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Effect of Acid-Base Disorders on Mortality and Level of consciousness for Patients Admitted to Intensive Care Unit: A Prospective Observational Study

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Abstract
Background: Acid-base disorders are very common in critically ill as well as contribute significantly to morbidity and mortality. **Aim:** To evaluate the effect of acid-base disorders on mortality and level of consciousness for patients admitted to ICU. **Design:** descriptive exploratory research design was utilized to conduct this study **.Setting:** This study was carried out in anesthesia intensive care units at Assiut university hospital. **Sample:** One hundred sixty adult male and female patients. **Tools:** Two tools were used in this study, the Critically Ill Patients Characteristics tool, and Acid-base parameters assessment tool. **Result:** more than one third of the patients (36.3%) **had** respiratory alkalosis and was the most common acid-base disorder observed on admission . Metabolic acidosis and respiratory acidosis was associated with higher mortality (36.4%), and (22.75). Length of ICU stay was significantly higher in non-survivors (10.23±6.91 versus 7.60±4.69, p= 0.007). Mortality was significantly higher in the GCS < 9 group with metabolic acidosis (37.5 % versus 33.3 %, p=0.033). **Conclusion:** Respiratory alkalosis was a common acid-base disorder. Acidemia whether due to metabolic or respiratory acidosis is associated with increased mortality in ICU patients. Low GCS low is associated with increased mortality especially in the patients with metabolic acidosis. **Recommendation:** Closely monitoring and early managment is important to correct acid-base imbalance to avoid poor patient outcomes.

Keywords: Acid-base disorders, Level of consciousness, Mortality & ICU

Introduction
Acid-base balance is crucial for the maintenance of homeostasis in the body and plays a critical role in protecting cellular function and tissue perfusion. Acid-base disorders are commonly seen in critically ill patients. The presence of these disorders typically reflects the seriousness of the underlying disease and is associated with poor outcomes **(Wang et al., 2019)**.

The normal function of nearly all physiological processes in the body depends on the maintenance of appropriate acid-base balance. When pH deviates from its normal range, pH-dependent enzymes and membrane transport proteins may not work properly, and metabolic pathways can be negatively affected **(Quade et al., 2021).**

A patient is considered to have acidemia when arterial pH is less than 7.35 and alkalemia when arterial pH is above 7.45. Acute changes in blood pH induce regulatory effects on protein and enzyme structure and function. **(Gilbert &Weiner, 2018).**

Acidosis alters ion channel function, neuronal excitability with reduced activity, cardiac arrhythmias, and decreased cardiac contractility, which together with vascular relaxation can cause hypotension. Acidosis impacts metabolism by inducing insulin resistance, it inhibits glycolysis and induces resistance to catecholamines. Respiratory acidosis can have several effects on CNS, including changes in cerebral blood flow, changes in neuronal function, and changes in consciousness. On the other hand, hypocapnia promotes cerebral vasoconstriction and decreases intracranial pressure. Severe hypercapnia can cause loss of consciousness (hypercapnic narcosis) triggered from a $PaCO_2$ greater than 90–120 mm Hg. **Kraut & Madias, (2017) ,Garibay et al.,(2019) &Figueiredo et al.,(2021).**

Alkalotic states present neurologically with alterations in the level of consciousness which may include epileptic activity and can rapidly progress to coma if the underlying disorder is left unchecked. Tachypnea-associated respiratory alkalosis tends to cause lightheadedness, syncope, or seizures from reduced cerebral blood flow but also peripheral symptoms such as acral and circumoral paresthesia and muscle cramps, with hyperreflexia and sometimes Chvostek's sign on examination **(Espay, 2014 & Wagner et al., 2019).**

Nurses are often the first member of the health care team to see arterial blood gas results and are playing a bigger role in the realm of blood gas analysis within the work area. Most nursing management is directed at the disease process that disrupts the acid-base balance. In general, collaborative interventions to manage acid-base imbalances caused by an underlying respiratory condition include respiratory support; likewise, collaborative interventions to manage acid-base imbalances caused by an underlying metabolic condition usually include fluid and electrolyte support **(Giddens, 2019)**.

Significance of the study

Acid-base disorders frequently accompany critical illness. Disorders of acid-base balance can create complications in many disease states and occasionally the abnormality may be so severe as to become a life-threatening risk factor. These disorders, if not early detected and managed, may lead to several complications and may be unable to restore normal health. It should be noted that any acid-base disorder is associated with high morbidity and mortality in critically ill patients.

This study has been undertaken to describe the most commonly encountered acid-base disorders and their significant effect on the patients' morbidity, level of consciousness and mortality during hospitalization and across different categories of ICUs. Nurses should be aware of these clinically important disturbances caused by different clinical scenarios and their underlying pathophysiological mechanisms involved for their appropriate management.

Aims of the study:

To evaluate the effect of acid-base disorders on mortality and level of consciousness for patients admitted to ICU.

Research question:

What is the effect of acid-base disorders on mortality and level of consciousness for patients admitted to ICU?

Patients and Methods

Research design:

descriptive exploratory research design was utilized to conduct the aim of this study

Setting:

The study was carried out in (anesthesia intensive care units) the Trauma Intensive Care Unit (6 beds), general Intensive Care Unit (14 beds), and Critical Care Unit (14 beds) at Assuit University Hospital.

Sample

Purposive sample of all available adult male and female critically ill patients ,admitted to the places mentioned above of ICUs who were one hundred sixty ,between February 2019 and January 2020.

Iclusion criteria:

1. Patients aged between 18 and 60 years old
2. Both sexes
3. Patients newly admitted to the ICU during the study period not exceeding 24 hours were included in the study.

Exclusion criteria:

1. Patients who had a history of COPD.
2. Patients who had head trauma.

Tools of the study:

Two tools were used in this study developed by the researcher based on reviewing the relevant literature.

Tool one: Critically Ill Patients Characteristics.

The researcher developed this tool after reviewing the relevant national and international literature **(Amalraj et al., 2017), & (Na et al., 2018);** to assess the patient's demographic data, and health-relevant data, it comprised of the following parts**.**

Part I- Personal and clinical data:

Included patient's sex, age, reason of ICU admission, type of admission, unit of admission, date of admission, date of discharge length of ICU stay, discharge status,

Part II: Vital signs and Hemodynamic parameter Assessment sheet:

Vital signs included temperature, heart rate, respiratory rate, blood pressure, mean arterial blood pressure, peripheral capillary oxygen saturation, and central venous pressure. The vital signs measurement adopted in this thesis are based on the current evidence-based literature **(Pinsky et al., 2019), and (Leenen et al., 2020).**

Part III: level of consciousness: Glasgow Coma Scale that was adopted from (**Petridou, & Antonopoulos, 2017)** it used to give a reliable, objective way of recording the conscious level of a person for initial as well as subsequent assessment. It classified as:

- Severe, with GCS ≤ 8
- Moderate, GCS 9 – 12
- Mild GCS ≥ 13

Reliability of Glasgow Coma Scale (GCS) was adopted from (**Reith, et al 2015).** As he cleared that GCS was highly reliable (Cronbach's alpha values were reported in eleven studies, of the six values derived from good quality studies, 100 % are over 0.80).

Part IV: APACHE II score (Acute physiology and chronic health evaluation II).

The APACHE II is still commonly used as an index of illness severity in critically ill patients admitted to ICU and has been validated in many research and clinical audit purposes. APACHE II is the severity of the disease classification system. It uses a point score based upon values of 12 routine physiologic measurements taken either upon ICU admission or within 24 hrs. of entry **(Knaus et al., 1985).** The APACHE II scoring system can be utilized to predict the mortality rate and discriminate the life survival of the patients in the Intensive Care Unit. The APACHE II variables will be analyzed with the multiple logistical regression model. The scoring result will be used to predict the patient's mortality rate as shown in the table below **(Hall et al., 2015), (Venkataraman et al., 2018) & (Pujiastuti et al., 2020).**

APACHE II score interpretation	
Apache II score	**Mortality rate (%)**
0 – 4	4
5 – 9	8
10 – 14	15
15 – 19	25
20 – 24	40
25 – 29	55
30 – 34	75
>34	85

APACHE II score interpretation Adopted from (Pujiastuti et al., 2020).

Tool two: Acid-base parameters assessment tool.

The researcher developed this tool after reviewing the relevant national and international literature **(Sackner, 2018), & (Kraut & Madias, 2018)**; to meet the need for the acid-base evaluation proposed. Acid-base parameters were calculated on arterial blood gases results. Analysis of the ABG included pH values, the partial pressure of arterial carbon dioxide (PaCO2), the partial pressure of the arterial oxygen (PaO2), bicarbonate (HCO3), base excess (BE**Ecf)**, Oxygen Saturation (SaO2), and lactate.

Methods

Data collection

- Firstly, the researchers reviewed the national and international related literature related to the topic of the study. This was using textbooks, scientific journals and internet search. This assisted in the preparation of the study tools and in the write-up of the literature review then the Study tools were developed by the researcher.
- Content validity: the tools were tested for content-related validity by a jury of 5 specialists in the field of critical care nursing and critical care medicine from Assiut university; then, the tools were designed in their final format.
- A pilot study was conducted on 10% (16 patients) of the sample in the selected setting to evaluate the applicability and availability of the tools. Also, to estimate the time needed to answer the study tools, then it was modified according to the result of the pilot study.
- **Reliability** of the adapted tools had been done after reviewing literature for tool one: "patient's assessment tool," tool two: "Acid-base parameters assessment tool," by using Cronbach's alpha internal consistency coefficient (r= 0.751, and 0.748, respectively) which its internal consistency "acceptable."

Ethical considerations:

An approval was obtained from the local ethical committee and the study followed the common ethical principles in clinical research.

Protection of human rights: informed consent was obtained from each patient or from the responsible person for the unconscious patient. The researcher emphasized that the patient is voluntary and the confidentiality and anonymity of the patients were assured through coding the data. Patient was assured that he can withdraw from the study at any time without any rational

- Data were collected from adult critically ill patients managed in intensive care units at Assiut university hospital between February 2019 and January 2020.
- Once the permission was granted the patients who have been admitted to each unit, and who met the criteria were obtained from the responsible nurse in each unit. Demographic data (age and sex) were recorded. Clinical data including, causes of ICU admission, type of admission, from the patient's sheet using tool 1 (part I), Classical vital signs and hemodynamic parameters were closely monitored and recorded.
- Multiple scoring systems including the Glasgow coma scale (GCS) and acute physiology and chronic health examination (APACHE) II scores have been used for the early prediction of severity of patients with acid-base disorders. Both GCS and APACHE II scoring systems are widely used in the evaluation of intensive care patients GCS for getting information about the level of consciousness and APACHE II for systemic evaluation based on physiological variables.
- The Glasgow Coma Scale was classified into two categories : less than 9 and more than or equal 9 (GCS < 9 and GCS ≥ 9) and this factor was studied to find out the effect level of conscious on patient outcomes with acid -base disorder.
- APACHE II score was calculated based on the worst values recorded during the first 24 h of admission. The online APACHE II Calculator was used to calculate the corresponding score for each patient. The variables were analyzed with the multiple logistical regression model. The scoring result used to predict the patient's mortality rate **(Pujiastuti et al., 2020).**
- The observed pH determined whether or not the primary disorders.
- Acid-Base Disorder (ABD) was compensated (by comparison with the normal range of pH: 7.35-

7.45). The direction of change of pH from mean denoted the primary disorder. If pH and $paCO_2$ moved opposite and bicarbonate and $paCO_2$ moved in the same direction, the result was primary respiratory disorder with a compensatory metabolic response. If pH, pCO_2, and bicarbonate moved in the same direction, the result was a primary metabolic disorder with a compensatory respiratory response. If pCO_2 and bicarbonate moved opposite with pH at mean, within range, or abnormal, the disorder was mixed. The direction of the pH shift from the mean indicated the stronger component.

- Acid -base imbalance and degree of compensation were done according to the following equation:

Simple acid-base disorder:

- Metabolic Acidosis: Expected $PCO_2 = 1.5 \times (HCO_3^- + 8 \pm 2)$.
- Metabolic Alkalosis: Expected $PCO_2 = 0.9 \times (HCO_3^- + 16 \pm 2)$.
- If measured PCO_2 is less than expected PCO_2, then respiratory alkalosis is present. If measured PCO_2 is greater than expected PCO_2, then respiratory acidosis is present.
- Respiratory Acidosis: Plasma HCO_3 will increase by 1 mEq / L for each 10 mm Hg increase PCO_2 in acute cases and 4 mEq / L in a chronic case
- Respiratory Alkalosis: Plasma HCO_3 will increase by 2 mEq / L for each 10 mm Hg decrease PCO_2 in acute cases and 5 mEq / L in a chronic case**(Ghatak et al., 2016).**.

The mixed acid-base disorders exists if:

- pCO_2 is abnormal and pH has not changed as expected or normal.
- pH is abnormal and pCO_2 has not changed as expected or normal **(Ghatak et al., 2016).**
- The researcher was assessed critically ill patients suffering from acid-base disorders using previously mentioned tools
- During hospitalization or at discharge, other clinical data at admission were collected from a patient's medical admission sheet. Daily routine follows up included laboratory tests, as well as physical examination, was done during their ICU stay. Finally, the researcher assessed the studied patients in the previously mentioned setting for outcome measures, including the length of patients' stays (LOS) in ICU and clinical condition at the time of discharge sorted out by using the following variables, survivors namely, (discharge to home, discharges against medical advice, transferred to another unit or transferred to another hospital), and non-survivors (death)

Statistical analysis

The statistical analysis was carried out using SPSS version 23. The collected data were tabulated and analyzed by using frequency distribution, the percentage for qualitative variables. Mean and standard deviation for quantitative variables. The chi-square test and ANOVA test are used to determine significance for the non-parametric variable. Level of significance that acid-base derangements are associated with GCS score and APACHE II SCORE, determined using P-values. $P\text{-value} < 0.05$ was considered indicating statistical significance.

Results

Table (1): Number and percentage distribution regarding baseline personal and Clinical data of the studied patients (n =160)

Variables	No	%
Age	42.39 ± 13.39	
Sex		
Male	100	62.5
Female	60	37.5
Reasons of ICU admission		
Respiratory disorders	32	20.0
Shock	28	17.5
Trauma	26	16.3
Sepsis/ infection	6	3.8
Post-operative	34	21.3
Post-cardiac arrest	26	16.3
Renal disorders	8	5.0
Unit of admission		
Trauma ICU	22	13.8
General ICU	82	51.3
Critical care unit	56	35
GCS score on admission	9.20 ± 4.42	
APACHE II SCORE	17.98 ±7.85	
Predicted Mortality rate	30.48 ± 19.18	
Length of ICU stay	9.35 ± 7.57	
Discharges status		
Transferred to another unit	112	72.5
Patient died (death)	44	27.5

Chi-square test: ICU: intensive care unit,
APACHE: Acute physiology and chronic health evaluation,
GCS: Glasgow Coma Scale.

Table (2): Mean ± SD distribution of the studied patients in relation to vital signs & hemodynamics parameters and comparison between survivors and non-survivors on 1st day of admission (n =160).

Variables	All patients (n=160)	Survivors (n=116)	Non-survivors (n=44)	P-value
	Mean ± SD	Mean ± SD	Mean ± SD	
Temperature	37.31±0.91	37.22±0.87	37.55±0.95	0.039*
Heart rate	110.25±21.34	108.91±22.06	113.77±19.11	0.199
Respiratory rate	23.53±7.6	23.59±8.08	23.36±6.26	0.869
MAP	80.08±16.15	82.41±14.6	73.91±18.44	0.003**
PACO2	93.84±6.09	93.31±6.79	95.23±3.37	0.076
CVP	8.16±4.75	8.14±4.88	8.23±4.44	0.916

Independent T-test quantitative data between the two groups
**Significant level at P-value < 0.05,*
***Significant level at P-value < 0.01*
MAP: Mean Arterial Pressure,
SPO2: Oxygen Saturation,
CVP: Central Venous Pressure.

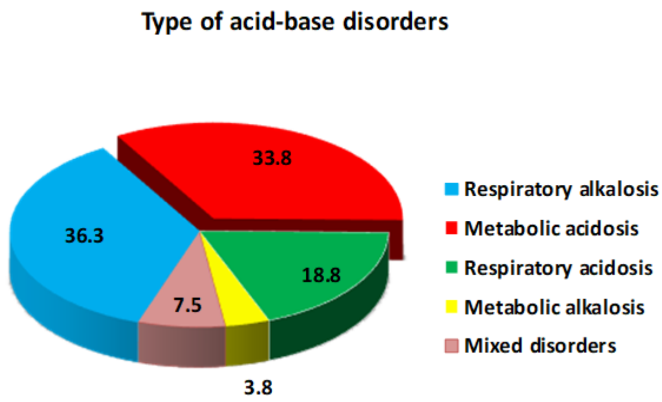

Figure (1): Frequency and percentages distribution of acid base disorders (n =160).

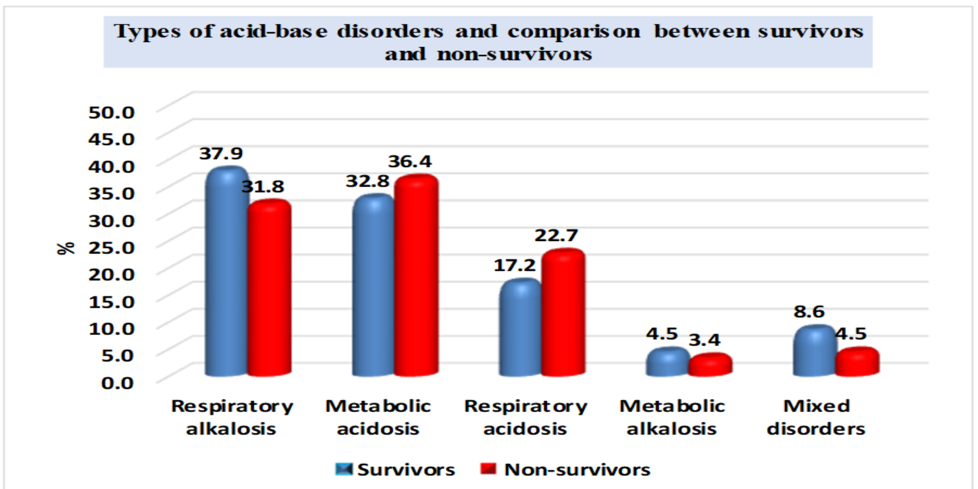

Figure (2): Comparisons between survivors and non-survivors in relation to acid-base disorders. (n =160).

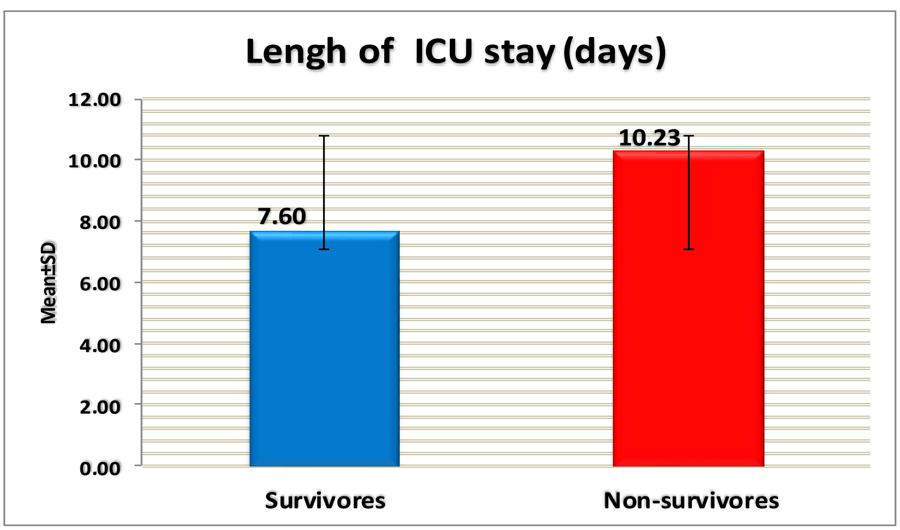

Figure (3): Show the length of ICU stay in comparison between survivors and non-survivors patients among studied group

Table (3): Comparison between the studied patients on basis of GCS in relation parameters of arterial blood gases (n=160)

Arterial blood gases	All patients (n=160)	GCS < 9 (n=93)	GCS ≥ 9 (n=67)	P-value
	Mean ± SD	Mean ± SD	Mean ± SD	
pH	7.34±0.14	7.31±0.14	7.38±0.14	0.001**
PaCO2	37.76±16.18	42.39±17.36	31.34±11.78	<0.001**
PaO2	100.11±56.95	102.26±65.79	97.13±42	0.576
HCO3	20.51±7.7	21.06±7.45	19.75±8.02	0.288
Base Excess	-5.35±8.45	-5.31±8.01	-5.4±9.1	0.952
SaO2	89.51±16.5	86.76±18.34	93.32±12.71	0.013*
Lactate	3.55±3.66	4.15±4.01	2.72±2.93	0.014*

Independent T-test quantitative data between the two groups
**Significant level at P-value < 0.05,* ***Significant level at P-value < 0.01*
PaCo2: partial pressure of carbon dioxide, PaO2: partial pressure of oxygen,
HCO3: Bicarbonate, BE: Base excess, FiO2: Fraction of inspired oxygen, SaO2: Oxygen saturation

Table (4): Relation between the acid-base disorders and level of consciousness (GCS) among studied patients

Acid-base disorders	GCS < 9 (n=93)						P. Value	GCS ≥ 9 (n=67)						P. value
	Survivors		Non-survivors		Total			Survivors		Non-survivors		Total		
	No	%	No	%	No	%		No	%	No	%	No	%	
Metabolic acidosis	21	34.4	12	37.5	33	35.5	0.033*	17	30.9	4	33.3	21	31.3	0.007*
Metabolic alkalosis	0	0.0	2	6.3	2	2.2		4	7.3	0	0.0	4	6.0	
Respiratory acidosis	18	29.5	8	25.0	26	28.0		2	3.6	2	16.7	4	6.0	
Respiratory alkalosis	12	19.7	10	31.3	22	23.7		32	58.2	4	33.3	36	53.7	
Mixed disorders	10	16.4	0	0.0	10	10.8		0	0.0	2	16.7	2	3.0	

Table (5): APACHE II and predicted mortality rate according to outcome in relation to acid-base disorders (n=160).

Acid-base disorders	APACHE SCORE			Predicted mortality rate		
	Survivors	Non- survivors	P. value	Survivors	Non-survivors	P. value
	Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD	
Metabolic acidosis	18.52 ± 7.17	26.25 ± 8.83	0.001**	32.21 ±17.65	50.00 ±21.13	0.002**
Metabolic alkalosis	13.50 ± 1.73	19.00 ± .00	0.013*	20.00± 5.77	25.00 ±0.00	0.312
Respiratory acidosis	14.70 ± 5.25	27.20 ± 4.39	<0.001**	21.40 ±10.06	53.00 ±13.58	<0.001**
Respiratory alkalosis	12.31 ± 5.05	22.14 ± 6.62	<0.001**	16.90 ±10.86	40.71 ±15.29	<0.001**
Mixed disorders	20.00 ± 6.56	21.00 ± .00	0.840	37.00± 23.23	40.00 ± 0.00	0.864

Table (1): Demonstrated the characteristics of the 160 studied patients with a mean age of (42.39 ± 13.39), while almost two-thirds of studied patients were male (62.5 %). The most common reasons for ICU admission were post-operative and respiratory disorders (21.3 %), and (20.0 %) respectively, and half of the patients admitted to general ICU (51.3%). In relation to the GCS, APACHE, and predicted mortality rate on admission, the means were (9.20 ± 4.42), (17.98 ±7.85), and (30.48 ± 19.18), respectively. As regards to the mean duration of ICU, stay was (9.35 ± 7.57). Concerning discharge status, more than two-thirds of patients (72.5%) improved, and transferred to another unit, while more than one-fourth of patients (27.5 %) died during their ICU stay.

Table (2): Illustrates the vital signs and hemodynamic parameters for the studied patients and comparison between survivors and non-survivors. The temperature was statistically significant differences increased in non-survivors as compared to survivors admission (37.55±0.95 versus 37.22±0.87, p = 0.039). Regarding to mean arterial pressure there were statistically significant differences between survivors and non-survivors increased in survived patients (82.41±14.6versus 73.91±18.44, p = 0.003).

Figure (1): This figure shows acid-base disorders distribution among studied patients, respiratory alkalosis was the most common acid-base disorder observed on admission (36.3%), while metabolic acidosis was the second acid-base disorder followed by respiratory acidosis (33.8%), and (18.8%), respectively. Mixed acid-base disorders and metabolic alkalosis were the least observed of acid-base disorders (7.5%), and (3.8%), respectively.

Figure (2): This figure shows acid-base disorders distribution among studied patients in comparison between survivors and non-survivors. Respiratory alkalosis was more common in survived patients compared to non-survivors (37.9% versus 31.8% p = 0.473), on the contrary, metabolic acidosis and respiratory acidosis, increased in non-survived patients compared to survivors (36.4% versus 32.8%), and (22.7% versus 17.2%).

Figure (3): Show the comparison between survivors and non-survivors in relation to the length of ICU. It represent that the mean length of ICU stay was significantly higher in non-survived patients compared to survivors with statistically significant differences (10.23±6.91 versus 7.60±4.69, p= 0.007)

Table (3): Show statistically significant differences between patients GCS and their arterial blood gases mean (pH, PaCO2, SaO2, and Lactate,). PH, PaCO2, and SaO2 significantly decreased (p=0.001, <0.001, and 0.013 respectively) and Lactate significantly increased (0.014) when GCS was low.

Table (4): The most common acid- base disorder for patients whose GCS below 9 was metabolic acidosis. Mortality was also significantly higher in the GCS < 9 group with metabolic acidosis (37.5 % versus 33.3 %, p=0.033) compared to the patients with GCS ≥ 9.

Table (5): This table shows that the APACHE II score increased in the non-survivor compared to survivors in metabolic acidosis, metabolic alkalosis, respiratory acidosis, and respiratory alkalosis with statistically significant differences (P= 0.001), (P =0.013), (p= <0.001), and (p= <0.001), respectively. Additionally, this table also shows that there was a statistically significant difference increased in the non-survivors compared to survivors regarding predicted mortality rate in metabolic acidosis, respiratory acidosis, and respiratory alkalosis with statistically significant differences (P= 0.002), (p= <0.001), and (p= <0.001), respectively.

Discussion

Acid-base disorders are a major source of morbidity and mortality among patients in the intensive care unit (ICU). Acid-base disorders may be so severe as to become a life-threatening risk factor **Brent, (2017) &Yusuf, (2020)**.

Therefore, in this article, the present knowledge about the effects of acid-base disorders on the level of consciousness, and mortality among critically ill patients admitted to ICU across different categories of ICUs in Assuit university hospital on the first day of admission.

The present study was conducted on one hundred sixty patients with acid-base disorders who were admitted to intensive care units. The mean age of the studied patients was around forty year, which was similarly demonstrated by **Heida et al.,(2021),** who reported that mean ages were (42.0± 8.30). Almost two-thirds of patients were male, which was similarly demonstrated by **Shreewastav et al., (2019),** who concluded that male suffered more from acid-base disorders than female, this finding of the present study could be attributed to the possible explanation that the percentage of males being admitted to the hospital is more than female patients may be because males in upper Egypt are more common to work in dangerous and difficult jobs with increased risk of trauma and its consequences. The categories for the reason of ICU admission were classified into respiratory disorders, Trauma, Sepsis, postoperative, Post cardiac arrest. Post-operative and respiratory disorders were the predominant reason for ICU admission.

In terms of ICU outcomes, the present study showed that the mean length of stay (LOS) at the ICU was nearly equal nine days, which is similar to **Toptas et al., (2018)**.

In comparison between survivors and non-survivors, the present study revealed that the mean length of ICU stay was statistically significance increased among non-survived patients. These findings were consistent with **Moitra et al., (2016)**, who concluded that mortality rates increased with increased length of stay. Concerning discharge status, more than two-thirds of patients improved and transferred to other units in stable condition, A quarter of the patients died during their ICU stay, which is in line with a similar study conducted by **Zampieri et al., (2014),** who reported that about one-fourth of patients died in ICU.

Regarding to Glasgow Coma Scale (GCS), the present study show that the mean GCS on admission was (9.20 ± 4.42). Additionally, more than half of patient had low GCS ≥ 9. This result is in contrast with **Buhary et al., (2017)**. Moreover, **(Hosseini and Ramazani, 2015)** & **(Goga et al., 2021), have** been cited that lower GCS scores were significantly associated with higher mortality or poor prognosis.

In the category of acid-base disorders, the current study shows that respiratory alkalosis is, overall, the most common acid-base disorder in ICU patients, more than one-third of patients presented in critical condition had respiratory alkalosis. The local and international findings are in keeping with current results of a high incidence of respiratory alkalosis **Praveen et al., (2014), Musleh et al., (2020) &**

Shreewastav et al., (2019). The reason that most acid-base disorders were respiratory alkalosis could be explained by multiple pathophysiological mechanisms that can stimulate respiration, as well as hypocapnia is significantly correlated with adverse outcomes in a variety of critical illnesses. Respiratory compensatory mechanisms could also explain the commonest type of respiratory alkalosis. Some iatrogenic factors should be considered in addition to body compensatory mechanisms. **(Song et al., 2012) & (Ronco et al., 2019).**

On the contrary **Reddi, (2020)**, & **Fujii et al., (2021)** who stated that metabolic acidosis was the predominant disorder in critically ill patients. Therefore, it is difficult to predict which acid-base disorder predominates in critically ill patients. Additionally, metabolic acidosis was the second most commonly encountered acid-base disorder in this observational study followed by respiratory acidosis, while metabolic alkalosis and mixed acid-base disorders were the least common disorders, respectively.

Concerning the magnitude of acid-base disorders, the present study demonstrated significantly increased mortality rates were observed in patients with primary metabolic acidosis and respiratory acidosis, respectively, although the majority of patients on admission had respiratory alkalosis. The current study is supported by **Samanta et al., (2018)**, who concluded that metabolic acidosis is associated with higher mortality rates in critically ill and injured patients. **(Goga et al., 2021),** also showed an increase in ICU mortality was noted in patients presenting with metabolic acidosis**.** In addition, **de Garibay et al., (2019),** stated that acidosis leads to a myriad of physiologic effects that can be deleterious and thus contribute to morbidity and mortality in patients.

A similar study by **Tiruvoipati et al., (2017)**, who concluded hypercapnic acidosis during the first 24 hours of intensive care admission is more strongly associated with increased hospital mortality than compensated hypercapnia or normocapnia. Indeed, acidemia whether due to metabolic or respiratory acidosis is associated with increased morbidity and mortality in ICU patients .However Musleh ***et al.*, (2020),** found that respiratory alkalosis was the most common acid-base disorder, however, associated with a low mortality rate.

Additional analyses were performed to compare the impact of acid-base disorders on a low level of consciousness. The present findings show that the most common acid- base disorder for patients whose GCS below 9 was metabolic acidosis. Mortality was also significantly higher in the GCS < 9 group with metabolic acidosis (37.5 % versus 33.3 %, $p=0.033$) compared to the patients with GCS ≥ 9.

The present study is supported by **Buhary et al., (2017),** who found that metabolic acidosis was the most prevalent disorder among the patients with low GCS with statistically significantly higher mortality

Terzioglu et al., (2015), mentioned that APACHE II scores, have been used in this study for the early prediction of severity of patients with acid-base disorders, as well as provides an overview of the patient's condition and predict mortality rate in ICU.

The present study showed that the APACHE II score was significantly increased in non-survivors when compared with survivors, in those patients who had metabolic acidosis, metabolic alkalosis, respiratory acidosis, and respiratory alkalosis. According to interpretation and analysis of the variables of the APACHE II score, the predicted mortality rate was also statistically significantly increased in non-survivors compared to survivors in those patients with metabolic acidosis, respiratory acidosis, and respiratory alkalosis. The results of this study are consistent with the findings of **Musleh et al., (2020)** who have recently reported that the mean score of APACHE II was significantly higher in non-survivors and correlated with the severity of the respiratory acid-base disorder (acidosis & alkalosis) and mortality. **(Amalraj et al., (2017)** conducted a prospective study found that the APACHE II and estimated mortality rate were higher in non-survived patients with statistically significant differences. Another study by **(Hosseini & Ramazani, 2015)**, have been cited that higher APACHE II GCS scores were significantly associated with higher mortality or poor prognosis.

Finally critical care nurses play a major role in close monitoring and early detection of acid -base disorder. Nurses are with patients at time of admission and take care of patients throughout their hospital stay. They are in the ideal position to determine different methodologies used to prevent this potentially life-threatening condition.

Conclusions:

Based on the current findings we concluded that the respiratory alkalosis is a common acid-base disorders. Acidemia whether due to metabolic or respiratory acidosis is associated with increased mortality in ICU patients. Low GCS is associated with increased mortality in the intensive care unit (ICU) especially in patients with metabolic acidosis.

Recommendation:

Closely monitoring and early managment is important to correct acid-base imbalance to avoid poor patient outcomes and helps in recognizing patients who need special intensive care.

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