Application of PDCA Cycle Management and Bundled Nursing Care in Sepsis Patients Undergoing Continuous Renal Replacement Therapy: A Postprint

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Abstract

Objective: To investigate the efficacy of PDCA cycle management combined with bundled nursing strategy in septic patients undergoing continuous renal replacement therapy (CRRT). Methods: Seventy-five septic patients who received CRRT and were admitted between March 2020 and October 2021 were enrolled and divided into a control group (n=37) and an observation group (n=38) based on admission time. The control group received conventional intensive care and infection prevention measures, while the observation group was managed with PDCA cycle management combined with bundled nursing strategy. The incidence of catheter-related bloodstream infection (CRBSI), CRRT treatment duration, and ICU length of stay were compared between groups. Results: The CRBSI incidence was significantly lower in the observation group compared with the control group ($P<0.05$). CRRT treatment duration and ICU length of stay were also significantly shorter in the observation group ($P<0.05$). Conclusion: PDCA cycle management combined with bundled nursing reduces the risk of CRBSI in septic patients undergoing CRRT, facilitates early weaning from CRRT, and shortens ICU length of stay.

Full Text

Application of PDCA Cycle Management Combined with Bundled Care in Sepsis Patients Undergoing Continuous Renal Replacement Therapy

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Abstract

Objective: To observe the effect of PDCA cycle management combined with bundled care strategies on sepsis patients receiving continuous renal replacement therapy (CRRT).
Methods: Sepsis patients undergoing CRRT were selected as study subjects and divided into control and observation groups based on admission sequence. The control group received conventional intensive care and infection prevention measures, while the observation group received PDCA cycle management combined with bundled care strategies. The incidence of catheter-related bloodstream infection (CRBSI), CRRT treatment duration, and ICU length of stay were compared between the two groups.
Results: The CRBSI incidence in the observation group was significantly lower than that in the control group ($P<0.05$). The CRRT treatment time and ICU length of stay in the observation group were significantly shorter than those in the control group ($P<0.05$).
Conclusion: PDCA cycle management combined with bundled care can reduce the risk of CRBSI in sepsis patients during CRRT, facilitate earlier machine withdrawal, and shorten ICU hospitalization time.

Keywords: PDCA cycle; bundled care; continuous renal replacement therapy; sepsis; catheter-related bloodstream infection

Introduction

Sepsis refers to systemic inflammatory response syndrome caused by infection. After pathogenic bacteria invade the body, their toxin components enter the bloodstream, activating the host defense system and triggering systemic reactions. This condition is critical with high mortality rates [1]. CRRT involves 24-hour extracorporeal blood purification to replace renal function, removing metabolic products and inflammatory substances from the body, and is now widely used in the rescue and treatment of severe sepsis patients [2]. However, compared with intermittent hemodialysis (IHD), the long treatment cycle of CRRT may increase the risk of catheter-related bloodstream infection (CRBSI). Liu Xiaotian et al. [3] reported that the CRBSI incidence in CRRT patients was [number] cases per thousand catheter-days. CRBSI not only increases patient mortality but also leads to waste of medical resources and increased hospitalization costs [4]. Therefore, effective prevention and treatment of CRBSI has remained a research priority in critical care medicine and nursing.

PDCA cycle management, as an important method for nosocomial infection management, is a procedural, standardized, and scientific management approach

widely applied in various nursing management tasks. It consists of four phases and eight steps that interconnect and promote each other, forming a spiral upward cycle where each loop solves practical problems. Like the nursing process, it is a scientific method and procedure for problem-solving [5]. Bundled care is an evidence-based approach that integrates multiple interconnected interventions based on clinical evidence. In recent years, it has been widely applied in ICU nursing [6], catheter-related infection control [7], ventilator-associated pneumonia, and other fields [8].

This study investigated the application effect of PDCA management combined with bundled care in sepsis patients undergoing CRRT.

Methods

Study Design and Participants Sepsis patients undergoing CRRT in the ICU of our hospital were selected as study subjects. The study was approved by the hospital ethics committee, and all patients or their families signed informed consent forms.

Diagnostic Criteria: Sepsis diagnosis complied with the latest international diagnostic criteria (Sepsis-3) [9]: body temperature >38°C or <36°C, heart rate >90 beats/min, mean arterial pressure <65 mmHg, urine output <0.5 ml/(kg·h), white blood cell count >12,000/mm^3 or <4,000/mm^3, or immature band neutrophils >10%.

Inclusion Criteria: Patients diagnosed with sepsis by physicians.

Exclusion Criteria:
1. Patients with poor prognosis or who died during hospitalization
2. Patients with congenital immune diseases
3. Patients with malignant tumors
4. Patients with severe, incurable cardiovascular or cerebrovascular diseases
5. Patients with psychiatric problems

Grouping Patients were divided into control and observation groups based on admission sequence. General data including age, gender, and sepsis type showed no statistically significant differences between groups (P>0.05).

Interventions Both groups received bundled sepsis treatment according to the Surviving Sepsis Campaign guidelines [10] and personalized CRRT adjustment following the 2020 edition of Blood Purification Operating Procedures. The control group received conventional ICU management and nursing, including vital signs monitoring, daily care, skin care, vascular access care, and nutritional support. The observation group received PDCA cycle management combined with bundled care strategies.

PDCA Cycle Management Protocol Plan: A quality management and infection control team was established. Team members reviewed relevant literature, collected detailed patient data, identified problems and risks in the nursing process and infection management, and designed scientific, reasonable, individualized nursing plans and management measures based on actual patient conditions.

Do: Nursing work was carried out according to the designed plan, including:

1. **Hand Hygiene:** Medical staff strictly followed hand hygiene procedures before and after contacting catheter insertion sites, and before and after insertion, replacement, touching catheters, or changing dressings, using rapid hand sanitizer for standardized handwashing. The infection control team periodically checked hand hygiene compliance and evaluated effectiveness, refining departmental hand hygiene standards.

2. **Site Selection and Skin Disinfection:** The subclavian vein was preferred, avoiding the femoral vein when possible. The catheter and surrounding skin were inspected each shift. Chlorhexidine 2% or povidone-iodine 10% was used for skin disinfection.

3. **Maximum Sterile Barrier:** During catheterization, strict aseptic technique was implemented with masks and sterile gloves. Sterile drapes covering the patient's body were used, and ultrasound-guided catheterization required sterile protective covers to reduce CRBSI incidence.

4. **Infection Monitoring:** Patient temperature was monitored in real-time. The puncture site was observed daily for redness, swelling, heat, pain, or exudate. Targeted infection monitoring included recording catheter status daily and monitoring white blood cell count and C-reactive protein when necessary. If fever or chills occurred during dialysis, CRBSI was considered after excluding other infection sources, and comprehensive evaluation determined whether catheter removal and tip culture were needed.

5. **Dressing Selection and Replacement:** Sterile transparent dressings or sterile gauze were used to cover the puncture site. Dressings were changed at least every 7 days for transparent dressings and every 2 days for gauze, with immediate replacement if damp or contaminated. Antimicrobial ointment or povidone-iodine ointment applied locally at the catheter puncture site could reduce CRBSI incidence.

6. **Aseptic Operation Protocol:** Strict aseptic technique was maintained during connection and disconnection. Sterile towels were placed under the catheter during each procedure. Catheter interfaces were disinfected with 10% iodine cotton balls for 15 seconds each and allowed to dry before operation. During disconnection, heparin saline or heparin-antibiotic lock solution was used, capped with sterile heparin caps, wrapped in sterile gauze, and fixed with adhesive tape. Strict aseptic technique was also maintained during replacement fluid preparation and changes to reduce

pyrogenic reactions. For femoral vein catheters, perineal cleanliness was ensured.

7. **Daily Catheter Necessity Assessment:** Daily evaluation of catheter necessity was conducted. The indwelling period for femoral vein catheters should not exceed 7 days, and for internal jugular or subclavian vein catheters, not exceed 14 days.
8. **Staff Education:** Nursing staff received education and training on vascular catheter indications, standardized catheter maintenance and care procedures, and CRBSI prevention and management. The quality management and infection control team regularly assessed staff competency and compliance.
9. **Patient Management:** Conscious patients were educated about catheter care precautions and hygiene habits. Unconscious patients received basic nursing care to ensure the catheter site remained dry and clean. Adequate daily nutrition, especially protein, was ensured to improve anti-infection capacity.
10. **Isolation Management:** Patients with CRBSI underwent pathogen identification and strict bedside contact isolation, with single-room isolation when possible and enhanced behavioral isolation.

Check: The quality management and infection control team conducted inspections through unannounced site checks, theoretical assessments, sampling monitoring, and random questioning to identify problems in each nursing stage. Periodic training was provided to improve technical skills and infection control compliance.

Action: Monthly team meetings were held to report infection assessment results and identified problems. Through literature review and collective discussion, problems in infection prevention and control were identified, and scientific corrective measures were designed to enter the next cycle, continuously improving nursing quality.

Outcome Measures The incidence of CRBSI, CRRT treatment duration, and ICU length of stay were recorded and compared between groups.

Statistical Analysis SPSS software was used. Measurement data were expressed as mean ± standard deviation ($\bar{x} \pm s$) and compared between groups using t-tests. Count data were expressed as percentages (%) and compared using ^{2} tests. $P<0.05$ was considered statistically significant.

Results

Comparison of CRBSI Incidence The observation group had [number] CRBSI cases with an incidence rate of [percentage], while the control group had [number] cases with an incidence rate of [percentage]. The difference in CRBSI incidence between groups was statistically significant ($P<0.05$).

Comparison of CRRT Treatment Time and ICU Length of Stay The CRRT treatment time and ICU length of stay in the observation group were significantly shorter than those in the control group ($P<0.05$) (Table 1).

Comparison of CRRT Treatment Time and ICU Length of Stay Between Two Groups ($\bar{x} \pm s$)

Group	CRRT Treatment Time (days)	ICU Length of Stay (days)
Observation Group	[value]±[value]	[value]±[value]
Control Group	[value]±[value]	[value]±[value]

Discussion

CRRT removes inflammatory substances and toxins from the body through diffusion and convection, helping sepsis patients achieve homeostasis. Although widely used in sepsis treatment [11], many risk factors during treatment and nursing can lead to CRBSI [12], threatening patient safety. Therefore, nosocomial infection management departments have included CRBSI incidence in nursing quality evaluation indicators.

PDCA cycle management serves as an important tool for nosocomial infection management—a procedural, standardized, and scientific approach widely applied in nursing management. It consists of four phases and eight interconnected steps forming a spiral upward cycle, solving practical problems in each iteration, much like the nursing process itself [13]. Bundled care integrates evidence-based medicine into bedside nursing, with interventions that are evidence-based and interrelated. It has been widely applied in ICU nursing [14], catheter-related infection control [15], ventilator-associated pneumonia, and other fields [16].

This study reviewed domestic and international literature and organized expert symposiums to summarize risk factors for CRBSI. By combining PDCA cycle management with bundled care strategies, we integrated the advantages of both methods and developed a systematic management approach. This included strict hand hygiene, scientific puncture site selection with standardized skin disinfection, maximum sterile barrier precautions, and infection monitoring. Results showed that the observation group had lower CRBSI incidence than the control group ($P<0.05$), demonstrating that PDCA combined with bundled care reduces CRBSI risk in CRRT patients.

Analysis reveals several key factors: First, establishing a quality management team before nursing implementation allowed for in-depth analysis of nursing problems and development of individualized care plans, facilitating implementation and pacing. Second, strict quality control during nursing with immediate problem reporting and feedback enabled continuous improvement through positive cycles. These findings align with Zhang Qixia et al. [17], who reported that improved clinical operability and compliance help reduce CRBSI incidence. Additionally, the observation group's shorter ICU stay and CRRT duration suggest that PDCA combined with bundled care enhances nursing competency, providing more comprehensive, systematic, reliable, and high-quality nursing services that meet patient needs and reduce factors affecting recovery. Ding Ni et al. [18] also indicated that effective, scientific nursing methods significantly improve treatment outcomes and prognosis in CRRT sepsis patients.

In summary, applying PDCA cycle management combined with bundled care strategies for sepsis patients undergoing CRRT can effectively reduce CRBSI risk, facilitate earlier machine withdrawal, and shorten hospitalization time, warranting clinical adoption.

Conflict of Interest Statement: The authors declare no conflict of interest.

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Note: Figure translations are in progress. See original paper for figures.