Relationship between Hydration Status And Cognitive Function Of Critically Ill Geriatric Patients

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ABSTRACT

Although it is well known that water is essential for human homeostasis and survival, only recently have we begin to understand its role in the maintenance of cognitive function. **Objective:** To investigate the relationship between hydration status and cognitive function among critically ill geriatric patients. **Methodology:** Thirty critically ill geriatric patients selected from the Intensive Care Units of the Alexandria Main University Hospital were included in the study. Three tools were used to collect the data; Assessment of hydration status of critically ill geriatric patients, The Mini- Mental State Examination, and Intensive Care Delirium Screening Checklist. **Results:** Of the total subjects, 70.0% had fluid volume deficit. Hemodynamic markers as temperature, heart rate, and central venous pressure were statistically significant different with hydration alteration. In addition to, physical markers as distention of neck vein, eye, lip & tongue conditions. 30.0% of the subjects had a moderate cognitive impairment and 50.0% had delirium with a statically significant difference between hydration alteration and cognitive impairment and delirium p= (.033, .047) respectively. **Conclusion & recommendations:** Dehydration or fluid volume deficit is prevalent in the critically ill geriatric patients. Additionally, cognitive impairment and delirium are more common in dehydrated patients than overhydrated patients. These findings suggest that critically ill geriatric patients should be continuously assessed for the presence of hydration status alterations (especially fluid volume deficit), cognitive impairment and delirium.

Key words: Aging, Cognitive function, Critical illness, Dehydration, Hydration status

Introduction

Water is the basic element of our bodies and every system in the human body relies on it. It is a key part of preventing illness and supporting wellness in people **(Suhr, et al., 2010)**. Without water, humans can survive only for days. Water comprises 55% of the total body weight in the elderly population and is vital for the homeostasis and life **(Popkin, et al., 2010)**. Proper hydration is a concern that is frequently overlooked in critically ill geriatrics because of the pre-existing risk factors(i.e. malnutrition, frailty); as well as intensive care unit-related challenges (i.e. catabolism, feeding, end of life care) and it is a common yet complex problem that require comprehensive intervention **(DiMaria-Ghalili & Nicolo, 2014)**.

When the elderly persons receive sub-optimal hydration, they are thought to be susceptible to dehydration and its consequences. Dehydration is not only a common but also a very serious condition in older adults. Dehydration is rated as one of the ten diagnoses that most frequently reported for Medicare hospitalizations, and 1.5% of community-dwellers are hospitalized with dehydration annually in the USA**(Lancaster, et al., 2003)**. Mortality rate in dehydrated patients is high if not treated adequately and in some studies exceeds 50% **(Bourdel-Marchasson, et al., 2004)**. As for morbidity, many studies revealed a correlation between high levels of dehydration and poor cognitive function as confusion and disorientation **(Suhr, et al., 2010; Suhr, et al., 2004; Wilson & Morley, 2003)**. Others found that dehydration was a significant risk factor for thromboembolic complications, infections, kidney stones, and pressure ulcers. Clearly, many older adults are likely to be dehydrated on admission to the intensive care units. These, in turn, can lead to increase difficulty in patient's care, and costly medical care **(Faes, et al., 2007)**. Recent researches conclude that if dehydration is not prevented or treated properly, it will lead to longer stay in intensive care unit, increased hospital readmission rates, and institutionalization **(Sfera, et al., 2016; Frangeskou, et al., 2015)**.

With aging, the ability of the aging kidney to concentrate the urine is decreased even if the older adult is deprived of water so that; urine flow is not sufficiently decreased. In addition, the response of aging kidneys to antidiuretic hormone also decreases, which increases the possibility of fluid volume depletion and dehydration **(Begum & Johnson, 2010)**. The mechanism of failure to concentrate urine, even in the presence of water deprivation, is unclear, and there is no consensus among researchers on its cause. Some suppose that the condition is a result of reduced plasma vasopressin, while others argue that vasopressin levels are the same in older adults but the aging changes in the kidney prevent the normal response to them. Furthermore, sensation of thirst decreases with age, all of these factors can result in the loss of self-regulating defense against dehydration. In a study included elderly men aged 65 and over and young healthy men aged 20 to 31years and both elders and young adults were deprived of water for one day and then allowed to drink as much water as they wanted for an hour. The study found that, the older adults did not drink enough water because they did not feel thirsty, but the young adults did **(Phillips, et al., 2004)**. Additional factors that can induce dehydration in geriatric patients include multiple medications, especially diuretics, sedatives, antipsychotics, and even non-steroidal anti-inflammatory drugs, and diseases as dementia, and incontinence **(Bennett, 2000)**.

Growing body of literature suggests that the water that we drink affect cognitive function, as it plays a vital role in neural conductivity. In geriatric patients, dehydration to a loss of fluid of more than 2% body weight, results in poor performance on tasks assessing memory and psychomotor performance. Dehydration can disrupt the mood and cognitive functioning at all ages especially in old age. Dehydration produces alterations in a number of important aspects of cognitive function such as concentration, alertness, and short-term memory **(Edmonds, et al., 2013)**. In addition to poor cognitive performance, recent work shows that dehydration is one of the several predisposing factors in observed delirium in geriatric patients; dehydration is both a predisposing and precipitating factor for delirium or acute confusional state **(Voyer, et al., 2009)**. On the other hand, other studies **(Armstrong, et al 2012; Ely, et al., 2012)** failed to find evidence of cognitive impairment due to dehydration. These discrepancies across studies make it troublesome to conclude whether, and how, dehydration affects cognitive performance.

Early detection of dehydration in critically ill geriatric patients is a challenging task for nurses due to lack of standardized or validated methods for clinical assessment of fluid deficit. In addition, typical manifestations of dehydration as delayed skin recoil, increased thirst, and orthostatic hypotension may not be present in older adults (60-75%) which constitute major challenges to detect hydration in critically ill geriatric patients. It is worthy to address dehydration to prevent hospital admission, delirium, cognitive impairment, and even death **(Edmonds, et al., 2013)**. Although being a common clinical problem, relatively little attention has been paid in literature to dehydration among critically ill geriatric patients, and due to inconsistent evidence of the impact of dehydration on cognitive performance. Up to our knowledge till the current date, no studies addressed the relationship between hydration status and cognitive function in critically ill geriatric patients has been done in Alexandria, Egypt. So this study aimed to investigate the relationship between hydration status and cognitive function among critically ill geriatric patients.

Research question:

Is there a relation between hydration status and cognitive function of critically ill geriatric patients?

Materials and Method

Design: A cross-sectional descriptive research design was used in this study.

Setting: The study was carried out at the Intensive Care Units of the Alexandria Main University Hospital, namely; Casualty Care Unit (unit I) and General Intensive Care Unit (unit III).

Subjects: A convenience sample of 30 critically ill geriatric patients admitted to the above mentioned settings was included in the study. Epi-Info program was used to estimate the sample size based on using 5% possible error and the confidence co-efficient 95% and it revealed a sample of 28 critically ill geriatric patients and it was increased to the nearest round figure to be 30 geriatric patients. Unconscious and/or patients who cannot communicate effectively, patients on hemodialysis or peritoneal dialysis were excluded from the study.

Tools of the study: Three tools were used to collect the necessary data.

Tool I: Assessment of hydration status of critically ill geriatric patients. This tool was developed by the researchers after reviewing the relevant literature to assess hydration status of critically ill geriatric patients. This tool included information about the following;

- Demographic and clinical data such as age, sex, past medical or surgical history, current patient diagnosis, and route of feeding.
- Patient's physiological parameters; as hemodynamic markers include temperature (◦C), heart rate (B/min), respiratory rate (C/min), blood pressure (mmHg), and central venous pressure (cmH2o). **Physical markers** for hydration as; signs and symptoms of fluid volume **deficit** such as: flat jugular vein, sunken eye, delayed capillary refill, dry lips, dryness of buccal mucosa, dry tongue, additional furrows, dark yellow urine color. Signs and symptoms of **fluid volume excess** include: distended neck vein, puffy eye, presence of edema, and crackled breath sound. **Hematologic markers** for hydration status such as; measured values of hemoglobin, hematocrit, platelets count, white blood cell count, sodium, potassium, urea, creatinine, and blood glucose level.

Tool II: **Mini- Mental State Examination (MMS)**

The MMS scale was developed by Folestien et al (1975). It was used to assess the cognitive function of the studied subjects **(Folestien, et al., 1975).** It includes questions related to orientation, registration, attention, calculation, recall and language. The MMS scale was translated into Arabic language and approved to be valid and reliable in another study **(Abdel Salam, 2012)**, reliability coefficient of 0.93 and 0.91 for normal and demented geriatric person respectively. Items were scored on 5 points Likert scale and ranged from(0-30) and classified as follows;0-9: Severe cognitive impairment,10-18: Moderate cognitive impairment, 19-23: Mild cognitive impairment and24-30: Normal cognitive function.

Tool III: Intensive Care Delirium Screening Checklist (ICDSC).

This tool was developed by Bergeron et al (2001). It was used to assess 8 key features of delirium namely; patients altered level of consciousness, inattention, disorientation, hallucination or delusion, psychomotor agitation or retardation, inappropriate mood or speech, sleep/wake cycle disturbance and symptom fluctuation. The score for each item was assigned as follows: obvious manifestation of an item = score one and no obvious manifestation of an item = score zero. The patient was classified as delirious when the total score was $\geq$4, while a total score of < 4 denoted that the patient is not-delirious **(Bergeron, et al., 2001)**. The ICDSC was translated and tested for reliability in a previous study **(Abdou, 2008)**.

Procedure: after seeking the permission of the hospital's administration and the study protocol being approved by the Ethical Research Committee at the Faculty of Nursing, Alexandria University. Content validity was done by a Jury of 7 experts in the related field. Reliability of the tools was assessed in previous Egyptian studies. A pilot study was carried out on five critically ill geriatric patients at the General Intensive Care Unit (unit III) (those patients were not included in the study participants).The anonymity, confidentiality and privacy of responses, voluntary participation was assured for every participant. The researchers attended the patients at the morning and evening shifts, and the geriatric patients who met the inclusion criteria were asked to participate in the study and assessed using the study tools after reviewing their medical records. Geriatric patients who couldn't speak because of being mechanically ventilated were asked to write or draw their answers on a blank paper or even point out their fingers. Data was collected by the researchers during approximately 3 months starting from August to October 2015.

Limitations of the study: This study was conducted in two ICUs from one geographical area and also the small sample size. Therefore, the results cannot be generalized to the general population.

Statistical analysis: The raw data was revised, coded and fed to statistical software IBM SPSS version 20. Chi-Square test and Fisher Exact test were used alternatively to test the association between two qualitative variables or to detect the difference between two or more proportions. The 0.05 level or below was used as the cutoff value for statistical significance.

Results

Table (1) represents the distribution of the studied critically ill geriatric patients according to their socio-demographic characteristics and clinical data. The results indicated that 66.7% of the studied subjects were aged 60 to less than 70 years with a mean age of 71.03±9.375 years. The results also indicated that 76.7% of studied subjects were females. Regarding patient's diagnosis, cardiovascular disease was the most common disease (33.3%) among the studied critically ill geriatric patients, followed by gastrointestinal disease by 16.6%. It was observed from the same table that, 36.6% of the studied subjects received either oral or enteral nutrition as a method for nutritional support and70.0% of the subjects had fluid volume deficit.

Table 1: Distribution of the studied critically ill geriatric patients according to their socio-demographic characteristics and clinical data

Item	**N=30**	**%**
Age: 60-	20	66.7
75-	7	23.3
85+	3	10.0
Sex : Female	23	76.7
Male	7	23.3
Current patient's diagnosis:		
Cardiovascular disease	10	33.3
Gastrointestinal disease	5	16.6
Neurologic disease	4	13.4
Respiratory disease	3	10.0
Poisoning	3	10.0
Renal disease	2	6.7
Trauma	2	6.7
Others	1	3.3
Route of nutritional support		
Oral intake	11	36.6
Enteral nutrition	11	36.6
Parentral nutrition	8	26.8
Hydration status alteration		
Fluid volume deficit	21	70.0
Fluid volume excess	9	30.0

Table 2: shows the distribution of the studied critically ill geriatric patients according to their hemodynamic markers of hydration alteration. The table revealed that the highest percentage of the studied subjects had bradycardia, hypotension, tachypnea, and low reading of central venous pressure. A statistical significant relationship was detected between hydration alteration and temperature p= (0.008), heart rate p= (.004), central venous pressure p= (.001).

Table 2: Distribution of the studied critically ill geriatric patients according to their hemodynamic markers of hydration alteration

Hemodynamic markers of hydration alteration	Studied subjects (N=30)		Fluid volume deficit	Fluid volume excess	Significant test χ^2/FET(p)
Temperature	**No**	**%**			
Hypothermia	9	30.0	4	5	7.631(.008)*
Normal	11	36.7	7	4	
Hyperthermia	10	33.3	10	0	
Heart rate					
Bradycardia	16	53.3	15	1	9.697(.004)*
Normal	8	26.7	4	4	
Tachycardia	6	20.0	2	4	
Blood pressure					
Hypotension	16	53.3	13	3	2.587(.230)
Normal	8	26.7	4	4	
Hypertension	6	20.0	4	2	
Respiratory rate					
Bradypnea	8	26.7	5	3	.519(.364)
Normal	10	33.3	7	3	
Tachypnea	12	40.0	9	3	
Central venous pressure	**(N=20)**				
Low	11	55.0	10	1	11.836(.001)*
Normal	4	20.0	3	1	
High	5	25.0	0	5	

* Significant value at $p < 0.05$ χ^2: Chi Square Test

FET: Fisher Exact Test (used instead of χ^2 if the expected values are less than 5 in more than 20% of the cells).

Table 3: illustrates the distribution of the studied critically ill geriatric patients according to their physical markers of hydration alteration (from head to toe assessment). The table revealed that, the majority of geriatric patients did not feel thirsty either they suffer from fluid volume deficit or excess. The highest percent of patients with fluid volume deficit had a normal jugular vein and eye condition with a statistical significant difference with hydration alteration p= (.000, .023) respectively. 70.0% of the critically ill geriatric patients had dry tongue and lips. Crackles were found in 36.6% of the studied subjects with no statistical significant difference between patients with hydration alteration p= (.572). The table also showed that, the majority of the studied patients had either dark or severe dark urine (50.0, 10.0%) respectively with a statistical significant difference with hydration alteration p= (.038).the majority of patients with fluid volume deficit had pitting edema and no anasarca.

Table 3: Distribution of the studied critically ill geriatric patients according to their physical markers of hydration alteration

		Physical markers of hydration alteration	Studied subjects (N=30)		Fluid volume deficit	Fluid volume excess	Significant test χ^2/FET(p)
Head		**Thirst sensation**	**No**	**%**			1.591(.179)
		Yes	8	26.7	7	1	
		No	22	73.3	14	8	
		Jugular vein					16.285(.000)*
		Normal	17	56.7	16	1	
		Flat	3	10.0	3	0	
		Distended	10	33.3	2	8	
		Eye condition					6.498(.023)*
		Normal	16	53.3	13	3	
		Sunken	7	23.3	6	1	
		Puffy	7	23.3	2	5	
Tongue	Turgor	One longitudinal furrow	9	30.0	6	3	.068(.319)
		Additional furrow	21	70.0	15	6	
	Condition	Moist	8	26.7	3	5	5.487(.029)*
		Dry	22	73.3	18	4	
Lips condition		Dry	21	70.0	19	2	10.519(.003)*
		Moist	9	30.0	3	6	
Mucosal condition		Moist	10	33.3	5	5	2.857(.085)
		Dry	20	66.7	16	4	
Chest		**Breath sound**					3.658(.572)
		Normal	14	46.7	11	3	
		Crackles	11	36.6	6	5	
		Wheezing	5	16.7	4	1	
Abdomen	Urine color	Pale straw	12	40.0	6	6	3.610(.038)*
		Dark yellow urine	15	50.0	12	3	
		Severe dark urine	3	10.0	3	0	
	Urine amoun	Normal amount	5	16.7	0	5	13.223(.079)
		Oliguria	13	43.3	12	1	
		Polyuria	12	40.0	9	3	
Edema		Absent	13	43.3	8	5	1.835(.176)
		Non pitting edema	5	16.7	3	2	
		Pitting edema	12	40.0	10	2	
Anasarca		Yes	3	10.0	3	0	1.429(.328)
		No	27	90.0	18	9	
Capillary refill		Normal	8	26.7	5	3	.292(.292)
		Delayed	22	73.3	16	6	

* Significant value at $p < 0.05$ χ^2: Chi Square Test

FET: Fisher Exact Test (used instead of χ^2 if the expected values are less than 5 in more than 20% of the cells)

Table 4: shows the distribution of the studied critically ill geriatric patients according to their hematological markers of hydration alteration. The table revealed that 40.0% of the studied subjects had high hemoglobin level those subjects constituted all geriatric patients with fluid volume deficit and 56.6% of the subjects had high hematocrit value. A statistical significant difference was found between hydration alteration and serum sodium, potassium, blood urea nitrogen, and plasma glucose p= (.038, .026, .045, .031) respectively.

Table 4: Distribution of the studied critically ill geriatric patients according to their hematological markers of hydration alteration

Hematological markers	Studied subjects (N=30)		Fluid volume deficit	Fluid volume excess	Significant test χ^2/FET(p)
Hemoglobin	No	%			
Low	3	10.0	2	1	9.771(.036)*
Normal	15	50.0	7	8	
High	12	40.0	12	0	
Haematocrit					
Low	9	30.0	3	6	11.271(.009)*
Normal	4	13.4	2	2	
High	17	56.6	16	1	
Platelets					
Low	1	3.3	1	0	2.845(.095)
Normal	24	80.0	15	9	
High	5	16.7	5	0	
White blood cells					
Normal	4	13.3	3	1	.055(.437)
High	26	86.7	18	8	
Sodium					
Low	9	30.0	2	7	15.761(.038)*
Normal	7	21.0	5	2	
High	14	46.6	14	0	
Potassium					
Low	3	10.0	2	1	4.802(.026)*
Normal	15	50.0	8	7	
High	12	40.0	11	1	
Urea	**(N=26)**				
Low	1	3.8	1	0	4.139(.045)*
Normal	13	50.0	6	7	
High	12	46.2	10	2	
Creatinine	**(N=28)**				
Normal	16	57.1	9	7	2.306(.109)
High	12	42.9	10	2	
Glucose					
Normal	11	36.6	5	6	4.983(.031)*
High	19	63.4	16	3	

* Significant value at $p < 0.05$ χ^2: Chi Square Test

FET: Fisher Exact Test (used instead of χ^2 if the expected values are less than 5 in more than 20% of the cells)

Table 5: distributes the studied geriatric patients according to their cognitive function of hydration alteration. The table demonstrated that 30.0% of the studied subjects had moderate cognitive impairment and 50.0% had delirium most of those patients had fluid volume deficit with a statically significant difference between hydration alteration and cognitive impairment and delirium p= (.033, .047) respectively.

Table 5: Distribution of the studied critically ill geriatric patients according to their cognitive function of hydration alteration

Cognitive function	Studied subjects (N=30)		Fluid volume deficit	Fluid volume excess	Significant test χ^2/FET(p)
Mini Mental State Examination	No	%			
Normal cognitive function	8	26.6	3	5	5.228(.033)*
Mild cognitive impairment	8	26.6	6	2	
Moderate cognitive impairment	9	30.0	8	1	
Severe cognitive impairment	5	16.8	4	1	
Intensive Care Delirium Screening Check list					
Delirious	15	50.0	13	2	3.968(.047)*
Not delirious	15	50.0	8	7	

* Significant value at $p < 0.05$ χ^2: Chi Square Test

FET: Fisher Exact Test(used instead of χ^2 if the expected values are less than 5 in more than 20% of the cells).

Discussion

Achieving optimal hydration is an essential part of holistic patient care and for optimal cognitive function. Maintaining fluid balance is important to avoid complications such as dehydration and overhydration, both of which can have serious clinical consequences **(Shepherd, 2011)**. Results of the present study revealed that the majority of studied subjects had fluid volume deficit (dehydration), and more than one third of the studied subjects was on enteral feeding. Suhr et al 2010 was in the same line with our result **(Suhr, et al., 2010)**. On the contrary to this finding, Basso et al 2013 indicated in his study that the majority of the studied ICU patients were more likely to be overhydrated and they related their results to the management strategy of supporting circulation and cardiovascular stability by using copious infusions which led to a marked tendency towards overhydration during the first days of ICU admission **(Basso, et al., 2013)**. The finding of our study could be related to the physiological changes that affect the elderly as the inability of the kidney to concentrate urine leading to less response to hormonal signals of fluid loss and decreased perception of thirst as well as increased adipose tissue **(Suhr, 2010)**. Moreover, disease state and pharmacological therapy can precipitate dehydration in critically ill geriatric patients. The present results indicated that as about one third of the studied subjects admitted to the ICU with cardiovascular disorders and most of them on diuretic therapy. In addition to gastrointestinal disorders which may manifest by vomiting, diarrhea and lead to fluid loss. Enteral feeding can increase the risk for fluid volume deficit due to lack of enteral tube flushing before or after feeding or related to tube occlusion that may hinder the administration of fluid. McMillen and Pitcher (2010) reported that the main cause of dehydration is inadequate fluid intake, excessive fluid loss or both. The present study revealed also that the majority of dehydrated subjects were females **(McMillen & Pitcher 2010)**. This finding may be attributed to women have more fat, and hence a smaller proportion of their body weight is made up by water (43.4% versus 50.8% for men) **(Bennett, 2000)**.

Cognitive function should be assessed and described on ICU admission and monitored routinely over time. In geriatric patients, acute physical illness initially present as changes in cognitive status **(Morton & Fontaine, 2013)**. Results of the current study revealed that there was a statistically significant relation between cognitive status and delirium with hydration alteration as the majority of critically ill geriatric patients who had fluid volume deficit had mild to severe cognitive impairment and delirium in comparison with those who had fluid volume excess. **Patel et at (2007), and Lindseth et al (2013)** reported that dehydration in older adults has been shown to be a reliable predictor of progressive deterioration in cognitive function and an overall reduction in quality of life **(Patel, et at., 2007; Lindseth, et al., 2013)**. Moreover, Voyer et al 2009 showed that dehydration is one of the several predisposing factors in observed confusion in long-term care residents **(Voyer, et al., 2009)**. Suhr et al 2010[1] reported that dehydration was related to worse immediate recall on a word list and to poorer working memory among the studied older adults **(Suhr, et al., 2010)**. Inouye, 2006 stated that decreased oral intake (dehydration and malnutrition) is among the predisposing factors for delirium **(Inouye, 2006)**. In the contrary, Armstrong et al 2012 found that most aspects of cognitive performance were not affected by dehydration **(Armstrong, et al., 2012)**, also Ely et al 2012[17]concluded that cognitive function was maintained normally in response to body fluid deficit **(Ely, et al., 2012)**. Our result may be explained by several hypotheses, first; the reduction of nitric oxide synthase that occurs during aging **(Wilson & Morley, 2003)**. Second, cellular dehydration is related to an increase in plasma osmolality and sodium concentration; which is known as hypernatremia, this in turn can cause change in mental function, because extracellular hyperosmolality inhabits acetylcholine **(Begum and Johnson, 2010)**. Third; it has been proposed that mild dehydration acts as a physiological stressor which competes with and draws attention from cognitive processes **(Popkin, et al., 2010)**.

The hematological markers were documented to be the most accurate means to assess patient's hydration status **(Shirreffs, 2003)**. In the current study, a significant difference was found between fluid volume deficit and excess patients in relation to hemoglobin, haematocrit, sodium, and blood urea values. Also, it was found that the majority of the patients who had fluid volume deficit had high levels of these markers. This finding was supported by Vivanti 2007 who pointed out that there was a relationship between all dehydration categories and the biochemical parameters such as sodium, urea, and creatinine **(Vivanti, 2007)**. Moreover, Shirreffs 2003 reported that hemoglobin and haematocrit can be used as sensitive markers of hydration status **(Shirreffs, 2003)**. This can be explained as, the increase in these values indicate hemo-concentration and then leading to intravascular volume depletion, and when these values decreased indicate hemo-dilution causing intravascular volume excess.

Thirst is among the physical markers of hydration alteration and fluid balance is maintained via thirst. Results of the current study indicated that there was a significant relation between thirst sensation and hydration alterations, and the majority of fluid volume deficit patients had no thirst sensation in comparison with fluid volume excess patients. This may be due to the fact that one of the most important physiological changes in old age is decreased thirst sensation (age-related hypodipsia). Waldreus et al 2011 found that hypertonic saline infusion revealed comparatively lower levels of thirst and less water intake in older adults compared with younger adults **(Waldreus, et al., 2011)**. These findings support the theory of age-related blunting of osmoreceptor sensitivity. This was supported by Arai et al 2013 who stated that thirst has often been equated with dehydration and hyperosmolality but not in older adults **(Arai, et al., 2013)**.

Another physical marker of hydration alteration is urine concentration and color. In this study, the majority of the studied subjects had dark or severe dark urine and this increased significantly in critically ill geriatric patients who had fluid volume deficit. This may be indicated by change in the urine color that related to the increase in the concentration and the chrome from increase sensible and insensible fluid loss with insufficient fluid intake. Fletcher et al 1998 reported that urine color is used as an index of hydration in critically ill patients **(Fletcher, et al., 1998)**. Moreover, Armstrong 1994 stated that urine color had a strong correlation with urine osmolality and specific gravity **(Armstrong, et al., 1994)**.

Conclusion and Recommendations

Based on the findings of the current study, it can be concluded that dehydration or fluid volume deficit is prevalent in the critically ill geriatric patients. Additionally, cognitive impairment and delirium is more common in dehydrated patients than over hydrated patients. Moreover, there were a significant relationship between patients' hydration status alterations and cognitive impairment and delirium.

In light of the current study's findings, the following recommendations are suggested:

Critically ill geriatric patients should be continuously assessed for the presence of hydration status alterations (especially fluid volume deficit), cognitive impairment and delirium and the patients should be kept well hydrated and hydration status should not be neglected. Integrating simple assessment tools including the ICU Delirium Screening Checklist into the routine assessment formats or the assessment flow sheet of the critically ill geriatric patients. In services training programs for the critical care nurses regarding importance of hydration, atypical manifestations of dehydration in old age, delirium and its causes in critically ill geriatric patients. Replication of the current study on a larger sample size and different populations is recommended for future researches.

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