The Effect of Implementing Nursing Driven Electrolyte Repletion Protocol on the performance of Critical Care Nurses and Patients' Outcomes

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Abstract

Background: an electrolyte imbalance means that the level of one or more electrolytes in the body is too low or too high it can happen when the amount of water in your body changes. Furthermore, Nursing-driven protocols for electrolyte replacement provide a standardized approach that allows nurses to independently initiate repletion based on specific thresholds and clinical criteria **Aim of the study:** This study aims to evaluate the effect of implementing nursing driven electrolyte repletion protocol on the performance of critical care nurses and patients' outcomes. **Design:** A quasi-experimental research design was utilized in this study. **Sample:** A non-random (convenience) sample of 40 nurses was selected from the after mentioned ICUs, also a non-random (purposive) sample of 76 patients admitted from the intensive care units. **Setting:** The study was conducted at intensive care units in The Memorial Souad Kafafi University Hospital**. Tools**: three tools were used for data collection. Tool I: Nurses self-administrated questionnaire assessment regarding nursing driven electrolyte repletion protocol, it consists of three parts: part I: nurses' demographic characteristics, part II: nursing driven electrolyte repletion protocol assessment knowledge questionnaire and part III: nursing driven electrolyte repletion protocol observation checklist. Tool II: electrolyte disturbance patients' assessment tool: it consists of two parts: part I: patients' demographic characteristics, part II: patients' medical history. Tool III: patients' outcomes observation checklist. **Results:** The study revealed the implementation of the developed protocol resulted in a marked improvement in nurses' knowledge and practice regarding the care of critically ill patients with electrolyte disturbances. The proportion of nurses with a satisfactory level of knowledge increased from 35.0% pre-protocol implementation to 82.5% post-protocol implementation, and those demonstrating a competent level of practice increased from 22.5% to 87.7%, with statistically significant differences ($P < 0.001$). Furthermore, patient outcomes showed substantial improvement post-protocol implementation, with physiological outcomes increasing from 44.7% to 76.3%, neurological outcomes from 30.3% to 82.9%, and general outcomes from 46.1% to 86.8%, all with statistically significant differences ($P < 0.05$) **Conclusion:** The study concluded that implementation of the developed nursing protocol led to marked improvement in nurses' knowledge and practice, as well as significant enhancement in patient physiological, neurological, and general outcomes among critically ill patients with electrolyte disturbances in the ICUs .**Recommendations:** Integrate nursing-driven electrolyte repletion protocols into standard critical care guidelines to ensure timely, safe, and evidence-based correction of electrolyte imbalances.

Keywords: *Repletion, Driven, Performance, Outcomes*

Introduction: -

As a result, ***Haire& Bryan, (2023)*** Electrolytes are minerals that have an electric charge when they are dissolved in water or body fluids, including blood. The electric charge can be positive or negative and have electrolytes in blood, urine (pee), tissues, and other body fluids. Additionally, ***Patel et al., (2023)*** an electrolyte imbalance means that the level of one or more electrolytes in the body is too low or too high. It can happen when the amount of water in your body changes. The amount of water that you take in should equal the amount you lose. If something upsets this balance, you may have too little water (dehydration) or too much water (over hydration). Furthermore, ***Williams, (2023)*** High or low levels of electrolytes disrupt normal bodily functions and can lead to life-threatening complications.

Additionally, ***Thompson et al., (2024***) electrolyte disorders are among the most common clinical problems encountered in the setting of intensive care. Critical disorders such as severe burns, trauma, sepsis, brain damage, and heart failure lead to disturbances in fluid and electrolyte homeostasis. Possible mechanisms include reduced perfusion to the kidney due to hypovolemia or hypotension; activation of hormonal systems such as renin-angiotensin-aldosterone system and vasopressin; and tubular damage caused by ischemic or nephrotoxic kidney damage, including renal insult caused by a myriad of medications used in the intensive care. In addition, inappropriate administration of electrolytes should be considered in the diagnosis and treatment of electrolyte disturbances.

Moreover**, *Merker et al., (2023)*** recommended protocols of care as a tool for the education of the multidisciplinary team. They can improve patient safety and decrease treatment costs by reducing inconsistencies in practice. Two studies conducted by ***Rajendram & Cascini, (2020)*** and ***Girbes & Marik, (2022)*** reported that protocols of care can formulate evidence-based guidelines for bedside care practices. Nurse leaders and unit managers should educate staff, including physicians and nurses, on the application of these protocols.

To begin with, ***Carolina et al., (2024)*** 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 ratio in the ICU is mostly 1 to 2. Therefore, critical care nurses can continually monitor and detect any changes in a patient's condition that require prompt management, such as electrolyte imbalances. Likewise, a descriptive design using a convenient sample of 66 nurses in Makkah City, Saudi Arabia was used by ***El* Sayed et al., (2022)** to

assess knowledge and perception of nurses regarding fluid and electrolyte balance in intensive care units. The researchers' findings clearly revealed the need for a teaching program to enhance the knowledge and perception of maintaining fluid and electrolyte balance.

Additionally, a quasi-experimental study by **Abdelgawad et al., (2020)** evaluated the effect of implementing a nursing-driven electrolyte repletion protocol on critically ill patients. The findings revealed that the application of the protocol significantly enhanced both the **effectiveness** and **timeliness** of electrolyte correction, leading to improved patient outcomes. Therefore, the aim of the study is to evaluate the effect of implementing nursing driven electrolyte repletion protocol on the performance of critical care nurses and patients' outcomes.

Significance of the study:

To begin with, ***Alhussaini, (2021),*** Electrolyte disturbances are frequent and clinically significant challenges encountered in critical care settings. Imbalances in electrolytes such as sodium, potassium, magnesium, and phosphate can lead to serious complications including arrhythmias, seizures, respiratory failure, and even death, particularly in critically ill patients. Timely identification and correction of these imbalances are essential for improving clinical outcomes and reducing the burden on healthcare systems. However, in many intensive care units (ICUs), the process of electrolyte repletion is often delayed due to reliance on physician orders, inconsistent protocols, or lack of nursing autonomy.

According to, ***Prasad et al., (2022)*** Electrolyte abnormalities can have dire consequences depending on the electrolyte involved. Serious morbidity and mortality have been noted following hyperkalemia leading to severe dysrhythmias and cardiac arrest, as well as complications from hypomagnesemia leading to seizures and arrhythmias, and from hyponatremia leading to post-admission psychosis and osmotic demyelination syndrome. The association of hypophosphatemia and poor clinical outcomes has also been reported.

According to ***Briassoulis et al., (2024)*** from a professional practice perspective, the implementation of a standardized, nursing-driven electrolyte repletion protocol has been shown to improve nurses' clinical decision-making, autonomy, and confidence. Also, critical care nurses involved in protocol-based electrolyte replacement demonstrated greater accuracy in selecting appropriate doses and routes of administration, leading to fewer medication errors and better alignment with patients' biochemical profiles. Additionally, implementing such a protocol enhances interdisciplinary collaboration, as nurses, pharmacists, and physicians coordinate care within a clearly defined scope of practice.

Theory of the study:

Knowledge to Action (KTA) framework was developed by ***Graham et al., (2006)*** as a systematic model to bridge the gap between research findings and clinical practice. It was introduced in response to the challenges associated with translating knowledge into action within healthcare settings. The framework consists of two main cycles: the **knowledge-creation cycle** and the **action cycle**, both of which interact dynamically to enhance evidence-based practice and improve patient outcomes.

Ten, (2022) the knowledge-creation cycle consists of three stages: knowledge inquiry, knowledge synthesis, and knowledge tools/products. These stages ensure that raw research findings are refined, synthesized, and transformed into accessible, practical tools that can be utilized by healthcare professionals. By structuring knowledge in this way, the framework helps to ensure that evidence-based guidelines are both relevant and applicable in real-world clinical settings.

Porritt et al., (2023) the action cycle is designed to facilitate the application of knowledge in clinical practice. It comprises seven key phases: (1) identifying the problem, (2) adapting knowledge to the local context, (3) assessing barriers to knowledge use, (4) selecting and implementing interventions, (5) monitoring knowledge use, (6) evaluating outcomes, and (7) sustaining knowledge use. Each of these phases is interconnected, creating an iterative and flexible process that can be adapted to different healthcare environments.

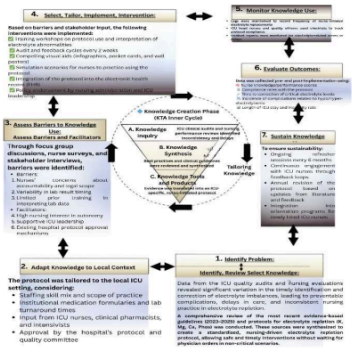

Figure (1) Application of the Knowledge to Action Framework with Electrolyte Imbalance Designated by the researcher based on Graham, I. D., Logan, J., Harrison, M. B., Straus, S. E., Tetroe, J., Caswell, W., & Robinson, N. (2006). Lost in knowledge translation: time for a map? Journal of continuing education in health professions, 26(1), 13-24.

Aim of the study

This study will aim to evaluate the effect of implementing nursing driven electrolyte repletion protocol on the performance of Critical Care Nurses and Patients' Outcomes.

This aim will be achieved through: -

- Assess nurse's knowledge regarding nursing driven electrolyte repletion for critically ill patients before and after implementing the protocol.
- Assess nurse's practices regarding nursing driven electrolyte repletion for critically ill patients before and after implementing the protocol.
- Design nursing driven electrolyte repletion protocol.
- Implement nursing driven electrolyte repletion protocol.
- Evaluate the effect nursing driven electrolyte repletion protocol on critical care nurses' performance, and patients' outcomes.

Research Hypothesis

To fulfill the aim of this study. The following research hypotheses are formulated: - The end of study will be:

H1. At the end of the study, the mean scores of knowledges and practice among nurses will be higher after the implementation of the program compared to before, as measured by Tools I and II.

H2. At the end of the study, patients' outcomes regarding physiological, general, and neurological status will improve after the implementation of the program compared to before, as measured by Tool III.

Subjects and Method:

Research design

A quasi-experimental research design was utilized in this study, involving one group of nurses (pre-/post-protocol) and two groups of patients (pre-/post-protocol).

Setting

This study was carried out in three Intensive Care Units (ICUs) at Souad Kafafi Hospital affiliated with a Misr University for Science and Technology (MUST). These units are General ICU, Stroke ICU, and Trauma ICU.

Sampling:

This study involved two main participant groups: nurses and patients (both assessed pre- and post-protocol implementation).

A. Nurses' Sample

A non-random (convenience) sample of 40 nurses was selected from the aforementioned ICUs. The total number of available nurses in these units was 45; five nurses were excluded due to participation in the pilot study.

B. Patients' Sample

A non-random (purposive) sampling technique was used to select the sample size from the intensive care units in souad kafafi hospital, which was included in the study. Based on sample size equation, 76 patients admitted for electrolytes imbalance were participated in this study.

Inclusion criteria: -

- Adult patients (18 years of age or over).
- Patients are currently admitted to ICU.
- Active order for "Initiate Adult Electrolyte Replacement Protocol" with electrolyte(s) selection: sodium, Calcium, Magnesium, Potassium and Phosphorous.

Exclusion criteria:

- Patients have any known or documented contraindications below.
- Hemodialysis/peritoneal dialysis
- Creatinine Clearance less than 20 mL/min
- Chronic adrenal insufficiency
- New electrical burn
- Rhabdomyolysis
- Diabetic ketoacidosis
- New crush injury
- Hypothermic patients
- Tumor lysis syndrome.

Tools for data collection:

Three tools were utilized to collect data pertinent to the study:

Tool I: Nurses Self-Administrated Questionnaire Assessment Regarding Nursing Driven Electrolyte Repletion Protocol.

This tool was developed by the researcher after reviewing the recent relevant literature **(Albers et al., 2022; Jauch et al., 2022; Morgenstern et al., 2024; O'Neill et al., 2025)**. It aimed to assess critical care nurses' knowledge and practices regarding nursing driven electrolyte repletion protocol. The tool is comprised of three parts as follows:

Part I: Nurses' Demographic Characteristics

This part involved nurses' age, gender, educational level, years of work experience in the

ICU, and attended previous training programs and workshops, and/ or conferences about electrolyte disturbance patients' management ……. etc.

Part II: Nursing Driven Electrolyte Repletion Protocol assessment Knowledge Questionnaire

It involved multiple-choice questions covering general information about electrolyte disturbance, assessment, and general supportive care.

A. General information about electrolyte disturbance

B. **Assessment of electrolyte disturbance patients**

C. **General supportive care for electrolyte disturbance patients**

It involved questions sub-divided into two main categories:

1. *Nursing Care during the acute stage.*
2. *Nursing Care during the sub-acute (Maintenance) stage.*

D. Management and Treatment of Electrolyte Disturbance

The Scoring system: Each correct answer was given one mark, and the wrong or unknown answer was given a zero. Scores ≥ 75% (32 marks) out of total 40 questions (40 marks) were considered satisfactory knowledge level. While the scores < 75% (32 marks) out of total 40 questions (40 marks) were considered unsatisfactory knowledge level. This percentage was decided by a panel of experts, who argued that the lowest acceptable knowledge level for nurses who care for critically ill patients is 75% ***(Badr et al., 2022; Mahmoud et al., 2023; Costa et al., 2024).***

Part III: Nursing Driven Electrolyte Repletion Protocol Observation Checklist

This part included multiple choice questions addressing assessment and general supportive nursing care for electrolyte disturbance patients.

A. **Assessment of electrolyte disturbance patients**:

B. **General supportive nursing care: The Scoring system**: Each item scored based on done correctly = 1 and or not done = 0. The scores ≥ 75% (37 marks) out of total 49 items (49 marks) were considered satisfactory practice level, while the scores < 75% (37 marks) out of total 49 items (49 marks) were considered unsatisfactory practice level. This percentage was decided by a panel of experts, who argued that the lowest acceptable knowledge level for nurses who care for critically ill patients is 75% ***(Abdelgawad et al., 2020; Mahmoud et al., 2023; Costa et al., 2024).***

Tool II: Electrolyte Disturbance Patients' Assessment Tool: This tool was developed by the researcher after reviewing the relevant literature ***(Hijazi & Al-Ansari, 2023; Couture et al., 2023; Palepu & Freebairn, 2024).*** It will be used to assess electrolyte disturbances patients on

admission to ICU. ***It consists of two parts:***

Part I: Patients' Demographic Characteristics: It was included demographic data of patients as: (name, age, gender, marital status, level of education, and units name…etc.

Part II: Patients' Medical History: it included assessment of the patients past medical history, family history of electrolyte disorders, recent surgeries or procedures, and known allergies…..etc.

Tool III: Patients' Outcomes Observation Checklist

This tool was developed by the researcher based on reviewing relevant literature ***(Schönenberger et al., 2022; Albers et al., 2022; Jauch et al., 2023; Schröder et al., 2024; Zhao et al., 2024; Powers et al., 2024).*** It aims to evaluate the effect of the nursing driven electrolyte repletion protocol on patients' outcomes. The tool includes assessing patients for manifestations of electrolyte imbalance by assessing general, physiological and neurological effects.

The Scoring system: Each observed item was scored as follows: "1" for Achieved, and "0" for Not Achieved. The total score was 16. A score ≥ 75% (12 marks or more) was considered an improved patient outcome level, while a score < 75% (less than 12 marks) was a Not Improved patient outcome level. This cutoff point was adopted based on expert consensus ***(Khalil et al., 2020; Zidan et al., 2023).***

Validity:

The content validity of the tool was assessed by five experts in the critical care nursing department Helwan University and critical care medicine department. Accordingly, essential modifications were made. Part II, III of tool I was translated into the Arabic language and the back translation technique was made to ensure the validity of the translation.

Reliability of the Tools

The overall reliability of total knowledge was tested by using weighted kappa and found to be 0.86. The reliability of practical was tested using Cronbach's alpha test and it was 0.93. These results indicate high-reliability tools.

Ethical Considerations

Ethical approval was obtained from the research ethics committee of the faculty of nursing, Helwan University. Permission to conduct the study was guaranteed by the administrative authorities of the convalescence and critical care hospital. Written informed consent was received from the participant nurses who agreed to participate in the study after providing them with a comprehensive explanation of the details of the study. All nurses were assured that participation in the study was voluntary and that they could withdraw from the study at any stage without responsibility. Participants' confidentiality and anonymity were assured. Also, the observed practices were not

considered a part of their annual performance evaluation.

Informed consent was obtained from patients after giving them information about the nature of the study. Furthermore, privacy and confidentiality of the collected data were assured, and participants were able to withdraw from the study at any stage without responsibility.

Pilot study

A pilot study was conducted in March 2024 to assess the feasibility and applicability of the study tools. It involved 10% of the total sample, including 8 patients and 5 nurses, to evaluate the clarity of the questions and the time required to complete the data collection tools. Based on the findings, necessary modifications were made. The subjects who participated in the pilot study were excluded from the main study sample.

Fieldwork:

According to the selected theoretical framework: This applied the Knowledge-to-Action (KTA) Framework to implement a nursing-driven electrolyte repletion protocol in ICUs, aiming to improve patient safety, efficiency, and care quality. Knowledge Inquiry: Identified frequent electrolyte disturbances (hypokalemia, hypomagnesemia, hypophosphatemia) in critically ill patients, linked to adverse outcomes such as arrhythmia, muscle weakness, and prolonged ICU stays. Literature showed delays and inconsistencies in correction. Knowledge Synthesis: Systematic reviews and clinical guidelines supported timely electrolyte monitoring and nurse-led interventions as safe and effective. Knowledge Tools: Developed a bilingual (English/Arabic) evidence-based protocol, with facilitator cards, educational videos, and expert reviews to ensure clinical accuracy.

Action Cycle Implementation: Problem Identification: ICU delays in electrolyte correction were recognized as a priority issue. A 9-month pre-post study (May 2024–Jan 2025) was planned. Local Adaptation: Adjusted protocol to hospital policies, drug availability, lab turnaround times, and nurses' scope of practice. Building & Baseline Assessment: Established trust with nurses, assessed their knowledge and practices through questionnaires, observation checklists, and patient outcome data. Barrier Assessment: Identified low confidence, protocol complexity, and legal concerns. Addressed with targeted training, simplified tools, and decision aids.

Implementation Strategy: Three-day training (six sessions) combined theory and practice: first day: Electrolyte basics, pathophysiology, and causes of imbalances. Second day: Patient assessment and supportive care. Third day: Protocol application for each imbalance, dosing, monitoring, and safety Pocket cards, case studies, and simulations supported learning.Monitoring & Evaluation: Audits, observations, and feedback ensured adherence. Pre- and post-tests showed significant improvements in nurses' confidence and protocol accuracy. Patient outcomes improved, with fewer

severe disturbances, faster corrections, and reduced complications. Implications: The KTA framework effectively bridged research and practice, enabling nurses to independently manage routine electrolyte replacement safely. Stakeholder engagement, contextual adaptation, and continuous monitoring were key to sustainability. This approach enhanced ICU efficiency and patient outcomes while empowering nursing practice.

Results

The present study aimed to evaluate the effect of implementing nursing driven electrolyte repletion protocol on the performance of critical care nurses and patients' outcomes.

Part I: Demographic Characteristics of the nurses studied

Table (1): Distribution of the nurses studied according to their characteristics (n=40).

Characteristics of the nurses studied	No	%
Age (in years)		
20-<30	28	**70.0**
30-<40	9	22.5
40-<50	3	7.5
Mean ± SD	29.31±3.04	
Gender		
Male	20	**50.0**
Female	20	50.0
Educational level		
Secondary technical school	1	2.5
Technical Nursing institute	4	10.0
BSc nursing	27	**67.5**
Postgraduate studies	8	20.0
Years of experience in ICU		
1-<5	20	**50.0**
5-<10	11	27.5
≥10	9	22.5
Mean ± SD	6.77±2.88	
Pervious attendance of training or workshops or conference about nursing management of electrolyte imbalance patients		
Yes	5	12.5
No	35	**87.5**

Table (1) shows that, 70.0% of the nurses studied were in age group 20-<30 with mean age 29.31±3.04 and equal gender 50.0% of them were females. Also, 67.5%

of them had BSc of nursing, 50.0% of them had 1-<5 years of experience in ICU and 87.5% of them didn't have pervious attendance of training or workshops or conference about nursing management of electrolyte imbalance patients

Table (2): Frequency distribution of the nurses studied according to their total domains of knowledge (n=40).

Domains	Pre protocol(n=40)				Post protocol(n=40)				McNamara test	P-value
	Satisfactory		Unsatisfactory		Satisfactory		Unsatisfactory			
	N	%	N	%	N	%	N	%		
A- General information about electrolyte disturbance	14	35.0	26	**65.0**	31	**77.5**	9	22.5	13.644	<0.001*
B- Electrolyte Disturbance Patient	12	30.0	28	**70.0**	30	**75.0**	10	25.0	15.282	<0.001*
C- General Supportive Care for electrolyte imbalance Patient	15	37.5	25	**62.5**	33	**82.5**	7	17.5	12.057	<0.001*
D- Management and Treatment of Electrolyte Disturbance	17	42.5	23	**57.5**	32	**80.0**	8	20.0	9.648	0.002*

Table (2) shows that 35.0% of nurses studied had satisfactory level of total domain of general information about electrolyte disturbance pre-protocol implementation which improved to 77.5% post protocol implementation. Also, 30.0% of nurses studied had satisfactory level of total domain of electrolyte disturbance patient which improved to 75% post protocol implementation. In addition, 37.5% of nurses studied had satisfactory level of total domain of general supportive care for electrolyte imbalance patient pre-protocol implementation which improved to 82.5% post protocol implementation. Moreover, 42.5% of nurses studied had satisfactory level of total domain of management and treatment of electrolyte disturbance pre-protocol implementation which improved to 80.0% post protocol implementation.

Additionally, there was a statistically significant difference between pre-protocol and post protocol implementation among the nurses studying regarding all total domains of level of knowledge about management and treatment of electrolyte disturbance at P-value < 0.05.

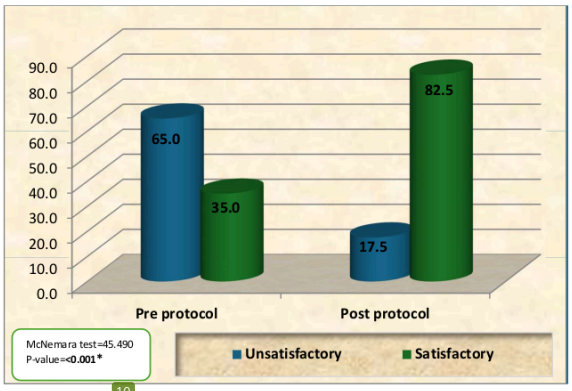

Figure (2): Frequency distribution of the nurses studied according to their total level of knowledge (n=40).

Figure (2) shows that 35.0% of nurses studied had satisfactory level of knowledge pre-protocol implementation which improved to 82.5% post protocol implementation. Also, there was a statistically significant difference between pre-protocol and post protocol implementation among the nurses studied regarding total level of knowledge at P-value < 0.001.

Table (3): Frequency distribution of the nurses studied according to their total domains of practice (n=40).

Domains	Pre protocol(n=40)				Post protocol(n=40)				McNamara test	P-value
	Competent		Incompetent		Competent		Incompetent			
	N	%	N	%	N	%	N	%		
A. Assessment of Electrolyte Disturbance Patient	14	35.0	26	**65.0**	34	**85**	6	15.0	27.528	**<0.001 ***
B. General Supportive Nursing Care	9	22.5	31	**77.5**	35	**87.5**	5	12.5	22.391	**<0.001 ***

Table (3) shows that 35.0% of the nurses studied demonstrated competent level of total domain of assessment of electrolyte disturbance patient pre-protocol implementation which improved to 85% post protocol implementation. Also, 22.5% of the nurses studied demonstrated competent level of total domain of general supportive nursing care pre-protocol implementation which improved to 87.5% post protocol implementation.

Additionally, there was a statistically significant difference between pre-protocol and post protocol implementation among the nurses studying regarding all total domains level of practice about management and treatment of electrolyte disturbance at P-value < 0.05.

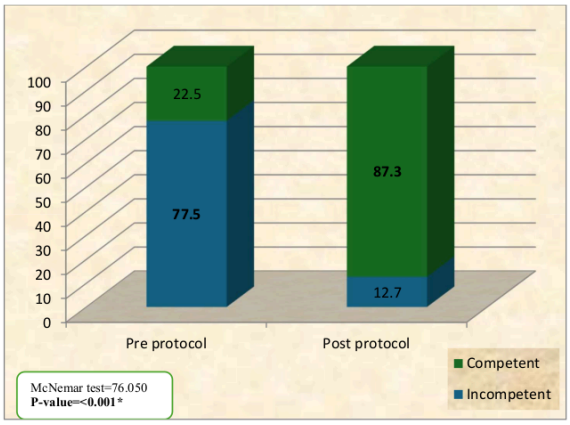

Figure (3): Frequency distribution of the nurses studied according to their total level of practice (n=40).

Figure (3) shows that 22.5% of the nurses studied demonstrated competent level of practice pre-protocol implementation which improved to 87.7% post protocol implementation. Also, there was a statistically significant difference between pre-protocol and post protocol implementation among the nurses studied regarding total level of practice at P-value < 0.001.

Part IV: Demographic Characteristics and medical history of the studied patients

Table (4): Distribution of the studied patients according to their characteristics (n=152).

Characteristics of the studied	Pre protocol (n=76)		Post protocol (n=76)		X2 Test	P-value
	No	%	No	%		
Age (years)						
<40	16	21.1	18	23.7	1.489	0.475
40-60	52	**68.4**	**54**	**71.1**		
>60	8	10.5	4	5.3		
Mean ±SD	48.09±10.82		46.30±10.78		t=1.021	0.309
Gender						
Male	38	**50.0**	40	**52.6**	0.105	0.746
Female	38	50.0	36	47.4		
Educational Level						
Illiterate	9	11.8	14	18.4	7.954	0.074
Primary	12	15.8	8	10.5		
Secondary	18	23.7	23	30.3		
University	37	**48.7**	31	**40.8**		
Other (specify)	0	0.0	0	0.0		
Marital Status						
Single	2	2.6	4	5.3	1.465	0.690
Married	63	**82.9**	**60**	**78.9**		
Divorced	9	11.8	8	10.5		
Widowed	2	2.6	4	5.3		
Admission Unit						
G.I.C. U	49	**64.5**	49	**64.5**	1.187	0.552
ST.C.U	15	19.7	11	14.5		
TU.C. U	12	15.8	16	21.1		

X^2-Chi-Square Test t= Independent t test P-value > 0.05= Non-significant (NS) *P-value ≤ 0.05= Significant (S

Table (4) shows that 68.4% and 71.1% of the studied patients were in age group 40-60 year old pre-protocol and post-protocol respectively. Also, 50.0% and 52.6% of them were males' pre-protocol and post-protocol respectively. 48.7% and 40.8% of them had university education pre-protocol and post-protocol respectively. Moreover, 82.9% and 78.9% of them were married pre-protocol and post-protocol respectively.

Additionally, there was no statistically significant difference between pre-protocol and post protocol implementation among the studied patients regarding all items of demographic characteristics at P-value > 0.05.

Part V: Patients' Outcomes of driven electrolyte repletion protocol

Table (5): Frequency distribution of the studied patients according to their total levels of outcomes (n=152).

Outcomes	Pre protocol (n=40)		Post protocol (n=40)		McNamara test	P-value
	N	%	N	%		
Physiological Outcomes						
Satisfactory	34	44.7	58	**76.3**	12.315	**0.014***
Unsatisfactory	42	**55.3**	18	23.7		
Neurological Outcomes						
Satisfactory	23	30.3	63	**82.9**	15.573	**0.048***
Unsatisfactory	53	**69.7**	13	17.1		
General Outcomes						
Satisfactory	35	46.1	66	**86.8**	13.623	**<0.001***
Unsatisfactory	41	**53.9**	10	13.2		

Table (5) shows that 44.7% of patients studied had improved the total of physiological outcomes level pre-protocol implementation compared to 76.3% of patients in post protocol implementation. Also, 30.3% of patients studied improved the total of neurological outcomes level pre-protocol implementation compared to 82.9% of patients in post protocol implementation. In addition, 46.1% of patients studied had improved the total of general outcomes level pre-protocol implementation compared to 86.8% of patients in post protocol implementation.

Additionally, there was a statistically significant difference between pre-protocol and post protocol implementation among the patients studying total levels of patient's outcomes at P-value < 0.05.

Part IV: Relation and correlation between the studied variables.

Table (6): Relationship between demographic characteristics of the nurses studied and their total level of knowledge pre and post **protocol** (n=40).

Characteristics of the nurses studied		Total level of knowledge									
		pre protocol				X^2 & P-value	post protocol				X^2 & P-value
		Unsatisfactory		Satisfactory			Unsatisfactory		Satisfactory		
		No	%	No	%		No	%	No	%	
Age (in years)	20-<30	20	**50.0**	8	20.0	2.184 & **0.336**	9	22.5	19	**47.5**	6.025 & **0.094***
	30-<40	5	12.5	4	10.0		0	0.0	9	22.5	
	40-<50	1	2.5	2	5.0		2	5.0	1	2.5	
Gender	Male	12	30.0	8	20.0	0.440 & **0.507**	5	12.5	15	**37.5**	0.125 & **0.723**
	Female	14	**35.0**	6	15.0		6	15.0	14	35.0	
Educational qualification	Secondary technical school	0	0.0	1	2.5	5.670 & **0.129**	0	0.0	1	2.5	2.800 & **0.423**
	Technical Nursing institute	3	7.5	1	2.5		1	2.5	3	7.5	
	BSc nursing	20	**50.0**	7	17.5		6	15.0	21	**52.5**	
	Postgraduate studies	3	7.5	5	12.5		4	10.0	4	10.0	
Years of experience	1-<5	15	**37.5**	5	12.5	2.560 & **0.278**	6	15.0	14	**35.0**	3.229 & **0.199**
	5-<10	7	17.5	4	10.0		1	2.5	10	25.0	
	≥10	4	10.0	5	12.5		4	10.0	5	12.5	
Pervious attendance of training courses	Yes	24	**60.0**	11	27.5	1.570 & **0.210**	9	22.5	26	**65.0**	0.448 & **0.503**
	No	2	5.0	3	7.5		2	5.0	3	7.5	

X^2-Chi-Square Test P-value > 0.05= Non-significant (NS) ***P-value ≤ 0.05= Significant (S**

Table (6) shows that Table (16) shows that there was no statistically significant relationship between total knowledge level of the nurses studied and their socio demographic characteristics preprogram implementation at P-value > 0.05. But there was a statistically significant relationship between total knowledge level of the nurses preprogram implementation studied and their age at P-value= 0.049.

Table (7): Relationship between demographic characteristics of the nurses studied and their total level of practice pre and post **protocol** (n=40).

Characteristics of the nurses studied		Total level of practice									
		Pre protocol				X^2 & P-value	post protocol				X^2 & P-value
		Incompetent		Competent			Incompetent		Competent		
		No	%	No	%		No	%	No	%	
Age (in years)	20-<30	24	**60.0**	4	10.0	3.771 & **0.152**	12	30.0	16	**40.0**	1.261 & **0.532**
	30-<40	5	12.5	4	10.0		2	5.0	7	17.5	
	40-<50	2	5.0	1	2.5		1	2.5	2	5.0	
Gender	Male	15	37.5	5	12.5	0.143 & **0.705**	7	17.5	13	**32.5**	0.107 & **0.744**
	Female	16	**40.0**	4	10.0		8	20.0	12	30.0	
Educational Level	Secondary technical school	0	0.0	1	2.5	5.406 & **0.144**	0	0.0	1	2.5	1.956 & **0.582**
	Technical Nursing institute	3	7.5	1	2.5		1	2.5	3	7.5	
	BSc nursing	23	**57.5**	4	10.0		12	30.0	15	**37.5**	
	Postgraduate studies	5	12.5	3	7.5		2	5.0	6	15.0	
Years of working experience in ICU	1-<5	17	**42.5**	3	7.5	1.395 & **0.498**	9	22.5	11	**27.5**	2.417 & **0.299**
	5-<10	8	20.0	3	7.5		2	5.0	9	22.5	
	≥10	6	15.0	3	7.5		4	10.0	5	12.5	
attendance Pervious of training program	Yes	28	**70.0**	7	17.5	1.004 & **0.316**	12	30.0	23	**57.5**	1.234 & **0.267**
	No	3	7.5	2	5.0		3	7.5	2	5.0	

X^2-Chi-Square Test P-value > 0.05= Non-significant (NS) ***P-value ≤ 0.05= Significant (S)**

Table (7) shows that there was no statistically significant relationship between the total practice level of the nurses studied and their socio demographic characteristics pre program implementation at P-value > 0.05.

Table (8): Correlation between total level of knowledge and practice pre and post protocol among the nurses studied (n=40).

Total level	Knowledge			
	Pre protocol		Post protocol	
	r	P-value	r	P-value
Practice	0.534	**0.001***	0.448	**0.004***

r=Spearman Correlation Coefficient Test **P-value > 0.05**= Non-significant (NS) ***P-value ≤ 0.05= Significant (S)**

Table (8) shows that there was significant statistical positive correlation between total level of knowledge and total level of practice pre program and post program implementation at P-value= 0.001and 0.004 respectively.

Discussion

According to ***Giannis et al., 2025*** Electrolytes are among the most common clinical problems encountered in the intensive care unit (ICU). Recent studies have reported that electrolyte imbalances are associated with increased morbidity and mortality among critically ill patients. To provide optimal care, health care providers should be familiar with the principles and practice of electrolyte physiology and pathophysiology. Electrolyte resuscitation should be aimed at restoration of normal hemodynamics and tissue perfusion. On the other hand, liberal electrolyte administration is associated with adverse outcomes such as prolonged stay in the ICU, higher cost of care, and increased mortality.

This chapter covers the discussion of results obtained from the current study that aimed to evaluate the effect of implementing nursing driven electrolyte repletion protocol on the performance of critical care nurses and patients' outcomes. **This aim will be achieved through: -**

Regarding the demographic characteristics of the study group (pre and post intervention), the current study included 40 nurses. It was found that more than two-thirds of the studied CCNs were in the age group of 20-<30 years, with a mean age of 29.31±3.04 years. This could be attributed to the demographic structure of the nursing workforce, where younger nurses represent a significant portion of staff, especially in specialized and demanding units like intensive care, as well as the physical and mental demands of critical care nursing, which may deter older nurses from remaining in such high-stress environments.

This finding consisted of **Sheta et al., (2024)** who was conducted Quasi – experimental (60 nurses) in intensive care unit of Benha University Hospital, Egypt entitled "Effectiveness of structured educational program on knowledge and practice among nurses regarding body fluid balance assessment for critically Ill patients" illustrates that, more than half of the nurses at the age between 25 -30 years old with mean age 28.49 ± 9.53.

But contradicted with **Mohamed et al., (2021)** who conducted A descriptive design (72 nurses) was utilized in the urology department at Zagazig University and AlAhrar Hospitals at Zagazig City in Sharkia Government, Egypt about " Nurses' role regarding care of patients with fluid and electrolyte imbalance undergoing urinary diversion " revealed that the majority of the studied nurses age more than 30 years ranged between 23-56 years old with mean ±SD 37±8.3

Concerning gender, the equal distribution of male and female nurse's half each this finding may reflect the increasing gender diversity in the nursing profession. In recent years, nursing has become more inclusive, attracting both males and females due to changes in societal perceptions and equal educational and employment opportunities for both genders. This balance could also indicate

progress toward gender equity in critical care nursing roles.

This finding is in concord with **Mahmoud et al., (2023)** who conducted A descriptive exploratory research design (60 nurses) was carried out at the ICU Medical and surgical units at El-Zagazig University Hospital, Egypt entitled " Nurse's knowledge and practice regarding care of fluids and electrolytes imbalance among critically ill patients " reported that more than half of study were male. But incongruent with, **Mohamed et al., (2023)** who A quazi experimental design (50 nurses) was conducted at intensive care unit at a liver hospital and eighty patients with acute liver failure Assiut, Egypt entitled " Effect of an educational program on nurses' competency about fluid, electrolyte and Acid Base disturbances among acute liver failure patients' outcomes" show that the majority of patients were male

Regarding the patient's education, more than two-thirds of the participants had a Bachelor of Science in Nursing (BSc), this can be linked to growing emphasis on academic qualifications in modern nursing practice. Nursing education programs have increasingly shifted toward bachelor's degrees as the standard minimum requirement, especially in specialized areas like critical care. Furthermore, BSc-prepared nurses are associated with improved patient outcomes and are often preferred in professional settings.

This explanation agrees with **El Sayed et al., (2023)** was conducted A quazi experimental design (66 nurses) at Maternity and Children Hospital, Makkah City, Saudi Arabia "Knowledge and perception of nurses regarding fluid and electrolyte balance in intensive care units" showed that, more than half of studied sample is a bachelor's degree

On the contrary **Trikhatri et al., (2023)** who conducted Descriptive, cross sectional research design (110 nurses) was carried out critical and general ward of the Chitwan Medical College Teaching Hospital, Nepal " Knowledge and practice regarding fluid and electrolytes administration among nurses working in a teaching hospital, chitwan" present that more than half of them had secondary school diploma.

contrarily **Hassan et al., (2022)** who conducted A descriptive research design (72 nurses) was carried out at Intensive care units in Damietta General Hospital, Egypt " Assessment of nurses' knowledge and practice regarding fluids and electrolyte imbalance in critical care units " Illustrate that more than one third of them had secondary school diploma.

As regards duration of experience, about half had 1<5 years of experience in ICU settings. This could stem from workforce trends in critical care nursing, where there is a continuous influx of relatively newly graduated nurses entering the ICU. This pattern could also be influenced by high turnover rates in intensive care units, which are often attributed to job-related stress, workload, and emotional demands. As a result, a substantial proportion of ICU nurses fall within the early career

stage.

This result was consistent with **Mohamed et al., (2023)** who was found that one quarter of nurses had durations of experience < 1 year, 1-3 years and more than one third had durations of experience 3-5 years.

But this result was inconsistent with **Mohamed et al., (2021)** who revealed that the majority of the studied nurses had total years of experience in hospital more or equally five years of experience.

Regarding attending any training session, the majority of the nurses had not previously attended any training, workshops, or conferences related to the nursing management of patients with electrolyte imbalance. This is possibly a result of the dynamic nature of ICU staffing and the relatively high turnover rates in critical care units, unavailability of staff development plans, training resources, and the lack of nursing staff which prevents them from attending training programs, lack of awareness about the importance of such training, or scheduling and workload constraints that prevent participation. Additionally, electrolyte management is often covered superficially during undergraduate education, necessitating more structured post-graduate clinical training opportunities.

On the same scope, **Mohamed et al., (2024)** who Quasi – experimental (60 nurses) was carried out at six critical care units affiliated to Minia University Hospitals, Egypt "Effect of educational protocol regarding accurate monitoring fluid balance on critical care nurses' knowledge and practice" Presents that the majority of the study group constituted hadn't attended any previous workshop regarding fluid balance monitoring. Likewise, **Eldsouky et al., (2022)** who Cross-sectional analytic design (160 nurses and 160 CHF patients) was carried out at Zagazig Main University Hospital, Egypt "Nurses' knowledge and practice concerning fluid and electrolyte balance among patients with congestive heart failure" Presents that, only minority of the nurses in the study sample had attended training courses in fluid /electrolyte balance.

out of scope with **Hosny et al., (2022)** who conducted A descriptive cross-sectional research design (52 nurses) conducted at the cardio-thoracic surgery department affiliated to Mansoura University Hospitals, Egypt " Assessment of nurses' knowledge and performance regarding fluid and electrolyte management for cardiac surgery patients " Presents that, more than two thirds attend fluids and electrolyte related workshops of them about one third attending only one workshop.

Concerning the total domains of nurses' knowledge shows that more than one third of nurses studied had satisfactory level of total domain of general information about electrolyte disturbance pre-protocol implementation, which improved to the majority post protocol implementation. Also, nurses studied satisfactory level of total domain of electrolyte disturbance patient which improved to the majority post protocol implementation. In addition, more than one

third of nurses studied had satisfactory level of total domain of general supportive care for electrolyte imbalance patient pre-protocol implementation which improved to the majority post protocol implementation. Moreover, more than one third of nurses studied had satisfactory level of total domain of management and treatment of electrolyte disturbance pre-protocol implementation which improved to the majority post protocol implementation.

Additionally, there was a statistically significant difference between pre-protocol and post protocol implementation among the nurses studying regarding all total domains of level of knowledge about management and treatment of electrolyte disturbance at P-value < 0.05.

In addition to **Elsayed & Saad ., (2023)** who A quazi experimental design (35 nurses) was conducted at the critical care units at El Hussein university hospitals, Egypt " Effect of Hybrid Educational Program on Nurses' Performance regarding Caring of Patients with Fluid and Electrolytes Imbalance in Critical Care Units" demonstrated that more than half of the studied nurses had unsatisfactory knowledge about fluid and electrolytes imbalance in critical care units at pre hybrid educational program implementation. While most and the majority of them had satisfactory levels of knowledge about fluid and electrolytes imbalance in critical care units at post and follow up phases of hybrid educational program implementation, respectively.

Additionally, it was reported that there was a highly statistically significant difference between satisfactory level of nurses' knowledge regarding nursing care for patients with fluid and electrolytes imbalance in critical care units at pre, post and follow up phases of hybrid educational program implementation related to all points at p value <0.01.

Be in favor of **Mohamed et al., (2023)** who Shows a significant progress in the knowledge of nurses about fluid and mineral's disorders in patients with acute liver cell failure before and after the application of the program. The total score of knowledge was significantly increased after application of the program (17.11 ± 3.60 vs. 8.99 ± 3.29; p< 0.001).

Regarding the total level of nurse's knowledge illustrates that (about one third) of the nurses studied had a satisfactory level of knowledge before protocol implementation, which significantly improved to (the majority) after the protocol was implemented. Additionally, there was a statistically significant difference between pre- and post-protocol implementation regarding the total level of knowledge among the studied nurses, with a P-value < 0.001. These findings emphasize the effectiveness of the protocol in enhancing nurses' overall knowledge of electrolyte imbalance management.

This explanation agrees with **Santos, (2022)** who A quazi experimental design (35 nurses) was the Providence Veterans Affairs Medical Center (PVAMC), Rhode Island, USA "Knowledge of electrolyte replacement protocols among medical-surgical registered nurses " showed that, increase

in overall correct answers from pre-test about two thirds (to post-test scores the majority. The results indicated the greatest overall improvement in knowledge after the educational session was approximately equal between the topics of recommendations for electrolyte repletion and electrolyte replacement considerations and precautions.

Be in favor of **Sheta et al., (2024)** who demonstrates that, there were highly significant differences between pre and post program implementation in relation to total mean score of nurses' knowledge regarding body fluid balance assessment for critically ill patients and nurses' knowledge was improved significantly post program implementation ($P < 0.001$).

Regarding nursing, total domains of nurses practice show that the nurses studied demonstrated a competent level of total domain assessment of electrolyte disturbance patient pre-protocol implementation which improved to post protocol implementation. Also, the nurses studied demonstrated competent level of total domain of general supportive nursing care pre-protocol implementation which improved to post protocol implementation. Additionally, there was a statistically significant difference between pre-protocol and post protocol implementation among the nurses studying regarding all total domains level of practice about management and treatment of electrolyte disturbance at P-value < 0.05.

Be in favor of **El-Shaboury et al., (2023)** who Quasi experimental design (45 Patients& 45 nurses) was carried out at Mansoura University Hospitals' Plastic and Reconstructive Burn Center, Egypt " Effect of implementing fluid and electrolyte resuscitation educational package on nurses' performance and outcomes of patients with burn" Demonstrated an apparent increase in the subtotal mean observed practice score post educational package regarding fluid and electrolyte resuscitation for burned patients, as compared to pre intervention(15.8 ± 4.14-22.6 ± 2.38) respectively. All throughout the assessment, there were statistically significant differences in nurses' practices with p value (0.00).

This result is consistent with the findings of **Ibrahim et al., (2023)** in her study titled "Effect of an educational program on nurses' practice regarding electrolyte imbalance among critically ill patients at Zagazig university hospital". The study revealed a significant improvement in nurses' performance post-program, particularly in assessment skills, where the competency rate increased from more than one third to the majority. The author attributed this improvement to structured hands-on training and real-case scenario discussions provided during the intervention.

Oppositely, **Fouad& Mohammed, (2022)** in their study titled "Impact of an instructional guideline on nurses' knowledge and practices regarding fluid and electrolyte balance in ICU at Benha university hospital" found improvements in assessment practice from more than one third to

more than two thirds. Although the improvement was statistically significant, it was less marked compared to the current study. The authors explained that inconsistent follow-up and limited practical simulation sessions may have impacted long-term skill retention.

Regarding nursing, the total level of nurse's practice illustrates that less than in quarter of the nurses studied demonstrated a competent level of practice before protocol implementation, which significantly improved to the majority after the protocol was implemented. Additionally, there was a statistically significant difference between pre- and post-protocol implementation regarding the total level of practice among the nurses studied, with a P-value < 0.001. These findings highlight the effectiveness of the protocol in enhancing nurses' clinical competencies in managing electrolyte imbalance patients.

This explanation agrees with **Elsayed& Saad., (2023)** who showed that, more than half of the studied nurses had incompetent level of practice regarding care of patients with fluid and electrolytes imbalance in critical care units at pre hybrid educational program implementation. While most and the majority of them had competent level of practice regarding care of patients with fluid and electrolytes imbalance in critical care units at post and follow up phases of hybrid educational program implementation, respectively.

This finding aligns with the study conducted by **Sheta et al., (2024)** who displays that, the total mean score of nurses' practices regarding assessment of fluid status for critically ill patients was improved significantly post program implementation ($P < 0.001$).

IV: Demographic Characteristics and medical history of the studied patients

Regarding the demographic characteristics of the pre and post groups, there were 76 patients pre groups and 76 patients post groups in this study. Regarding demographic characteristics of the studied patients of reveals that more than two thirds of the studied patients were in the age group of 40–60 years pre-protocol and post-protocol, respectively. Additionally, half and more than half of them were males pre- and post-protocol, respectively. Regarding educational level, about half of the patients had a university education pre-protocol, compared to more than one third post-protocol. Moreover, the majority of the patients were married pre- and post-protocol, respectively.

Furthermore, there was no statistically significant difference between pre-protocol and post-protocol implementation among the patients studied regarding all demographic characteristics, with a P-value > 0.05. This indicates that the demographic distribution of patients remained consistent throughout the study and confirms that the improvements noted were attributable to the applied protocol and not underlying medical changes.

This result is consistent with the findings of **Migdanis et al., (2023)** who Quasi experimental

design (42 patients) was conducted at a single surgical unit of a public university hospital, Georgios." Administration of an oral hydration solution prevents electrolyte and fluid disturbances and reduces readmissions in patients with a diverting ileostomy after colorectal surgery: A Prospective, Randomized, Controlled Trial" found that baseline demographic characteristics such as age, gender, chronic disease prevalence or allergy history and medical history remained consistent before and after the application of a nursing protocol aimed at correcting electrolyte imbalances in ICU patients, with no significant differences ($P > 0.05$).

Regarding age, the current study revealed that more than two thirds of the studied patients were in the age group of 40–60 years pre- and post-protocol, respectively.

This finding is consistent with the results of **Balc et al., (2023)** who Descriptive Exploratory research (996 Patients) study carried in Emergency Department (ED) of Uludag University Faculty of Medicine, Iraq titled " General characteristics of patients with electrolyte imbalance admitted to emergency department" show that the mean age of the patients was 59.28±16.79.

This explanation was supported by **Duzalan& Pakyuz, (2022)** who Quasi experimental design (80 nurses) was conducted t five publicly funded dialysis centers located in Istanbul Province, Turkey " Educational interventions for improved diet and fluid management in hemodialysis patients: An interventional study" there were half in each group mean age was 64.12±55.50 years.

Regarding gender, half and more than half of them were males pre- and post-protocol, respectively.

Go along with **Eldsouky et al., (2022)** who indicates that more than half were males. Go along with **Gunturi et al., (2022)** who prospective, observational study (42 patients) Was performed at the ICU of a secondary care referral hospital located in a resource challenged settings of South India" Electrolytes imbalance and their clinical outcomes in the intensive care unit " there were more than half of the participants were male.

Oppose with **Conley et al., (2022)** who retrospective study (145 patients) Was performed at t at Bay Care Health System, Tampa, Florida " Safety of a nurse-driven standardized potassium replacement protocol in critically ill patients with renal insufficiency " there were more than half of the participants were female.

Regarding educational level, about half of the patients had a university education pre-protocol, compared to more than one third post-protocol. Likewise, **Hussein et al., (2020)** who Descriptive Exploratory research (600 Patients) study carried in the Trauma, General and Postoperative Intensive Care Units at Assuit University Hospital, Assuit, Egypt " Mortality prediction among critically ill patients during intensive care unit stays at Assiut university hospital " As well shows that a about half the sample had bachelor's degrees.

This finding is inconsistent with the results of **Taha et al., (2024)** who Quasi experimental design (60 patients) was conducted in the outpatient clinics of the cardiology department at Zagazig University Hospitals, Egypt " Effect of nursing intervention program on maintaining fluid and electrolytes balance among patients with congestive heart failure" show that about half have basic/secondary level of education

Concerning marital status, the majority of the patients were married pre- and post-protocol, respectively. This finding is consistent with the results of, **Eshetu et al., (2023)** who Quasi experimental design (130 nurses) was conducted Comprehensive Specialized Hospital, Ethiopia" Assessment of electrolyte imbalance and associated factors among adult diabetic patients attending the university of Gondar " show that among the study groups, about half 115 were married.

Related to total levels of patient's outcomes illustrates a marked improvement in patient outcomes following protocol implementation. Specifically, of patients had improved total physiological outcomes in the pre-protocol phase, which increased significantly to post-protocol. Similarly, only patients demonstrated improved neurological outcomes pre-protocol, which rose to after implementation. Regarding general outcomes, improvement showed before the protocol, rising to post-protocol.

These enhancements were statistically significant, with a P-value < 0.05, indicating the protocol's effectiveness in enhancing various clinical dimensions of patient health, particularly in areas of electrolyte balance, cognitive function, and general physiological stability.

Be in favor of **Abdelgawad et al., (2021)** who revealed as patient outcome, the electrolyte depletion related adverse events differed between both groups. The incidence of dysrhythmia, ileus and weaning failure were significantly lower in the study group, whereas the incidence of tremors did not reach statistical significance. Consequently, there were significantly decreased mechanical ventilation and ICU days without significant change of mortality rate in the intervention group as compared to the control group and overall patient outcomes, including reduced ICU stay and stabilized serum electrolytes after protocol implementation ($P < 0.01$).

Be in favor of **Todd et al., (2021)** who a retrospective study (51 patients) was conducted The Methodist Hospital, southeast Texas " A multidisciplinary protocol improves electrolyte replacement and its effectiveness " revealed overall electrolyte replacement improved from about half to the majority (P .03), and its overall effectiveness increased from about half to about two thirds (P .01).

Part IV: Relation and correlation between the studied variables.

Regarding Relationship between demographic characteristics of the nurses studied and

their total level of knowledge pre and post protocol Table (16) shows that there was no statistically significant relationship between total knowledge level of the nurses studied and their socio demographic characteristics preprogram implementation at P-value > 0.05. But there was a statistically significant relationship between the total knowledge level of the nurses preprogram implementation studied and their age at P-value= 0.049.

Similarly, **Taha et al., (2024)** who show that no significant correlations were shown between their knowledge or practice scores and their demographic characteristics.

But this finding is not supported by the study of **Mohamed et al., (2021)** who revealed that there was negative significant correlation between total knowledge score of studied nurses and age, also experience per year.

But this finding is not supported by the study of **Elsayed& Saad., (2023)** who revealed that, there were highly statistically significant relation between total level of nurses' knowledge regarding caring of patients with fluid and electrolytes imbalance in critical care unit, their education level and years of experience at (P= < 0.01).

Regarding relationship between demographic characteristics of the nurses studied and their total level of practice pre and post protocol demonstrates that there was no statistically significant relationship between the total practice level of the nurses studied and their socio-demographic characteristics before program implementation, with a P-value > 0.05. This indicates that factors such as age, gender, education level, and years of experience did not significantly influence nurses' baseline practice levels in managing electrolyte imbalance before the implementation of the protocol.

This finding is consistent with the results of **Hassan, (2021)** who illustrates that there was no statistically significant relation between nurses 'total practice so and their demographic characteristics at different trainings of the study.

This finding is consistent with the results of **Mansour, (2020)** who show that there was no significant statistical correlation between studied nurses' age studied (P=0.69) and education level (P=0.71), and years of work experience in ICUs and total practice level.

Related to Correlation between total level of knowledge and practice pre and post protocol among the nurses studied reveals a significant positive correlation between the total level of knowledge and the total level of practice among the nurses studied both before and after program implementation, with P-values of 0.001 and 0.004, respectively. This indicates that as nurses' knowledge about electrolyte imbalance improved, their practice also enhanced, reinforcing the importance of educational interventions in improving nursing competency and patient care outcomes.

This finding aligns with the study conducted by **El Sayed& El Sayed, (2021)** who show there were statistically significant differences among the studied nurses in their knowledge, perception, and practices levels between pre, and post-implementation of an educational program.

This finding aligns with the study conducted by **Awad et al., (2021)** who show that It indicates that there were highly statistically significant positive correlations between the studied nurses' total knowledge and total practices regarding monitoring fluid and electrolyte replacement therapy for burn patient pre and post program implementation (P<0.001).

This finding aligns with the study conducted by **Allam et al., (2023)** who clarifies that is a positive significant correlation between nurses' overall knowledge and overall practice score one-week post intervention (P value =0.028).

On the contrary **Trikhatri et al., (2023)** who present study didn't show significant association between level of knowledge and practice with in–service education however the majority nurses didn't receive in–service education regarding fluid and electrolytes administration. It is seen that periodic check or review of knowledge and practice regarding fluid and electrolytes administration among nurses is necessary. On the basis of the periodical evaluation nurse managers and organization can determine education programs, in lacking part of the fluid and electrolytes administration procedure (preparation, administration or monitoring) the nurse should receive education or training courses.

Recommendations

Based upon the results of the current study, the following recommendations were suggested:

Recommendations for Better Patient Outcomes:

1. Integrate nursing-driven electrolyte repletion protocols into standard critical care guidelines to ensure timely, safe, and evidence-based correction of electrolyte imbalances.
2. Conduct regular training programs for critical care nurses to enhance their knowledge and skills in electrolyte monitoring and repletion procedures.
3. Ensure continuous monitoring and documentation of electrolyte levels and clinical parameters to evaluate the effectiveness of the protocol in real-time.
4. Encourage interdisciplinary collaboration between nurses, physicians, and pharmacists in managing electrolyte disturbances for critically ill patients.

Recommendations for Future Research:

1. Replicate the study in different critical care settings and across multiple institutions to validate the generalizability of the findings.

2. Replicate the study on a larger probability sample selected from different geographical areas in Egypt is recommended to obtain data for more generalizability of findings.
3. Examine the long-term impact of nursing-driven electrolyte repletion protocols on patient morbidity, mortality, and length of ICU stay.
4. Investigate barriers and facilitators to protocol implementation from the perspective of nursing staff and healthcare administrators.

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