The Effect of Normovolemic versus Decreasing Maintenance Fluids on Critically Ill Multiple Trauma Patient's Clinical Outcomes

Sheren M. Diab [(1)], Sohair M. Weheda [(2)], Nagwa Abbas [(3)], Esraa H. Nassar [(4)], Safaa E Sayed [(5)]

1,3 Lecturer of Critical Care and Emergency Nursing, Faculty of Nursing, Tanta University, Egypt
2 Professor of Medical Surgical Nursing, Faculty of Nursing, Alexandria University, Egypt
4 Lecturer of Emergency Medicine & Traumatology, Faculty of Medicine, Tanta University, Egypt
5 Assist prof of Critical Care and Emergency Nursing, Faculty of Nursing, Tanta University, Egypt.

drsherendiab @gmail.com

Abstract

Background: Major trauma is a life-threatening emergency condition that requires immediate intervention. Resuscitation of low volume fluid or decreasing maintenance fluids maintains tissue perfusion and decreases the negative consequences of early vigorous resuscitation. **Aim** of the study was to evaluate the effect of normovolemic versus decreasing maintenance fluids on ICU multiple trauma patient's clinical outcomes. **Method**: A quasi experimental comparative research design was utilized in this study, purposive sample of 40 adult critically ill patients with multiple traumas would be enrolled sequentially into two groups, each group consists of (20) patients. This study was carried out in trauma intensive care unit at Emergency Hospital affiliated to Tanta University Hospitals, Egypt .Three tools were used to conduct the study. **Tool I:** social-demographic and clinical data sheet, **Tool II**: injury severity score, **Tool III:** patients' outcome sheet. **Results:** There were sixty percent of patients in control group had age more than 30 years compared to 45% of patients in the study group. The male patient represents the highest percentage in this both groups. It was observed 90.0% of the study groups had injury severity score between (17-25) score. While 80.0% of the control groups has > 25 injury severity score level. a significant improvement regarding mean scores of pulse rate, respiratory rate, and Fio2 on discharge. The mean score of sodium, urea and creatinine was improved significantly among study groups compared with control groups on discharge where P= 0.022 and 0.00 respectively. Seventy percent of patients in control group had long duration of stay in ICU more than 20 days compared to (55.0%) of patients in the study group. **Conclusion**: It can be concluded that trauma patients in the ICU who received decreasing maintenance fluids at 30 mL/h in normotensive trauma patients had improved physiological parameters, decreased ICU stay and days on ventilator. **Recommendations:** Emergency hospital should include decreasing maintenance fluids for trauma patients admitted to the ICU if not contraindicated. Nursing and medical staff should be informed with the updated protocols of fluid resuscitation therapy and its application in clinical practice for emergency and critically ill patients.

Key Wards: Clinical Outcomes**,** normovolemic fluids, Decreasing Maintenance Fluids**,** Critically Ill Multiple Trauma Patients

Introduction

A traumatic injury is encountered in ten percent of the global burden of disease. Uncontrolled post-traumatic hemorrhage is the major cause of death among injured patients and nearly 30% of deaths occur due to traumatic bleeding **(Chalya et al., 2011) and Chatrath et al., 2015).**

The using of fluid resuscitation in traumatized patients restores the blood loss, improve tissue perfusion, and decrease mortality rate. Large fluid volumes which are used for trauma patients may result in adverse effects such as high mortality, morbidity rate and long duration of hospital stay. However, decreasing maintenance fluids or low fluid volume administration regain tissue perfusion and decreases the adverse effects of high fluid volume resuscitation. Intravenous fluids resuscitation are lifesaving for hypovolemic shock; however, it sometimes may cause bleeding **(Strehlow, 2010; Kudo et al., 2017; Hahn, 2013; El-Gamasy et al., (2019).**

Large fluid volume resuscitation decreased blood viscosity, increased risk for hemorrhage, gastrointestinal, cardiac complications, acute respiratory distress syndrome, and multi-organ failure. Long ventilator days, mortality rate and hospital stay may be associated with higher volume fluid **(Spahn et al., 2019) and Ablove et al., 2016).**

A previous study suggested that higher rates of fluid resuscitation increasing risk of hepatocellular injury while slower rates of fluid resuscitation is associated with improvements of cell mediated immunity. The administration of hypotensive resuscitation or decreasing maintenance fluid is another method to the early fluid volume resuscitation. It includes using of low flow fluid rate that maintain tissue perfusion in trauma patients. It increases systemic blood pressure without reaching above norm tension **(Chatrath et al., 2015 and Albreiki et al., 2018).**

The standard fluid administration for traumatized patient includes using of normal saline with lactated ringer solution for hypovolemic shock, but it may be associated with further complications such as acidosis if given in large volumes**Cherkas .,(2011) and Bouglé et al (2013).**

The aim of administering intravenous fluids is to restore effective circulating volume in trauma care. Clinical markers which are used to monitor adequate intravascular volume status are physiological parameters, renal function test, and central venous pressure. Lastly, large volume fluid resuscitation may have been associated with increased mortality, systemic complication and increasing intensive care length of stay than decreasing maintenance fluids **Boldt and Ince, (2010) and Cherkas, (2011).** Therefore, the present study aimed to evaluate the effect of normovolemic versus decreasing maintenance fluids on critically ill multiple trauma patient's clinical outcomes.

Significance of the study

Worldwide, trauma is a leading cause of death, and blood loss result in almost 30% of trauma deaths. Globally, trauma cause around 10% of total deaths and 15% of disability. The deaths occur due to faulty decision and inappropriate care. It was estimated that 10-20% of these deaths are preventable with better control of bleeding. Concerns over the use of vigorous crystalloid resuscitation in traumatic hemorrhagic shock have been changed. Recent research has shown that restoring volume before complete hemostasis in some forms of trauma can result in increased blood loss, hypothermia, and dilutional coagulopathy **(Gururaj et al., 2008) and Chatrath et al., 2015).**

So, the effect of the fluid volume infused may be more important than the type selected. a dilutional coagulopathy and extensive tissue edema could be a result of increased fluid. This influences negatively organ function leading to worsen renal, hepatic and cardiac function as well as increasing the occurrence of pulmonary edema that worsens ventilation–perfusion mismatch. Also, abdominal compartment syndrome may progress to a polycompartment syndrome **Malbrain et al., (2014), Strunden et al., (2011) and Wise et al., (2017).**

Moreover, Resuscitation injury is important parameter to understand. Capillary permeability increases after major trauma, resulting in intravascular fluid loss into the interstitial space. Furthermore, acidosis caused by major trauma impairs cardiac function. Using a large amount of crystalloids to treat these patients may cause cellular swelling and dysfunction. Dilutional coagulopathy, clot destruction due to high blood flow, decreased blood viscosity, and interstitial edema are all caused by fluid. Acute respiratory distress syndrome and multi-organ failure are more likely to occur. Resuscitation with a large amount of crystalloid causes gastrointestinal and cardiac complications. Increased extremity compartment pressures and coagulation disturbances. Large volume fluid resuscitation has been shown to cause secondary abdominal compartment syndrome. It affects patients who have no underlying abdominal injury and lead to mortality rate of more than 50%, **Ablove et al (2006) and Balogh et al (2003).**

Consequently, the emerging concept of decreased fluid volume resuscitation which knew as permissive hypotension minimize the harmful effects of early vigorous resuscitation while maintaining a lower-than-normal but sufficient level of tissue perfusion for short periods. Permissive hypotension is part of the injury prevention resuscitation technique, which aims to alleviate the events that aggravate hemorrhage. This technique included permissive hypotension, reducing of crystalloid resuscitation, control of hypothermia, prevention of acidosis, and early use of blood products to avoid coagulopathy **Chatrath et al (2015).**

Operational Definition of Clinical Outcomes: the clinical outcomes involved in this study include physiological parameters, ABG, blood chemistries, systemic complications, ICU stay & ventilator days, and mortality rate.

Aim of the Study

The aim was to assess the effect of normovolemic versus decreasing maintenance fluids on ICU multiple trauma patient's clinical outcomes.

Hypothesis

H1) Multiple trauma patients managed by decreasingmaintenance fluids will have improved physiological parameters, ABG, and blood chemistries than those undergoing normovolemic fluids.

H2) the systemic complications among patients who are managed by decreasing maintenance fluids will be lower than those in the normovolemic fluids group.

H3) patients managed by decreasing maintenance fluids will have short ICU stay & ventilator days, and low mortality rate than patients managed by normovolemic fluids.

Materials and Method

Study Design

A quasi-experimental comparative research design was utilized to determine the effect of normovolemic versus decreasing maintenance fluids on ICU multiple trauma patient's clinical outcomes.

Study Setting

This study was conducted in trauma intensive care unit at Emergency Hospital affiliated to Tanta University Hospitals, Egypt. The hospital has one floor for trauma intensive care unit which consists of 5 wards, each ward contains 6 beds (The capacity of the unit includes 30 beds). Data was gathered over a time of approximately 8 months from **June 2018** to **January 2019.**

Subjects

A purposive sample of 40 critically ill adults' patients and meeting the inclusion criteria. they would be divided into two groups; each group consists of (20) patients. The sample size estimated by Power analysis of independent t tests [One tail, Effect size = 0.55; The significance level (α) at 0.05; Power (1-β) = 0.85]

The two groups were as following:

Group (I): Was the control group received normovolemic fluids.

Group (II): Was the Study group, they would receive decreasing maintenance fluids.

The following criteria were used to choose the subjects:

- Both sexes, age ranged from 18 to 60 years
- Newly admission
- Diagnosed with multiple trauma
- Hemodynamically stable trauma patients.

Exclusion criteria were:

- The patients with unstable hemodynamic condition
- The patients had co-morbidity disease as renal/ hepatic/heart failure, malignancy and cardiogenic shock upon admission

Tools of the study

Data were collected using three tools:

Tool I: social-demographic and clinical data sheet.

It was constructed by the researchers after reviewing the relevant literatures and involved of two parts: **Mclean & Shaw (2018)**, **Barmparaset al., (2016)**

Part (a): Social-demographic data which includes patient's code, age, sex, and marital status.

Part (b): Patient medical clinical data

It was constructed after searching of the related literatures which include data such as status on discharge, types of traumas, length of stay at critical care unit and ventilator days as well as diagnosis, past medical history (such as hypertension, cardiac history, stroke, COPD, and diabetes mellitus and the monitored intake & output per day**.**

Tool II: injury severity score (ISS score)

It was formulated by **Rowell et al. (2011)** from the Abbreviated Injury Scale (AIS), and adopted by the researcher to evaluate severity of trauma. It correlates with mortality, morbidity, length of stay and other indicators of severity.

Each injury in the following six body regions is assigned an **Abbreviated Injury Scale (AIS) (Javali et al., 2019)** score according to its severity on a six-point ordinal scale: AIS 1 = Minor, AIS 2 = Moderate, AIS 3 = Serious, AIS 4= Severe, AIS 5= Critical, AIS 6 = Maximal, survivable, this includes, Head or neck injuries, Facial injuries, Chest injuries, Abdominal or pelvic contents injuries, Extremities or pelvic girdle injuries and External and other trauma injuries. Each body region's highest Abbreviated Injury Scale (AIS) score was used. Then the Injury Severity Score (ISS) was calculated by squaring and adding the score of the three most seriously injured body regions.

The Injury Severity Score (ISS) ranges from zero to seventy-five. The ISS score is automatically assigned 75 if an injury is given an Abbreviated Injury Scale (AIS) of 6 (presently defined as uncurable injury). The score is immediately set to 75 if any of the three Abbreviated Injury Scale (AIS) scores is a 6.

A major trauma is identified as the Injury Severity Score (ISS) being greater than 15 (ISS> 15). **Bolorunduro et al. (2011)** categorized and validated the Injury Severity Score (ISS) as follows ISS <9 = Mild, ISS 9 – 15 =Moderate, ISS 16–24 = serious, ISS 25-– 49= Severe, ISS 50-–74= critical and ISS 75 = maximum.

Tool III: patients' outcome sheet it was designed by the researchers after searching literature **(McLean and Shaw, (2018) and Mirbaha et al., (2016).** It consisted of three parts:

Part (a): Assessment of patient's physiological Parameters. It includes Glascow coma scale **GCS**, vital signs, Fio2, and CVP, methods of O2 therapy and the monitored intake & output per day on first day of admission and on day of discharge.

Part (b): Assessment of the laboratory investigation of patients, it includes Arterial blood gases (ABG), electrolytes, kidney function test, and blood chemistries.

Part (c): Assess the signs of systemic complications among patients. It includes crackles, tachypnea, cough, cyanosis, peripheral edema, pulmonary edema, cerebral edema, and renal failure on admission and discharge.

Method of data collection:

The study was done as following:

1- **An official hospital permission** to carry out the research was got from the responsible authority

2- Tool development:

The study conducted using four tools. Tools (I, and III) were developed by the researcher. While Tools (II) were adopted and used by researcher, this included injury severity score (ISS score).

3- Validity of the tools

The tools were tested for content validity panel experts in the field of the for revision of its content validity and clarity, and accordingly needed modifications were done. Content validity index = 97.8%.

4. Reliability of the tools.

It was estimated for the tools I, II and III using Cronbach's alpha test and was 0.886, Cronbach's Alpha for Tool I was 0.876, Tool II was 0.883. and Tool III Was 0.897.

5. A pilot study: -

It was conducted on 15% of the patients (six critically ill patients). Data obtained from pilot sample were excluded from the present study.

6. Data were gathered from June 2018 to January 2019 and include **the following three phases:** assessment, implementation and Evaluation

Assessment Phase: The researcher used tool I to document patient's socio-demographic and medical data for both groups. More over tool II was used to by the researcher to produce the injury severity score (ISS).It was estimated through Abbreviated Injury Scale (AIS) by squaring the score of the three most seriously injured body parts and then added together to calculate the Injury Severity Score (ISS) .The researcher assessed clinical outcomes for both groups on day of admission and day of discharge by tool III. The clinical outcomes were assessed through the physiological and lab investigations parameters, Glasgow coma scale (GCS), signs of systemic complications, length of ICU stay, ventilator days, and status of patient on discharge.

Implementation Phase

Normotensive trauma patients admitted to the ICU were administered maintenance crystalloid fluids at 30 mL/h (decreasing maintenance fluids group) then compared with patients who received a standard rate of crystalloids at 60 mL + 1 mL/kg over 20 kg or in general between 125 and 150 mL/h. (Normovolemic group) through the admission and discharge.

Evaluation Phase

This phase consisted of comparing the outcomes for both groups including; physiological**,** lab investigations parameters, Signs of systemic complications, length of ICU stay, ventilator days, and status of patient on dischargeusing tool I and III.

Ethical Consideration

Written consent was obtained from patients to be involved in the study after purpose clarification about the study. Confidentiality and anonymity were assured by data coding.

Statistical analysis:

The data was coded, analysed, and tabulated, and statistical analysis was performed using the SPSS software statistical computer package version 25. The mean and standard deviation (Mean, SD) of quantitative data were determined. Continuous variables were defined by mean and standard deviation, while categorical variables were represented by number and percent (N %). The Chi-square test (χ^2) and the Fisher exact test were used to compare categorical variables in qualitative results. The independent samples T-test was used to compare the means of two groups. Pearson and Spearman's correlation coefficient r were used to assess the correlation between variables. A significance was adopted at $P<0.05$ for interpretation of results of tests of significance (*). Also, a highly significance was adopted at P<0.01 for interpretation of results of tests of significance (**). **Gerstman., (2008)**

Results

Table (1): showed the Distribution of the studied patients in relation sociodemographic data. It was found that 60% of patients in normovolemic fluids group had age more than 30 years compared to 45% of patients in the decreasing maintenance fluids group, nearly two third of patients in control group (65.0%) and study group (75.0%) were male. Also, the present study showed that more than half (60%) of the control group were married, compared to 65% of decreasing maintenance fluids group.

Table (2): showed the distribution of the studied patients in relation to types of traumas and ISS level. It was revealed that, the majority (85.0%) of the control group diagnosed as traumatic brain injury compared with (80%) of patients who received decreasing maintenance fluids group. Base of skull fracture was encountered (40%) of the control groups to nothing in study group. Also, half (50.0%) of control groups had vault of skull fracture compared to (20.0%) of patients who received decreasing maintenance fluids group.

Concerning to injury severity score level on admission, it was observed 90.0% of the study groups had injury severity score between (17-25) score. While 80.0% of the control groups has > 25 injury severity score level with a significant difference among both groups with p (0.00).

Figure (1): Showed the Distribution of the studied patients in relation to their past medical history percentage. It was observed that hypertension was encountered among (55.0%) of the control group compared to (20.0%) of patient who received decreasing maintenance fluids group. furthermore (30.0%) of the normovolemic fluids group had past history of diabetes mellitus compared to (25.0%) of patients in study group.

Table (3): Represented the distribution of studied patients in relation to mean scores of physiological parameters among the studied groups on admission and discharge. It was showed that a significant improvement of mean scores of pulse rate, respiratory rate, systolic and diastolic blood pressure among control group on admission to discharge where P< 0.05. As well in study group it was found significant improvement regarding mean scores of pulse rate, respiratory rate, and Fio2 on admission scores were (109.55± 13.539, 27.95±3.748, and 94.00± 18.468 respectively) then decrease on discharge to (87.95± 5.414, 21.10±2.573, and 36.40± 23.298 respectively) with P< 0.05.

Moreover, it was observed a significant change among both groups on discharge regarding mean scores of body temperature, respiration rate, Fio2 and CVP with P< 0.05.

Table (4): This table showed the distribution of studied patients in relation to methods of oxygen therapy on admission and discharge among the studied groups. **Regarding methods of oxygen therapy by ventilator, face mask, and room air there were** similar percentages with non-significant difference between both groups on admission.

On the other hand, a similar proportion of decreasing maintenance fluids group (50.0%) was on face mask and room air respectively compared to 50% and 10% among control group respectively with a significant improvement among patients who received decreasing maintenance fluids group. Also, it was observed that no patient among study group attached to mechanical ventilator compared to 40% among control group. A significant improvement among patients who received decreasing maintenance fluids group was observed on discharge compared to control group

Table (5): Revealed the Distribution of studied patients in relation to GCS severity on admission and discharge among the studied groups**. Concerning to GCS severity,** it was founded that more than half of both groups (55% and 75%) respectively had moderate conscious level on admission. While on discharge a significant difference was observed among control and study groups where 65% of study group had mild conscious level compared to 10% in control group.

Table (6): This table revealed Distribution of studied patients in relation to mean score of ABG parameters among the studied groups. It was showed that the mean of Pao2 on discharge was (93.86± 2.34) among control groups compared with (97.07± 2.34) among decreasing maintenance fluids group with a significant improvement P= 0.00. As well, the mean of PaCo2 on discharge was (37.58± 4.28) among normovolemic fluids group compared with (33.62± 4.09) among decreasing maintenance fluid group with a significant improvement where P less than 0.005.

Table (7): Represented Distribution of studied patients in relation to mean score of renal function and sodium results among the studied groups. **In relation to serum sodium and kidney function,** the results revealed a significant improvement of mean score of sodium, urea and creatinine among decreasing maintenance fluid group compared with control group on discharge with P= (0.022 and(0.00)respectively.

Table (8): Showed the percentage distribution of the studied groups in relation to systemic complications. It was observed that most of patients in normovolemic fluids group (75%) had crackles and tachypnea compared to 35% of patients in decreasing maintenance fluid group with a significant difference between two groups with p=0.001.

Table (9): Revealed the distribution of studied patients in relation to length of ICU stay (in days), ventilators days and state of discharge. It was showed that more than half (60.0%) of patients in normovolemic fluids group were complete recovery compared to (100%) of patients in decreasing maintenance fluids group. In addition, it is also observed that 40.0% of patients in control group were died compared to nothing in decreasing maintenance fluids group. **Concerning length of ICU stay in days**, 70.0% of patients in control group had long duration of stay in ICU more than 20 days compared to (55.0%) of patients in decreasing maintenance fluidsgroup.

Regarding duration of ventilator days. 60.0% of patients in control group had long duration of stay on ventilator more than 15 days compared to (35.0%) of patients in study group with a significant difference was observed between control and study group regarding ventilator days where p = 0.008*.

Table 10: Showed the mean distribution of the studied groups in relation to the monitored intake & output per day**. In relation to monitor intake and output ratio per day (m/L),** it was revealed that the mean ratio **on admission** was (1095.00± 187.71) among control groups compared with (525.00± 218.55) among study groups with a significant difference between both groups P= 0.00*. Moreover, the mean ratio **on discharge** was (754.40± 451.76) among control groups compared with (-329.00± 98.91) among study groups with a significant difference between both groups P= 0.00*.

Table 11: Represented the Correlation between the monitored intake & output ratio per day and signs of heart failure among the studied groups throughout the periods of the study. This table revealed that there was a positive correlation in relation to peripheral edema and ratio of intake and output on admission and discharge among control groups P=0.00*, 0.01* respectively. Moreover, there was a positive correlation in relation to crackles and ratio of intake and output for the study group on discharge P=0.02*.

Table (1): Distribution of the studied patients in relation sociodemographic data.

Characteristics	The studied patients (n=40) Control group (n= 20) N	%	Study group (n=20) N	%	χ^2 P
Age (in years)					
▪ ≤30	8	40.0	11	55.0	FE
▪ >30	12	60.0	9	45.0	0.527
Range	**(18-60)**		**(13-58)**		t=371
Mean ± SD	**38.30±14.953**		**32.95±13.926**		P=0.249
Sex					
▪ Male	13	65.0	15	75.0	FE
▪ Female	7	35.0	5	25.0	0.490
Marital status					
▪ Married	12	60.0	13	65.0	FE
▪ Single	8	40.0	7	35.0	0.744
Emergency Surgery					
▪ No	12	60.0	14	70.0	FE
▪ Yes	8	40.0	6	30.0	0.507

FE: Fisher Exact test # More answer was chosen.

Table (2): Distribution of the studied patients in relation to types of traumas and ISS level.

	The studied patients (n=40) Control group (n= 20) N	%	Study group (n= 20) N	%	χ^2 P
Type of traumas:					
1. Base of skull fracture	8	40.0	0	0.0	
2. Vault of skull fracture	10	50.0	4	20.0	
3. Vertebral column fracture	2	10.0	0	0.0	
4. Rib/sternal fracture	4	20.0	8	40.0	
5. Pelvic fracture	10	50.0	5	25.0	
6. Clavicle fracture	2	10.0	2	10.0	
7. Scapular fracture	0	0.0	2	10.0	**16.044**
8. Upper extremity fracture	2	10.0	1	5.0	**0.014***
9. Lower extremity fracture	9	45.0	7	35.0	
10. Traumatic brain injury	17	85.0	16	80.0	
11. Splenic injury	6	30.0	0	0.0	
12. Hemothorax or pneumothorax	0	0.0	2	10.0	
13. Lung injury	0	0.0	2	10.0	
14. Liver injury	2	10.0	0	0.0	
15. Kidney/ genitourinary injury	2	10.0	0	0.0	
ISS level:					
▪ ≤16	1	5.0	2	10.0	**27.048**
▪ (17-25)	3	15.0	18	90.0	**0.00***
▪ >25	16	80.0	0	0.0	

More answer was chosen.

Figure (1): Distribution of the studied patients in relation to their past medical history percentage.

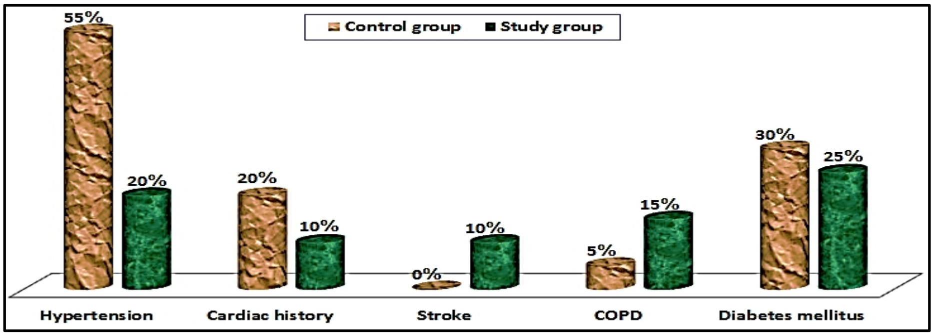

Table (3): Distribution of studied patients in relation to mean scores of physiological parameters among the studied groups on admission and discharge.

Vital signs	The studied patients (n=40) Range Mean ± SD Control group (n= 20) On admission	Control group (n= 20) On discharge	t P	Study group (n= 20) On admission	Study group (n= 20) On discharge	t P
▪ Temperature (0c)	(36-40) 37.01±1.132	(35-38) 36.63±0.954	1.148 0.258	(37-39) 37.59±0.596	(37-38) 37.34±0.258	1.722 0.093
Group 1 VS Group 2 t, P	4.042, 0.052	**10.183, 0.003***				
▪ Pulse (b/m)	(63-133) 106.40±20.990	(60-99) 82.80±16.926	**3.914 0.000***	(89-128) 109.55±13.539	(78-99) 87.95±5.414	**6.625 0.000***
Group 1 VS Group 2 t, P	0.318, 0.576	1.680, 0.203				
▪ Respiration (c/m)	(26-30) 27.30±1.261	(12-26) 17.40±4.639	**9.211 0.000***	(24-38) 27.95±3.748	(16-24) 21.10±2.573	**6.738 0.000***
Group 1 VS Group 2 t, P	0.540, 0.467	**9.731, 0.003***				
▪ Systolic blood pressure (mm:Hg)	(100-160) 120.15±33.205	(60-130) 106.50±29.249	**2.398 0.022***	(100-170) 129.70±21.880	(110-130) 119.50±8.256	1.951 0.059
Group 1 VS Group 2 t, P	1.154, 0.290	3.659, 0.063				
▪ Diastolic blood pressure (mm:Hg)	(60-110) 86.00±17.889	(40-90) 67.00±17.199	**3.424 0.001***	(60-100) 80.70±14.542	(70-80) 74.00±5.026	1.947 0.059
Group 1 VS Group 2 t, P	1.057, 0.310	3.052, 0.089				
▪ Fio_2	(40-100) 94.00±18.468	(21-100) 67.40±28.072	**3.540 0.001***	(40-100) 94.00±18.468	(21-99) 36.40±23.298	**8.665 0.000***
Group 1 VS Group 2 t, P	0.00, 1.00	**14.442, 0.001***				
▪ CVP	(4-14) 8.40±3.378	(5-17) 8.65±3.558	0.228 0.821	(7-22) 12.10±4.723	(7-20) 11.35±4.603	0.509 0.614
Group 1 VS Group 2 t, P	**8.121, 0.007***	**4.308, 0.045***				

* Significant at level P<0.05

Table (4): Distribution of studied patients in relation to methods of oxygen therapy on admission and discharge among the studied groups.

Method of O_2 therapy	The studied patients (n=40)									
	On admission					On discharge				
	Control group (n=20)		Study group (n=20)		χ^2 P	Control group (n=20)		Study group (n=20)		χ^2 P
	N	%	N	%		N	%	N	%	
▪ Ventilator	18	90.0	18	90.0	FE 1.00	8	40.0	0	0.0	**13.333 0.001***
▪ Mask	2	20.0	2	20.0		10	50.0	10	50.0	
▪ Room air	0	0.0	0	0.0		2	10.0	10	50.0	

* Significant at level P<0.05

Table (5): Distribution of studied patients in relation to Glasgow coma scale(GCS) severity on admission and discharge among the studied groups.

	The studied patients (n=40)									
	On admission					On discharge				
	Control group (n=20)		Study group (n=20)		χ^2 P	Control group (n=20)		Study group (n=20)		χ^2 P
	N	%	N	%		N	%	N	%	
GCS severity										
▪ Mild	0	0.0	1	5.0	5.767 0.056	2	10.0	13	65.0	**12.911 0.002***
▪ Moderate	11	55.0	15	75.0		10	50.0	4	20.0	
▪ Severe	9	45.0	4	20.0		8	40.0	3	15.0	

* Significant at level P<0.05

Table (6): Distribution of studied patients in relation to mean score of arterial blood gases (ABG) parameters among the studied groups.

Parameter	The studied patients (n=40)					
	On admission			On discharge		
	Control group (n= 20)	Study group (n= 20)	t P	Control group (n= 20)	Study group (n= 20)	t P
ABG						
▪ PH	(7-7) 7.28±0.07	(7-7) 7.30±0.03	1.619 0.211	(0-7) 6.61±2.26	(2-7) 6.88±1.53	0.193 0.663
▪ PaO2	(50-90) 66.21±11.03	(52-89) 71.16±10.12	2.182 0.148	(89-98) 93.86±2.34	(91-99) 97.07±2.34	**18.731 0.00***
▪ PaCO2	(41-62) 54.77±6.36	(42-66) 55.53±8.17	0.108 0.744	(33-44) 37.58±4.28	(26-42) 33.62±4.09	**8.948 0.005***
▪ HCO3	(13-29) 20.68±6.05	(17-32) 22.37±5.88	0.802 0.376	(9-30) 20.44±7.11	(16-24) 19.44±2.544	0.347 0.559

* Significant at level P<0.05

Table (7): Distribution of studied patients in relation to mean score of renal function and sodium results among the studied groups.

Parameter	The studied patients (n=40)					
	On admission		t P	On discharge		t P
	Control group (n= 20)	Study group (n= 20)		Control group (n= 20)	Study group (n= 20)	
▪ Na+ (mEq/L)	(122.0-155.4) 139.67±9.66	(130.4-140.3) 136.02±3.71	2.491 0.123	(119.0-164.1) 142.54±12.58	(133.7-138.2) 135.75±1.65	**5.713** **0.022***
▪ Creatinine	(0.5-2.4) 1.145±0.53	(0.9-2.1) 1.46±0.41	**4.486** **0.041***	(0.8-4.0) 2.23±1.07	(0.8-1.7) 1.23±0.29	**16.259** **0.00***
▪ Urea	(18.0-44.0) 34.46±7.92	(22.0-82.2) 37.61±16.87	0.571 0.454	(22.3-60.4) 40.98±12.07	(24.0-38.4) 29.04±4.70	**17.005** **0.00***

* Significant at level P<0.05

Table (8): Percentage distribution of the studied groups in relation to systemic complications

	The studied patients (n=40)				χ^2 P
	Control group (n= 20)		Study group (n= 20)		
	N	%	N	%	
Assess for signs of heart failure					
▪ Crackles	15	75.0	7	35.0	
▪ Tachypnea	15	75.0	0	0.0	
▪ Cough	10	50.0	2	10.0	
▪ Cyanosis	6	30.0	0	0.0	**25.56**
▪ Edema	11	55.0	0	0.0	**0.001***
▪ Pulmonary edema	1	5.0	0	0.0	
▪ Cerebral edema	11	55.0	0	0.0	
▪ Renal failure	6	30.0	0	0.0	

* Significant at level P<0.05
FE: Fisher Exact test

Table (9): Distribution of studied patients in relation to length of ICU stay (in days), ventilators days and state of discharge

Characteristics	The studied patients (n=40)				χ^2 P
	Control group (n= 20)		Study group (n=20)		
	N	%	N	%	
State of discharge					
▪ Complete recovery	12	60.0	20	100.0	FE
▪ Died	8	40.0	0	0.0	0.243
Length of ICU stay (in days)					
▪ <20	6	30.0	9	45.0	FE
▪ ≥20	14	70.0	11	55.0	0.514
Range	**(15-27)**		**(13-28)**		t=1.568
Mean ± SD	**21.60±4.535**		**19.90±4.038**		P=0.218
Ventilators days					
▪ Not ventilated	0	0.0	2	10.0	
▪ 10-15 days	8	40.0	11	55.0	3.789 0.150
▪ >15 days	12	60.0	7	35.0	
Range	**(15-25)**		**(0-22)**		**t=7.965**
Mean ± SD	**18.55±3.395**		**14.10±6.181**		**P=0.008***

FE: Fisher Exact test
* Significant at level P<0.05

Table (10): Mean distribution of the studied groups in relation to the monitored intake & output per day

	The studied patients (n=40)		χ^2
	Control group (n= 20)	Study group (n= 20)	P
	N %	N %	
Monitored intake & output ratio per day (M/L)	Range Mean±SD		
On admission	(800-1500) 1095.00±187.71	(250-950) 525.00±218.55	**t=8.848 P=0.00***
On discharge	[(200)-1300] 754.40±451.76	[(200) -(500)] 329.00±98.91	**t=10.752 P=0.001***

* Significant at level P<0.05

Table (11): Correlation between monitored intake & output ratio per day and signs of heart failure among the studied groups throughout the periods of the study.

Signs of heart	Monitor intake & output Ratio							
	On admission				On discharge			
	Control group		Study group		Control group		Study group	
	r	P	r	P	r	P	r	P
▪ Crackles	-0.255	0.277	-0.028	0.908	0.291	0.169	**0.475**	**0.02***
▪ Tachypnea	-0.255	0.277	-	-	-0.291	0.169	-	-
▪ Cough	0.186	0.433	-0.351	0.130	-0.005	0.971	-0.270	0.232
▪ Cyanosis	-0.193	0.415	-	-	-0.398	0.215	-	-
▪ peripheral Edema	**0.765**	**0.000****	-	-	**0.628**	**0.01***	-	-
▪ Pulmonary edema	0.284	0.225	-	-	0.076	0.843	-	-
▪ Cerebral edema	-0.222	0.346	-	-	-0.328	0.142	-	-
▪ Renal failure	0.232	0.326	-	-	0.008	0.756	-	-

r: Spearman coefficient
* Significant at level P<0.05

Discussion

Trauma is a leading cause of worldwide death due to blood loss. Decreasing maintenance fluids or permissive hypotension decrease the adverse effects of high fluid volume and maintain tissue perfusion**Chatrath et al (2015).**

Concerning distribution of the studied patients in relation to types of traumas and injury severity score. The present result revealed that, the majority of the control and study group had traumatic brain injury. This may be related to that the majority of traumatic brain injury may be related to car accidents, careless driver and traffic violations. Our results come in line with the study done by **Alqarafiet al., (2019)** which indicate that the commonest cause of trauma result from motor car accidents that may result from defects in cars and roadways that contribute to a car accident.

In relation to injury severity score, the current result revealed that, the majority of the control and study group had high injury severity score on admission. This may be attributed to most studied patients had traumatic brain injury and more than one organ had injured. This result is supported by study done by **Gad et al., (2012)** who reported that major trauma is commonly defined using an Injury Severity Score (ISS) threshold of 15 which need further observation and care from ICU staff.

On the other hand **Hui (2021)** reported that **injury severity score** is not well used in trauma evaluation and it may underestimate the injury in a single region in patients with severe trauma.

Regarding distribution of the studied patients in relation to their **past medical**

history. The present result showed that hypertension was encountered among more than half of the control group compared to twenty percent of the patient received decreasing maintenance fluids group. Systemic hypertension may increase mortality rate. This result is similar to **Sellmannet al (2012)** who concluded that patients who had pre hospital hypertension had poor outcome than normotensive traumatic brain injury patients.

As regard physiological parameters. The current study revealed significant changes among control and study group on discharge regarding mean scores of body temperature, respiration rate, Fio2 and CVP. Physiological parameters especially CVP was used to guide fluid responsiveness. This result is agreed with **Paul et al (2010)** who reported that FiO2, respiratory rate, CVP, and fluid balance may be important factors in monitoring and preventing volume overload. This result was contradicted with **Marik et al (2013)** suggested that CVP should not be used as the hemodynamic response to a fluid challenge.

In addition, **Abdalla et al (2020)** reported that there is no correlation between CVP and circulating blood volume, and CVP more than 8 mmHg is independently associated with a higher mortality and increased risk of acute kidney injury .

In relation to methods of oxygen therapy, the current result showed a significant improvement among patient received decreasing maintenance fluids group on discharge where majority of study group using face mask and room air compared with normvolemic fluid group. This indicated that decreasing maintenance fluids volume enhance oxygen delivery rate and reduce the need for high oxygen administration. This result is supported with **Siamet al (2013)** who concluded that adequate fluid replacement volume is very important to achieve maximal oxygen delivery rate in a trauma patients and improve other hemodynamic variables to normal physiological range.

On the other hand, **Siam et al (2014)** stated that oxygen deficit had been occurred after fluid administration and result in increased the workload on the heart without adequate increase in oxygen supply.

Concerning to GCS severity, the present finding revealed that more than half of both groups had moderate conscious level on admission. This may relate that the majority of patients in this study had traumatic brain injuries. This result is agreed with **Mohamed et al (2020)** who reported that most of the sample had had moderate conscious level at admission.

In addition, a significant difference among both groups on discharge was found, where more than half of study group had mild GCS score compared to ten percent in control group. This result is contradicted with **York et al (2000)** who reported that fluid restriction didn't achieve change in level of consciousness in the traumatic brain injured patient who

Regarding to arterial blood gases parameters, the current result revealed an improvement of the mean of Pao2 and PaCo2 on discharge among study groups who received decreasing maintenance fluids compared to control groups. This may be indicator that low-volume fluid resuscitation can be effective methods to improve the patient condition and measuring arterial blood gases give necessary information for monitoring and follow-up of patient. In this regard **Taleghaniet al., (2017)** suggested that oxygen saturation and arterial blood gases and base excess can be used to monitor the adequacy of fluid therapy.On the other hand, **Mirbaha et al., (2016)** reported that fluid resuscitation therapy in septic shock patients had no significant effect on blood gas parameters or systolic blood pressure.

In relation to serum sodium and kidney function, the present results revealed that a significant improvement of mean score of sodium, urea and creatinine among study groups who received decreasing maintenance fluids compared with control groups on discharge. This indicated that low volume fluid administration decreases capillary edema and improves kidney function. This result is online with **Shin et al., (2018)** who reported that restrictive fluid administration decrease capillary edema, improvesserum sodium and kidney function while high fluid volume administration causing edema, and impair renal function.

As regard distribution of the studied groups in relation to systemic complications, the present results revealed that majority of patients in control group had crackles and tachypnea compared to one third of patients in the study group, also more than half of control group had peripheral edema. This result was agreed with **Granadoet al., (2016)** who found that systemic complications is associated with high fluid volume resuscitation such a crackles and tachypnea. This can be explained that volume overload may lead to a clinical syndrome with symptoms associated with pulmonary or systemic congestion **Ibrahim, (2021).** Moreover **Thibodeau et al., (2018) reported that** Peripheral edema was a relatively common signs in (66%) of patients with signs of heart failure. This congruent with the current study where more than half of control group had peripheral edema**.**

In relation to status of patient on discharge, it was found that all of the patients in the study group had complete recovery compared to sixty percent of control group. Also, the majority of patients in control group had long duration of stay in ICU more than 20 days compared to study group. The cause of long duration of stay in ICU that the most of patients had severe injuries and received high volume fluid resuscitation. This result is similar to **Mariket al (2017)** who stated that administration of high fluid volume was associated with long stay duration in ICU and increasing mortality rate. Also, **Yoshihisa et al., (2018)** and **Fudim et el., (2021)** reported that the extent of extravascular volume overload is closely correlated with increased morbidity and mortality.

More over the results of the study done by **Albreiki and Voegeli,(2018)** stated that the mortality rate amongst patients who received conservative resuscitation was lower than standard aggressive resuscitation, which indicates that low fluid volume resuscitation had better effect among traumatized patients.

Regarding duration of ventilator days. More half of patients in control group had long duration of stay on ventilator more than 15 days compared to one third of patients received decreasing maintenance fluids group. This result was disagreed with **Mohamed et al., (2020)** who found that the most of patients in his study stayed less than fifteen days attached to mechanical ventilator and low percent of them stayed more than twenty days.

Concerning correlation between monitored intake & output ratio per day and signs of heart failure among the studied groups throughout the admission and discharge periods of the study. A significant positive correlation was found as regard to peripheral edema and ratio of intake and output on admission and discharge among control group. This result is agreed with **Martins et al., (2011) who** indicated that edema can be a validated indicator for the assessment of excess fluid volume. Also, **Tsutsui et al., (2019) and Bozkurt et al (2021)** had indicated that fluid retention/edema is a cardinal symptom of heart failure.

Moreover, there was a positive correlation in relation to crackles and ratio of intake and output for the study groups on discharge. This finding is consistent with a retrospective study which identified crackles in 96.6% of congestive HF patients. **Lopes et al (2009). Also, Martins et al., (2011)** reported thatcrackles were a validated nursing diagnosis of excess fluid volume.

Finally, we may conclude that limiting maintenance fluids in normotensive trauma patients can reduce ICU stay and ventilator days, resulting in a better patient's outcome.

Conclusions

It can be concluded that administration of reducing maintenance fluids at 30 mL/h in trauma patients lead to a better physiological parameter, decreased ICU stay and less days on the ventilator**.**

Recommendations

- Emergency hospital should include decreasing maintenance fluids for all normotensive trauma patients admitted to the ICU if not contraindicated.
- Nursing and medical staff should be informed with the updated protocols of fluid resuscitation therapy and its application in clinical practice for emergency and critically ill patients.
- Further research should be implemented on large group of patients

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