Relation between Hydration Status and Cognitive Function among Critically Ill Patients

Asmaa H. H. Othman[1], Sahar Y. Mohammad[2], Eman M. M. Abubakr[3]

[1]Demonstrator in Critical Care and Emergency Nursing, Biritish University in Cario, Egypt.
e-mail: asmaahamed992@gmail.com
[2]Professor of Critical Care and Emergency Nursing, Faculty of Nursing, Ain Shams University, Cairo, Egypt.
e-mail: dr.sahar.yassien@nursing.asu.edu.eg
[3]Lecturer of Critical Care and Emergency Nursing, Faculty of Nursing, Ain Shams University, Cairo, Egypt.
e-mail: dr.eman.abobakr@nursing.asu.edu.eg

Received September 23, 2024, accepted October 6, 2024, Published January 1, 2025.

ABSTRACT

Context: Proper hydration is important for optimal cognitive functioning as it plays an important role in neural conductivity. Failure to consume sufficient water leads to the deterioration of cognitive and neurologic functions, and dehydration is a risk factor for delirium.
Aim: This study assessed the relation between hydration status and cognitive function among critically ill patients.
Methods: The study used a descriptive correlational research design and was conducted in medical intensive care units I and II at Ain Shams University Hospitals. A purposive sample of 86 critically ill patients was selected. Four tools were used: A patient's hydration status physical assessment, a mini-mental state examination, a motor activity assessment scale, and an intensive care delirium screening checklist.
Results: Clarified that 46.5% of the studied patients had Euhydration, 30.2% had dehydration, and 23.3% had overhydration on the day of admission. Regarding cognitive functions, 29.1% of the studied patients had no cognitive impairment, 34.9% had mild cognitive impairment, 36% had severe cognitive impairment, and 53.5% had delirium on the day of admission. A statistically significant negative correlation between the total score of hydration and the total score of cognitive function throughout the four assessments was revealed in this study.
Conclusion: The current study concluded a statistically significant negative correlation between hydration status and cognitive function among critically ill patients. Integrating simple assessment tools, including the intensive care delirium screening checklist, into the routine assessment formats or the assessment flow sheet of critically ill patients, is recommended. Conducting training programs for the critical care nurses regarding caring for critically ill patients who experience hydration and cognitive problems to keep them up-to-date experience, knowledge, and evidence-based practice related to caring for such a group of patients.

Keywords: Cognitive function, critically ill patients, hydration status

Citation: *Othman, A. H. H., Mohammad, S. Y., & Abubakr, E. M. M. (2025).* Relation between hydration status and cognitive function among critically ill patients. *Evidence-Based Nursing Research*, 7(1), 28-40. http://doi.org/10.47104/ebnrojs3.v7i1.369

1. Introduction

Critically ill patients are at great risk for fluid and electrolyte imbalances that affect cognitive ability and mood. Severe dehydration has been shown to cause cognitive deficits such as short-term memory and visual perceptual abilities, as well as mood disturbance. In contrast, water consumption can improve cognitive performance, particularly visual attention and mood *(Joannes-Boyau et al., 2022).*

Proper hydration is important for optimal cognitive functioning as it plays a vital role in neural conductivity. Dehydration occurs when the body loses more water than is taken in, whereas hypohydration refers to the state of water deficit. These conditions result in less-than-optimal hydration and may elicit adverse physiological consequences. However, the adult human body contains around 60% water. All the cells in the body, including brain cells, depend on this water to carry out essential functions. Therefore, if water levels are too low, the brain cells cannot function properly, leading to cognitive problems *(Patel et al., 2023).*

Fluids are commonly used in critically ill patients to improve hemodynamics, give caloric intake, protect the kidneys from chemicals such as contrast, globin, uric acid, and others, and enhance drug dilution. Intravenous fluids in critically ill patients can generally be divided into resuscitation, replacement, and maintenance. While resuscitation fluids are especially important in the initial phase of treatment to regain hemodynamic stability and are administered as boluses, maintenance fluids are mostly given as continuous infusions and aim to cover a patient's daily requirements. Replacement fluids have a special status and are designed to compensate for specific losses (such as electrolytes) *(Rivera, 2022).*

Failure to consume enough water leads to the deterioration of cognitive and neurologic functions, organ failure, and, in extreme cases, death (*Káňová et al., 2023).* Dehydration is a risk factor for delirium, which presents as dementia in critically ill patients. A recent study shows that dehydration is one of several predisposing factors in the observed confusion among long-term care residents. In addition, dehydration worsens cognitive performance, especially for tasks requiring attention, executive functions,

[1]Correspondence author: Asmaa Hamed Hasan Othman

and coordination, when water deficiencies exceed 2% of body weight *(Gonçalves et al., 2022).*

One systematic review of 89 studies reported that prevalence of cognitive impairment ranged from 5.1% to 41% with a median of 19.0%. The incidence (11 studies) of cognitive impairment ranged from 22 to 76.8 per 1000 person-years, with a median of 53.97 per 1000 person-years *(Pais et al., 2020).* Delirium is an acute health problem that affects critically ill adult patients admitted to the intensive care unit (ICU) *(WHO, 2021).*

Delirium continues to be an increasing challenge for the healthcare team, especially nurses, who have the most person-to-person contact with the patients during their hospital stay *(Thomas et al., 2021).* It affects a patient's conscious and cognitive state, causing an acute alteration in attention, perception, and behavior, which has a significant impact on the healthcare system due to prolonged stay at hospitals, increased healthcare costs, readmission, falls, and adverse patient outcomes such as death, longer duration of mechanical ventilation, and higher re-intubation rate *(Al-Hoodar et al., 2022).*

The prevalence of delirium is approximately 23,000 per 100,000 hospitalized patients worldwide *(Gibb et al., 2020).* A high incidence of delirium, up to 46.3% among patients admitted to intensive care units, had been reported. Delirium affects more than 20% of all hospitalized patients and 80% of mechanically ventilated intensive care unit patients *(Rosgen et al., 2020).*

2. Significance of the study

Delirium is often a misdiagnosed, unrecognized, and misunderstood condition in the intensive care unit that has been associated with increased mortality and morbidity. The prevalence of delirium is approximately 23,000 per 100,000 hospitalized patients worldwide *(Gibb et al., 2019).* A high incidence of delirium, up to 46.3% among patients admitted to intensive care units, had been reported. Delirium affects more than 20% of all hospitalized patients and 80% of mechanically ventilated intensive care unit patients *(Rosgen et al., 2020).* Therefore, this study was conducted to assess the relation between hydration status and cognitive function among critically ill patients.

3. Aim of the study

The present study aimed to assess the relation between hydration status and cognitive function among critically ill patients through the following:

- Assessing the hydration status among critically ill patients.
- Assessing the cognitive function among critically ill patients.
- Assessing the relation between hydration status and cognitive function among critically ill patients.

3.1. Research Questions

The study was conducted to answer the following questions:

- What is the hydration status among critically ill patients?
- What is the cognitive function among critically ill patients?
- Is there a relation between hydration status and cognitive function among critically ill patients?

4. Subjects & Methods

4.1. Research Design

A descriptive correlational research design was conducted to achieve the aim of this study. A correlational research design investigates relationships between variables without the researcher controlling or manipulating them. A correlation reflects the strength and direction of the relationship between two (or more) variables. The direction of a correlation can be either positive or negative *(Bhandari & Kumar, 2023).*

4.2. Study setting

This study was conducted at medical intensive care units (ICU) I and II on the first floor of Ain Shams University Hospital, affiliated with Ain Shams University, Cairo, Egypt. Each unit consisted of two rooms. The first room had five ICU beds with five mechanical ventilators, five monitors, and five pulse oximeters. The second room had 12 beds with 12 mechanical ventilators, 12 monitors, 12 pulse oximeters, a physician's office, a nursing office, a computer room, and a counter.

4.3. Subjects

A purposive sample of 86 critically ill patients was included in the study from the previously mentioned settings. The sample was calculated using the following equation *(Thompson, 2012)* with a confidence level of 95% and the flow rate of cases, which is 740 cases of critically ill patients admitted to the unit /year (2021).

$n = [2 (Z\alpha/2 + Z\beta)^2 \times p (1\text{-}p)] / (p1 - p2)^2]$

Therefore,

$n = [2(1.96 + 0.84)^2 \times 0.9 (1\text{-}0.9)] / (0.136 – 0.045)^2]$

Hence, the total sample size required from the hospitals = 86 patients.

Inclusion criteria

The studied patients were selected according to the following criteria: Adult-conscious patients from both genders, ages 18 to 60, on oral or tube feeding, and patients with central venous catheters and urinary catheters.

Exclusion criteria

Patients diagnosed with neurodegenerative disease, depression, or being treated with antidepressants; taking corticosteroids and diuretics; had vomiting, diarrhea, or fever within the past three days.

4.4. Tools of data collection

The tools used for the study consist of

4.4.1. Patient's Hydration Status Physical Assessment Record

Patient's hydration status physical assessment record was used to assess the hydration status of critically ill patients. It was adapted from *Afifi et al. (2022), Hise and Gonzalez (2018), Bak et al. (2017), and DAS-Taskforce 2015 et al. (2015)*. The investigator modified it to add lip condition and whole-body edema. It was filled by the investigator from the patient. The tools consisted of three parts as the following:

Part I: Patient demographic data. It included seven items: patient's hospital number, gender, age, marital status, educational level, residence, and occupation.

Part II: Patient hydration status. assessed the general signs of altered hydration status, including thirst sensation, eye condition, irritability or restlessness, sleepiness, cool peripheral, and fatigue on the day of admission, the first day, the second day, and the third day after admission. This part includes an assessment of the fluid balance, including oral intake in 24 hours, amount of NGT intake in 24 hours, amount of IV fluid in 24 hours, Total intake in 24 hours, total output in 24 hours, and daily fluid balance on the day of admission, the first day, the second day, and the third day after admission. These data are presented as descriptive statistics of numbers and percentages.

4.4.2. Mini-Mental State Examination (MMSE)

It was adopted from *Folstein et al. (1975).* A mini-mental state examination was used to assess the cognitive function of the studied subjects. It was written in English language and translated by the investigator to the Arabic language filled by the investigator. It included assessing five mental functions: orientation (ten questions), registration (three questions), attention and calculation (five questions), recall (three questions), and language praxis (nine questions).

Scoring system

Items were scored on a Likert scale and ranged from (0-30) each function was scored as orientation (ten grades), registration (three grades), attention and calculation (five grades), recall (three grades), and language and praxis (nine grades) with each subsection was scored as one grade for each item and the total score 30. Moreover, the total score was classified as follows:

- Severe cognitive impairment 0-17
- Mild cognitive impairment 18-23
- No cognitive functions 24-30

4.4.3. Motor Activity Assessment Scale (MAAS)

It was adopted from *Devlin and Muller (1999).* It is used to assess motor activity in unventilated patients. This tool was used in the current study before Intensive Care Delirium to determine whether the patient patients could be assessed for delirium. If MAAS <2 unable to assess for delirium screen. Suppose MAAS >2 screens using intensive care delirium. The investigator filled it out in English. It included seven questions (Unresponsive to pain; opens eyes and moves to pain only; opens eyes and moves to voice; calm and cooperative; restless but cooperative; follows commands, agitated, dangerously agitated).

Scoring system

- *MAAS < 2 records: Unable to assess" for delirium screen or no delirium detected*
- *MAAS > 2 records: Screen using Intensive Care Delirium Screening Checklist (ICDSC).*

4.4.4. Intensive Care Delirium Screening Checklist (ICDSC)

This checklist was adopted from *Bergeron et al. (2001).* The (ICDSC) was in English and filled by the investigator. It is used to assess eight key features of delirium, namely, patient altered level of consciousness, inattention, disorientation, hallucination or delusion, psychomotor agitation or retardation, inappropriate mood or speech, sleep/wake cycle disturbance, and symptom fluctuation.

Scoring system

The scores for each item were assigned as follows: Obvious manifestation of an item equal to one and no obvious manifestation of an item equal to zero. Regarding the altered level of consciousness, score zero, If MAAS is (0) no response, score one response to a noxious stimulus only. Score (0) if MAAS score is 3 (calm, cooperative, interacts with the environment without prompting). Score (1) if MAAS score is 2, 4, 5, or 6 (MAAS score of 2 is a patient who only interacts or responds when stimulated by light touch or voice – no spontaneous interaction or movement; 4, 5, and 6 are exaggerated responses). If MAAS ≠ 0 or 1, screen items 2-8 and complete a total score of all eight items.

Regarding inattention, score one for any of the following: Difficulty following conversation or instructions, easily distracted by external stimuli, and difficulty shifting focuses; score zero for no obvious manifestation of an item. Regarding disorientation, score one for any obvious mistake in person, place, or time and zero for no obvious manifestation of an item.

Regarding hallucination or delusion, score one for any of the following: Unequivocal manifestation of hallucinations or behavior probably due to hallucinations, delusions, and gross impairment in reality testing; score zero for no obvious manifestation of an item.

Regarding psychomotor agitation or retardation score one for any of the following: Hyperactivity requiring additional sedatives or restraints in order to control potential dangerousness (e.g., pulling out IV lines, hitting staff), hypoactivity or clinically noticeable psychomotor slowing and differs from depression by fluctuation in consciousness and inattention, score zero for no obvious manifestation of an item.

Regarding inappropriate speech or mood, score one for any of the following: Inappropriate, disorganized, or incoherent speech and inappropriate display of emotion related to events or situations; score zero for no obvious manifestation of an item. Regarding sleep/wake cycle disturbance score one for any of the following: Sleeping less than 4 hours or frequently waking at night (do not consider wakefulness initiated by medical staff or loud environment) and sleeping during most of the day, score zero for no obvious manifestation of an item.

Regarding symptom fluctuation, score one for fluctuation of the manifestation of any item or symptom over 24 hours (e.g., from one shift to another) and score zero for no obvious manifestation of an item. The total score was evaluated as follows:

- Patient classified as suggested delirious: score ≥4
- The patient is not delirious: score <4

4.5. Procedures

Ethical Consideration: Official permission to conduct the study was obtained from the Scientific Research Ethics Committee at the Faculty of Nursing, Ain Shams University.

Participation in the study was voluntary, and subjects were given complete information about the study before signing the informed consent. The investigator explained the purpose and nature of the study, stating the possibility to withdraw at any time, and confidentiality of the information was assured. The participant's ethics, values, culture, and beliefs were respected.

Validity: The study tools were tested for validity (face and content validity). Face validity aimed to determine whether the tools measured what they were supposed to measure. Content validity was conducted to determine whether the tools' content can achieve the study's aim. It was measured by a jury of seven experts from different academic categories (four professors, one assistant professor, and two lecturers of critical care nursing) at the Faculty of Nursing at Ain Shams University. The experts reviewed the tool for clarity, relevance, accuracy, comprehensiveness, simplicity, and applicability, and necessary modifications were made.

Reliability: Alpha Cronbach's was used to determine the internal consistency of the study tools. The reliability of the tools was tested to determine the extent to which the tools' items relate. Alpha Cronbach's reliability coefficient normally ranges between 0 and 1, with higher values (more than 0.7) denoting acceptable reliability. The reliability scores of tools are (0.714, 0.833, 0.815, and 0.843) for the patient's assessment record, Mini-Mental State Examination (MMS), Intensive Care Delirium Screening Checklist (ICDSC), and total questionnaire, respectively.

Initially, the investigator got approval from the general manager of Ain Shams University Hospital and then from the head nurse of ICU I & II to collect the patients' data.

A pilot study was carried out on 10% of the total sample (n=9) of critically ill patients to test the feasibility of the research process and applicability of the constructed tools, the clarity of the questions, and the time needed to complete the study tools. Based on the results, modifications were made, and the subjects included in the pilot study were excluded from the main study sample.

Fieldwork: The investigator explained the study's aim and determined the sample size and method of data collection from the patients. After approval, the investigator began using the study's tools to collect data. Data were collected within six months, from June 2023 to November 2023.

The investigator visited ICU I & II four days/week during the morning and afternoon shifts (8:00 am to 8:00 pm). The ratio of the patients/day was four patients till the sample size was completed.

The assessment tools were applied for four days because the patient's stability status changed from the day of admission to the second and third days after admission. The investigator assesses each patient's hydration status at the same time every day and simultaneously applies the patient's mini-mental state examination, motor activity assessment, and intensive care delirium every day.

The investigator used the motor activity assessment scale for unventilated patients to complete the intensive care delirium screening checklist (if MAAS > 2, the intensive care delirium checklist screening was completed by the investigator).

The study's tools were completed and filled in by the investigator within an average time of (40-60) minutes for patient hydration status and physical assessment, (30) minutes for assessment of Mini-Mental State, (5) minutes for assessment of Motor Activity Assessment MAAS (40) minutes for assessment of Intensive Care Delirium.

The assessment tools are applied for four days because the patient's stability status changes from the day of admission to the third day after admission.

4.6. Data analysis

Data were collected, organized, tabulated, and analyzed using the Statistical Package for Social Sciences, version 22.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean±standard deviation (SD). Qualitative data were expressed as frequency and percentage. Pearson's correlation coefficient (r) test was used to assess the degree of association between two sets of variables. The confidence interval was 95%, and the accepted error margin was 5%. So, the p-value was considered significant: P-value ≤0.05 was considered significant, and P-value >0.05 was considered insignificant.

5. Results

Table 1 illustrates that 69.8% of the studied patients were males, 58.1% were >50 years with a mean age of 48.95±4.75 years, and 64.0% were married. Regarding educational level, 47.7% of the studied patients could not read or write, 64.0% lived in rural areas, and 65.1% were non-employed.

Table 2 reveals that 64%, 61.6%, 60.5%, and 58.1% of the studied patients had no thirst sensation on the day of admission, the first day, the second day, and the third day after admission, respectively. Also, 52.3%, 58.1%, 61.6%, and 64% of the studied patients had normal eye condition on the day of admission, the first day, the second day, and the third day after admission, respectively. In addition, 70.9%, 68.6%, 73.3%, and 76.7% of the studied patients had no irritability or restlessness on the day of admission, the first day, the second day, and the third day after admission, respectively. While 70.9%, 69.8%, 65.1%, and 62.8% of the studied patients had no sleepiness on the day of admission, the first day, the second day, and the third day after admission, respectively. In addition, 65.1%, 62.8%, 59.3%, and 53.5% of the studied patients had no cool periphery on the day of admission, the first day, the second day, and the third day after admission, respectively. Also, 65.1%, 67.4%, 69.8 %, and 70.9% had no fatigue on the day of admission, the first day, the second day, and the third day after admission, respectively.

Table 3 indicates that 64.0%, 67.4%, 70.9%, and 74.4% of the studied patients had normal fluid intake in 24 hrs. on the day of admission, the first day, the second day, and the third day after admission, respectively. Also, 58.1%, 60.5%, 64.0%, and 66.3% had normal total output in 24 hrs. on the day of admission, the first day, the second day, and the third day after admission, respectively.

Figure 1 clarifies that 46.5% of the studied patients had Euhydration, 30.2% had dehydration, and 23.3% had overhydration on the day of admission, respectively. Meanwhile, 53.5% of the studied patients had Euhydration, 25.6% had dehydration, and 20.9 % had overhydration on the third day after admission, respectively.

Table 4 reveals that regarding orientation function, 36.0% of the studied patients were mildly impaired on the day of admission, 37.2% had severely impaired registration on the first day after admission, 40.7% were not impaired on the second day after admission, and 46.5% were mildly impaired on the third day after admission**.**

Regarding registration function, 37.2% of the studied patients were severely impaired on the day of admission, 37.2% were mildly impaired on the first day after admission, 41.9% were mildly impaired on the second day after admission, and 40.7% had no impairment on the third day after admission.

Regarding attention and calculation function, 34.9% of the studied patients had no impairment on the day of admission, 40.7% were severely impaired on the first day after admission, 36.0% were mildly impaired on the second day after admission, and 38.4% were mildly impaired on the third day after admission.

Regarding recall function, 36.0 % of the studied patients were mildly impaired on the day of admission, 36.0% were severely impaired on the first day after admission, 41.9% were mildly impaired on the second day after admission, and 46.5% were mildly impaired on the third day after admission.

Regarding language and praxis function, 41.9% of the studied patients were severely impaired on the day of admission, 34.9% were not impaired on the first day after admission, 46.5% were mildly impaired on the second day after admission, and 34.9% were mildly impaired on the third day after admission.

Figure 2 reveals the cognitive function of the studied patients. On the day of admission and the first day after admission, 36.0 % and 34.9%, respectively, had severe cognitive impairment, while 40.7% and 40.9% of the studied patients had mild cognitive impairment on the second and third days after admission, respectively.

Table 5 clarifies that 57% and 61.6% of the studied patients had altered levels of consciousness on the day of admission and the first day after admission. In comparison, 55.8% and 60.5% of them had inattention on the day of admission and the third day after admission. 52.3% of them were disoriented on the day of admission, while 60.5% of them had hallucinations, delusions, and psychosis on the first and second days after admission. 61.6% of the studied patients had psychomotor agitation or retardation on the day of admission and the first day after admission, while 51.2% of them had inappropriate speech or mood on the day of admission. 59.3 % had sleep-wake/cycle disturbance on the first day of admission, while 53.5% had symptom fluctuation on the day of admission.

Figure 3 shows that 53.5% of the studied patients suggested delirium on the day of admission and the first day after admission. At the same time, 52.3% and 50% suggested delirium on the second and third days after admission, respectively.

Table 6 shows a statistically significant negative correlation between total score of hydration status and total score of cognitive function on the first day after admission (p-value <0.05), and there was a statistically significant negative correlation between cognitive function and delirium on the first day after admission (p-value <0.05). At the same time, there was a positive correlation between the total score of hydration status and delirium on the first day after admission (p-value <0.05).

Table 7 illustrates a statistically significant negative correlation between the total score of hydration status and total score of cognitive function on the second day after admission (p-value <0.05), and there was a statistically significant negative correlation between cognitive function and delirium on the second day after admission (p-value <0.05). At the same time, there was a positive correlation between the total score of hydration status and delirium on the second day after admission (p-value <0.05).

Table 8 denotes a statistically significant negative correlation between the total score of hydration status and total score of cognitive function on the third day after admission (p-value <0.05), and there was a statistically significant negative correlation between cognitive function and delirium on the third day after admission (p-value <0.05). In comparison, there was a positive correlation between total hydration status score and total delirium score on the third day after admission (p-value <0.05).

Table 9 clarifies a statistically significant relation between hydration status and age of the studied patients on the day of admission, the first day, the second day, and the third day after admission, while there was a statistically significance relation between hydration status and educational level of the studied patients on the day of admission and the second day after admission (p-value <0.05).

6. Discussion

Body hydration status plays a relevant role in health and disease. For instance, high intracellular water content is associated with better functional performance and lower risk of frailty in older adults. Any imbalance of the hydration status can have health effects to life-threatening consequences. Dehydration, for instance, can strongly impair the body's cognitive functions and physical abilities. In contrast, high extracellular water content due to environmental or behavioral factors can lead to severe complications in patients in the form of edema *(Hagi et al., 2021).* Therefore, this study assessed the relationship between hydration status and cognitive function among critically ill patients.

Regarding demographic data of the studied patients, more than two-thirds of the studied patients were males, more than one-half of them were above fifty years, the mean age was 48.95±4.75 years, nearly two-thirds of them were married, nearly one-half could not read or write, near two-thirds of them were from rural residents, and were non-employed. From the investigator's point of view, this could be because males are at high risk for cardiovascular diseases due to smoking or familial hypercholesterolemia. Regarding age, older patients are more likely to develop chronic health conditions such as heart disease, diabetes, respiratory issues, and kidney disease. These conditions can make them more susceptible to severe illness and complications, necessitating ICU care that was present in this study. Also, most do not work because of their age and clinical conditions. Most of them are married because of their age according to culture regarding their level of education might be due to rural

Table (1): Frequency and percentage distribution of the studied patient's demographic data (n=86).

Demographic data	No.	%
Gender		
Male	60	69.8
Female	26	30.2
Age (years)		
<30 years	5	5.8
30-<40 years	6	7.0
40-<50 years	25	29.1
>50 years	50	58.1
Mean±SD	48.95±4.75	
Marital Status		
Single	20	23.3
Married	55	64.0
Divorced / Widow	11	12.8
Education Level		
Cannot read and write	41	47.7
Read &write	20	23.3
Secondary Education	23	26.7
High Education	2	2.3
Residence		
Urban	31	36.0
Rural	55	64.0
Occupation		
Employed	30	34.9
Non – Employed	56	65.1

Table (2): Frequency and percentage distribution of the studied patients' general signs of altered hydration status (n=86).

General signs of altered hydration status	Day of admission		1st day after admission		2nd day after admission		3rd day after admission	
	No.	%	No.	%	No.	%	No.	%
Thirst Sensation								
Yes	31	36.0	33	38.4	34	39.5	36	41.9
No	55	64.0	53	61.6	52	60.5	50	58.1
Eye condition								
Normal	45	52.3	50	58.1	53	61.6	55	64.0
Sunken	21	24.4	20	23.3	22	25.6	21	24.4
Puffy	20	23.3	16	18.6	11	12.8	10	11.6
Irritability or restlessness								
Yes	25	29.1	27	31.4	23	26.7	20	23.3
No	61	70.9	59	68.6	63	73.3	66	76.7
Sleepiness								
Yes	25	29.1	26	30.2	30	34.9	32	37.2
No	61	70.9	60	69.8	56	65.1	54	62.8
Cool Peripheral								
Yes	30	34.9	32	37.2	35	40.7	40	46.5
No	56	65.1	54	62.8	51	59.3	46	53.5
Fatigue								
Yes	30	34.9	28	32.6	26	30.2	25	29.1
No	56	65.1	58	67.4	60	69.8	61	70.9

Table (3): Frequency and percentage distribution of the studied patients' fluid balance status (n=86).

Fluid balance	Day of admission		1st day after admission		2nd day after admission		3rd day after admission	
	No.	%	No.	%	No.	%	No.	%
Total intake in 24 hrs.								
Low less than 500 ml	15	17.4	13	15.1	12	14.0	10	11.6
Normal 2500-3500 ml	55	64.0	58	67.4	61	70.9	64	74.4
High more than 3500ml	16	18.6	15	17.4	13	15.1	12	14.0
Total output in 24 hrs								
Low less than 500 ml	5	5.8	4	4.7	4	4.7	2	2.3
Normal 2500-3500 ml	50	58.1	52	60.5	55	64.0	57	66.3
High more than 3500ml	31	36.0	30	34.9	27	31.4	27	31.4
Daily balance	Mean±SD 320±36.78		Mean±SD 285±2.15		Mean±SD 295±40.55		Mean±SD 200±39.57	

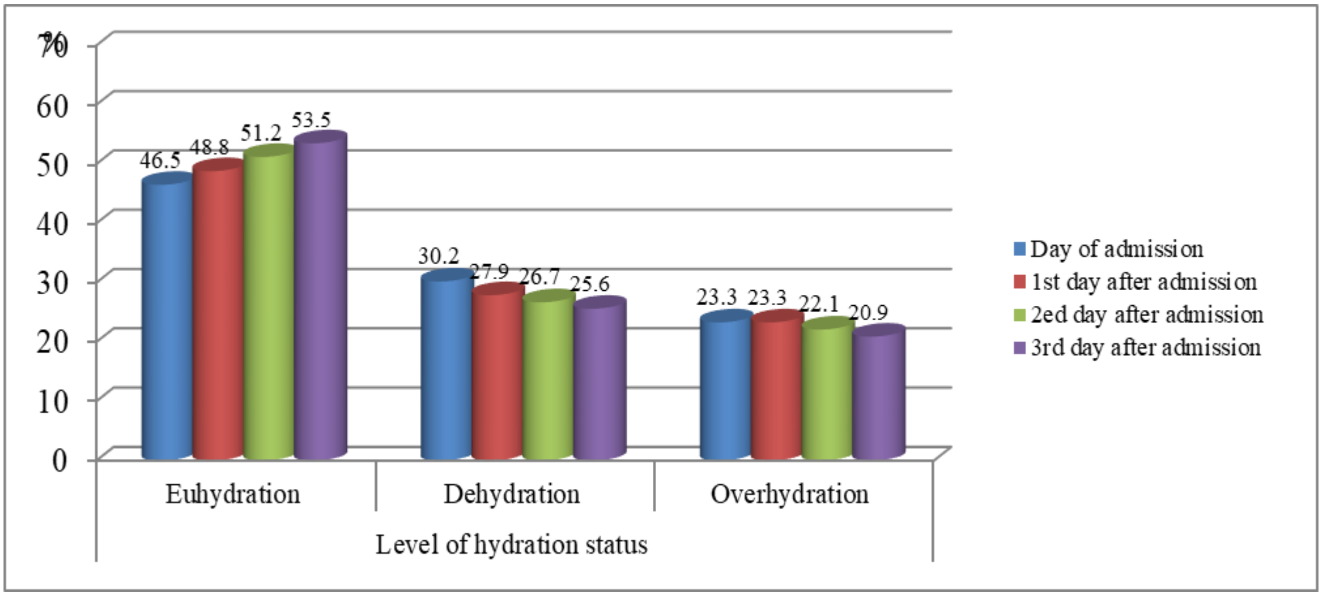

Figure (1): Percentage distribution of total studied patients' level of hydration status on the day of admission, first day, second day, and third day after admission (n=86).

Table (4): Frequency and percentage distribution of the studied patients according to cognitive function (MMSE) (n=86).

Cognitive functions	level	Day of admission		1st day after admission		2nd day after admission		3rd day after admission	
		No.	%	No.	%	No.	%	No.	%
Orientation	**No impairment**	29	33.7	30	34.9	35	40.7	28	32.6
	Mild impairment	31	36.0	24	27.9	25	29.1	40	46.5
	Severe impairment	26	30.2	32	37.2	26	30.2	18	20.9
Registration	**No impairment**	23	26.7	26	30.2	28	32.6	35	40.7
	Mild impairment	31	36.0	32	37.2	36	41.9	31	36.0
	Severe impairment	32	37.2	28	32.6	22	25.6	20	23.3
Attention &Calculation	**No impairment**	30	34.9	28	32.6	29	33.7	29	33.7
	Mild impairment	27	31.4	23	26.7	31	36.0	33	38.4
	Severe impairment	29	33.7	35	40.7	26	30.2	24	27.9
Recall	**No impairment**	27	31.4	26	30.2	27	31.4	26	30.2
	Mild impairment	31	36.0	29	33.7	36	41.9	40	46.5
	Severe impairment	28	32.6	31	36.0	23	26.7	20	23.3
Language &Praxis	**No impairment**	21	24.4	30	34.9	30	34.9	29	33.7
	Mild impairment	29	33.7	27	31.4	40	46.5	30	34.9
	Severe impairment	36	41.9	29	33.7	16	18.6	27	31.4

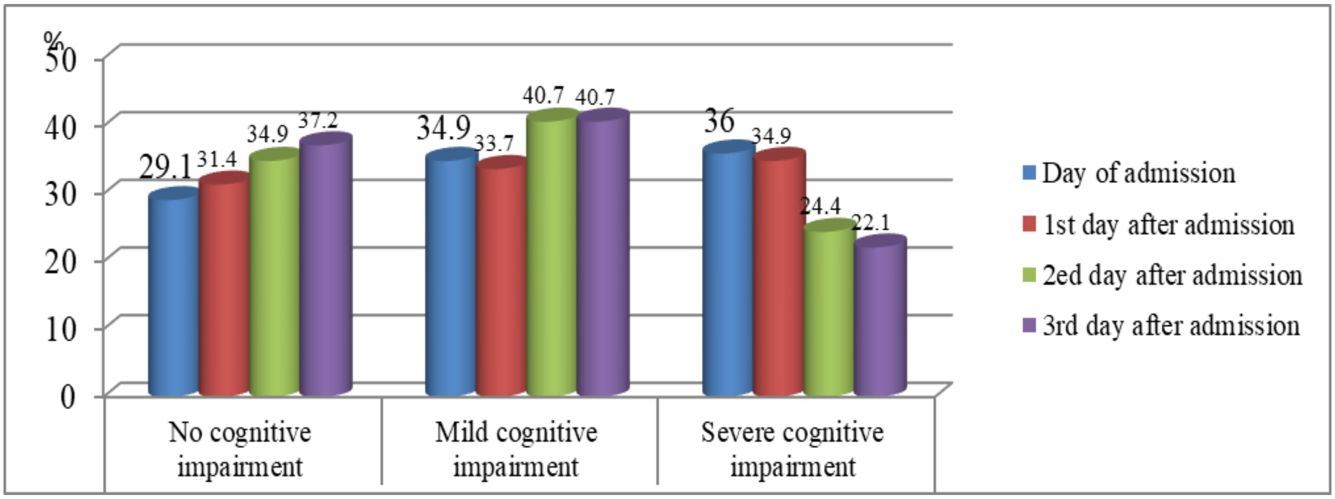

Figure (2): Percentage distribution of total studied patients' cognitive function on admission, first day, second day, and third day after admission (n=86).

Table (5): Frequency and percentage distribution of the studied patient's delirium state (n=86).

Delerium state	Day of admission		1st day after admission		2nd day after admission		3rd day after admission	
	No.	%	No.	%	No.	%	No.	%
Altered Level of Consciousness	49	57.0	53	61.6	50	58.1	36	41.9
Inattention	48	55.8	43	50.0	46	53.5	52	60.5
Disorientation	45	52.3	35	40.7	42	48.8	41	47.7
Hallucination/ delusions/ psychosis	42	48.8	52	60.5	52	60.5	48	55.8
Psychomotor agitation or retardation	53	61.6	53	61.6	46	53.5	34	39.5
Inappropriate speech or mood	44	51.2	40	46.5	41	47.7	41	47.7
Sleep-wake/cycle disturbance	41	47.7	51	59.3	49	57.0	48	55.8
Symptom fluctuation	46	53.5	40	46.5	36	41.9	43	50.0

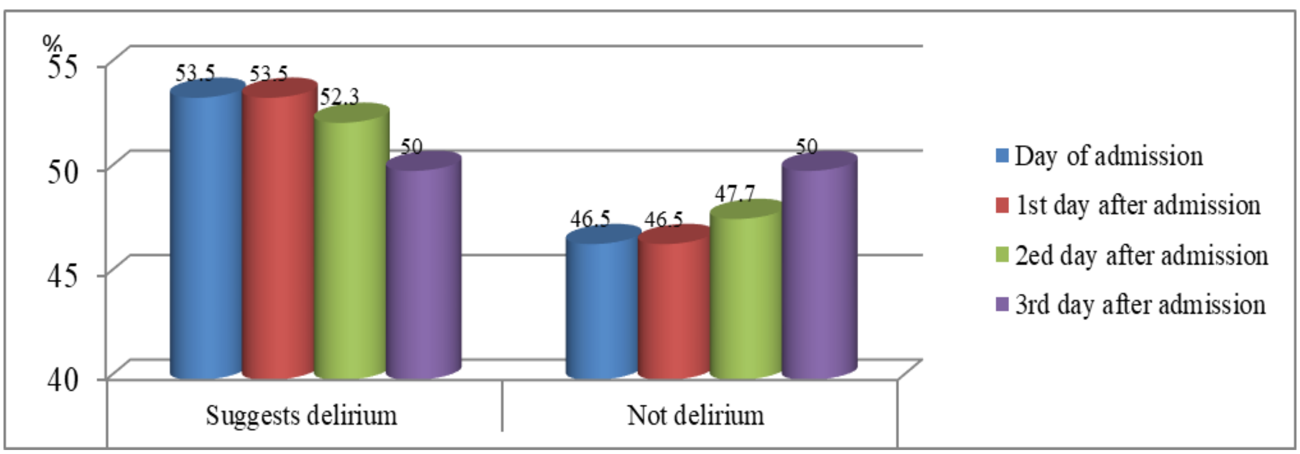

Figure (3): Percentage distribution of total studied patients' delirium on the day of admission, first day, second day, and third day after admission (n=86).

Table (6): Correlation between total score of hydration status, total score of cognitive function, and total delirium level on admission (n=86).

Item	The total score of hydration status R	p-value
Total score of cognitive function	-0.643	<0.001
Total score of Intensive Care Delirium	0.602	<0.001
Item	**Total score of cognitive function R**	**p-value**
Total score of Intensive Care Delirium	-0.350	0.031

Table (7): Correlation between total score of hydration status, total score of cognitive function, and total delirium level on the first day after admission (n=86).

Item	The total score of hydration status r	p-value
Total score of cognitive function	-0.329	0.035
Total score of Intensive Care Delirium	0.346	0.032
Item	**Total score of cognitive function r**	**p-value**
Total score of Intensive Care Delirium	-0.491	<0 .001

Table (8): Correlation between total score of hydration status, total score of cognitive function, and total delirium level on the second day after admission (n=86).

Item	The total score of hydration status r	p-value
Total score of cognitive function	-0.396	0.022
Total score of Intensive Care Delirium	0.455	<0.001
Item	**Total score of cognitive function r**	**p-value**
Total score of Intensive Care Delirium	-0.673	<0.001

Table (9): Correlation between total score of hydration status, total score of cognitive function, and total delirium level on the third day after admission (n=86).

Item	The total score of hydration status r	p-value
Total score of cognitive function	- 0.465	<0.001
Total score of Intensive Care Delirium	0.722	<0.001
Item	**Total score of cognitive function r**	**p-value**
Total score of Intensive Care Delirium	- 0.744	<0.001

residents having limited access to schools and educational resources. Schools may be far from remote villages, making it difficult for children to attend regularly. Additionally, schools in rural areas may lack adequate funding, qualified teachers, and proper facilities, which can impact the quality of education. These results agreed with *Hassan and Abd Elhamid (2017),* who stated in the study" Relationship between hydration status and cognitive function in critically ill geriatric patients" that less than two-thirds of the studied patients were aged 60 to less than 70. In addition, these results agreed with *Afifi et al. (2022),* who stated in the study entitled: "Factors affecting hydration status among critically ill patients" that half of the studied patients were more than or equal to sixty years old. More than half of the studied patients were males and not working, and more than two-thirds were married. Conversely, the study disagreed with the educational level of the studied patients, that more than one-third of them were highly educated.

According to general signs of altered hydration status, the current study reveals that more than half of the studied patients had not a thirst sensation, irritability or restlessness, sleepiness, cool peripheral and fatigue with normal eye condition on the day of admission, first, second and third day after admission. From the investigator's point of view, these findings may be due to patients in the ICU often receiving fluids through intravenous (IV) lines or feeding tubes. These methods can provide necessary hydration without requiring the patient to drink orally.

This result is in line with *Holroyd (2020),* who found in the study entitled "Frequency volume charts and fluid balance monitoring: Getting it right" that following fluid balance is crucial for medical staff to monitor patients' hydration status and administer fluids as needed, even if the patient does not express thirst.

The current study agreed with *Mansutti et al. (2020),* who stated in the study entitled "Episodes of psychomotor agitation among medical patients: Findings from a longitudinal multicenter study" that irritability or restlessness occurs in up to one-quarter of older people hospitalized for medical illnesses and is more common (up to one third) in those admitted to intensive care units.

This study disagreed with *Vanhorebeek et al. (2020),* who stated in the study entitled "ICU-acquired weakness, intensive care med" that critically ill patients frequently acquire muscle weakness, cool peripheral, and fatigability in the ICU, adversely affecting short- and long-term outcomes.

The fluid balance in the studied patients reveals that around two-thirds of the studied patients had normal fluid intake and output within 24 hours on the day of admission and the first, second, and third days after admission. From the investigator's point of view, they may be related to most ICU patients administering intravenous fluids, adjusting fluid infusion rates, and closely monitoring their intake and output. Additionally, healthcare providers in the ICU have strategies to minimize fluid losses, such as controlling fever, optimizing respiratory support, and managing gastrointestinal losses. Regular assessment and documentation of fluid intake and output are essential components of patient care in the ICU.

The current study agreed with *Lo Basso (2020),* who found in the study entitled "Mitigating delirium for the elderly postoperatively without medication," that most of the studied ICU patients were more likely to have normal fluid intake and fluid output.

Regarding the total number of studied patients' hydration statuses, around half of the studied patients had euhydration on the day of admission, the first, second, and third day after admission. From the investigator's point of view, this may be related to the management strategy of supporting circulation and cardiovascular stability by using copious infusions and monitoring fluid intake and output to maintain hydration.

This study's findings agreed with *Millard-Stafford et al. (2021),* who stated in the study titled "The beverage hydration index: Influence of electrolytes, carbohydrate, and protein" that nearly one-quarter of patients were dehydrated, more than one-third were normally hydrated, and two-fifths were overhydrated upon ICU admission.

These results contradict *Ellis et al. (2020),* who stated in the study titled "Using volunteers to improve the experience of older patients in the emergency department." Over half of the studied patients had fluid volume deficits (dehydration). In contrast, one-third had fluid volume excesses (overhydration), but they reported that a few studied patients had normal hydration.

This study finding was contrary to *Elsaman (2021),* who stated in the study titled "Factors affecting the change of the urine color as a hydration indicator among critically ill patients" that more than two-thirds of the patients studied had excess fluid volume.

Regarding orientation function, the present study reveals that more than one-third of the studied patients had mild impairment on the day of admission and severe impairment on the first day after admission. Regarding registration, attention and calculation, recall, and language and praxis, around one-third had severe impairment on the day of admission and the first day after admission. At the same time, less than half of them had no or mild impairment on the second and third days after admission, which improved on the second and third days after admission. From the investigator's point of view, this may be due to age being the primary cause of cognitive impairment, and many patients are admitted with cardiovascular, liver, neurologic, renal, and respiratory disorders on admission. Additionally, the environment of the ICU had too much noise from staff and the voice of monitors, lights, and no wall clock that was controlled on the second and third day after admission.

Concerning the mini-mental state examination (total cognitive function), more than one-third of the studied patients had severe cognitive impairment on the day of admission, the first day after admission that was improved on the second and third day after admission. From the investigator's point of view, this may be due to patients having hypovolemia, fluid loss affects cognition function, and age is the primary cause of cognitive impairment. In addition, nearly similar percentages of the studied patients were admitted with cardiovascular, GIT, renal, neurologic, and respiratory disorders that might include hypertensive crisis, hepatic or pre-hepatic coma, uremic coma, altered conscious level, or hypercapnic disorders. Also, around one-third of them were hypervolemic on admission.

This result is congruent with *Lauretani et al. (2020),* who stated in the study entitled "Treatment of delirium in older persons" that one-third of the studied subjects had moderate cognitive impairment, and one-half had delirium. Most of those patients had fluid volume deficits.

According to intensive care, delirium clarifies that more than half of the studied patients had altered level of consciousness, inattention, disorientation, psychomotor agitation or retardation, inappropriate speech or mood, and symptom fluctuation on the day of admission that progressively improved on the first, second, and third day after admission. From the investigator's point of view, that might be that patients admitted to the ICU due to severe medical illnesses such as respiratory failure or shock can lead to inadequate oxygen delivery to the brain (hypoxia) or decreased blood flow (hypoperfusion), which impairs cognitive function and contribute to altered mental status. Patients in the ICU receive multiple medications, including sedatives and analgesics. These medications can have sedative effects, alter neurotransmitter levels, and contribute to delirium or other cognitive disturbances. Patients may experience significant pain and discomfort due to their condition or medical interventions; pain can contribute to agitation, restlessness, and difficulty concentrating or following instructions. The ICU environment is noisy and busy, with frequent monitoring and medical interventions that can disrupt sleep patterns. Sleep deprivation and fragmentation can contribute to cognitive dysfunction, confusion, and mood disturbances.

Regarding intensive care delirium, more than half of the studied patients suggested delirium on the day of admission and the first, second, and third days after admission. From the investigator's point of view, the study patient might have taken sedatives, opioids, and anticholinergic drugs, which can increase the risk of delirium. These medications may affect neurotransmitter levels in the brain or directly affect cognitive function.

These results disagreed with *Detroyer et al. (2020),* who stated in the study entitled "Psychometric properties of the intensive care delirium screening checklist when used by bedside nurses in clinical practice" and reported that less than one-third developed delirium and less than one-quarter of patients without delirium.

Concerning the correlation between total score of hydration status, total score of mini-mental state, and total score of intensive care delirium, there was a negative correlation between total score of hydration status and total score of mini-mental state on the day of admission on the first day, on the second day and the third day after admission. From the investigator's point of view, a negative correlation between hydration status and mini-mental state suggests that lower hydration levels upon admission to the ICU are associated with lower mini-mental state scores, indicating poorer cognitive function. Ensuring adequate hydration may be important for preserving cognitive function in critically ill patients.

There was a negative correlation between mini-mental state and intensive care delirium on the day of admission, on the first day, on the second day, and on the third day after admission. From the investigator's point of view, negative correlation between mini-mental state scores and intensive care delirium scores: A negative correlation between mini-mental state scores (which measure cognitive function) and intensive care delirium scores (which assess delirium symptoms) suggested that lower cognitive function upon admission is associated with a higher likelihood or severity of delirium. This finding highlights the vulnerability of patients with impaired cognitive function to delirium in the ICU setting.

While, there was a positive correlation between the total score of hydration status and the total score of intensive care delirium on the day of admission, on the first day, on the second day, and on the third day after admission. From the investigator's point of view that; Positive correlation between hydration status and ICDSC scores reflects the understanding that adequate hydration is integral to maintaining cognitive function and reducing the risk of delirium in critically ill patients. Monitoring and optimizing hydration status are important components of comprehensive care in the ICU, aimed at improving patient outcomes and reducing the incidence of delirium. These correlations highlight the importance of assessing hydration status, cognitive function, and delirium risk upon admission to the ICU and tailoring patient care accordingly.

These results are in line with *Parkinson et al. (2021),* who stated in the study entitled " Prevalence of dehydration among older adults" that there was a statistically significant relation between cognitive status and delirium with hydration alteration in the majority of critically ill patients who had fluid volume deficits, mild to severe cognitive impairment and delirium, in comparison with those who had fluid volume excess.

This result agreed with *Brody et al. (2019),* who stated in the study entitled "Cognitive performance in adults aged 60 and over: National health and nutrition examination survey" that there was a statistically significant difference between hydration alteration and cognitive impairment and delirium.

This result is supported by *Bethancourt et al. (2020),* who stated in the study titled "Cognitive performance about hydration status and water intake among older adults" that cross-sectional data makes comparisons across individuals when there may be deviations in one's baseline hydration status and resulting shift from one's own baseline cognitive test score that may be more informative of the relationship between hydration and cognitive performance.

7. Conclusion

The current study concluded that less than half of the studied patients had Euhydration, less than one-third had dehydration, and less than one-quarter had overhydration on the day of admission, respectively. One-quarter had dehydration, and less than one-quarter had overhydration on the third day after admission, respectively. Concerning cognitive function, more than one-third of the studied patients had severe cognitive impairment on the day of admission and the first day after admission. In contrast, less than half of the studied patients had mild cognitive impairment on the second day and third day after admission. According to Delirium, more than half of the studied patients had delirium on the day of admission, the first day, the second day, and the third day after admission. Additionally, there was a statistically significant negative correlation between total score of hydration status and total score of mini-mental state and there was a statistically significant negative correlation between mini-mental state and delirium. There was a positive correlation between the total hydration status score and the total intensive care delirium score on admission, the first, second, and third days after admission.

8. Recommendations

Based on the results of this study, the following recommendations were proposed:

- Integrate simple assessment tools, including the ICU Delirium Screening Checklist, into the routine assessment formats or the assessment flow sheet of the critically ill patients.
- Adequate hydration is integral to maintaining cognitive function and reducing the risk of delirium in critically ill patients.
- Conducting training programs for the critical care nurses regarding critically ill patients who experience hydration and cognitive problems to keep them abreast enough knowledge and evidence-based practice related to caring for this group of patients.
- Further research should be conducted to raise awareness of patients about hydration status and factors affecting hydration status.
- Replication of the current study on a larger sample size and different populations is recommended for future research.
- Implement educational programs for nurses who care for critically ill patients suffering from dehydration and cognitive impairment to improve their outcomes.

9. References

Afifi, S. S., Ahmed, O. A., Abd Elrahman, A. A., & Abd Elsalam, S. N. (2022). Factors affecting hydration status among critically ill patients. *Egyptian Journal of Health Care, 13*(2), 1213–1225. https://di.org/10.21608/ejhc.2022.240854

Al-Hoodar, R. K., Lazarus, E. R., Al Omari, O., & Al Zaabi, O. (2022). Incidence, associated factors, and outcome of delirium among patients admitted to ICUs in Oman. *Critical Care Research and Practice, 2022*(1), 4692483. https://doi.org/10.1155/2022/4692483.

Bak, A., Tsiami, A., & Greene, C. (2017). Methods of assessment of hydration status and their usefulness in detecting dehydration in the elderly. *Current Research in Nutrition and Food Science Journal, 5*(2), 43–54. Https://doi.org/10.12944/crnfsj.5.2.01.

Bergeron, N., Dubois, M. J., Dumont, M., Dial, S., & Skrobik, Y. (2001). Intensive care delirium screening checklist: Evaluation of a new screening tool. *Intensive Care Medicine, 27(5), 859–864.* https://doi.org/10.1007/s001340100909

Bethancourt, H. J., Kenney, W. L., Almeida, D. M., & Rosinger, A. Y. (2020). Cognitive performance in relation to hydration status and water intake among older adults, NHANES 2011–2014, *European Journal of Nutrition, 59*(7), 3133–3148. https://doi.org/10.1007/s00394-019-02152-9

Bhandari, I., & Kumar, R. (2023). Effect of silica fume and PCE-HPMC on LC^3 mortar: Microstructure, statistical optimization, and life cycle Assessment. *Construction and*

Building Materials, *403*, 133073. https://doi.org/10.1016/j.conbuildmat.2023.133073

Brody, D. J., Kramarow, E. A., Taylor, C. A., McGuire, L. C. (2019). Cognitive performance in adults aged 60 and over: National health and nutrition examination survey, 2011–2014, National health statistics reports, (126), 1–23.

DAS-Taskforce 2015, Baron, R., Binder, A., Biniek, R., Braune, S., Buerkle, H., Dall, P., Demirakca, S., Eckardt, R., Eggers, V., Eichler, I., Fietze, I., Freys, S., Fründ, A., Garten, L., Gohrbandt, B., Harth, I., Hartl, W., Heppner, H. J., Horter, J., … Weisshaar, G. (2015). Evidence and consensus based guideline for the management of delirium, analgesia, and sedation in intensive care medicine. Revision 2015 (DAS-Guideline, 2015) - short version. *German medical science: GMS e-journal, 13,* Doc19. https://doi.org/10.3205/000223

Detroyer, E., Timmermans, A., Segers, D., Meyfroidt, G., Dubois, J., Van Assche, A., Joosten, E., & Milisen, K. (2020). Psychometric properties of the intensive care delirium screening checklist when used by bedside nurses in clinical practice: A prospective descriptive study. *BMC Nursing, 19*(21). https://doi.org/10.1186/s12912-020-00415-z

Devlin, J. F., & Müller, D. (1999). Field and laboratory studies of carbon tetrachloride transformation in a sandy aquifer under sulfate-reducing conditions. *Environmental Science & Technology, 33*(7), 1021-1027. https://doi.org/10.1021/es9806884

Ellis, B., Melady, D., Foster, N., Sinha, S., Lau, V., Saraga, S., & pa McLeod, S. L. (2020). Using volunteers to improve the experience of older patients in the emergency department. *Canadian Journal of Emergency Medicine, 22*(4), 514–518. https://doi.org/10.1017/cem.2020.9

Elsaman, S. E. A. (2021). Factors affecting change of the urine color as a hydration indicator among critically ill patients. *Egyptian Journal of Health Care, 12*(4), 1422–1434. https:doi.org/0.21608/ejhc.2021.209614

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). Mini-mental state: A practical method for grading the cognitive state of patients for the clinician, *Journal of Psychiatric Research*, *12*(3),189-98. https://doi.org/10.1016/0022-3956(75)90026-6

Gibb, K., Seeley, A., Quinn, T. J., Siddiqi, N., Shenkin, S., Rockwood, K., & Davis, D. (2019). The consistent burden in published estimates of delirium occurrence in medical inpatients over four decades: A systematic review and meta-analysis study. *Age and Ageing (Preprint). 49*(3), 352 360. https://doi.org/10.1093/ageing/afaa040.

Gonçalves, M. V., Ribeiro, L. R., Aquino, J., Catto, R., Nobre, R. K., Freitas, R. M., Barros, R. L., & Böhlke, M. (2022). Overhydration in acute kidney injury: Is it always a menace to critically ill patients, A survival study using bioimpedance spectroscopy, *Clinical Nutrition ESPEN, 49*(4), 499-503. https://doi.org/10.1016/j.clnesp.2022.02.115

Hagi, K., Nosaka, T., Dickinson, D., Lindenmayer, J. P., Lee, J., Friedman, J., Boyer, L., Han, M., Abdul-Rashid, N. A., & Correll, C. U. (2021). Association between cardiovascular risk factors and cognitive impairment in people with schizophrenia: A systematic review and meta-analysis. *JAMA Psychiatry, 78*(5), 510-518. https://doi.org/10.1001/jamapsychiatry.2021.0015

Hassan, B. H., & Abd Elhamid, M. H. (2017). Relationship between hydration status and cognitive function of critically ill geriatric patients. *Egyptian Journal of Health Care, 8*(1), 124–136. https:doi.org/10.21608/ejhc.2017.17961

Hise, A. C. D. R., & Gonzalez, M. C. (2018). Assessment of hydration status using bioelectrical impedance vector analysis in critical patients with acute kidney injury. *Clinical Nutrition*, *37*(2), 695-700. https://doi.org/10.1016/j.clnu.2017.02.016

Holroyd, S. (2020). Frequency volume charts and fluid balance monitoring: Getting it right. *Journal of Community Nursing*, *34*(1).

Joannes-Boyau, O., Le Conte, P., Bonnet, M. P., Cesareo, E., Chousterman, B., Chaiba, D., Douay, B., Futier, E., Harrois, A., Huraux, C., Ichai, C., Meaudre Desgouttes, E., Mimoz, O., Muller, L., Oberlin, M., Peschanski, N., Quintard, H., Rousseau, G., Savary, D., Tran-Dinh, A., … & Weiss, E. (2022). Guidelines for the choice of intravenous fluids for vascular filling in critically ill patients, 2021. *Anaesthesia Critical Care & Pain Medicine, 41*(3), 101058. https://doi.org/10.1016/j.accpm.2022.101058

Káňová, M., Petřeková, K., Borzenko, N., Rusková, K., Nytra, I., Dzurňáková, P., & Burda, M. (2023). Monitoring hyperhydration and polyneuropathy in critically ill patients using Bioelectrical impedance. *Research Square* (preprint). https:doi.org/10.21203/rs.3.rs-3485725/v1

Lauretani, F., Bellelli, G., Pelà, G., Morganti, S., Tagliaferri, S., & Maggio, M. (2020). Treatment of delirium in older persons: What we should not do. *International Journal of Molecular Sciences, 21*(7), 2397. https://doi.org/10.3390/ijms21072397

Lo Basso, A. (2020). mitigating delirium for the elderly postoperatively without medication. Health Science Research Commons. DNP Projects. Goerge Washington University.

Mansutti, I., Venturini, M., Palese, A. & Team, E. (2020). Episodes of psychomotor agitation among medical patients: Findings from a longitudinal multicenter study. *Aging Clinical and Experimental Research, 32*, 1101–1110 https://doi.org/10.1007/s40520-019-01293-5

Millard-Stafford, M., Snow, T. K., Jones, M. L., & Suh, H. (2021). The beverage hydration index: Influence of electrolytes, carbohydrate, and protein, *Nutrients, 13*(9), 2933. https://doi.org/10.3390/nu13092933

Pais R, Ruano L, P Carvalho O, Barros H. (2020). Global Cognitive Impairment Prevalence and Incidence in Community Dwelling Older Adults-A Systematic Review. *Geriatrics (Basel),* 5(4), 84. Https://doi.org/ 10.3390/geriatrics5040084.

Parkinson, E., Hooper, L., Poland, F., Roberts, S., Van Hout, E., & Bunn, D. (2021). Prevalence of dehydration among older adults across settings: A systematic review and meta-analysis. Protocol: University of East Anglia

Patel, B. K., Wolfe, K. S., Patel, S. B., Dugan, K. C., Esbrook, C. L., Pawlik, A. J., Stulberg, M., Kemple, C.,

Teele, M., Zeleny, E., Hedeker, D., Pohlman, A. S., Arora, V. M., Hall, J. B., & Kress, J. P. (2023). Effect of early mobilization on long-term cognitive impairment in critical illness in the USA: A randomized controlled trial. *The Lancet Respiratory Medicine, 11*(6), 563-572. https://doi.org/10.1016/S2213-2600(22)00489-1

Rivera, S. (2022). *Nephrology, an Issue of Critical Care Nursing Clinics of North America*. 1st eds. E-Book (Vol. 34–4). Elsevier Health Sciences.

Rosgen, B. K., Krewulak, K. D., Stelfox, H. T., Ely, E. W., Davidson, J. E., Fiest, K. M. (2020). The association of delirium severity with patient and health system outcomes in hospitalized patients: A systematic review. *Age and Ageing; 49*(4), 549-557. https://doi.org/10.1093/ageing/afaa053.

Thomas, N., Coleman, M., & Terry, D. (2021). Nurses' experience of caring for patients with delirium: Systematic review and qualitative evidence synthesis. *Nursing Reports (Pavia, Italy), 11*(1), 164–174.https://doi.org/10.3390/nursrep11010016

Thompson, S, K., B. (2012). Effect sizes and confidence intervals for effect sizes. *Psychology in Schools, 44*(5), 423–432. https:doi.org/10.1002/pits.20234

Vanhorebeek, I., Latronico, N., Van den Berghe G. (2020). ICU-acquired weakness. *Intensive Care Medicine, 46*(4), 637-653. https:doi.org/10.1007/s00134-020-05944-4

World Health Organization, (2021). The top 10 causes of death. Available at: https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death.