Original Article

Fluid Balance and Level of Consciousness in Intensive Care Patients

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Abstract

Background: The management of fluid balance in the intensive care unit (ICU) is an indispensable part of the care and treatment process. Especially, changes in the level of consciousness may make it difficult to manage fluid balance.

Purpose: This study was conducted to determine the relationship between fluid balance and level of consciousness in ICU.

Methods: This cross-sectional and observational study included 209 patients hospitalized in ICU. An input-output monitoring form was used to assess the fluid balance of the patients, while the Glasgow Coma Scale (GCS) was used to assess their levels of consciousness.

Results: Among the patients who were monitored for a week, the mean fluid balance value was 689.90±101.37 ml on the first day and 1141.53±1188.28 ml on the seventh day, where a significant increase occurred in positive fluid balance within the week ($p<0.01$). While there was no significant relationship between the patients' levels of consciousness and their fluid balance on the first day ($p>0.05$), on the seventh day; the mean fluid balance value of the patients who were categorized as 'coma' in the GCS was significantly higher than others ($p<0.05$).

Conclusions: It was observed that the ICU patients had a positive fluid balance, while an increase in positive fluid balance was observed in time in the patients who were in a coma. Nurses are recommended to pay more importance to the monitoring of the fluid balance of patients who are experiencing advanced changes in consciousness like a coma.

Keywords: Intensive care, consciousness, fluid balance, coma, nursing care.

Introduction

In the intensive care unit (ICU), providing fluid supplementation to support the functional status of patients is a commonly applied practice (Oren, 2016). Therefore, the management of fluid balance in the ICU is an indispensable part of the care and treatment process (Davies et al., 2019; Bouchard & Mehta, 2010). Fluid balance, which is defined as balancing fluid input and output for metabolic processes to work effectively, may be a life-saving process for ICU patients (Oren, 2016). In addition to this, the emergence of sudden and rapid changes in fluid balance in patients hospitalized in the ICU is among the most prevalently encountered problems (Asfour, 2016; Ozen & Enc, 2013). While there may be an underlying disease in the etiology (Demirel et al., 2006), factors such as fluid therapy that is routinely administered to almost all patients (Vincent, 2019), and the accurate calculation of fluid balance may lead to fluid imbalance in ICU patients (Diacon & Bell, 2014; Jeyapala et al., 2015).

Failing to notice or overlooking fluid imbalance in the early period brings about physiological problems including the administration of high-cost treatments, disruption of the integrity of the skin and mucous membrane of the patient and pulmonary edema, in addition to psychological problems associated with long-term hospitalization in the ICU (Atilmis, 2015; Leach, 2010; Davies et al., 2019). Some previous studies have reported that fluid imbalance is associated with increased mortality (Balakumar et al., 2017; Ozgur & Akin, 2021). For this reason, monitoring fluid balance as a part of the life signs of the patient is a basic practice for every patient receiving treatment and every nurse working in the ICU (Asfour, 2016; Jeyapala et al., 2015). Nonetheless, the management of fluid balance in patients receiving treatment in the ICU is a complex process (Diacon & Bell, 2014). This is because fluid balance is influenced by many factors including age, gastrointestinal losses, ambient temperature, sex, body type, activity level, lifestyle, eating disorders and chronic diseases (Ozen & Enc, 2013). Especially changes in the level of consciousness may make it difficult to manage fluid balance.

Changes in consciousness are frequently observed in patients hospitalized in the ICU (Upadhyay et al., 2017). The fact that consciousness cannot be objectively measured by any machine today makes it difficult to detect changes in consciousness and health problems brought about by these changes in the early period (Laureys et al., 2002). Fluid imbalance, which is a prevalently observed phenomenon especially in the ICU, may lead to the emergence of changes in the level of consciousness by also causing electrolyte imbalance. Similarly, in cases like a coma where consciousness degrades on an advanced level, it may become more difficult to notice fluid imbalance and associated health problems. That is, the status of the patient may turn into a vicious cycle in terms of achieving fluid balance. The literature review did not reveal any previous study which examined the relationship between fluid balance and level of consciousness in patients receiving treatment in the ICU. In this study, it was planned to determine the relationship between consciousness levels and fluid balance in ICU patients within a certain period, and it was aimed to draw attention to fluid balance/imbalance in cases of changes in consciousness. Accordingly, it is believed that this study may be guiding for nurses who provide treatment and care for ICU patients and contribute to the literature. Thus, the following research questions were formulated:

- Is there a difference in fluid balance in a week in intensive care patients?
- Is there a relationship between the level of consciousness and fluid balance in intensive care patients?

Methods

Design and Participants: This study was carried out with a cross-sectional and correlational design. The population of the study consisted of adult intensive care patients who were hospitalized in the ICU of a public hospital between February and August 2021. The study included 209 patients who were admitted to the ICU at the institution where the study was conducted, were 18 years old or older, had not received a surgical procedure within the last six months, did not have any congenital anatomical problem in their eyes or aphasia, did not have a spinal cord injury, did not have a problem of intoxication, had a urine output of more than 0.5-1 ml/kg/h per day, had been receiving treatment and care in the ICU for at least a week and agreed to participate in the study. Patients who died in or were discharged from the ICU within a week were excluded.

Measures: The data of the study were collected using a patient information form, an Input-Output Monitoring (IOM) Form and the Glasgow Coma Scale (GCS).

Patient information form consisted of three parts. The first part included seven questions on the personal information of the patient. The second part included seven questions on the disease-related information of the patient. The third part included 15 parameters for identifying the factors that affected the fluid balance of the patient. Input-output monitoring form was used to assess the fluid balance of the patients who were included in the study. This form included hourly measurement values for the amount of fluid taken through the oral, parenteral and enteral routes and the amount of fluid discharged through urine, vomiting or diarrhea. Additionally, in each patient, the amount of unobservable fluid loss was added to the fluid output value. Unobservable fluid loss was defined as a loss of 10 ml per kg per day for each patient (Davies et al., 2019). The total amounts of fluids consumed by the patients and their fluid outputs were measured with marked containers and recorded in units of ml for every day. Urinary catheters were placed in all patients hospitalized in the ICU, and the urine outputs of all patients in this study were measured and recorded hourly. In this form, fluid balance was assessed after the completion of 24 hours of measurements. In the process of determining fluid balance, the amount of fluid output was subtracted from the amount of fluid input, and the result was used in the analyses (Atilmis, 2015; Schneider et al., 2012).

Glasgow Coma Scale was used in the study to determine the levels of consciousness of the patients. Although GCS was developed for the purpose of measuring traumatic brain injuries, it is the first classification scale that allows the objective measurement of the consciousness statuses of patients, and it is prevalently used today in the assessment of neurological status in diagnosis and treatment in many branches of medicine (Arli, 2018). GCS is used by scoring in three categories as eye opening, verbal responses and motor responses. The total GCS score of the patient is obtained by adding the scores of the patients in all three categories. In GCS, the total score range is 3-15. Changes in consciousness are categorized based on the total GCS score, where a score of 15 indicates complete consciousness (the patient is aware of themselves and their environment), scores of 13-15 indicate lethargy (the patient has a tendency to fall asleep, they are woken up with auditory stimuli), scores of 9-12 indicate stupor (the patient is nearly unconscious, they do not wake up with auditory stimuli, they open their eyes only with powerful and repeated stimuli), and scores of 3-8 indicate the state of coma (the patient cannot be woken up with verbal stimuli, the patient with severe coma is completely unable to respond to painful stimuli) (Arli, 2018; Sepit, 2005).

Data Collection: The data collection forms to be used in the study were filled out by an experienced nurse in the ICU where the study was conducted on two different days (first and seventh days of admission to the ICU). Sociodemographic data were collected by speaking to the patients themselves or their legal guardians in person. The life signs, levels of consciousness and fluid input-output of the patients that were monitored were recorded. The laboratory results of the patients were obtained from their patient file.

Data Analysis : The SPSS 22.0 software was used to analyze the data collected in the study. The distributions of the sociodemographic and disease-related characteristics of the patients were analyzed using percentage and mean tests. The categorical data on fluid balance collected on the first and seven days were compared using McNemar's test, whereas the quantitative data were compared using Paired-samples t-test. Kruskal-Wallis test was used to compare the fluid balance values of the patients based on their levels of consciousness. In the analyses, the results were interpreted on the significance level of 0.05.

Ethical Consideration: Before collecting data, written approval (Decision no: 2021-01/09) was obtained from the Non-Invasive Clinical Studies Ethics Board of a university. Additionally, before data collection, all patients to be included in the study or their legal guardians were informed about the content of the study and that participation was on a voluntary basis, and their verbal and written consent was obtained.

Results

The mean age of the ICU patients who were included in this study was 66.18±15.47 years, where 61.7% were 65 years older. Among the patients, 52.2% were female, 87.1% were married, 52.6% were secondary school graduates, and 69.9% were not working at any job. Thirty-four percent of the patients were still smoking, 15.3% were consuming alcohol. While 51.2% were overweight, and 12.4% were obese.

Table 1 shows the characteristics of the patients related to their ICU admission. Of the patients, 7.7% were completely conscious according to GCS, while 50.2% were in a coma. Forty-nine-point-eight percent of the patients were intubated. Forty-four percent of the patients were receiving treatment in the ICU due to neurological diseases/disorders, and 19.6% were receiving treatment due to electrolyte disturbances. Almost all patients (97.6%) had at least one chronic disease.

Among the ICU patients, edema was found in 18.7% at the time of admission, while this rate became 52.2% at the end of the week, and the increase was statistically significant ($p<0.01$). Furthermore, while the rates of using medication with diuretic effect and daily frequencies of defecation in the patients significantly increased, the prevalence of feelings of thirst and dry mouth was significantly lower on the seventh day in comparison to the first day ($p<0.01$) (Table 2).

There was a significant increase in the mean GCS score of the patients from the first day to the seventh day, while significant reductions were observed in the same period in their blood pressure, heart rate, fever, respiratory rate, skin turgor and albumin values ($p<0.01$) (Table 3).

In the analysis of the fluid input and output values of the patients, it was determined that their mean fluid balance value was 689.90±101.37 ml on the first day and 1141.53±1188.28 ml on the seventh day, where this increase was statistically significant ($p<0.01$) (Table 4).

As a result of the comparison of the fluid balance values of the patients based on their consciousness levels, while there was no significant relationship between fluid balance and consciousness levels on the first day ($p>0.05$), on the seventh day, the mean fluid balance value of the patients who were in a coma was found to be significantly higher than others ($p<0.05$) (Table 5).

Table 1. Intensive care unit hospitalization-related characteristics of the patients (N = 209)

Characteristics	n	%
Consciousness status according to GCS		
Completely conscious	16	7.7
Lethargy	24	11.5
Stupor	64	30.6
Coma	105	50.2
The patient is intubated		
Yes	104	49.8
No	105	50.2
Reason for admission to the ICU		
Neurological diseases/disorders	92	44.0
Electrolyte disturbances	41	19.6
Cardiac diseases/failure	25	12.0
Respiratory diseases/failure	23	11.0
Renal diseases/failure	19	9.1
Other (sepsis, trauma)	9	4.3
Number of chronic diseases diagnosed by a physician other than the indication of ICU hospitalization		
None	5	2.4
One	6	2.9
Two	80	38.3
Three	69	33.1

Four or more	49	23.4
Name of the chronic disease*		
Hypertension	92	25.3
Diabetes	83	22.8
Epilepsy/Alzheimer's/Dementia/CVD	55	15.2
Heart failure	47	12.9
COPD/Asthma	43	11.9
Cancer	25	6.7
Renal failure	7	1.9
Hypothyroidism	7	1.9
Other (Ankylosing Spondylitis, Cirrhosis, Hyperthyroidism, HIV)	5	1.4
Duration of the chronic disease		
<10 years	129	61.7
≥10 years	80	38.3

*Multiple options were marked. **The number 'n' showed variation. GCS: Glaskow Coma Scale; CVD: Cardiovascular Diseases ; COPD: Chronic obstructive pulmonary disease; HIV:Human Immunodeficiency Virus

Table 2. Parameters of the patients related to their fluid balance

Parameters	First day		Seventh day		Test*; p
	Yes n (%)	No n (%)	Yes n (%)	No n (%)	
Edema presence	39(18.7)	170(81.3)	102(52.2)	100(47.8)	46.676; p<0.01
Fecal incontinence presence	114(54.5)	94(45.5)	102(52.2)	100(47.8)	0.254; 0.614
Status of using medication with diuretic effect	125(59.8)	84(40.2)	151(72.2)	58(27.8)	9.470; p<0.01
Status of daily defecation	50(23.9)	159(76.1)	73(34.9)	136(65.1)	7.014; p<0.01
Status of vomiting	26(12.4)	183(87.6)	14(6.7)	195(93.3)	3.559; 0.059
Dry mouth status	114(54.5)	95(45.5)	33(15.8)	176(84.2)	57.658; p<0.01

*McNemar test

Table 3. Physiological parameters of the patients

Parameters	The first day M±SD	The seventh day M±SD	Test*; p
Systolic blood pressure (mmHg)	135.72±25.06	119.89±22.88	10.223; p<0.01
Diastolic blood pressure (mmHg)	65.42±10.80	57.55±10.43	8.327; p<0.01
Heart rate (beats/min)	83.77±18.10	76.62±17.40	6.275; p<0.01
Fever (^{0}C)	36.71±0.52	36.51±0.27	4.778; p<0.01
Respiration (times/min)	16.83±3.97	15.79±3.39	4.493; p<0.01

Skin turgor (sec)	3.98±2.62	2.43±2.56	11.980; p<0.01
Na (mEq/Lt)	139.56±8.49	140.93±7.39	-1.956; 0.052
Albumin (mg/dl)	15.31±8.06	14.08±7.12	4.691; p<0.01
Glaskow Coma Scale score	8.11±3.94	8.44±5.50	-1.026; 0.306

*Paired Samle t test

Table 4. Comparison of the fluid balance of the patients between the first and seventh days

	Fluid input				Fluid output		
	Oral (ml)	Enteral (ml)	Paranteral (ml)	Total (ml)	Urine (ml)	Vomiting (ml)	Total (ml)
The first day							
Mean	324.97	330.52	1587.99	2243.49	1545.31	52.60	1551.10
SD	459.86	562.59	1068.19	1109.14	1029.29	20.10	1029.02
Fluid balance amount (ml) (M±SD)	689.90±101.37 (min=-1970, max=4640)						
The seventh day							
Mean	444.54	637.27	1626.02	2789.23	1568.89	31.66	1572.53
SD	808.10	796.54	1077.60	964.44	892.40	11.48	893.27
Fluid balance amount (ml) (M±SD)	1141.53±1188.28 (min=-1700, max=6600)						
The first day – the seventh day							
Test*, p	-4.880; p<0.01						

*Paired Samle t test

Table 5. Comparison of the fluid balance of the patients based on their consciousness levels

			Fluid balance amount M±SD	Test*, p
The first day				
Consciousness status	n	%		
Completely conscious	16	7.7	681.25±1049.48	
Lethargy	24	11.5	404.06±1070.53	
Stupor	64	30.6	822.50±686.83	4.988; p=0.173
Coma	105	50.2	845.90±978.90	
The seventh day				
Consciousness status	n	%		
Completely conscious	62	29.7	897.61±974.96	
Lethargy	21	10.0	651.90±779.63	8.069; p=0.045**
Stupor	21	10.0	904.35±747.73	
Coma	105	50.2	1349.23±1445.34	

*Kruskal-Wallis test **p<0.05

Discussion

Monitoring and assessing fluid balance well in ICU is a vital issue for the patient (Oren, 2016; Asfour, 2016). Especially knowing about the parameters that may affect fluid balance and taking them under control may be facilitating in the management of fluid balance. This study was carried out to investigate the relationship between fluid balance and levels of consciousness in patients receiving treatment in an ICU.

While fluid management seems easy in theory, it may be very difficult in clinical practice (Ozgur & Akin, 2021). The general rule for fluid management as a routine nursing activity in the ICU is to monitor fluid input and output at hourly intervals every day, record the obtained values and assess them (Oren, 2016; Davies et al., 2019). In this study, the mean fluid balance value of the patients was identified as 689.90±101.37 ml on the first day and 1141.53±1188.28 ml on the seventh day, which showed a statistically significant increase within a week. This was interpreted as an important finding as the patients had a positive fluid balance, and they carried the risk of edema development. In ICU patients, fluid balance is frequently disrupted, and a positive fluid balance is prevalent among these patients (Balakumar et al., 2017). A previous study revealed that the mean total fluid balance of patients was 2.6±5.2 L, and most patients had a positive fluid balance (Lee et al., 2015). In another study, the mean daily fluid balance on the first day of admission was found as 1424 ml in patients hospitalized in the ICU and 1394 ml in patients hospitalized in other clinics (Pittard et al., 2017). In the ICU, oral restrictions and the intensive provision of fluid therapy for patients due to metabolic disorders may lead to a positive fluid balance. In a study conducted with polytraumatic patients hospitalized in the ICU, it was determined that higher levels of fluid intake were correlated with an increase in extracellular fluid quantities in the period between the fourth and tenth days, and fluid balance was influenced by fluid intake (Joskova et al., 2017). Likewise, the inaccurate calculation of fluid balance, especially failing to include unobservable fluid loss in the calculation, may also support findings about the presence of a positive fluid balance in patients. A study conducted in an ICU revealed that among fluid balance values recorded on patient files, 65% were accurate, and 35% were inaccurate. In the same study, the factors that influenced the monitoring results of fluid balance reported by nurses were stated as the inaccuracy of the measurement equipment, constant application of intravenous infusion, time management, workload and lack of skill/training (Asfour, 2016). To prevent a positive fluid balance, which increases the risk of mortality in ICU patients, it is needed to take the factors that cause it under control (Pittard et al, 2017; Koonrangsesomboon & Khwannimit, 2015; Lee et al., 2015).

Changes in the fluid balance of the patient lead to rapid changes in all functions of the patient, especially their life signs (Ozen & Enc, 2013). Moreover, reasons including a disruption in consciousness, lack of sufficient oral intake and disruption in urinary release may make the protection of the fluid balance of the patient more difficult. In this study, as a result of the comparison of the fluid balance values of the patients according to their consciousness levels, while no significant difference was observed on the first day, it was determined that the fluid balance values of the patients who were in a coma were significantly higher than those of others on the seventh day. A previous study reported a relationship between GCS scores and fluid balance status, where the mean GCS score of those with a normal fluid balance was 14.9±0.6, the mean score of those with edema development tendencies was 14.8±0.8, the mean score of those with dehydration development tendencies was 14.8±0.8, the mean score of those with a mixed status in the form of hypervolemia-dehydration tendencies was 14.2±2.0, and the GCS scores of the patients with a mixed status were significantly lower (Ozgur & Akin, 2021). In this study, it was a thought-provoking finding that there was an increase in fluid balance as a result of the treatments and care provided to the patients in the sample for a week, although the number of patients who were comatose did not change. It is possible for diseases/deficiencies in patients and treatment provided in the ICU to affect fluid balance. Additionally, the constant fluid therapy given to patients may also lead to an increase in fluid balance. In the literature, it has been reported that clinicians continue to administer fluid therapy to patients most of the time, even when not indicated (Vincent, 2019). Especially in cases of advanced deterioration of consciousness like coma cases, the most appropriate approach would be to provide fluid therapy based on the need of the patient and according to the fluid output from the body.

This study had some limitations. The fact that the sample was small and that the study was conducted with patients receiving treatment in the ICU of only one hospital may have limited the generalizability of the results. Additionally, this study provides cross-sectional information in that it investigated the fluid balance and consciousness levels of the patients for only a week. Moreover, the inability to control for variables that could affect fluid balance in this study was also an important limitation. Despite these limitations, our study is the first study in the national and international literature that has examined the relationship between fluid balance and levels of consciousness in ICU patients. Monitoring fluid balance by also considering changes in consciousness levels may provide nurses with deeper points of view.

Conclusion: In this study, an increase was determined in the positive fluid balance of the patients who were monitored in the ICU for a week, and in particular, the fluid balance values of the comatose patients were higher. The results of this study are important in terms of suggesting that fluid balance may be disrupted even further in cases of consciousness change such as coma cases. In addition to the general nursing approach of closely monitoring fluid balance in the ICU, it is also important to examine patients in risky conditions like a coma more sensitively. Accordingly, nurses should pay more attention to the monitoring of the fluid balance of patients who are experiencing consciousness changes on advanced levels such as coma patients. Furthermore, it is recommended to provide regular in-service training for nurses regarding fluid therapy, fluid balance and fluid management in cases of change in consciousness, and for the intensive care team to plan and implement fluid therapy based on the need and tolerance of each patient. Finally, it is recommended to conduct similar studies with randomized-controlled designs and larger samples and monitor the fluid balance of patients separately based on their consciousness levels.

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