Factors Affecting Change of the Urine Color as a Hydration Indicator among Critically Ill Patients

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Abstract

Background: Urine color (UC) is affected by fluid intake and loss from the body. Critically ill patients are exposed to many stressors added to the fluid intake or loss that can disturb body fluids movement affecting the color of the excreted urine. **Aim:** To assess factors affecting change of the urine color as a hydration indicator among critically ill patients. **Design:** A descriptive research design was used. **Setting:** The study was conducted at three general intensive care units in the Teaching Main University Hospital, Alexandria, Egypt. **Subjects:** A purposive sample of 150 critically ill adult patients having a urinary catheter on the first day of admission to the selected setting. **Tools of data collection:** (1) Patient's demographic and clinical data assessment (2) Urine color chart. **Results:** 70.5% of the studied patients showed UC of dehydration. UC changed insignificantly with the unconscious state ($P = 0.73$) and changed significantly with age over 40 years, increased body temperature, diagnosis of respiratory and neurological alteration, general edema, mechanical ventilator, blood urea nitrogen and blood osmolality ($P \leq 0.05$). **Conclusions:** Some factors specific to critically ill patients can affect UC significantly such as age, temperature, diagnosis, mechanical ventilator, edema, blood urea nitrogen and blood osmolality. **Recommendations:** critical care nurses should not depend on change of the UC alone for confirming dehydration in critically ill patients.

Keywords: Critically ill patients, Factors, Hydration, Urine color.

Introduction:

Maintaining hydration of critically ill patients is very important as there is a significant correlation between death and hydration. Improper hydration in critically ill patients may exacerbate various health problems including harmful medication effects, venous thromboembolism and urinary tract infections. Urinary tract infection represents up to 40% of healthcare-associated infections (Barchitta et al., 2021). Urinary tract infection related to the urinary catheter is the second common infection in intensive care units(Mentes & Gaspar, 2020; Shadle et al., 2021). Thus, high morbidity, mortality, length of stay and cost can result from improper assessment and management of hydration. Assessing the hydration status is a challenging nursing practice in the intensive care unit(ICU)(Fortes et al., 2015).

Critical care nurses (CCNs) have a great role in assessing and managing fluid disturbance as the nurse is the first medical person who deals with patients' body fluids. CCNs depend on various ways to assess a hydration status such as clinical examination and measurement of central venous pressure, fluid balance, plasma sodium, urea, creatinine, and osmolality, urine output and UC to guide therapy. UC assessment is easy, simple, fast, practical, and cheap. however, UC is not accepted as a part of clinical assessment in ICU (Agrinier et al., 2019; Belasco et al., 2020; Kleinpell et al., 2019). It is generally recognized that UC is affected by fluid intake and loss in healthy and unhealthy people. UC is a reliable validated method for assessing hydration status in healthy adults, children, and non-critically ill patients, but this is not documented for critically ill patients. Kavouras et al (2016) and Perrier et al (2017) found that UC is accurate in adults and children to assess hydration status. Manz et al (Manz et al., 2002) confirmed that UC informs fluid volume excess or deficit in healthy persons (McKenzie et al., 2017). demonstrated that pregnant and nonpregnant women can use UC as a practical reference for fluid management.

Critically ill patients are exposed to many stressors affecting body fluids movements such as the disease process, compensatory mechanisms, hemodynamic instability, disturbed level of consciousness, and therapeutic interventions such as mechanical ventilation (MV). The stress response in critical illness enforces increasing glucocorticoid, decreasing aldosterone, and disturbing vasopressin levels. In addition, changes in hepatic metabolism may alter urinary pigments production.

In critically ill patients, MV is used in severe acute lung injuries that can cause renal vasoconstriction and lower renal blood flow affecting the volume of excreted urine. There are several mechanisms for MV effect. It has been found that 15 cm H2O positive pressure induced by MV depresses cardiac output, renal blood flow, and urine volume by 20 to 30 % so that UC is altered (Aitken L, Marshall A, 2019; Kostelnik et al., 2021).These combinations of changes among critically ill patients may alter the normal relationship between UC and hydration status.

Significance of thy study:

The UC utility and validity are not confirmed among critically ill patients. However, UC can be evaluated by using a simple scale such as an eight color chart established by Armstrong et al (1994) to assess hydration in general population, healthy adults and children. After searching, there is one study by Fletcher et al (1999) that examined the value of UC in evaluating the hydration status of critically ill patients. They found that UC had an insignificant addition to the hydration status assessment. Also, they showed that UC is mainly controlled by factors not related to hydration. These factors change and are unpredictable in those patients. Therefore, further study is needed to clarify these factors that interfere with the use of UC in the assessment of hydration status among critically ill patients.

Aim of the study

To assess factors affecting change of the urine color as a hydration indicator among critically ill patients.

Research question

What are the factors affecting change of the urine color as a hydration indicator among critically ill patients?

Subject and Methods

Subjects and methods for this study were portrayed under four main designs:

1) Technical design
2) Operational design
3) Administrative design
4) Statistical design

1) Technical design

The technical design for the study includes research design, setting, subjects and tools for data collection

Research design

Descriptive research design.

Setting

The study was achieved at three general intensive care units, namely unit I, unit II, unit III in Teaching Main University Hospital, Alexandria, Egypt. These units receive newly admitted patients who have a variety of disorders in the acute stage of illness.

Subjects

A Purposive sample of 150 critically ill patients.

Inclusion criteria:

- Adult patients remain for at least one day in the selected ICUs.
- Patients in the first day of admission to the selected ICUs
- Patients have a urinary catheter for 24 hours.

Exclusion criteria:

- Patients have unrecorded blood pressure, hemodialysis, peritoneal dialysis, hyperbilirubinemia (serum bilirubin > 20 µmol / L), hematuria, urinary tract infection, hypertonic intravenous fluid such as mannitol, diuretics such as Furosemide, drugs such as isoniazid, or foods such as beets that change UC.

Sample size

The sample size was calculated based on the power analysis estimation of the Epi-Info program using population size over 6 months (240 patients), expected frequency 50%, acceptable error 5%, and confidential co-efficient 95%. The program revealed a minimum sample size of 148 patients, so this study included 150 patients.

Technique:

The first patient meeting the previous criteria was taken as the first one in the studied sample until the sample reached total number of the study.

Ethical considerations:

Written consent was obtained from the conscious patient or family member (for the unconscious patient) after explaining the aim of the study, potential benefits, and hazards from participation. The anonymity, confidentiality, and privacy of responses, voluntary participation, and the right to withdraw from the study were emphasized.

Tools for data collection

Tool I: "Patient's demographic and clinical data assessment".

It was developed by the researcher after reviewing the related literature(Gross W, Samarin M, 2017; Litchfield I, Magill L, 2018; Ortiz Lasa et al., 2019). It is used to collect data related to demographic and clinical. It included three parts

Part 1: Patient's demographic: age and gender. **Part 2:** Vital signs: respiratory rate, heart rate, mean arterial blood pressure, and body temperature. **Part 3:** Clinical data: date of admission, health history, current diagnosis, current medication and fluids, consciousness level, attaching with MV, presence of general edema, serum sodium, blood urea nitrogen (BUN), blood osmolality and fluid balance /24 hours.

Tool II: Urine color chart: It was adopted from Armstrong et al (1994). The researcher used it to check the urine color (UC) and see if the patient was overhydrated, euhydrated, or dehydrated. The chart contained eight colors (figure 1): I) Color of over-hydration: number 1. II) Colors of euhydration: numbers 2 and 3. III) Colors of dehydration: numbers 4, 5, 6, 7, 8.

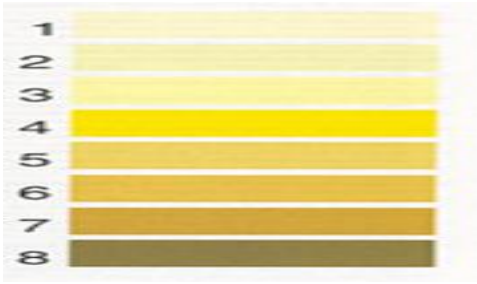

Figure (1): Urine color chart adopted from Armstrong et al (1994).

Tool validity and reliability

The developed tool (tool I) was tested by the researcher for content validity and reliability. The content validity of tool I was tested by five experts in the critical care nursing, Faculty of Nursing, Alexandria University, and the reliability was tested and accepted as Cronbach's $\alpha = 0.813$.

The adopted tool (tool II) was proved to be valid and reliable as Cronbach's $\alpha = 0.993$ by Johnson et al (2020)

2) Operational design

The operational design for the study included:

- Preparatory phase.
- Pilot study.
- Field work.

Preparatory phase:

Reviewing of the related literature to help the researcher to acquaire knowledge about the significance of the problem and to guide the researcher in preparing tools for data colloction.

Pilot study

A pilot study was carried out with 10% of total patients (15 patients) to evaluate the clarity and applicability of the study tools. The necessary modifications were done to the tools when needed. These patients were omitted from the studied patients.

Field wok

The researcher collected the data 5 day/ week from February 2019 to October 2019. The researcher assessed patients daily in morning and evening shift. According to the inclusion and exclusion criteria, patients were enrolled in this study. At the first day from patients' admission in the selected units, demographic data were collected from the medical records using tool I part 1. At the last hour of the first day, the researcher performed clinical assessment, obtained venous blood sample for lab investigation analysis and recorded the clinical data using tool I part 2 and 3. Blood osmolality was calculated using the formula: serum osmolality = (2 x serum sodium) + [glucose, in mg/dL]/18 + [blood urea nitrogen, in mg/dL] /2.4). (Bunn D, Jimoh O, 2019)

Data of observed patients' UC was collected using tool II at the last hour from the first day of patients' admission in the selected urine. The researcher assessed the patient's UC using a urine color chart of tool II as follows: the researcher closed the urinary catheter with a clamp. After one hour, the researcher removed the clamp to obtain 20-30 ml of urine in a clear container. The researcher assessed the urine for color in a well-lighted room against the UC chart and recorded the number of the chart color that most carefully matched the urine sample. Patients were categorized according to UC as following: I) Color of overhydration (number 1). II) Colors of euhydration (numbers 2 and 3). III) Colors of dehydration (numbers 4, 5, 6, 7, and 8).

3) Administrative design

The data was collected by the researcher from February 2019 to October 2019. Before starting to collect data from the patients, approval was obtained from Research Ethics Committee, Faculty of Nursing, Alexandria University, Alexandria, Egypt to conduct this study. An official letter was sent from the Faculty of Nursing to the responsible hospital authority to gain approval to conduct the study after explaining the study aim.

4) Statistical design

Data were analyzed using SPSS software package version 20. Analysis and interpretation of data were made using the following statistical measures: frequency; mean and standard deviation; and Monte Carlo for Chi-square test, ANOVA test, and P is significant if ≤ 0.05.

Results:

Figure (1): illustrates distribution of the studied patients according to urine color of hydration. In the figure, UC of dehydration appeared in 70.5% of the studied patients.

Table (1): shows relationship between the UC of hydration and demographic data. The table shows that 42.1% of patients aged over 40 years. UC changed significantly related to age (P=0.01).

Table (2): demonstrates a comparison between the UC of hydration and vital signs. 70.5% of patients with increased body temperature (with high Mean ± SD) had UC of dehydration. UC changed significantly related to body temperature (P=0.00).

Table (3): presents a comparison between the UC of hydration and clinical data. About half of the studied patients with respiratory and neurological alteration (24.3% and 25.9%) showed UC of dehydration. Also, UC of dehydration appeared in 57.9% of unconscious patients, 55.7% of patients with general edema, and 70.5% of patients attached with MV, 32.6 % of patients with increased sodium, 43.2% of patients with increased BUN, 44.21% of patients with increased blood osmolality and 47.3% of patients with positive fluid balance/24 hours. UC changed

significantly related to diagnosis, presence of general edema, MV, BUN, blood osmolality ($P \leq 0.05$).

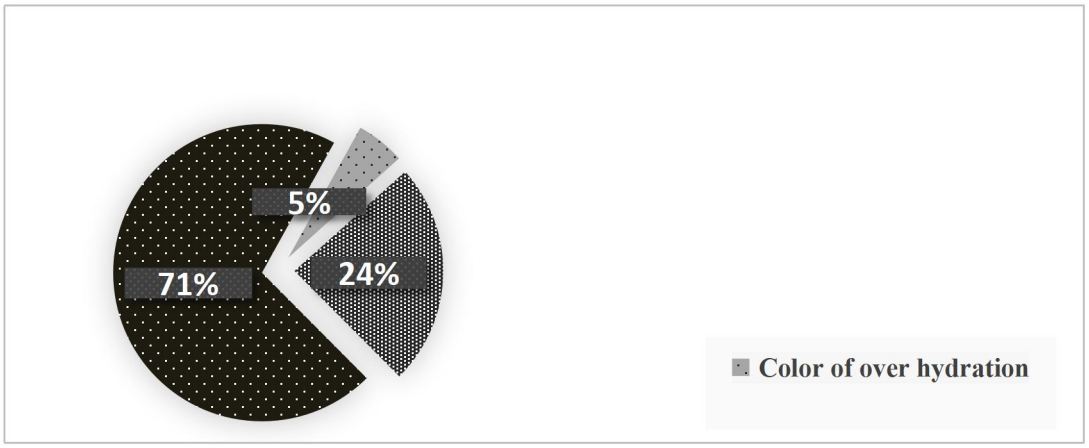

Figure (1): Distribution of the studied patients according to urine color of hydration.

Table (1): Relationship between the urine color of hydration and demographic data in the studied patients.

Demographic characteristics	Total 100%	The urine color of hydration (n= 150) 100%										Significance test	
		Color of over hydration 5.3%	Color of euhydration 24.2%			Color of dehydration 70.5%							
		Color 1 5.3%	Color 2 5.3%	Color 3 18.9%	Total 24.2%	Color 4 29.5%	Color 5 2.1%	Color 6 13.7%	Color 7 20%	Color 8 5.3%	Total 70.52%	χ^2	^{MC}p
Gender %													
Male	50.5	3.2	0.0	7.4	7.4	13.7	1.1	9.5	12.6	3.2	40.1	9.9	0.17
Female	49.5	2.1	5.3	11.6	16.9	15.8	1.1	4.2	7.4	2.1	30.6		
Age (years) %													
20 – 30	25.3	3.2	0.0	1.1	1.1	9.5	0.0	6.3	3.2	2.1	21.1	23.6	0.01*
31 – 41	15.8	2.1	0.0	6.3	6.3	2.1	0.0	1.1	4.2	0.0	7.4		
>40	58.9	0.0	5.3	11.6	16.9	17.9	2.1	6.3	12.6	3.2	42.1		

*: Statistically significant at $p \leq 0.05$

Table (2): Relationship between the urine color of hydration and vital signs in the studied patients.

Vital signs	The urine color of hydration (n= 150) 100%								Significance test	
	Color of over hydration 5.3%	Color of euhydration 24.2%			Color of dehydration 70.5%					
	Color1 5.3%	Color 2 5.3%	Color 3 18.9%	Color 4 29.5%	Color 5 2.1%	Color 6 13.7%	Color 7 20%	Color 8 5.3%	(F)	P
Heart rate										
Min.– Max.	56.0 – 130.0	38.0 – 144.0	60.0 – 150.0	56.0 – 153.0	110.0 – 120.0	55.0 – 140.0	36.0 – 138.0	80.0 – 112.0	0.7	0.67
Mean ± SD.	88.4 ± 27.3	102.4 ± 45.5	101.7 ± 21.2	103.8 ± 23.2	115.0 ± 7.1	98.9 ± 26.5	110.1 ± 28.8	91.8 ± 13.4		
Reparatory rate										
Min. – Max.	18.0 - 40.0	16.0-36.0	11.0-45.0	13.0-37.0	18.0-51.0	13.0-42.0	16.0-37.0	14.0 - 45.0	0.6	0.74
Mean ± SD.	22.8 ± 9.7	24.2 ± 8.5	23.3 ± 9.0	23.3 ± 5.9	34.5 ± 23.3	24.6 ± 6.9	23.8 ± 5.9	25.4 ± 12.1		
Temperature										
Min. – Max.	35.5 – 37.0	37.0 – 38.50	36.0 – 38.0	36.9 – 40.0	38.0 – 38.0	36.0 – 40.0	37.0 – 40.0	37.0 – 39.5	3.4*	0.00*
Mean ± SD.	36.4 ± 0.7	37.6 ± 0.6	37.2 ± 0.6	37.8 ± 0.8	38.0 ± 0.0	37.7 ± 0.9	38.1 ± 0.9	38.0 ± 1.2		
Mean arterial blood pressure										
Min – Max.	60.0 – 110.0	63.0 – 106.0	66.0 – 130.0	10.0 – 133.0	100.0 – 110.0	67.0 – 123.0	70.0 – 103.0	90.0 – 133.0	0.7	0.64
Mean ± SD.	80.0 ± 21.2	89.6 ± 16.0	91.0 ± 17.1	91.1 ± 26.4	105.0 ± 7.1	94.8 ± 19.4	89.1 ± 10.1	103.6 ±17.1		

*: Statistically significant at $p \leq 0.05$

Table (3): Relationship between the urine color of hydration and clinical data of the studied patients.

Demographic characteristics	Total 100%	the urine color of hydration (n= 150) 100% Color of over hydration 5.3%	Color of euhydration 24.2%			Color of dehydration 70.5%						Significance test	
		Color 5.3%	1 Color 5.3%	2 Color 18.9%	3 Total 24.2%	Color 29.5%	4 Color 2.1%	5 Color 13.7%	6 Color 20%	7 Color 5.3%	8 Total 70.52%	χ^2	^{MC}p
Diagnosis %													
Cardiovascular	22.1	0.0	2.1	11.6	13.7	3.2	0.0	2.1	1.1	2.1	8.7		
Respiratory	32.6	5.3	0.0	3.2	3.2	10.5	0.0	7.4	4.2	2.1	24.3	48.0	0.00*
Neurological	29.5	0.0	0.0	3.2	3.2	8.4	1.1	2.1	13.7	1.1	25.9		
Others	15.8	0.0	3.2	1.1	4.3	7.4	1.1	2.1	1.1	0.0	11.7		
Consciousness %													
Unconscious	83.2	4.2	5.3	15.8	21.3	22.1	2.1	10.5	17.9	5.3	57.9	4. 6	0.73
Conscious	16.8	1.1	0.0	3.2	3.2	7.4	0.0	3.2	2.1	0.0	12.7		
General edema %													
Yes	58.9	0.0	0.0	3.2	3.2	24.2	2.1	10.5	13.7	5.3	55.7	33.9	0.00*
No	41.1	5.3	5.3	15.8	21.1	5.3	0.0	3.2	6.3	0.0	14.6		
Attaching to MV %													
No	9.5	1.1	0.0	4.2	4.2	2.1	0.0	1.1	1.1	0.0	4.2	52.1	0.00*
Yes	90.5	4.2	5.3	14.7	20	27.4	2.1	12.6	18.9	5.3	66.3		
Sodium %													
Decreased	13.7	0.0	0.0	4.2	4.2	4.2	1.1	0.0	3.2	1.1	9.5	21.3	0.09
Normal	46.3	4.2	1.1	12.6	13.7	10.5	0.0	5.3	11.6	1.1	28.4		
Increased	40	1.1	4.2	2.1	6.3	14.7	1.1	8.4	7.4	1.1	32.6		
BUN %													
Decreased	7.4	2.1	0.0	3.2	3.2	1.1	0.0	0.0	0.0	1.1	2.1	26.8	0.03*
Normal	41.1	1.1	4.2	10.5	14.7	8.4	0.0	6.3	9.5	1.1	25.3		
Increased	51.6	2.1	1.1	5.3	6.3	20.0	2.1	7.4	12.6	1.1	43.2		
Blood Osmolality %													
Decreased	12.6	0.0	0.0	7.4	7.4	0.0	0.0	2.1	0.0	3.2	5.26	34.1	0.00*
Normal	28.4	3.2	0.0	4.2	4.2	13.7	1.1	2.1	3.2	1.1	21.1		
Increased	58.9	2.1	5.3	7.4	13.7	15.8	1.1	9.5	16.8	1.1	44.21		
Fluid balance/ 24 hours %													
Positive	66.3	1.1	5.3	12.6	17.9	18.9	1.1	8.4	16.8	2.1	47.3	8.7	0.27
Negative	33.7	4.2	0.0	6.3	6.3	10.5	1.1	5.3	5.3	1.1	23.2		

*: Statistically significant at $p \leq 0.05$, MV: Mechanical Ventilator, BUN: Blood urea nitrogen

Discussion

Dependence on using UC in assessing hydration status in critically ill patients needs to be studied. The present study is the first to handle factors affecting UC in assessing hydration among critically ill patients. In the present study, most of the patients had UC of dehydration. Hauteas et al (2020) showed that most of the studied patients suffered from severe dehydration based on evaluating their UC. Appearance of UC of dehydration indicates concentrated urine. In critically ill patients, concentrated urine may increase the risk for complications of kidney injury, stone information and urinary tract infection (Shaikh et al., 2019). Silva et al (J. L. A. da Silva et al., 2021) demonstrated that dehydration increased the risk for developing urinary tract infection by 40 times among hospitalized elderly patients.

Moreover, the current study revealed that some patients had UC of dehydration, despite of their positive fluid balance. This means that there are factors other than fluid intake or loss may affect UC change as evidenced by concentrated UC with positive fluid balance. These factors can be related to patients, critical illness and associated therapeutic intervention (Balıkoğlu et al., 2021). These factors can affect UC change due to fluid distribution in the body as fluid shifts from intravascular to extravascular decreasing renal blood flow. Barley et al (2020) demonstrated that hydration assessment may be complicated by accumulating and shifting of fluids between distinct sits in the body. Mentes et al (2016) concluded that nobody fluid (urine, blood, and saliva) demonstrated hydration status perfectly through the day because the brain responds throughout the day to many dynamic challenges to water balance.

In the present study, UC changed significantly related to age. UC of dehydration appeared in more than a third of patients in the **age group over 40 years**. This can be attributed to the fact that people over 40 years are at high risk for atherosclerosis, hypertension, and cardiovascular disease. These diseases may be associated with altered cardiac pumping function, fluid movement disturbance, decreased renal blood flow, and low urine output (Burns, 2016; Cook G, Hodgson P, Hope C, Thompson J, 2019). Moreover, function of the kidney decreases through aging. this results in changes in the kidney structure by a reduced size and number of the nephrons leading to decreased urinary output. This change starts slowly and progressively by age 20 years (Hauteas et al., 2020). On the other hand, Hooper et al (2016) contradicted with these results as they revealed that UC is too low to be helpful to discover hydration status in older people.

In a systematic review done by Kostelnik et al (2021), various studies evaluated UC to urine osmolality and urine specific gravity and demonstrated a lower correlation in older adults aged over 60 years. This indicates that UC is unable to express fluid intake or loss in older critically ill patients. Botigué et al (2021) demonstrated that dehydration is most widespread in elderly individuals. Hauteas et al (2020) presented that severe dehydration occurred among most of the patients in the age group from 40 to 79 years as the age progresses, poor flow of the blood may hasten kidney damage. Stookey (2019) and Swastika et al (2021) demonstrated that age is a factor that contributes to variations in total body fluids.

The present study showed that UC changed significantly related to **the diagnosis**. About half of the studied patients with respiratory and neurological alteration showed UC of dehydration. This may be related to that the patients' conditions necessitated attaching to MV. MV can result in fluid retention, development of edema, decreasing urine output and concentrating UC without body fluid loss. Perrier et al (2015) accepted that UC changes in response to illness. Flamarion et al (2021) demonstrated that numerous diseases have been diagnosed by the associated UC. On the other hand, Rowat et al (2014) showed that UC is unable to indicate dehydration in acute stroke patients.

In the current study, half of the **unconscious** patients showed UC of dehydration. Unconscious patients have disturbance in neurological function and are at risk of fluid and electrolyte imbalance (Elsayed S, Reda N, 2017). Lawrence et al (2020) revealed that thirst sensation as a response to dehydration is principally hindered in unconscious patients. Silva et al (2019) demonstrated that thirst is the most reported memory by critically ill patients when they were comatosed.

The current study showed that half of the patients with **edema** had UC of dehydration. Edema

may occur as an MV complication or from the disease process.

The presence of edema may lower cardiac output, decrease renal blood flow, and decrease urine formation to become more concentrated (Baid, 2016). This means that UC of dehydration may be related to fluid body shift other than fluid loss. This emphasizes that UC may be not sensitive to hydration status and can't express fluid intake or loss in critically ill patients (Rowat A, Smith L, Graham C, Lyle D, Horsburgh D, 2014).

The current study demonstrated that UC changed significantly related to the **mechanical ventilator**. Most of the patients attached to MV showed UC of dehydration. MV provides positive pressure ventilation that increases intrathoracic pressure impeding venous return to the heart, results in low cardiac output, decreases renal blood flow, retains body fluids, and later decreases urine output. Therefore, UC becomes concentrated. MV has a vital role in affecting UC as in the current study (Kuiper et al., 2019; Seal AD, Suh H-G, Jansen LT, Summers LG, 2019).

In the current study, most of the patients with positive fluid balance (increased fluid intake) showed UC of dehydration. It may be due to MV complications such as the development of edema. Consequently, UC of dehydration resulted from the fluid shift and decreased renal blood flow (Asfour, 2016; Pinnington et al., 2016). This suggests that UC as a hydration indicator is unable to express correctly increased fluid intake in critically ill patients.

The current study showed that a third of the patients with increased sodium had UC of dehydration. Moreover, UC changed significantly related to increased **blood osmolality**, increased **blood urea nitrogen**. The present study finding is supported by Perrier et al(2017) who referred to that there was a relationship between plasma osmolality and UC. Altered serum osmolality, blood urea nitrogen and serum sodium can be affected by intravascular fluid loss and dehydration (Butler-Dawson et al., 2019). Cheuvront et al(2013) showed that there is a vital physiological foundation for suggesting the relationship between blood osmolality and intracellular fluid amount. Ekman et al (2020) revealed that blood hyperosmolality labels dehydration that is directed by concentrated UC. In critically ill patients, factors other than intravascular fluids loss such as water shifting with the developed edema and comorbidity of the disturbed renal function can affect UC change (Jones et al., 2019).

Critically ill patients share with non-critically ill patients that **body temperature** affects UC change. This study demonstrated that most of the patients having increased body temperature showed UC of dehydration. Pyrexia is associated with hyperhidrosis resulting in body fluid loss. Additionally, pyrexia is associated with increased respiratory rate, which increases the insensible loss from the respiratory tract. This result is in line with Kalhoff (2014) who found that insensible respiratory loss can cause dehydration. Wardenaar et al (2021) illustrated that UC is concentrated owing to sweat losses without fluid replacement. Johnson et al (2020) showed that dehydration is correlated to changes in thermoregulation.

This suggested not to depend on UC in assessing critically ill patients' hydration status as UC alone is not a sufficient tool to assess hydration status. In adults and children, Adams et al (2021) concluded that UC, void numbers and increased urine osmolality/24 hours produce a strong tool in detecting dehydration status. In a physically active population, Wardenaar et al (2021) revealed that UC should be linked with other methods to permit better assessing hydration status.

Conclusion

From the current study, it can be concluded that most of the studied patients showed UC of dehydration. There are some factors specific to the critically ill patients that can affect UC change other than fluid intake or loss. These factors are age over 40 years, diagnosis of respiratory and neurological disorders, general edema, MV, serum sodium, blood urea nitrogen and blood osmolality. Another factor of increased body temperature can affect UC in critically ill due to fluid loss.

Recommendations

Based on the study findings, it can be recommended that CCNs should not depend on change of the UC alone for confirming dehydration in critically ill patients. CCNs should consider the guidelines in patients with UC of dehydration who are at risk for urinary tract infection. Further studies are needed to replicate the current study on larger sample size for generalization and to study other urine indices in combination with UC to assess hydration status among the critically ill patients.

Limitation of the study

The study had some limitations, such as only one hospital used as a study setting that impacted the generalization of the investigation results. Also, the selection bias may be present by using a convenience sample.

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