increase in extracellular sodium to more than145 meq/l (7). The most prevalent cause of this abnormality is lethargy, variation in mental status that may result in coma and convulsion as well (2).

In a study by Mandel and Ohio's colleagues that was performed on 116 hypernatremic patients, mortality rate was 66% (8).

Variations in combination

Variations in combination consist of change in the density of potassium, calcium and magnesium that are physiologically important and they will not cause osmolarity change. Potassium is the most abundant positive ion in ICF.

Total rate of extracellular potassium is 3.5-5 meq/l in an adult. However, such a small volume is sufficient to maintain the functions of neuromuscular system and heart (4).

Potassium Abnormality

Hypokalemia: It is the reduction of potassium to a rate smaller than 3.5meq/l. major sources of potassium excretion, other than renal system, are bowel juices (1). On the basis of difference in

degrees of hypokalemia, symptoms of hypokalemia are different. Between its common symptoms are fatigue, myalgia, muscular weakness in lower extremities and primary variations in ECG in the form of flat invert T waves.

Hyperkalemia

It is an increase in serum levels of potassium to more than 5meq/l. This is commonly created due to an increase in the release of potassium from cells or a decrease in renal excretion (9).

Hyperkalemia symptoms are initiated with weakness and senselessness that may proceed toward paralysis and bring entanglement of respiratory mussels that causes a decrease in respiration rate. Hyperkalemia also causes metabolic acidosis. The most serious hyperkalemia complication is cardiac toxicity.

Acute Renal Failure: (ARF)

Acute renal failure is a syndrome that is identified with a relatively rapid decrease in renal function, resulting in the accumulation of fluids, crystalloid salts and nitrogen metabolites in body (10). Post operation ARF often occurs due to hypovolemia. Clinically it is commonly identified with a daily increase in creatinine (Cr) and Blood Urea Nitrogen (BUN) that may be accompanied with oliguria, normal Central Vein Pressure (CVP) and decrease in the capacity of kidney for condensing the urine in an osmolarity more than plasma (11). ARF is classified into prerenal, renal and post renal categories depending on the causes of occurrence. That is why after a final diagnosis of ARF, the initial interventions should be taken for removal of recurrent elements. Therefore, adjustment of the prescribed medications for the treatment of failure should be considered (12).

MATERIALS AND METHODS

Medical records of 378 ICU patients of Shahid Beheshti Hospital from April 2000 to march 2002 were evaluated in this analytical, descriptive and retrospective study because daily or at most every other day. The samples were taken from patients having been hospitalized in ICU wards. These patients had been under accurate monitoring in ICU and they had had biochemical tests.

A questionnaire containing the needed variables (appendix questionnaire) was prepared and the data from the records of the patients were taken to SPSS system and were statistically analyzed by using chi-square and fisher's Exact test methods (Table 1 A,B) Age, sex, hospitalization service according to specialty (internal medicine, surgery, neurology, orthopedic, etc), cause and duration of hospitalization in ICU and the status of patient while discharging from ICU (recovery death) would also be included in the questionnaire. The patients with traumas, those having undergone surgical operations and those embedded in ICU would be evaluated depending on the types of trauma (multiple trauma, abdomen etc) and types of surgical operation (peritonitis, laparotomy, orthopedic surgery, neurosurgery) Meanwhile, biochemical test for sodium (Na) potassium (K), creatinine (Cr) and BUN were carried out for the patients in ICU were also evaluated and recorded on the related forms.

Whereas there are no well-developed data on electrolyte disorders and mortality rates of the patients embedded in ICU in our country, this study intends to provide more information about these abnormalities in order to reduce mortality rates in ICU.

RESULTS

Out of 378 records of the patients included in our study, 2/3 of them were male (Fig. 1).

Mean age of the study population was 46.8 years and over1/2 were more than 45 years old (Fig. 2)

1/3 of the patients (123 patients) were those having undergone a neurosurgery and the patients with general surgery ranked second in number.

26% of the hospitalized patients had internal diseases (non surgical) and 74% of the population had surgical problem, 58% of the population at least had one surgical operation and 45% of the patients had been taken to ICU after surgical operations. 45.5% of the population had referred because of traumas among which head traumas were more prevalent. 75% of the patients had been admitted as

emergency cases and mortality rate in ICU was 35% (Fig. 3). Average time of hospitalization had been 15.7 days in the hospital and 8.5 days in ICU.

23% of the patients had episodes of Na>145 and 59% of patient Na<135. 28% of the patients had episodes of K>5 and 37% of patient K<3.5.

35% of the patients had BUN>20 and 21% of them had Cr>1.5 (Fig. 4). This study has compared sodium, potassium, BUN and Cr rates with statistically significant variables such as age, sex, hospitalization ward, numbers of surgical operations, types of surgery, traumas and hospitalization time (p<0.5). Hypokalemia was more prevalent among female than male (39% against 36% with p<0.05) and there was a direct relation between age and three disorders: hypernatremia, increase in BUN and creatinine (Fig. 5).

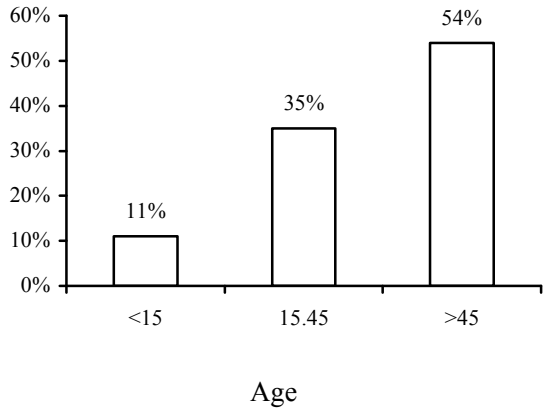

Fig. 2. Frequency Distribution of the patients embedded in ICU according to age groups

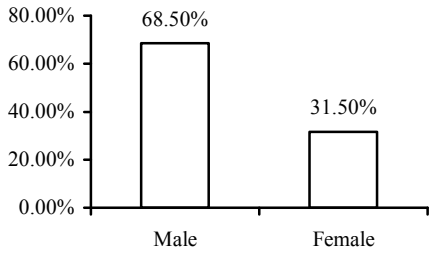

Fig. 1. Frequency Distribution of the patients embedded in ICU according to sex)

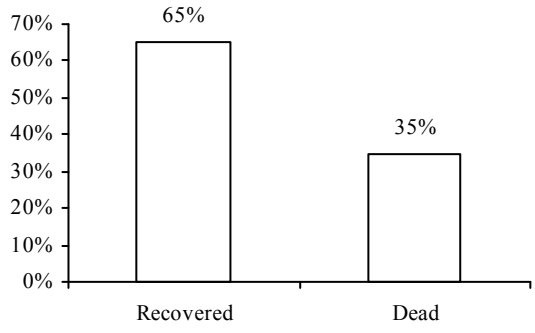

Fig. 3. Frequency Distribution of the patients embedded in ICU according to their prognosis

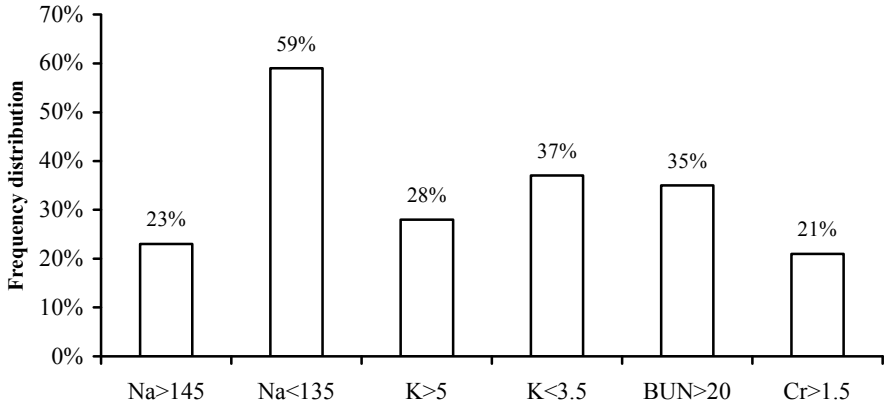

Fig. 4. Frequency Distribution of Electrolyte disorders in ICU patients

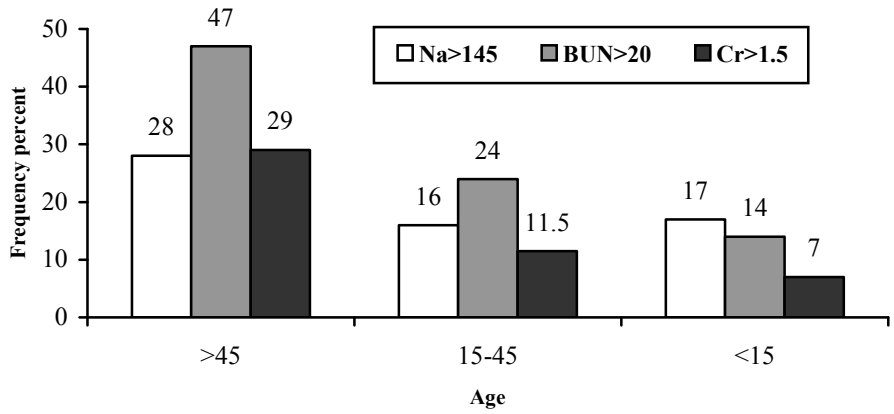

Fig. 5. Frequency Distribution of different types of electrolyte disorders according to the age groups of (ICU patients) (p<0.05)**.**

The highest rate of hypernatremia incidence was seen with neurology patients (50%) and such a disorder was seen in 12% of the surgical patients. Hyponatremia had its highest rate among urology patients (100%) and patients having had surgery (68%) ranked 3rd in terms of prevalence of hyponatremia (Fig. 6).

Regarding the number of surgical operations, hyponatremia was the most common electrolyte disorder for the patients who had one, two three operations. The highest rate of hypernatremia (30%) belonged to these patients who had just one operation & the highest rate of hyponatremia (83%) belonged to patients who had two surgical operations. Those who had 3 operations suffered from BUN and Cr disorders more than others (p<0.05)

Considering the kind of surgical operation, 31% of patients with peritonitis suffered from hypernatremia and the lowest rate of this disorder was in gastrointestinal bleeding. Following tracheostomy, the highest rate of hyponatremia had been respectively in entrails perforation, peritonitis and elective laparotomy (p>0.05) but the other disorders had not been statistically significant.

Patients with trauma had a better condition in comparison with those without trauma. Hyperkalemia and BUN>20 for nontraumatic patients were respectively 30% and 44% and for traumatic patients were 25% and 20% (p<0.05).

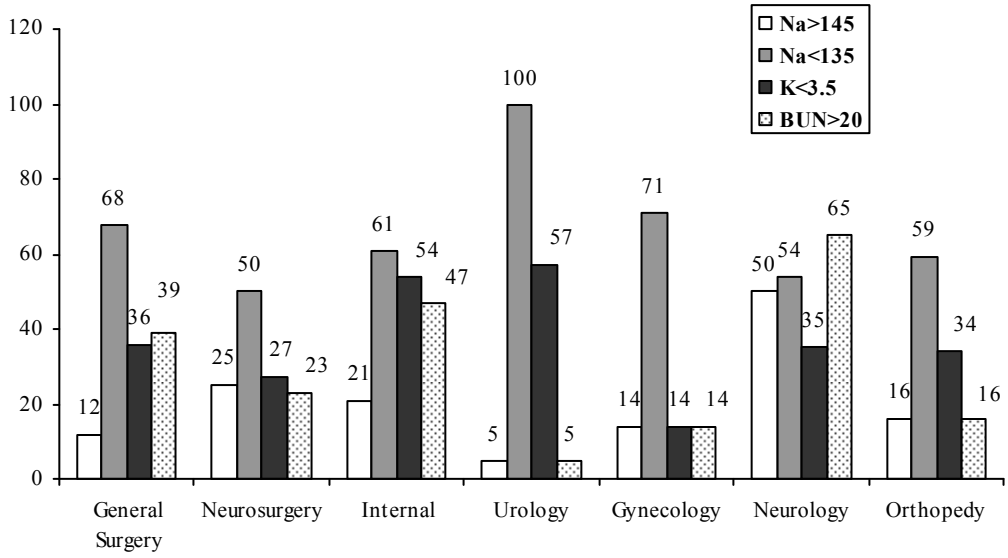

Fig. 6. Frequency distribution of Electrolyte disorders according to specialty with ICU patients (p<0.05)

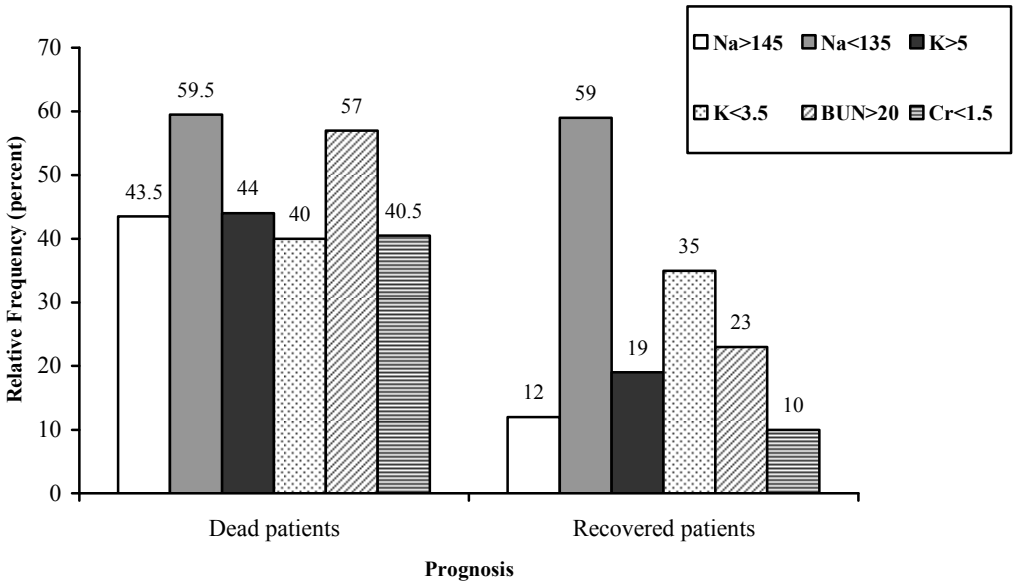

Fig. 7. Frequency Distribution of Electrolyte Disorders according to the prognosis of the ICU patients.

Increasing the period of hospitalization in ICU caused increasing disorder in sodium serum level, potassium, BUN and Creatinine which was statistically significant ($p<0.05$) and the highest disorder could be seen in sodium serum level.

In a way that hyponatremia in 47% of patients who were in ICU less than 5 days, will change to 86% of patients who were more than 10 days in ICU.

The highest rate of hypokalemia was seen in urology patients and the highest BUN disorder was observed with neurology, internal medicine and general surgery patients respectively as indicated by diagram No.6.

There were high rates of electrolyte disorders in the both dead and recovered ICU-embedded patients as well. The most prevalent disorder with both groups was hyponatremia ($p<0.05$), (Fig. 7).

DISCUSSION

Adjustment of the combination of body fluids is one of the most important aspects of patient care. The importance of this subject is doubled with the patients embedded in ICU in a way that their improper combination causes sever disorders in all systems, for example renal disorder will cause an increase in creatinine and BUN levels and accumulation of fluids, salt and nitrogen metabolites.

A study revealed that 5% of the patients embedded in surgery and internal medicine wards had had an episode of ARF and that 60% of the cases were related to traumas or surgical operations.

70% of the patients in our study were male and over half of them were more than 45 years old. Electrolyte disorders hypernatremia, urea and creatinine) had been increased with the age ($p<0.05$) and there was a direct relation between the three disorders and increase in age. Increase in age, presence of background diseases and in absorption and excretion of electrolytes would bring greater possibility of such disorders (Fig. 5)

Although majority of patients were male, hypokalemia in female was more than male (39% against 36%) and this disorder was statistically significant ($p<0.05$). 74% of the patients had surgical reasons for their hospitalization while the study carried out by Gareia and his colleagues in Madrid indicated that 64% of the patients embedded in ICU had surgical reasons. The aforesaid increase may be justified by presentation of two reasons:

1- Greater frequency of surgical emergencies resulting greater number of surgical operations.

2- Surgical patients are in aggravated general physical conditions upon admission and that is why they need greater ICU service compared to the patients admitted because of the complaints related

to internal medicine. 45% of the patients had been taken to ICU after surgical operations. This is a justification for the fact that 74% of the patients have surgical reasons of hospitalization. However, there is a necessity for the presence of scientific measures and reasons for hospitalization. The studies by Mathous and Walis had mortality rates of 15% and 17% respectively for ICU. Our study indicated a rate of 35% and this great difference is indicative of the necessity for more accurate evaluation & management of the patients and also the importance of modification of electrolyte disorders.(13,14)

The study by Polderman revealed that incidence of Hypernatremia in ICU was 14.6% However, in our research it was 23%. Absence of adjustment of body fluids and dehydration are the causes of high rate of above disorders. Electrolyte disorders & high rates of BUN and Cr were depending on the wards in which the patients had been admitted statistically significant ($p<0.05$) in a way that the highest rate of hypernatremia (50%) was observed with neurology patients that was statistically significant ($p<0.05$). No hypernatremia was observed with urology patients (Fig. 6)

Our study was like the previous studies, indicates the fact that sodium variations had been most common so there is a great requirement for the adjustment of it for the patients hospitalized in ICU (15).

The study carried out by Dautd and Hanish on 237 general surgery patients taken to ICU showed that 6.30% of the patients suffered from hyponatremia. However, our study proved over ten times of the aforesaid rate(86%). Higher rates of hyponatremia with surgical patients can be explained by the following reasons (16).

1-Release of ADH during anaesthesia and surgical stress.

2- Accumulation of fluids because of concurrent cardiac and renal failure.

3- Extreme use of fluids with improper rate of electrolytes. The highest occurrence of BUN >20, was seen with neurology and internal medicine patients (Fig. 6) that is with non-surgical patients. This is while literature says that 55% of the cases of ARF are related to traumas or surgical operations and remaining cases are related to internal medicine and /or gynecology patients. Lack of reception of proper fluids, using nephrotoxic medications and infections are the causes of ARF.

Except Hyponatremia, other electrolyte disorders are in a statistically significant relation to the prognosis of patients in a way that the dead group had greater rates of all disorders) (except hyponatremia (Fig. 7).

The study by Polderman had a mortality rate of 32% for the patients with hyponatremia embedded in ICU. However, our study had a rate of 59.5% and this is the case underlines hyponatremia as an indicator of the quality of care provided in ICU. 36.5% of the patients died. However, the rate was 25-27% in the study by Mathous and Walis. On the other hand, our study also showed that there was a direct relation between period of hospitalization in ICU and electrolyte disorders and mortality, whereas there is a direct relation between types of disease, severity of disease and duration of hospitalization, then a greater care should be given to such patients in order to decrease the rate of mortality.

Conflict of interests

The authors declare that they have no competing interests.

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