Iran J Public Health, Vol. 51, No.3, Mar 2022, pp.544-551

Original Article

The Effectiveness of a Specialized Nursing Team Intervention in the Unplanned Interruption of Continuous Renal Replacement Therapy

Zhen Lu [1], Yanyan Hong [2], Yali Tian [1], Li Zhang [2], *Yan Li [3]

1. *Department of Critical Care Medicine, Jiangsu Province Hospital, Jiangsu 210029, China*
2. *Department of Nursing, Nanjing Hospital of Chinese Medicine Affiliated to Nanjing University of Chinese Medicine, Nanjing 210001, China*
3. *EICU, Nanjing Hospital of Chinese Medicine Affiliated to Nanjing University of Chinese Medicine, Nanjing 210001, China*

***Corresponding Author:** Email: susieyaner327@163.com

(Received 19 May 2021; accepted 18 Jul 2021)

Abstract

Background: To explore the application of specialist nursing teams in patients undergoing unplanned interruptions in continuous renal replacement therapy.

Methods: Sixty-six patients admitted to the intensive care unit of Jiangsu Province Hospital, China for continuous renal replacement therapy (CRRT) and experienced unplanned interruptions from Aug 2020 to Mar 2021 were enrolled as study subjects. Twenty four patients with conventional care were taken as the control group, and 42 patients in the specialized nursing team were taken as the experimental group. The age, type of disease, and degree of illness of the two groups were statistically processed and the differences were not significant ($P>0.05$) and were comparable. The control group received routine CRRT care after CRRT rescue, and the experimental group received CRRT care model from a specialized nursing team.

Results: Patients in the group with specialized nursing care had 49 instances of CRRT unplanned interruptions, and the routine care group had 79 instances of CRRT unplanned interruptions. The number of unplanned interruptions in the experimental group was less than that of the control group, and the difference was statistically significant ($P<0.001$). The incidence of complications in the experimental group were lower than that of the control group ($P<0.05$). The satisfaction and quality of life of nurses in the specialist nursing group were clearly lower than those of the control group, and the difference was statistically significant ($P<0.05$).

Conclusion: Specialist nursing teams could reduce the occurrence of unplanned interruptions in CRRT patients in intensive care and allow patients to receive continuity of care.

Keywords: Continuous renal replacement rate; Intensive care unit (ICU); Unplanned interruption rate

Introduction

Continuous renal replacement therapy (CRRT) is a form of extracorporeal circulation blood purification administered to patients for 24 h to help remove toxins from the blood and promote re-

covery of renal function. CRRT techniques have been widely used in clinical practice as an important tool to save critically ill patients (1). Eight percent to 10% of critically ill patients undergo renal replacement therapy (2).

The specialized nature of CRRT technology, the complexity of its operation, and the influence between various factors have created numerous problems that force patients to interrupt their treatment at unscheduled times, severely affecting the continuity of patient care and delaying the timing of treatment. Unplanned interruptions are now a common problem in the clinical implementation of CRRT (3, 4).

Specialized nursing staff are clinical nurses who have undergone specialized training to attain high levels of expertise in a particular or specialized area of care (5). As important participants in the continuum of renal replacement therapy services, nursing staff have a direct impact on the rate of unplanned interruptions. To standardize the behavior of nursing staff, our hospital has established a specialized nursing group to provide care and attention to patients. The nursing situation of continuous renal replacement therapy by our hospital's specialized nursing team was studied in this research.

Materials and Methods

General information

Sixty-six patients admitted to the Intensive Care Unit of Jiangsu Province Hospital, China for continuous renal replacement therapy (CRRT) from Aug 2020 to Mar 2021 were enrolled for the study. Patients were split into the control group and experimental group according to their order of admission. Patients admitted in Aug to Dec 2020 were included in the control group and those admitted in Jan to Mar 2021 were included in the experimental group. Basic information: 24 patients were in the control group, including 11 males and 13 females, aged 37 to 86 yr, mean age (71.08±12.809) yr. Forty two patients were in the experimental group, including 19 males and 23 females, aged 37 to 91 yr, mean age (71.55±11.167) yr. The general data of gender, age, and primary disease of the two groups were compared, and the differences were not statistically significant (P>0.05) and were comparable, as seen in Table 1.

Table 1: Comparison of general information between two groups of patients ($\bar{x}$±s) cases (%)

Variable		*Control group (n=24)*	*Experimental group (n=42)*	x^2/t *value*	*P-value*
Age (yr)		71.08±12.80	71.55±11.16	0.157	0.876
Gender (male/female)		11/13	19/23	0.002	0.963
Acute physiology and chronic health score/score		25.35±2.03	25.31±2.12	0.075*	0.941
Comlications	Pulmonary infection	10 (41.67)	18 (42.86)	0.778	0.855
	Heart failure	3 (12.50)	7 (16.67)		
	Acute pancreatitis	5 (20.83)	10 (23.81)		
	Others	6 (25.00)	7 (16.67)		

This study was reviewed and approved by the hospital medical Ethics Committee (NO. JPH2020EC134).

Inclusion criteria: ①Patients undergoing CRRT in the Emergency Intensive Care Unit (EICU) of Nanjing Hospital of Chinese Medicine. ②All machines used are the same Fresenius model. ③Intensive Care Unit (ICU) time greater than 24 h. (4) No statistical differences in patient age and APACHE II scores.

Exclusion criteria: ①Patients who were unable to continue the study due to unforeseen reasons such as death, surgery, etc. during data collection. ②Patients who have been admitted for less than 24 h. ③Patients under the age of 18. ④Pregnant patients and patients with a history of mental illness, etc.

Research method

Routine nursing care was performed on patients in the control group after CRRT rescue, including monitoring of vital signs, fluid management, line management, and symptomatic care. CRRT care model was performed by the specialized nursing team for the experimental group.

First, formation of a specialized nursing team: Members consisted of the head nurse and nurses of the blood purification center and ICU. All members had extensive experience and could carry out CRRT rescue skillfully and had the required communication skills. Secondly, the personnel involved in the study were trained in CRRT to understand its theory, process, and operation.

Second, formation of specialized nursing: The head nurse of the ICU and the head nurse of the blood purification center form a specialized management team, with nurses from each of the two units participating as core staff in management and operations.

Third, communication: Communicate with patients at 12-h intervals to elaborate on the patient's location, disease condition, and time, and explain to the patient the content of treatment and care coordination to eliminate the patient's unfamiliarity and fear.

Fourth, training process: Training the specialized nursing team for CRRT-related knowledge. The head nurse provides CRRT-related theoretical knowledge training to the team members and provides timely updates on knowledge in the field to avoid misunderstandings. Understand the relevant knowledge through expert lectures, training courses, case sharing and hands-on operation, and raise questions for discussion and analysis to avoid similar problems.

Fifth, regular assessment: Monthly irregular inspection of management, summarization and reflection on the work of the previous month at the beginning of each month to guide the work of the next month. In addition, carry out monthly assessment of CRRT knowledge for the staff of the specialized nursing team, where failure to meet the admission criteria will result in removal or rectification.

Finally, operation process: ① Catheter pre-flush, nursing staff to check whether each line is tightly connected during their operations, flush the line using heparin saline, and tap the filter to release the air bubbles with the pre-flush liquid. If the patient's condition allows, a 30-min heparin diluent catheter soak may be conducted, so that the catheter and filter adsorbs a small amount of heparin to reduce filter clotting (6). ② On the machine operation: Clean hand hygiene, wear sterile gloves while handling. After laying a sterile towel under the catheter, open the kit and place two 20 ml syringes, two 5 ml syringes, and gauze inside the kit. Pour saline in the treatment tray, wrap the catheter with dry gauze with one hand. Wrap the tip of the catheter with dry gauze with the other hand and unfurl a gauze block soaked with 2% chlorhexidine gluconate. Rub the gauze block against the dialysis catheter connector for at least 15 seconds. Connect the 5 ml syringe to the arterial end, open the catheter clamp, and draw 3 ml of blood. Inject the blood on the gauze block to observe the presence of blood clots. Test the patency of the arterial end with a 20 ml syringe pumped with saline, requiring repeated pumping and pushing at least 3 times (pumping should be fast and strong, do not forcibly inject when there is resistance to pushing, filling the 20 ml syringe within 6 s indicates patency of the catheter). Flush the arterial end with saline and close the catheter clamp. After finishing this, clean up the venous end in the above manner (7). Documentation of all information is checked by two nurses and then logged into the electronic information database, see Table 2.

Table 2: CRRT specialized nursing team care measures

Event	***Procedures***
Formation of specialized nursing team	A specialist management team is formed by the head nurse of the ICU and the head nurse of the blood purification center, with nurses from each of the two units participating as core staff in management and practical operations.
Communication methods	Communication procedures: Communicate with the patient at 12-h intervals, elaborate on the patient's location, disease condition, and time, and explain to the patient the content of treatment and care coordination to eliminate the patient's unfamiliarity and fear.
Knowledge training	CRRT-related knowledge training for the specialized nursing team, CRRT-related theoretical knowledge training by the head nurse to the team members, timely updates on information in the field to avoid misunderstandings. Understand the relevant knowledge through expert lectures, training courses, case sharing and hands-on operation, and raise questions for discussion and analysis to avoid similar problems.
Periodic assessment	Monthly irregular inspection of management, summarization and reflection on the work of the previous month at the beginning of each month to guide the work of the next month. Carry out monthly assessment of CRRT knowledge for the staff of the specialized nursing team, where failure to meet the admission criteria will result in removal or rectification.
Standardized operating procedures	① Catheter pre-flush, nursing staff to check whether each line is tightly connected during their operations, flush the line using heparin saline, and tap the filter to release the air bubbles with the pre-flush liquid. If the patient's condition allows, a 30-min heparin diluent catheter soak may be conducted, so that the catheter and filter adsorb a small amount of heparin to reduce filter clotting[6]. ② On the machine operation: Clean hand hygiene, wear sterile gloves while handling. After laying a sterile towel under the catheter, open the kit and place two 20 ml syringes, two 5 ml syringes, and gauze inside the kit. Pour saline in the treatment tray, wrap the catheter with dry gauze with one hand. Wrap the tip of the catheter with dry gauze with the other hand and unfurl a gauze block soaked with 2% chlorhexidine gluconate. Rub the gauze block against the dialysis catheter connector for at least 15 seconds. Connect the 5 ml syringe to the arterial end, open the catheter clamp, and draw 3 ml of blood. Inject the blood on the gauze block to observe the presence of blood clots. Test the patency of the arterial end with a 20 ml syringe pumped with saline, requiring repeated pumping and pushing at least 3 times (pumping should be fast and strong, do not forcibly inject when there is resistance to pushing, filling the 20 ml syringe within 6 s indicates patency of the catheter). Flush the arterial end with saline and close the catheter clamp. After finishing this, clean up the venous end in the above manner.
Care Information Completion	Documentation of all information is checked by two nurses and then logged into the electronic information database.

Observation indicators

Understand basic physical information about the patient. Observe and record patients' basic physical indicators, unplanned interruption rates, patient CRRT consumable costs, and average individual filter use time through the hospital's critical care nursing staff.

A planned interruption of dialysis treatment is defined as the completion of the planned dialysis treatment objective or the completion of dialysis treatment time. The treatment objective refers to the patient's treatment parameters such as the setting of the patient's total dehydration, blood urea nitrogen, blood creatinine index, blood ions, etc. When dialysis is forcibly discontinued before the desired target is reached, it is considered an unplanned CRRT interruption (8). Indications for unplanned interruption: transmembrane pressure (TMP) >260 mm Hg (1 mm Hg ≈ 0.133 kpa) (9), filter coagulation grade II or higher, and interruptions due to inability to eliminate various alarms. Among them, the filter coagulation is based on the Blood Purification Therapy Standards Manual (10) Grade III coagulation as the standard Grade 0: no coagulation or several fibrous coagulations; Grade I: <10% fibrous coagulation; Grade II: <50% fibrous coagulation; Grade III: >50% fibrous coagulation.

Statistical analysis methods

For statistical analysis, SPSS22.0 (IBM Corp., Armonk, NY, USA) statistical software was used for data processing. Quantitative data were expressed as mean ± standard deviation ($\bar{x} \pm s$), and independent samples *t*-test was used for comparison between two groups. Count data were expressed as frequencies and percentages (%), and $\chi 2$ test was used for comparison between two groups. The difference was considered statistically significant at $P<0.05$.

Results

The unplanned interruptions, number of sets of consumables, and Length of CRRT use in the experimental group were less than patients in the control group, and the difference was statistically significant ($P < 0.001$) (Table 3).

Table 3: Comparison of the time of CRRT use, quantity of consumables sets, and number of unscheduled interruption cases between the two groups of patients

Groups	*Number of cases*	*Length of CRRT use(h)*	*Number of sets of consumables*	*Unplanned interruptions*
Control	24	273.92±31.44	8.21±1.40	3.29±0.19
Experimental	42	144.17±35.35	5.52±1.02	1.17±0.16
t		-14.915	-8.979	-48.341
P-value		<0.001	<0.001	<0.001

The incidence of complications in the experimental group was lower than that in the control group, and the difference was statistically significant ($P < 0.001$) (Table 4).

Satisfaction and quality of life of nurses in the specialized nursing team were significantly lower than in the control group, with statistically significant differences ($P < 0.001$) (Table 5).

Table 4: Comparison of complications between the two groups of patients (n/%)

Groups	*Number of cases*	*Fever*	*Nausea*	*Vomiting*	*Convulsion*	*Hypotension*	*Total complications*
Control	24	4 (6.15)	1(1.54)	2(2.08)	5 (7.69)	3 (4.62)	15 (23.08)
Experimental	42	2(3.08)	1(1.54)	0(0.00)	1(1.54)	0(0.00)	4 (6.14)
$\chi 2$				20.908			
P-value				<0.001			

Table 5: Satisfaction with care scores, quality of life scores, anxiety and depression scores in both groups ($\bar{x}$ ±S)

Event	*Groups*		*χ2/t*	*P-value*
	Control group (n=24)%	Experimental group (n=42)%		
Nurse satisfaction				
Satisfied	9 (37.50)	6 (14.29)		
Relatively satisfied	13 (54.17)	25 (59.52)	6.170	0.046
Not satisfied	2 (8.33)	11 (26.19)		
Quality of life	75.90±2.96	84.28±2.31	12.780	<0.001
Total functional area score	55.66±5.78	60.02±4.59	3.374	0.0013
Somatic function	60.04±3.59	63.60±3.80	3.734	0.004
Role function	52.10±4.76	58.50±4.03	5.808	<0.001
Cognitive function	60.46±4.46	65.80±4.59	4.593	<0.001
Social function	61.50±5.30	63.00±6.20	0.995	0.3236
Anxiety	14.23±1.21	10.67±1.07	-12.396	<0.001
Depression	16.24±1.18	11.23±1.15	-16.866	<0.001

Discussion

CRRT is commonly used in clinical practice to replace impaired renal function with extracorporeal circulation blood purification therapy lasting 24 h or more. It is often used in the treatment of patients with acute or severe illnesses such as severe infections, organ failure, and abnormal renal function. In clinical treatment, it is likely that patients will be forced to have CRRT interrupted due to the patient's own deterioration, inappropriate operation or other external factors. Unplanned interruptions can reduce the efficacy of treatment, prolong treatment time, increase the cost of treatment, increase the patient's burden, and may lead to other complications and eventually increase the patient's risk of disease. Clinical exploration has begun to address the causes associated with unplanned interruptions so as to reduce its rate of occurrence. For example, Benfield et al (11) applied lean thinking to the workflow of CRRT and confirmed that it could improve the quality of care. Sanchez-Izquierdo-Riera et al (12) applied failure modes and effects analysis to improve the safety of CRRT, and the observation group used the filter for a longer period of time than the control group. The unplanned interruptions in this paper were defined as treatment time less than 24 h or failure to achieve the treatment objective. Patients in critical care are at higher risk during CRRT time, and this group of patients with severe disease of their own have problems of rapid onset, complex disease, and rapid changes in condition. In clinical

practice, treatment times are often prolonged for patients due to disease problems, and severe cases may even experience forced treatment interruptions.

This study started off from a nursing perspective. By establishing a specialized nursing team and improving training and guidance on CRRT professional knowledge and handling techniques to nursing staff, the quality of care for patients on CRRT was improved. This was done to help reduce unplanned interruptions, prevent incorrect operation, and to detect potential risk factors. These contribute to preserving the continuity of CRRT for patients to promote patient recovery. Foreign scholars pay attention to the training and guidance provided to CRRT nursing staff. For example, Windt (13) attempts the combination of online learning and real-time training model to enhance nursing competence. This study was different from the traditional nursing model, as it established a team specialized for critically ill CRRT patients and takes targeted measures for existing problems so that the nursing approach can be better adapted to the needs of patients. Smooth treatment of patients was ensured and the occurrence of unplanned interruptions was avoided. The results showed that there were 49 unplanned interruptions of CRRT for patients treated by the specialized nursing team and 79 unplanned interruptions of CRRT for patients in the conventional care group, with a statistically significant difference between the two groups (P<0.05). The integration of existing nursing resources, reasonable staffing, and scientific optimization of the process of CRRT can ensure the successful completion of CRRT. These are consistent with the results of this study.

Patients often experience other adverse symptoms while undergoing CRRT due to decreased immunity, allergic reactions during treatment, and side effects from treatment. The study reduced the incidence of adverse events through control of nursing care and avoids problems and errors in nursing care by allocating resources and standardizing implementation, thereby reducing the risk of adverse events. By emphasizing preventive measures, reasonable allocation of various resources, measuring implementation before establishing standards, and correcting deficiencies, efficiency of achieving objectives is ensured (14). In this study, the rate of unplanned interruption and complications were lower in the experimental group than in the control group (P< 0.05), which demonstrated that the application of the specialized nursing team with CRRT patients can effectively prevent unplanned interruptions and complications, and reduce the occurrence of adverse conditions.

The nurses in the specialized nursing team had lower satisfaction than those in the conventional nursing group, with a statistically significant difference (P<0.05). As nursing staff involved in the specialized nursing team are required to undertake more training and work, nurse workload will also increase compared to the conventional nursing group. The extension of working hours and long-term high-intensity requirements lead to a decrease in job satisfaction among nursing staff. The longer working hours increase the anxiety and reduce the quality of life of the nursing staff, which will affect the quality of care received by patients in the long run. We suggest that while improving the quality and workload of nursing staff, more attention should be paid to the life and psychological status of nursing staff, and work should be adjusted in a timely manner.

Conclusion

There were many factors that influence unplanned interruptions of CRRT, and the service of nursing staff is an important part of it. By forming a specialized nursing team and training personnel on the theory and operation of CRRT, unplanned interruptions due to human factors is reduced. Increasing the contact between nursing staff and patients relieves the patient's nervousness about the disease and reduces the patient's negative feelings and fear. The 24-hour close working relationship between the medical and nursing staff and their constant attention to the regular operation of CRRT prevent the occurrence of various emergencies and reduce un-

planned interruptions due to inappropriate treatment. Reducing unplanned interruptions improves the quality of care and clinical outcomes, and reduces the financial and psychological burden on patients. From the perspective of patients, enhancing monitoring and care can ensure the effectiveness of CRRT, thereby improving the quality of care received.

Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

Acknowledgements

No funding was received.

Conflicts of interest

The authors declare that there is no conflict of interest.

References

1. Tolwani A (2012). Continuous renal-replacement Therapy for acute Kidney injury. *N Engl J Med,* 367(26):2505-2514.
2. Rewa O, Villeneuve PM, Lachance P, et al (2017). Quality indicators of continuous renal replacement therapy (CRRT) care in critically ill patients: a systematic review. *Intensive Care Med,* 43(6):750-763.
3. Roeder VR, Atkins HN, Ryan MA, Harms HJ (2013). Putting the C back in to continuous renal replacement therapy. *Nephrol Nurs J,* 40(6):509-15.
4. Rewa O, Villeneuve PM, Eurich DT, et al (2015). Quality in dicators in continuous renal replacement therapy (CRRT) care in critically ill patients: protocol review. *Syst Rev,* 4:102.
5. Finkelman A (2013). The clinical nurse specialist: Leadership in quality improvement. *Clin Nurs Spec,* 27(1):31-35.
6. Fang XH, Mei BG (2016). Analysis of the causes of unscheduled off-boarding of continuous renal replacement therapy and nursing countermeasures. *Chongqing Medicine,* 45(27):3881-3883.
7. Lai YH, Luo SF, Au HM (2020). Effect of standardized nursing procedures on the chance of unscheduled CRRT down. *General Practice Nursing,* 18(06):728-731.
8. Fei S, Jin J, Wang H, Zeng F, Xu J, Chen J (2015). Study on factors associated with unplanned down time of continuous renal replacement therapy. *Chinese Journal of Nursing,* 2015, 50(1).
9. Baldwin I, Fealy N (2009). Nursing for renal replacement therapies in the Intensive Care Unit: historical, educational, and protocol review. *Blood Purif,* 27(2):174-18.
10. Chen, Xiang-Mei (2010). Standard operating procedures for blood purification [M]. Beijing: People's Military Medical Publishing House, 43-49.
11. Benfield CB, Brummond P, Lucarotti A, et al (2015). Applying lean principles to continuous renal replacement therapy processes. *Am J Health Syst Pharm,* 72(3):218-23.
12. Sanchez-Izquierdo-Riera JA, Molano-Alvarez E, Saez-de la Fuente I,et al (2016). Safety management of a clinical process using failure mode and effect analysis: continuous renal replacement therapies in intensive care unit patients. *ASAIO J,* 62(1):74-9.
13. Windt K (2016). Development of online learning modules as an adjunct to skills fairs and lectures to maintain nurses' competency and comfort level when caring for pediatric patients requiring continuous renal replacement therapy (CRRT). *Nephrol Nurs J,* 43(1):39-46.
14. Patel S, Topping A, Ye X, et al (2018). Association between Heights of dialysis patients and outcomes: results from a ret- rospective cohort study of the international MONitoring Dialy- sis Outcomes (MONDO) database initiative. *Blood Purif,* 45(1-3):245-253.