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Developing Nursing Standards for Maintaining Fluid and Electrolyte Balance for Critically Ill Patients in Intensive Care Units

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Abstract

Background: Fluid and electrolyte disturbances are the most frequently reported problems in intensive care units (ICUs). These disturbances are associated with high morbidity and mortality rate among critically ill patients. Early detection and management of fluid and electrolyte imbalance can improve patients' outcome, decrease the length of intensive care stay and reduce the cost of health care services.

Purpose: To develop nursing standard for maintaining fluid and electrolyte balance for critically ill patients in ICUs of Mansoura University Emergency Hospital.

Method: The study has a descriptive exploratory design. The study included a convenience sample of 40 critical care nurses who were involved in providing direct care for critically ill patients in the study setting. Additionally, 15 experts from the field of critical care were recruited in the study to evaluate the validity of data collection tools.

Results: The majority of the studied nurses had got somewhat a satisfactory practice level for fluid and electrolyte assessment and management in the study setting. No significant correlation was found between nurses' practices scores and their socio demographic characteristics. Most items of the proposed nursing standard for maintaining fluid and electrolyte balance for critically ill patients were agreed upon by the expert group.

Conclusion: Nursing practice for maintaining fluid and electrolyte balance for critically ill patient in the studied setting was somewhat acceptable. The developed nursing standard can be used as a base for enhancing nursing practice and consequently improve patient outcome. Further research is needed to evaluate the effectiveness of the developed nursing standard in maintaining fluid and electrolyte balance for critically ill patients in ICUs.

Keywords: Critical care nurses; Critically ill patients; Fluid and electrolyte balance; ICU; Standard of nursing care

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Introduction

Critically ill patients are at high risk for developing fluid and electrolyte disturbances in ICUs which associated with increased morbidity and mortality rates [1,2]. Many factors can contribute to shifting in fluid and electrolyte levels among critically ill patients. Disease process in critically ill patients is the main factor that causes this imbalance. Another causing factor is nurses' practice errors, such as inappropriate administration of fluid and electrolyte, and medications administration errors [3]. These factors are interfering with body absorption of electrolytes and having negative impact on the function of body organs that responsible for maintaining fluid and electrolyte balance [4].

To deliver optimal patient care, health care providers should be aware of all principles and practices of fluid and electrolyte

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physiology and pathophysiology [1] as well as effective treatment measures. This requires accurate assessment of patients' fluid balance status through appropriate monitoring, calculation and correct recording of patients' parameters [3]. Additionally, appropriate management of electrolyte disturbances requires early detection and management of the underlying primary disorders [5].

Critical care nurses play a vital role in caring for critically ill patients. They are well trained to provide continuous monitoring and advanced care for different critical conditions. The nurse-patient ration in the ICU is mostly 1 to 2. Therefore, critical care nurses are in a position to continually monitor and early detect any changes in patient's condition that requires prompt management, such as fluid and electrolyte imbalances. Critical care nurses should have knowledge and clinical skills required for optimal maintenance of patients' hydration status and electrolyte balance [6]. They should also have critical thinking and advanced problem solving skills, and practice based upon evidence-based research in order to provide high quality patient care [7,8]. Health quality is always a primary concern in health care institutions. In nursing, it is described as the process for attainment of highest degree of excellence in the delivery of patient care [9]. Nursing standard is the level of performance and practice that accepted or expected from nurses [10]. It is a useful tool to promote nurses' practice and ensure high quality care. Nursing standard is not an evaluation instrument in itself but it offers a base for measuring the quality of care delivered [7]. Health care institutions that aim to achieve quality assurance in nursing are concerned with developing procedures, policies and rules that promote health care services. These policies must be guided by optimal nursing standard of care taking into account the culture, beliefs and available resources of the concerned institution [11]. Many studies were conducted to develop varies nursing standards for optimal care delivery for critically ill patients [12-14]. Quite surprisingly, fluid and electrolyte disturbances among critically ill patients are yet a common clinical relevance in ICUs. This issue has received little attention both at national and international levels. To the best of our knowledge, research which studied nursing practice for maintaining fluid and electrolyte balance in ICUs in Egypt is scare. Therefore, the current study was conducted to investigate this area.

The aim of the study

This study aims to develop nursing standard for maintaining fluid and electrolyte balance for critically ill patients in ICUs of Mansoura University Emergency Hospital, Egypt.

Materials and Method

Research design

This study has a descriptive exploratory research design.

Setting

This study was conducted in three ICUs at Mansoura University Emergency Hospital including: Medical ICU (ICU1), Surgical ICU (ICU2) and General ICU (ICU3). ICU1 includes 10 beds, and it receives patients who experience neurological impairment, poisoning or shock. ICU2 involves 10 beds, and it provides care for patients with trauma and surgical disorders. ICU3 includes 4 beds, and it provides health care services for critically ill patients with different disorders. The nurse-patient ratio in these units is nearly 1:2.

Sample

The study involved a convenience sample of 15 experts (G1) in the field of critical care and 40 nurses (G2) who work in the above mentioned ICUs. The expert group includes 5 medical consultants and specialists, and 3 head nurses from the study setting. It also includes 7 academic staff from Critical Care and Emergency Nursing, and Medical Surgical Nursing Departments from Faculty of Nursing, Mansoura University. The nurses' group involves critical care nurses who were involved in direct patient care in the selected ICUs, who have at least one year of work experience in the ICU.

Instrument

Two tools were used to collected data for this study. Tool I is 'Nursing Competencies for Fluid and Electrolyte Standard Questionnaire' which was developed by the primary investigator based upon relevant literature [12,13,15] to validate the content of the proposed nursing standard. This tool compromised of two parts. Part 1 covers experts' personal and background information, such as age, educational level, and years of work experience in the ICU, and attendance of training programs on fluid and electrolyte balance. Part 2 addresses experts' opinions regarding nursing competencies required for maintaining fluid and electrolyte balance for critically ill patients in ICUs. It includes basic nursing assessment measures and all nurses' responsibilities concerning maintaining fluid, sodium, potassium and calcium balance for critically ill patients. The experts were asked to record their responses to items on a three-point scale (1="disagree", 2="somewhat agree", 3="agree"). The total score <60% is considered unsatisfactory agree level; while score ≥ 60% is considered satisfactory agree level.

Tool II is 'Nursing Standards for Maintaining Fluid and Electrolyte Balance Observation Checklist' which was adapted from Mahani [16] and modified based upon relevant literature [17]. This tool aims to assess the competency level of critical care nurses for maintaining fluid and electrolyte balance. It encompasses procedures and actions for management of fluid and electrolyte disturbances. It consists of two main parts. Part I collects nurses' personal and background information, and part II is an observation checklist for nurses' practices for management of fluid and electrolyte imbalance. Nurses' performance was evaluated on a three-point scale (0="Not done", 1="Done Incompletely", 2="Done Completely"). The total score >75% was considered satisfactory practice, while score <75% was considered unsatisfactory practice.

The tools were tested for its content validity by a group of 5 experts in the field of critical care. The reliability of the tools was

tested by using Cronbach's Alpha test that measures the internal consistency of the tools. The reliability of tool I and tool II was 0.85 and 0.81 respectively, which indicates high reliability.

Ethical considerations

Ethical approval was obtained from the Research Ethical Committee of Faculty of Nursing, Mansoura University (Ref.N.77/2016). Participants were informed about the aim, benefits and risks of the study. They were assured that participation in the study was voluntary. Informed consent was obtained from those who accepted to take part in the study. The confidentiality of collected data was maintained. Data were safely stored in a cabinet and no one can get access to the data expect the investigators.

Data collection

Data were collected between February and May 2017. Before initiating data collection, a permission to conduct the study was obtained from the hospital's administrative authority after providing details description of the study. The experts' questionnaire (tool 1) was pilot tested before commencing the study for linguistic purposes. It was also evaluated for clarity and applicability by three faculty staff members from critical care and emergency nursing department.

The experts were interviewed individually at their work place to collect their opinions about the required nursing competencies for maintaining fluid and electrolyte balance for critically ill patients using tool I. They were asked to mark each activity with either 'agree', 'somewhat agree' or 'disagree'. Each interview lasted between 45 and 60 minutes. Accordingly, an observation checklist for nurses' practice for maintaining fluid and electrolyte balance for critically ill patients was developed.

A pilot study was conducted on 4 critical care nurses to assess the objectivity, applicability and accessibility of the observation checklist (tool II) before starting data collection. Participants in the pilot study were excluded from the main study. Participant nurses were observed twice according to their predetermined schedule. Critical care nurses' performance during management of fluid and electrolyte disturbance for critically ill patients was evaluated using tool II. The P value of the two observations was calculated and available correlation finding was obtained.

Statistical analysis

Survey data were entered into statistical package of social sciences (SPSS) version 16.0 (SPSS Inc., Chicago, IL, USA). One-way ANOVA test was used to find the association between variables of qualitative data. Generally, the level of significance was set at p value<0. 05 while p value>0.05 indicated a non-significant result. Microsoft Excel (2016) was used for calculation of agreement and content validity index (CVI). Agreement of a question is the number of experts choosing one of the two highest ranked answers for the given question (Totally agree or somewhat agree for the survey in the study). Content validity index (CVI) of a question or a survey is the survey agreement score divided by the total number of experts (15 in this study).

Results

This study yielded huge amount of results related to the developed nursing standard. For the purpose of this paper, only some of the results will be presented.

Experts' personal and background information

Table 1 illustrates personal and background data of the expert group. It showed that 40% of the experts were in the age group between 40 and 49 years old with a mean age of 42.5 ± 7.04. More than half of them had over 20 years of work experience with mean of 17.2 ± 5.01. More than one third of the experts were lecturers. Additionally, 73.3% of the experts attended training programs on fluid and electrolyte balance in ICU, with 63.6% of them attended this program in a form of lectures.

Assessment measures required for fluid and electrolyte standard

Table 2 describes experts' opinions regarding assessment measures required to be included in fluid and electrolyte nursing standard. The results showed that 100% of the experts strongly agreed that the central venous pressure (CVP), fluid balance chart, presence of seizure and nutrition supplements are assessment criteria that should be included in the management plan of fluid and sodium disturbances. Additionally, all experts (100%) strongly agreed to include the assessment of electrocardiogram (ECG) changes, peripheral pulses, nutrition, positive trousseaus triad signs and chvostraks sign as assessment measures for potassium and calcium imbalance. Moreover, all experts somewhat agreed that daily assessment of body weight and hypoactive or hyperactive reflexes

Table 1 Experts' personal and background information.

Variables		No. = 15	
		No.	%
Age	30-39 years	5	33.3
	40-49 years	6	40
	≥ 50 year	4	26.7
Mean ± SD	**42.5 ± 7.04**		
Years of work experience in ICU	1-9 years	1	6.7
	10-19 years	5	33.3
	≥ 20 years	9	60
Mean ± SD	**17.2 ± 5.01**		
Position	Professor	4	26.7
	Lecturer	5	33.3
	Assistant lecturer	3	20
	Head nursing	3	20
Attending training programs about fluid and electrolyte in ICU	No	4	26.7
	Yes	11	73.3
Types of training programs	Lectures	7	63.6
	Workshops	2	18.2
	Both	2	18.2

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Table 2 Experts' opinions regarding assessment measures required for fluid and electrolyte nursing standard.

Basic Competencies	Disagree		Somewhat Agree		Strongly Agree		Agreement	Individual content validity index (I-CVI)
	No	%	No	%	No	%		
Measure CVP/ 6 hour(for fluid and sodium disorder)	0	0%	0	0%	15	100%	15	1
Measure fluid intake and output /hour (for fluid, sodium, potassium disorder)	0	0%	0	0%	15	100%	15	1
Assess changes in body weight daily	0	0%	15	100%	0	0%	15	1
Assess nutrition supplements (sodium, potassium and calcium disorders)	0	0%	0	0%	15	100%	15	1
Assess presence of seizure (sodium disorder)	0	0%	0	0%	15	100%	15	1
Assess skin turgor, color and mucus membrane	0	0%	2	13.3	13	86.70%	15	1
Assess muscle for tone, strength, cramp and twitching in sodium disturbance	2	13.33%	10	66.66%	3	20%	13	0.87
Assess for hypoactive or hyperactive reflexes and muscle strength (potassium and calcium disorder)	0	0	15	100	0	0	15	1
Assess ECG changes (potassium and calcium disorder)	0	0%	0	0%	15	100%	15	1
Check peripheral perfusion: capillary refill and peripheral pulses (potassium and calcium disorder)	0	0%	0	0%	15	100%	15	1
Assess for positive trousseaus traid , chvosteks signs in hypocalcaemia	0	0%	0	0%	15	100%	15	1

CVP (Central Venous Pressure)
ECG (Electro Cardiogram)

changes are important assessment criteria for fluid and electrolyte imbalance. Skin assessment (86.7%) and muscle changes (66.66%) were also selected as indicators for fluid and electrolyte disturbances.

Nurses' practices for maintaining fluid balance for critically ill patients

Table 3 displays critical care nurses' practices for maintaining fluid balance for critically ill patients who experience fluid balance disturbance. The results illustrated that nearly half of studied nurses were competent in assessment of the CVP/hour in the first and second assessments (47.5%, 52.5% respectively). Only 40% of nurses were competent in measuring fluid intake and output. In the study settings, the weighing scale was not available; therefore, weight assessment was not done for all patients.

Table 3 Nurses' practices for maintaining fluid balance for critically ill patients.

Basic competencies	1st Assessment						2ndAssessment						P value
	Done Completely		Done Incompletely		Not Done		Done Completely		Done Incompletely		Not done		
	No	%	No	%	No	%	No	%	No	%	No	%	
Fluid parameters measurement													
Measure of CVP/hour accurately	19	47.5	15	37.5	6	15	21	52.5	18	45	1	2.5	0.008
Measure of fluid intake and output/hour accurately	16	40	0	0	24	60	16	40	22	55	2	5	<0.0001
Weigh patient daily	0	0	0	0	40	100	0	0	0	0	40	100	1
Signs and symptoms indicating for fluid disturbance													
Auscultat chest sound	7	17.5	13	32.5	20	50	10	25	17	42.5	13	32.5	0.002
Assess presence of edema	23	57.5	13	32.5	4	10	15	37.5	23	57.5	2	5	0.06
Assess flat/distended neck vein	6	15	1	2.5	33	82.5	6	15	1	2.5	33	82.5	1
Assess skin turgor, color and mucus membrane	3	7.5	14	35	23	57.5	5	12.5	10	25	25	62.5	1
Nursing interventions toward maintaining fluid balance													
Monitor laboratory results	27	67.5	9	22.5	4	10	32	80	7	17.5	1	2.5	0.005
Change patient's position /2 hours	36	90	2	5	2	5	37	92.5	1	2.5	2	5	0.025
Provide skin care to edematous part and check bony prominence	36	90	2	5	2	5	22	55	12	30	6	15	0.16
Increase or restrict fluid intake as ordered	36	90	2	5	2	5	36	90	2	5	2	5	1

Regarding assessment of signs and symptoms of fluid imbalance, only 17.5% and 25% of nurse's auscultated chest sounds competently in the first and second assessments respectively. However, 50% and 32.5% of the nurses did not perform chest auscultation in the first and second assessments respectively. More than half of the nurses were able to assess the presence of edema competently in the first assessment. However, in the second assessment only 37.5% were competent in identifying type, degree, extent and site of edema. The majority of nurses did not assess neck vein when managing fluid disturbance in the two assessments (82.5%). More than half of the nurses did not perform skin assessment when managing fluid disturbance (57.5% and 62.5% respectively).

Concerning nursing interventions for maintaining fluid balance for critically ill patients, it was noted that the majority of nurses were competent in changing patient's position, performing skin care and determining the amount of fluid intake in the first assessment (90%). However, in the second assessment, nearly half (55%) of nurses were competent in performing skin care for critically ill patients. More than half of nurses (67.5%) in the first assessment and 80% of nurses in the second assessment were able to interpret patient's laboratory results. Significant differences were noted regarding measuring CVP and fluid chart, auscultating chest sounds, changing patient position and monitoring lab investigations ($p<0.001$).

Correlation statistical findings

Table 4 depicts the correlation between nurses' demographic characteristics and the practice level for management of fluid and electrolyte disturbances. There was no significant statistical correlation between studied nurses' age (P=0.69) and education level (P=0.71), and total practice level. The highest satisfactory practice level was noted in nurses between the age of 20 and 29 years old (36.1%). Nurses who graduated from Technical Nursing Institute (38.9%) had high satisfactory practice level than other nurses. There were no significant differences between nurses' level of practice, and their educational level, age and years of work experience in ICUs.

Discussion

The focus of this study was developing nursing standard for maintaining fluid and electrolyte balance for critically ill patients in ICUs of Mansoura University Emergency Hospital. The results of the study showed that the majority of the experts agreed about most of the proposed interventions to be included in nursing standard for maintaining fluid and electrolyte balance for critically ill patients in ICUs. The current study findings revealed experts' overall agreement about including monitoring fluid balance chart in the standard. In accordance with other studies, the experts recommended accurate monitoring of fluid balance activities as vital criteria for critically ill patients' baseline interventions [18,19]. Therefore, it was emphasized that more training programs on measuring and maintaining fluid balance for critically ill patients should be organized for novices critical care nurses [19].

The results of the current study showed experts' agreement about the importance of CVP monitoring in assessment and management of fluid and sodium imbalance for critically ill patients. This finding is consistent with a previous study conducted by Li et al. [20] to investigate the correlation between elevated CVP and critically ill patients' outcomes. They reported that increased CVP is correlated with poor patient outcome and prolonged ICU length of stay. Other studies which investigated CVP in fluid management in ICU concluded that CVP is an important criterion for cardiopulmonary status, but should not be the only predictor for volume status changes among ICUs patients [21,22].

Table 4 Correlations between nurses' demographic characteristics and their practice level regarding maintaining fluid and electrolyte balance: Statistically significant difference 0.05; Statistically insignificant difference >0.05;Highly Statistically significant difference 0.001.

Variables	Total Practice Level				Test of significance
	Unsatisfactory N (4)		Satisfactory N (36)		
	No	%	No	%	
Age in years					
20-29 years	2	50	13	36.1	χ2:2.27
30-39 years	2	50	12	33.3	
40-49 years	0	0	10	27.8	P:0.69
≥ 50 year	0	0	1	2.8	
Educational level					
Bachelors Nurse	1	25	5	13.9	χ2:1.66
Technical Nursing Institute	1	25	14	38.9	
Secondary Nursing school	2	50	12	33.3	P:0.71
Post graduates study	0	0	5	13.9	
Years of work experience					
1-9 years	3	75	14	38.9	χ2:2.567
10-19 years	1	25	8	22.2	P:0.26
≥ 20 years	0	0	14	38.9	

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In the current study, all experts strongly agreed to include assessment of presence of seizure in nursing standard for management of critically ill patients who experience sodium disturbance. This is aligned with previous studies which investigated seizures that caused by electrolyte abnormalities [23,24]. These studies suggested monitoring of seizures for patients who have electrolyte disturbances in ICUs.

Our study revealed experts' agreement about assessment of ECG changes as a predictor for potassium and calcium disturbances among critically ill patients. This finding is harmonized with prior research that found an association between higher incidence of ventricular arrhythmia among ICU patients and electrolyte disturbances [25,26]. On the contrary, Cohen et al [27] study which assessed electrocardiogram manifestations in hyperkalemia concluded that ECG changes were not indicative of the severity of potassium disorder among ICU patients. They suggested that potassium management should be guided by sequential potassium level measurements.

Regarding critical care nurses' practices for maintaining fluid and electrolyte balance for critically ill patients in ICUs, the majority of nurses had somewhat satisfactory practice level. This is a surprising result taking into account that the studies nurses did not attend any training programs concerning fluid and electrolyte management. Nurses' satisfactory performance level could be due to nurses' experience in caring for critically ill patients. This finding is on the same line with a previous study which assessed nurses' knowledge and practice regarding fluid and electrolyte management for burned patients [28]. The study reported high (37%) to moderate (42%) nurses' practice for fluid and electrolyte preservation in burn ICU. However, other studies found that the majority of nurses had low practice level for maintaining fluid and electrolyte balance for ICU patients [16,18]. The researchers attributed their results to increased nurses' workload and lack of education. This highlighted the need for continuous educational programs for critical care nurses on preserving fluid and electrolyte balance.

Our results showed that only 40% of nurses were competent in measuring and recording fluid intake and output. In this regards, Diacon et al. [29] reported that 79% of recoded fluid balance by critical care nurses was deviated by more than 50 ml from the required balance. Similarly, a study conducted by Vincent et al. [30] found that nurses' performance regarding measuring fluid intake and output was low. These results were attributed to lack of nurses' education and training on measuring and recoding fluid balance. This was emphasized by an Egyptian study which revealed that more than two thirds of the recorded fluid balance chart was accurate and complete due to nurses' attendance of continuous education programs on maintaining and recording fluid balance [19].

The current study showed that a high percentage of nurses were incompetent in monitoring CVP. This is consistent with other Egyptian studies which investigated nurses' practice regarding fluid and electrolyte maintenance in ICUs [17,31]. We agree with the authors that the reason could be due to nurses' heavy workload and limited time. It could be suggested that reducing nurse-patient ratio in ICU to 1:1 can contribute to accurate measurement and documentation of patients' parameters.

In accordance with other Egyptian studies, no statistical significant differences were noted between nurses' level of practice, and their ages, educational level and years of work experience in ICUs [16,19]. Our study showed that nurses graduated from Technical Nursing Institute had higher performance level than bachelor and postgraduate nurses. This is because the focus of nursing education in Technical Nursing Institute is students' clinical training and experience rather than acquisition of knowledge. Clinical training is a core component of undergraduate nurses' education; therefore, a great focus should be given to students' clinical skills and performance.

Conclusion

Based on the study findings, it can be concluded that, the studied nurses have got somewhat satisfactory level of practice regarding fluid and electrolyte disturbance assessment and management. The developed nursing standard includes all important elements that needed for maintaining fluid and electrolyte balance for critically ill patients in ICUs. Future large scale studies are needed to investigate the effectiveness of the proposed fluid and electrolyte nursing standard on critically ill patients' outcome.

Recommendation

In the light of our study findings, continuous training programs should be organized for critical care nurses on maintaining fluid and electrolyte balance to enhance their performance, and consequently improve the outcome of care. The developed fluid and electrolyte nursing standard needs to be tested for its effectiveness on critically ill patients' outcome.

Limitations

This study has a small sample size which may limit the generalization of the research findings. The unavailability of weighing scales in the studied ICUs lead to missing an important assessment criterion for fluid and electrolyte status.

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Conflicts of Interest

The authors declare that there are no conflicts of interest.

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