

Article

# Assessment of Nurses' Knowledge Regarding Continuous Renal Replacement Therapy

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**Abstract:** Continuous Renal Replacement Therapy (CRRT) is a critical intervention for Acute Kidney Injury (AKI) in intensive care units (ICUs), requiring specialized nursing knowledge. This study assessed nurses' CRRT knowledge levels and explored the impact of demographic factors. A descriptive cross-sectional study was conducted with 46 nurses from two governmental hospitals in Al-Najaf City (March 1–4, 2025). Data were collected via a validated questionnaire and analyzed using Statistical Package for Social Sciences (SPSS) (Version 26), employing descriptive statistics and ANOVA ( $p \leq 0.05$  significance). Most nurses (80.43%) demonstrated moderate CRRT knowledge (Mean Score (MS) 2.25, Standard Deviation (SD) = 0.58), with only 4.35% exhibiting good knowledge. No significant relationships were found between knowledge and demographic factors (age, sex, education, experience; all  $p > 0.05$ ). A strong positive correlation existed between knowledge and attitude ( $r = 0.696$ ,  $p < 0.0001$ ). Nurses' CRRT knowledge is moderate, with gaps in complex aspects. Demographic factors do not influence competency, highlighting the need for targeted training over reliance on experience. Implement structured CRRT training programs (simulation, case studies), continuing education workshops, and mentorship initiatives to enhance knowledge and patient outcomes.

**Keywords:** CRRT, Nursing Knowledge, Intensive Care, Training Programs, Patient Safety

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## 1. Introduction

### Historical background

Continuous Renal Replacement Therapy (CRRT) has evolved significantly since its inception in the late 1970s as an alternative treatment for critically ill patients with Acute Kidney Injury (AKI) (Ronco et al., 2017). Initially developed by Dr. Peter Kramer, CRRT was designed to provide gradual fluid and solute removal in hemodynamically unstable patients, distinguishing it from intermittent hemodialysis (Ronco et al., 2019). Over the decades, advancements in CRRT technology, including improved filters, anticoagulation methods, and monitoring systems, have enhanced its efficacy and safety (Ostermann et al., 2020). Despite these advancements, the successful implementation of CRRT remains heavily dependent on the expertise of healthcare providers, particularly nurses, who play a pivotal role in patient management (Cuadros et al., 2017).

The growing prevalence of AKI in intensive care units (ICUs) has increased the demand for CRRT, with studies indicating that up to 60% of critically ill patients with AKI

require this intervention (Gaudry et al., 2020). However, historical data suggest that variations in nursing knowledge and practice have led to inconsistencies in CRRT delivery, affecting patient outcomes (Saad et al., 2024). Understanding the historical progression of CRRT and its clinical applications provides context for evaluating current nursing competencies and identifying areas for improvement.

### **Introduction**

CRRT is a complex and high-risk therapy requiring specialized nursing skills, including machine operation, troubleshooting, fluid balance management, and complication recognition (Macedo & Mehta, 2023).

While several studies have examined nurses' knowledge and performance in CRRT, many reveal significant gaps in understanding, particularly in low-resource settings (Yu et al., 2024). (Andrade et al., 2019) showed that only a portion of ICU nurses demonstrate adequate knowledge of CRRT, highlighting the need for standardized and consistent training programs to enhance their competency and confidence in handling complex CRRT procedures.

Despite nurses playing a crucial role in the delivery of CRRT, there is a notable gap in research regarding the assessment of their knowledge levels, especially among undergraduate nursing students and early-career practitioners (Nance, 2019). Furthermore, much research has been conducted on the experiences and preparedness of experienced ICU nurses, but there is a notable gap in understanding the preparedness of newly graduated nurses entering critical care settings (Baudoin et al., 2022). Additionally, rapid advancements in CRRT technology require standardized and continuous education for nurses, as initial training alone is insufficient to ensure competency in managing this high-risk therapy, therefore, evidence highlights that inadequate training correlates with increased complications, emphasizing the need for hands-on learning and simulation-based programs to improve patient outcomes and nurse proficiency (Stoltman, 2018). This study aims to assess current nursing knowledge regarding CRRT, identify educational deficiencies, and propose evidence-based strategies to enhance training programs.

### **Importance of the study**

Enhancing nurses' knowledge of CRRT is crucial for improving patient safety and treatment efficacy. Poor CRRT management can lead to severe complications, including circuit clotting, electrolyte imbalances, and hemodynamic instability (Vaara et al., 2024). Studies have shown that CRRT troubleshooting education significantly improved the knowledge and self-confidence of ICU nurses (Nance, 2019). By evaluating current knowledge levels, this study will contribute to the development of targeted training programs, ultimately reducing CRRT-related adverse events and improving patient outcomes.

Furthermore, this project aligns with global efforts to standardize CRRT practices and ensure evidence-based nursing care (Stoltman, 2018). As CRRT is increasingly utilized in ICUs globally, it is crucial to comprehend the educational requirements of nurses (Baldwin, 1997). The findings of this study will provide valuable insights for nursing educators, hospital administrators, and clinical trainers, facilitating the integration of updated CRRT protocols into nursing education and practice.

### **Statement of the Problem**

Assessment of Nurses' Knowledge Regarding Continuous Renal Replacement Therapy.

### **Objectives of the Study**

- a. To assess nurses' knowledge regarding the importance of Continuous Renal Replacement Therapy.
- b. To find out the relationship between nurses' knowledge and their demographical data.

## Definition of Terms

Knowledge:

### a. Theoretical Definition:

Knowledge refers to the comprehensive understanding and awareness acquired through education, training, and experience that enables nurses to provide effective care (Rafii et al., 2021).

### b. Operational Definition:

In this study, nurses' knowledge regarding CRRT is measured using a structured questionnaire assessing their understanding of CRRT principles, indications, complications, and nursing management.

## Continuous Renal Replacement Therapy

### a. Theoretical Definition:

CRRT is an extracorporeal blood purification therapy designed to support patients with AKI or fluid overload by slowly removing solutes and fluids over an extended period, mimicking the function of natural kidneys (Ronco et al., 2002).

### b. Operational Definition:

In this study, CRRT refers to the specialized renal replacement modality (e.g., Continuous Veno-Venous Hemofiltration (CVVH), Continuous Veno-Venous Hemodialysis (CVVHD), Continuous Veno-Venous Hemodiafiltration (CVVHDF)) used in critical care settings, with a focus on nurses' knowledge of its mechanisms, indications, and clinical management.

## 2. Materials and Methods

### Study Design

We conducted a descriptive cross-sectional study. Data was collected between March 1st, 2025, and March 4th, 2025.

### Administrative Arrangements

We got permission from the Al-Najaf Directorate of Health. This approval allowed us to access and recruit participants from government hospitals in Najaf City. This approval process is detailed in Appendix B.

### Setting of the Study

The study was conducted at two governmental hospitals (Al-Sadr Medical City and Al-Hakeem General Hospital in Al-Najaf City).

### The Sample of the Study

We chose a group of 46 nurses who work at Al-Sadr Medical City and Al-Hakeem General Hospital in Al-Najaf City. This wasn't a randomization selection technique; instead, we specifically looked for nurses working at these hospitals because they were relevant to our study (purposive sample).

### Sampling Criteria

#### a. Inclusion criteria

Nurses who work at the Al-Sadr Medical City at the Respiratory Care Unit (RCU), ICU, and Dialysis Center, and the nurses who work at the Al-Hakeem General Hospital at Coronary Care Unit (CCU) and Dialysis Center in Al-Najaf City.

#### b. Exclusion Criteria

All the nurses who do not work in the above-mentioned units.

### Instrument of the Study

By reviewing related Guidelines (Kidney Disease: Improving Global Outcomes (KDIGO) Clinical Practice Guidelines for AKI, The Acute Disease Quality Initiative (ADQI)

Consensus Guidelines, The Surviving Sepsis Campaign (SSC) Guidelines, and The European Renal Best Practice (ERBP) Guidelines), the questionnaire was prepared and modified depending on previous Guidelines, and it was divided into four main sections (section one contained demographic information, section two included knowledge assessment regarding CRRT, section three included attitude towards CRRT, and section four included practice and implementation of CRRT). The total number of questions for this tool was 25.

### Current Study Validity

The capability of collecting needed data by questionnaire is called validity. For determining the validity of the created questionnaire (9) experts (who have more than five years of experience in the medical and nursing profession) were consulted in order to explore the current study's questionnaire for its competence, relevance, intelligibility, and clearness to achieve the selected objectives.

A primary copy of the current study questionnaire was constructed and offered to the experts detailed in (Appendix A).

Furthermore, the majority of experts approved that the questionnaire was well-designed and developed in order to assess the nurses' knowledge regarding CRRT. Moreover, the suggestions of the vast majority of experts were taken into consideration. So far, the final copy of the research tool has been reformed and prepared for carrying out the study.

### Data Collection

The researchers, by using the developed and modified questionnaire and by means of checklist technique, collected data. The total number of collected samples was 46 (nurses), who were selected purposively. The data collection period continued from March 1st, 2025, to March 4th, 2025.

### The Statistical Analysis

All the data in the current study were entered into the Statistical Package for Social Sciences (SPSS) program (version 26). The means and the standard deviation were calculated. Chi-square (non-parametric test) and Multiple response crosstab were used for qualitative data. A p-value  $\leq 0.05$  was considered statistically significant.

## 3. Results

**Table 1.** Distribution of Socio-Demographic Characteristics for the Studied Nurses (N=46).

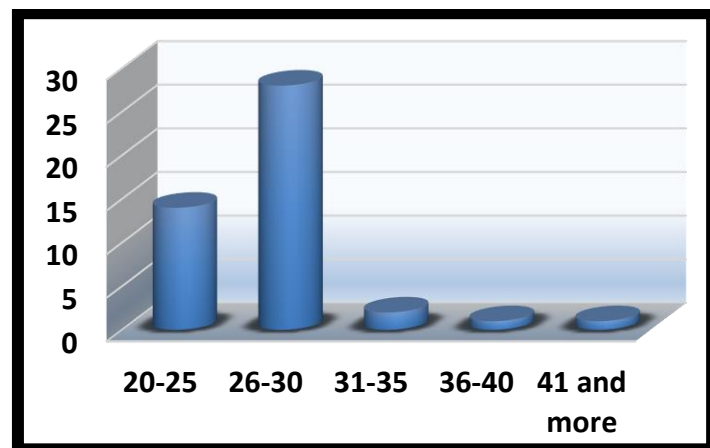
Socio-Demographic Characteristics	Rating and Intervals	F.	%
Age	20-25	14	30.43
	26-30	28	60.87
	31-35	2	4.35
	36-40	1	2.17
	41 and more	1	2.17
Sex	Males	17	36.96
	Females	29	63.04
Educational level	Nursing Secondary School	2	4.35
	Diploma	17	36.96
	Bachelors	25	54.35
	Master	2	4.35
	Ph.D	0	.00
Years of experience	< 1	10	21.74
	1-3	12	26.09
	4-6	13	28.26

	> 6	11	23.91
Years of experience	< 1	24	52.17
in critical care unit	1-3	14	30.43
	> 3	8	17.39
	Total	46	100%

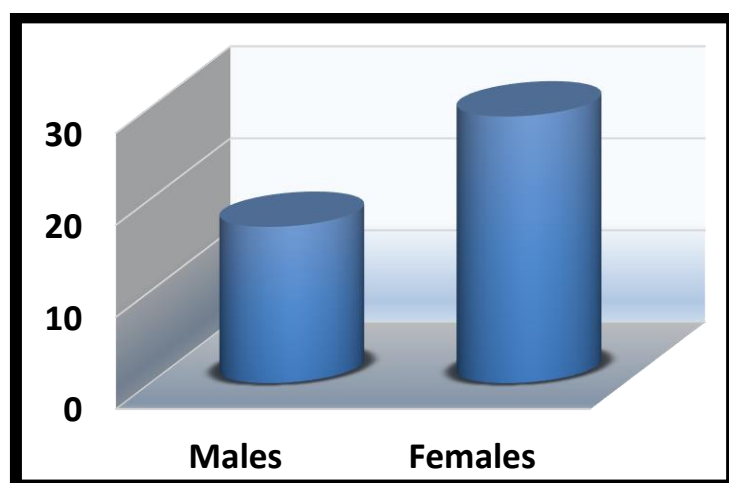
%= percentage, F. = frequency.

Table 1 presents the socio-demographic characteristics of the studied nurses (N=46). The majority of participants (60.87%) were aged between 26-30 years, with fewer nurses in older age groups.

Females represented a higher proportion (63.04%) compared to males. In terms of educational attainment, more than half (54.35%) held a bachelor's degree, while a small percentage had completed a master's degree (4.35%) or nursing secondary school (4.35%); notably, none held a Doctor of Philosophy (PhD). Regarding overall work experience, nurses were fairly distributed across different ranges, with the largest group (28.26%) having 4-6 years of experience. However, more than half of the nurses (52.17%) had less than one year of experience, specifically in the critical care unit, indicating that many participants were relatively new to critical care settings, see Figures 1 to 5.



**Figure 1.** Bar chart of studied nurses (N=46) according to their age groups (Years).



**Figure 2.** Bar chart of studied nurses (N=46) according to their sex.

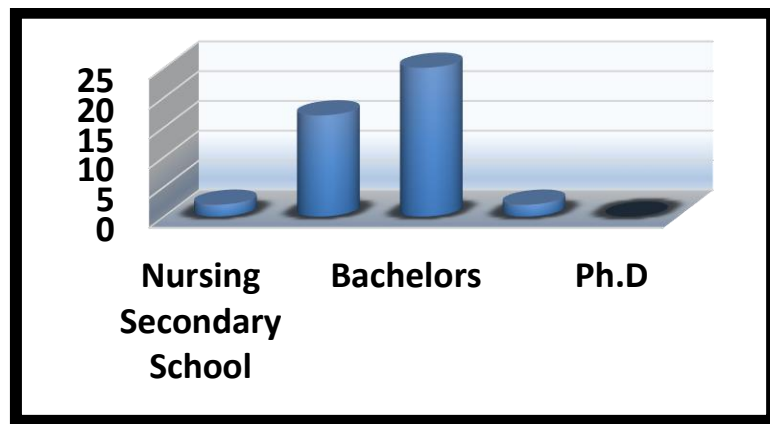


Figure 3. Bar chart of studied nurses (N=46) according to their education.

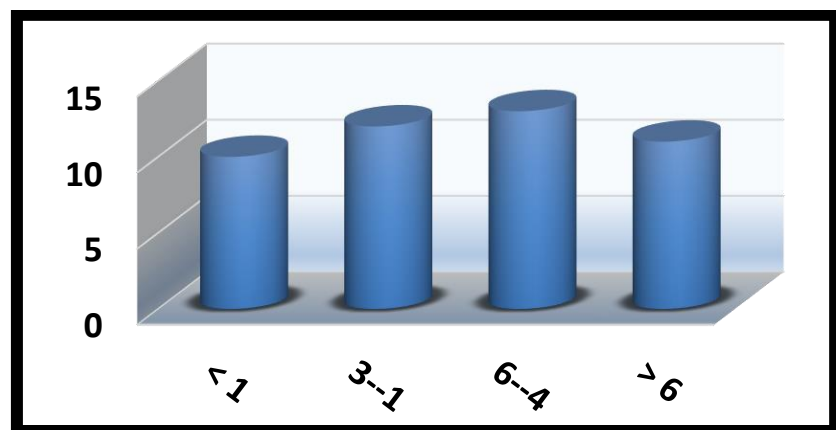


Figure 4. Bar chart of studied nurses (N=46) according to their years of experience.

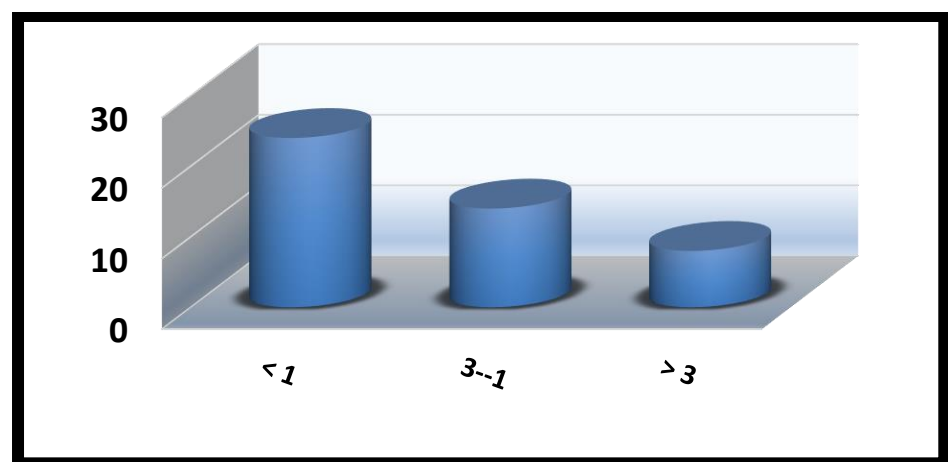


Figure 5. Bar chart of studied nurses (N=46) according to their years of experience in the critical care unit.

Table 2. Statistical distribution of Nurses' Knowledge Items Regarding CRRT (N=46).

Knowledge Items	Rating and Intervals	F.	%	MS	SD	Assess
q1	Strongly agree	10	21.74	2.39	1.20	moderate
	Agree	21	45.65			
	Neutral	6	13.04			
	Disagree	5	10.87			

q2	Strongly disagree	4	8.70	2.24	.77	moderate
	Strongly agree	5	10.87			
	Agree	29	63.04			
	Neutral	8	17.39			
	Disagree	4	8.70			
q3	Strongly disagree	0	.00	2.11	.77	moderate
	Strongly agree	8	17.39			
	Agree	28	60.87			
	Neutral	7	15.22			
	Disagree	3	6.52			
q4	Strongly disagree	0	.00	2.24	.97	moderate
	Strongly agree	9	19.57			
	Agree	24	52.17			
	Neutral	7	15.22			
	Disagree	5	10.87			
q5	Strongly disagree	1	2.17	2.17	1.02	moderate
	Strongly agree	12	26.09			
	Agree	21	45.65			
	Neutral	7	15.22			
	Disagree	5	10.87			
q6	Strongly disagree	1	2.17	2.13	1.09	moderate
	Strongly agree	16	34.78			
	Agree	15	32.61			
	Neutral	9	19.57			
	Disagree	5	10.87			
q7	Strongly disagree	1	2.17	1.98	.98	moderate
	Strongly agree	16	34.78			
	Agree	21	45.65			
	Neutral	3	6.52			
	Disagree	6	13.04			
q8	Strongly disagree	0	.00	2.28	.83	moderate
	Strongly agree	8	17.39			
	Agree	20	43.48			
	Neutral	15	32.61			
	Disagree	3	6.52			
q9	Strongly disagree	0	.00	2.52	.98	moderate
	Strongly agree	6	13.04			



	Agree	19	41.30			
	Neutral	13	28.26			
	Disagree	7	15.22			
	Strongly disagree	1	2.17			
	Strongly agree	11	23.91			
	Agree	19	41.30			
q10	Neutral	5	10.87	2.39	1.18	moderate
	Disagree	9	19.57			
	Strongly disagree	2	4.35			

%= percentage, F. = frequency, Mean  $\leq 1.66$ : Poor, 1.67-3.33: moderate, 3.34 and more: Good, Assess.: Assessment.

Table 2 presents the statistical distribution of nurses' knowledge regarding CRRT among the studied sample (N=46). Across all ten knowledge items, the Mean Scores (MS) ranged from 1.98 to 2.52, indicating a moderate level of knowledge according to the assessment criteria (Mean 1.67–3.33 = moderate). The percentage of nurses who agreed or strongly agreed with the knowledge items varied, with the highest agreement observed in items such as q6 and q7, where 34.78% strongly agreed. Neutral responses were common in several items, such as q8 and q9, suggesting uncertainty or limited confidence in some areas. Additionally, disagreement and strong disagreement responses were relatively low overall but present, particularly in q10, where 19.57% disagreed. The Standard Deviations (SD) ranged from 0.77 to 1.20, reflecting moderate variability in responses. Overall, these findings indicate that while the nurses possess an acceptable, moderate level of knowledge regarding CRRT, there remains room for improvement, particularly in strengthening their understanding and confidence in specific knowledge areas.

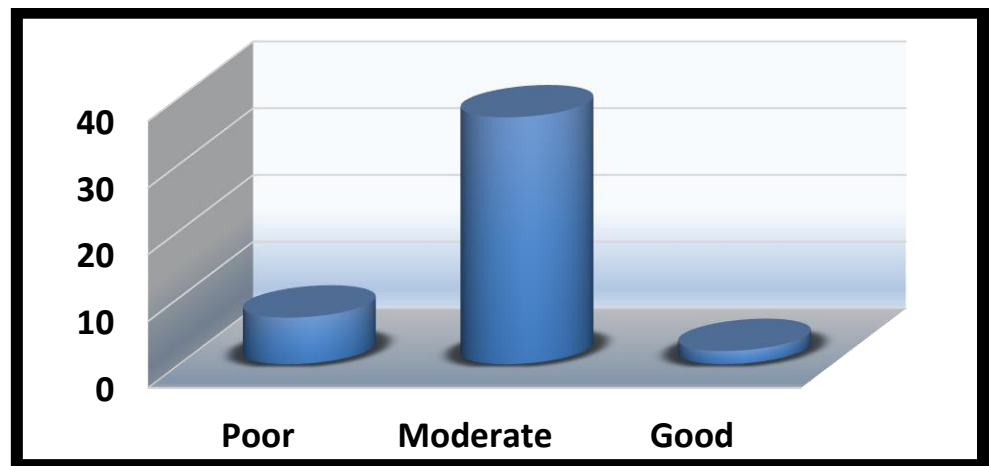
**Table 3.** Statistical distribution of Nurses' Knowledge overall Items Regarding CRRT (N=46).

Overall Items	Rating and Intervals	F.	%	MS	SD	Assess
Nurses' knowledge	Poor	7	15.22			
regarding the importance of	Moderate	37	80.43	2.25	.58	moderate
CRRT	Good	2	4.35			

%= percentage, F. = frequency, Mean  $\leq 1.66$ : Poor, 1.67-3.33: moderate, 3.34 and more: Good, Assess: Assessment.

Table 3 summarizes the overall statistical distribution of nurses' knowledge regarding the importance of CRRT among the studied sample (N=46). The majority of nurses (80.43%) demonstrated a moderate level of knowledge, while a smaller proportion (15.22%) had poor knowledge, and only 4.35% were classified as having good knowledge. The MS was 2.25 with an SD of 0.58, further confirming that, on average, the participants' knowledge was assessed as moderate. These results suggest that although most nurses possess an adequate understanding of the importance of CRRT, there is a need for targeted educational interventions to enhance knowledge levels and increase the proportion of nurses achieving a good knowledge assessment (see figure 6).





**Figure 6.** Bar chart distribution of Nurses' Knowledge overall Items Regarding CRRT.

**Table 4.** Statistical distribution of Nurses' Attitude Items Regarding CRRT (N=46).

Attitude Items	Rating and Intervals	F.	%	MS	SD	Assess
q1	Strongly agree	15	32.61	2.11	1.06	Negative
	Agree	17	36.96			
	Neutral	10	21.74			
	Disagree	2	4.35			
	Strongly disagree	2	4.35			
q2	Strongly agree	19	41.30	1.74	.77	Negative
	Agree	22	47.83			
	Neutral	3	6.52			
	Disagree	2	4.35			
	Strongly disagree	0	.00			
q3	Strongly agree	17	36.96	1.72	.69	Negative
	Agree	27	58.70			
	Neutral	0	.00			
	Disagree	2	4.35			
	Strongly disagree	0	.00			
q4	Strongly agree	8	17.39	2.26	.98	Negative
	Agree	25	54.35			
	Neutral	8	17.39			
	Disagree	3	6.52			
	Strongly disagree	2	4.35			
q5	Strongly agree	10	21.74	2.07	.85	Negative
	Agree	27	58.70			
	Neutral	6	13.04			
	Disagree	2	4.35			
	Strongly disagree	1	2.17			
q6	Strongly agree	13	28.26	2.00	.82	Negative
	Agree	22	47.83			
	Neutral	9	19.57			

	Disagree	2	4.35			
	Strongly disagree	0	.00			
	Strongly agree	23	50.00			
	Agree	19	41.30			
q7	Neutral	4	8.70	1.59	.65	Negative
	Disagree	0	.00			
	Strongly disagree	0	.00			

%= percentage, F. = frequency, Mean  $\leq 2.5$ : Negative,  $> 2.5$ : Positive, Assess.: Assessment.

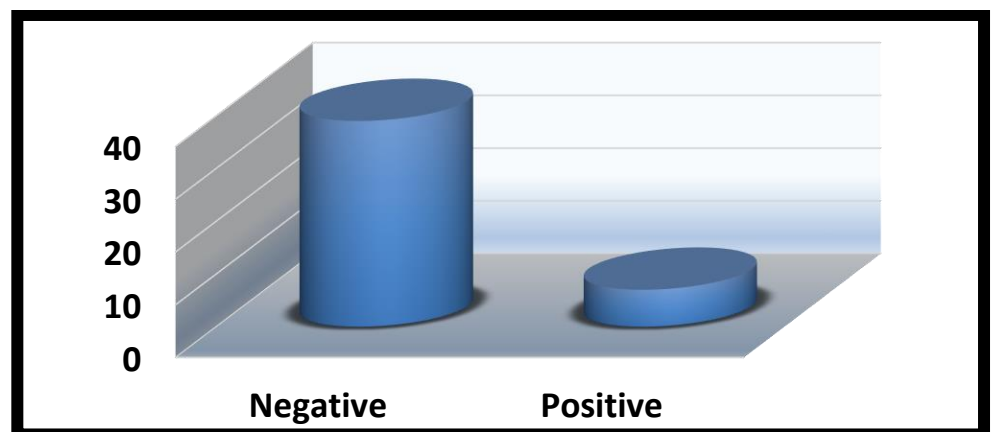
Table 4 shows the statistical distribution of nurses' attitudes toward CRRT across seven attitude items among the studied sample (N=46). The MS for all items ranged from 1.59 to 2.26, indicating an overall negative attitude according to the assessment criteria (Mean  $\leq 2.5$  = Negative). A significant proportion of nurses either agreed or strongly agreed with the attitude statements, with responses like 50% strongly agreeing on item q7 and 47.83% agreeing on q2 and q6. Despite these seemingly positive response rates, the overall mean scores remained within the negative range, suggesting that while many nurses acknowledge aspects of CRRT, their overall attitude may be influenced by factors such as limited confidence, experience, or perceived challenges in its application. The SD ranged from 0.65 to 1.06, reflecting moderate variability in responses (see figure 7).

**Table 5.** Statistical distribution of Nurses' Attitude overall Items Regarding CRRT (N=46).

Overall Items	Rating and Intervals	F.	%	MS	SD	Assess
Nurses' Attitude regarding the importance of CRRT	Negative	39	84.78	1.93	.53	Negative
	Positive	7	15.22			

%= percentage, F. = frequency, Mean  $\leq 2.5$ : Negative,  $> 2.5$ : Positive, Assess.: Assessment.

Table 5 presents the overall statistical distribution of nurses' attitudes regarding the importance of CRRT among the studied sample (N=46). The vast majority of nurses (84.78%) exhibited a negative attitude, while only 15.22% demonstrated a positive attitude toward CRRT. The MS was 1.93 with an SD of 0.53, confirming that the overall attitude was assessed as negative (Mean  $\leq 2.5$  = Negative), see figure 7.



**Figure 7.** Bar chart distribution of Nurses' Attitude overall Items Regarding CRRT.

**Table 6.** Statistical correlation between Nurses' Knowledge and Attitude Regarding CRRT (N=46).

Pearson Correlation		Nurses' Attitude regarding the importance of CRRT	
Nurses' knowledge regarding the importance of CRRT	r		.696
	Sig.		<0.0001

Table 6 demonstrates the statistical correlation between nurses' knowledge and their attitude regarding the importance of CRRT among the studied sample (N=46). The Pearson correlation coefficient (r) is 0.696, indicating a strong positive correlation between knowledge and attitude with a p-value of less than 0.0001.

**Table 7.** Statistical relationship between demographic data with Nurses' Knowledge and Attitude Regarding CRRT (N=46) using one away ANOVA statistical test.

Socio-Demographic Characteristics	Rating and Intervals	Nurses' knowledge		P-value (Sig.)	Nurses' Attitude		P-value (Sig.)
		Mean	SD		Mean	SD	
Age	20-25	2.11	.50	.528 (NS)	1.85	.41	.380 (NS)
	26-30	2.34	.63		1.97	.58	
	31-35	1.75	.21		1.36	.10	
	36-40	2.30	.		2.43	.	
	41 and more	2.60	.		2.29	.	
Sex*	Males	2.25	.56	.990 (NS)	2.04	.51	.254 (NS)
	Females	2.24	.61		1.86	.53	
Educational level	Nursing			.720 (NS)			.816 (NS)
	Secondary School	2.50	.57		2.21	.10	
	Diploma	2.17	.69		1.87	.55	
	Bachelors	2.30	.53		1.93	.51	
	Master	1.95	.49		2.07	1.11	
Years of experience	Ph.D	.	.	.130 (NS)	.	.	.208 (NS)
	< 1	2.04	.55		1.86	.34	
	1-3	2.09	.46		1.76	.55	
	4-6	2.49	.70		2.01	.59	
Years of experience in critical care unit	> 6	2.31	.54	.130 (NS)	2.06	.57	.208 (NS)
	< 1	2.20	.67		1.81	.47	
	1-3	2.11	.40		1.98	.46	
	> 3	2.61	.45		2.18	.72	

\*Statistics done using independent t test.

Table 7 shows a statistical relationship between nurses' demographic data and their knowledge and attitude regarding CRRT, using a one-way ANOVA and independent t-test for sex (N=46). The findings indicate no statistically significant differences (NS) in nurses' knowledge or attitudes across all socio-demographic characteristics, as all p-values are greater than 0.05.

#### 4. Discussion

##### A. Assessment of Nurses' Knowledge Regarding CRRT

The study revealed that the majority of nurses (80.43%) demonstrated a moderate level of knowledge about CRRT, with an MS of 2.25 (SD = 0.58). Only 4.35% of nurses exhibited good knowledge, while 15.22% had a poor understanding. These findings are consistent with recent studies highlighting gaps in CRRT knowledge among critical care nurses. For instance, (Calabrese & Musio, 2021) found that nurses generally have a basic understanding of CRRT, but many may lack deeper knowledge about its clinical applications and potential complications. This gap in understanding can impact the quality of care provided to patients undergoing CRRT. Similarly, a study by (Nance, 2019) noted that ICU nurses demonstrated varied levels of knowledge regarding CRRT, with only 30% scoring highly on knowledge assessments. This finding underscores the critical need for targeted training programs to improve nurse competency in CRRT management and enhance patient care outcomes.

The moderate knowledge level observed in this study may be attributed to several factors. First, CRRT is a complex therapy requiring specialized training, which many nurses may not receive during their initial education (Mehta, 2005). Second, the high workloads in critical care units often restrict opportunities for continuous professional development, as nurses face challenges balancing patient care demands with time for educational activities. This limitation can hinder their ability to stay updated on advancements in medical practices and technologies, which are essential for improving patient outcomes and maintaining professional competence (Viljoen et al., 2016). This aligns with the current study's finding that 52.17% of nurses had less than one year of experience in critical care, suggesting that novice nurses may lack exposure to CRRT cases.

Item-specific analysis revealed variability in knowledge across different aspects of CRRT. For example, items related to CRRT indications (q6, q7) had higher agreement rates (34.78% strongly agreed), while items addressing complications (q10) showed higher disagreement (19.57%). This echoes the findings of (Stoltman, 2018), who noted that nurses often face challenges in identifying and managing complications associated with CRRT, such as electrolyte imbalances, circuit clotting, and anticoagulation issues. These complications can arise due to the complexity of CRRT and variability in training standards. Recognizing and addressing these issues is critical as they can significantly impact patient outcomes. The moderate SD (0.77–1.20) further indicates variability in knowledge levels, underscoring the need for standardized educational interventions.

##### B. Relationship Between Nurses' Knowledge and Demographic Data

The study found no statistically significant relationships between nurses' knowledge and demographic characteristics such as age, sex, educational level, or years of experience (all  $p$ -values > 0.05). This contrasts with some previous studies but aligns with others, suggesting that knowledge acquisition may depend more on training and clinical exposure than on demographic factors.

##### Age and Experience

Although older nurses and those with more experience tended to score slightly higher in knowledge (e.g., nurses aged 41+ had an MS of 2.60), these differences were not statistically significant ( $p = 0.528$ ). This finding contradicts the work of (Brost, 2022), who reported that experienced nurses had significantly better CRRT knowledge than their less experienced counterparts. However, it supports the argument by (Przybyl et al., 2017) that CRRT programs emphasize structured training as critical for ensuring competency in managing this complex therapy. Incorporating adult learning principles and diverse teaching methods - such as online modules, didactic lectures, return demonstrations, and high-fidelity patient simulations - is essential for effective training. Structured programs provide nurses with the skills needed to care for critically ill patients receiving CRRT, highlighting the importance of training over mere experience alone.

### Educational Level

Nurses with higher educational qualifications (e.g., bachelor's degrees) showed marginally better knowledge (mean = 2.30) compared to those with diplomas (mean = 2.17), but the difference was not significant ( $p = 0.720$ ). This aligns with a study by (Cordoza et al., 2021) which found that formal education alone, such as didactic training, is insufficient for achieving CRRT proficiency without hands-on practice. Notably, none of the nurses in this study held a PhD, highlighting a potential gap in advanced CRRT training opportunities.

### Sex

The study found no significant difference in knowledge between male and female nurses ( $p = 0.990$ ), consistent with the findings of (Tomasa Irriguible et al., 2017), who reported no notable influence of gender on CRRT-related parameters. This suggests that knowledge acquisition is gender-neutral and depends more on training and clinical exposure.

### Years of Experience in Critical Care

Nurses with over three years of critical care experience had the highest knowledge scores (mean = 2.61), but this difference was not statistically significant ( $p = 0.130$ ). This mirrors the results of a study by (Mottes et al., 2013) which emphasized that while experience contributes to knowledge, formal CRRT-specific education is essential for enhancing performance and patient outcomes.

### C. Nurses' Attitude Regarding CRRT

The findings of this study reveal that the majority of nurses (84.78%) exhibited a negative attitude toward CRRT, as evidenced by an MS of 1.93 (SD = 0.53), which falls below the threshold for a positive attitude (Mean  $\leq 2.5$  = Negative). This aligns with recent literature suggesting that nurses' attitudes toward specialized therapies like CRRT are significantly influenced by their level of knowledge, confidence, and clinical experience (Nance, 2019). The negative attitude observed in this study may stem from the moderate knowledge levels identified earlier, as the Pearson correlation analysis confirmed a strong positive relationship ( $r = 0.696$ ,  $p < 0.0001$ ) between knowledge and attitude. This suggests that improving nurses' knowledge could potentially enhance their attitudes toward CRRT.

The study also found that a significant proportion of nurses agreed or strongly agreed with specific attitude items, such as 50% strongly agreeing with item q7 ("CRRT is essential for patient care"). However, the overall negative attitude indicates that these positive perceptions may be offset by uncertainties or challenges in practical application. This is consistent with findings by (Welbaum, 2021), who reported that nurses often face challenges in managing CRRT due to its complexity and the high-acuity nature of the ICU setting, necessitating specialized training and experience.

The lack of significant differences in attitudes across demographic groups (e.g., age, education, experience) further underscores the need for targeted educational interventions, as generic training may not address the specific gaps contributing to negative attitudes.

In conclusion, the negative attitude toward CRRT among nurses highlights the importance of integrating comprehensive, hands-on training programs into professional development initiatives. By addressing knowledge gaps and fostering confidence in CRRT application, healthcare institutions can improve both nurses' attitudes and the quality of care delivered to critically ill patients requiring this therapy.

## 5. Conclusion

Based on the presented results and their discussion:

- a. This study underscores that while nurses possess a moderate level of CRRT knowledge, significant gaps remain, particularly in complex aspects of the therapy.

- b. Demographic factors did not significantly influence knowledge levels, suggesting that targeted educational interventions, rather than reliance on experience or education alone, are key to improving competency.
- c. Future research should explore the impact of structured training programs on nurses' CRRT knowledge and patient outcomes.

#### Recommendations:

The findings highlight the need for:

- a. Structured CRRT Training Programs: Incorporating simulation-based learning and case studies to address knowledge gaps, particularly in complications and troubleshooting.
- b. Continuing Education: Regular workshops and online modules to keep nurses updated on CRRT advancements.
- c. Mentorship Programs: Pairing novice nurses with experienced CRRT practitioners to enhance hands-on learning.

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