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Original Article

Prevention of peripherally inserted central catheter-related infections in very low-birth-weight infants by using a central line bundle guideline with a standard checklist



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ABSTRACT

Objective: To investigate the effectiveness and feasibility of using a central line bundle (CLB) guideline with a standard checklist in the prevention of peripherally inserted central catheter (PICC)-related infections (CRIs) in very low-birth-weight infants (VLBWIs).

Methods: Fifty-seven VLBWIs who underwent PICC insertion at a hospital in Qingdao, China, between November 2012 and June 2013, were monitored with the CLB guideline and a standard checklist. Fifty-three VLBWIs who underwent PICC insertion were monitored by standard hospital procedures. The incidence of CRIs was compared between the two groups.

Results: The incidence of infection significantly decreased from 10.0% catheter days in the control group to 2.2% catheter days in the study group ($p < 0.05$). The indwelling catheter time significantly increased in the study group compared to the control group (31.9 ± 15.0 days vs. 24.8 ± 7.4 days, respectively, $p < 0.05$). Colonization infections also decreased from 6.9% catheter days in the control group to 2.2% catheter days in the study group ($p < 0.05$). The incidence of catheter-related bloodstream infections decreased from 3.1% catheter days in the control group to 0% catheter days in the study group.

Conclusion: The use of a CLB guideline with a standard checklist could be an effective and feasible protocol for preventing CRIs and prolonging indwelling catheter time in VLBWIs.

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1. Introduction

The use of the peripherally inserted central catheter (PICC) technology is widespread because of its simplicity,

osmotolerance, and longevity [1]. However, 16.4%–28.8% of the PICCs are susceptible to catheter-related infections (CRIs), a severe complication of PICC placement [2–4]. If treatment of the CRI is not timely, the incidence of further infection and mortality rates are high [5]. Therefore,

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identifying methods to reduce or eliminate CRIs is important. A central line bundle (CLB) guideline was first proposed by the Institute for Healthcare Improvement, and included five key measures—hand hygiene, maximum sterility, chlorhexidine disinfection, choosing the best puncture site, and daily assessment of whether to remove the catheter [6]. These measures effectively reduce the occurrence of catheter-related bloodstream infections (CRBSIs) [7,8].

Very low-birth-weight infants (VLBWIs) have a low immune response and indistinct symptoms after an infection compared to other populations [9]. It is unknown whether a CLB in VLBWIs is effective and safe, and whether it could prevent bacterial colonization and infection [10]. We investigated the effectiveness of the CLB guideline in preventing PICC CRIs in VLBWIs. We hypothesized that using the CLB guideline with a standard checklist could prevent CRIs in very low-birth-weight infants.

2. Materials and methods

2.1. Clinical data

In this study, 110 VLBWIs who received PICCs were enrolled. All patients met the standards of PICC insertion. Fifty-seven VLBWIs were included in the study group. The CLB guideline and a standard checklist were implemented between November 2012 and June 2013. Fifty-three patients were included in the control group. This group had catheters inserted, but the CLB guideline and a standard checklist were not implemented. This study was conducted in accordance with the Declaration of Helsinki. This study was conducted with approval from the Ethics Committee of Qingdao Center Medical Group. Written informed consent was obtained from the parents of all enrolled VLBWIs.

2.2. Bundle insertion

A senior nurse, who was qualified to perform catheter insertions, inserted PICCs in all the participants. The following conditions were established for the study group: 1) creation of a PICC treatment center, 2) hand hygiene, 3) maximum sterility, 4) skin preparation, and 5) selection of the best puncture site. The PICC supplies (single-lumen 1.9-Fr catheter and No. 26 catheter sheath, BD Inc., Illinois, USA) were kept in a fixed location. Regular inspections were undertaken to ensure the presence of adequate supplies and backups within the study period. The VLBWIs underwent PICC line insertion only in the treatment center. The nurse and assistants were required to wash their hands in strict accordance with the seven-step hand-washing method. For maximum sterility, the nurse and assistants wore sterile surgical gowns, gloves, hats, and masks. Masks were completely and tightly wrapped around the nose and mouth. The hats completely covered all hair. The patients were completely covered with sterile towels with only the puncture site exposed. The pre-puncture upper arm (from the fingertips to the fossa cubitalis) was washed with warm soapy water followed by cleaning with a 75% alcohol solution. This procedure was repeated two or three times according to the condition of the patient's skin. Thereafter, Anerdian

(Disinfection Technologies Ltd., Haili Kang, ShangHai) was used to disinfect the skin from the armpits down to the fingertips three times. Anerdian is a skin disinfectant widely used in clinics. It contains iodine (0.2% ± 0.02%), chlorhexidine acetate (0.45% ± 0.045%), and ethanol (65% ± 5%). Anerdian kills intestinal bacteria, pyogenic bacteria, yeast and pathogenic bacteria. The skin was allowed to dry naturally before the best puncture site was selected. The first choice was the basilica vein, followed by the cubital and axillary veins. Puncture of the lower limbs was avoided. In the control group, strict hand hygiene, skin preparation, and aseptic manipulation practices were followed; however, the measures of using the PICC treatment center, ensuring maximum sterility, and selecting the best puncture site were not enforced or implemented.

2.3. Bundle maintenance

The following conditions were established for the study group: 1) hand hygiene, 2) dressing management, 3) filling and sealing the catheter tube, and 4) daily assessments by duty nurses. Hands were washed in strict accordance with the seven-step hand-washing method, or a hand disinfectant was used before and after touching the catheters and dressings. The dressing was replaced exactly every week after catheter insertion. Daily assessment guidelines were as follows: observed whether the puncture site exhibited redness, swelling, tenderness, or inflammation; avoided removing the catheter because of simplex fever; and comprehensively evaluated the need to remove the catheter according to clinical manifestations and laboratory findings. In addition, the catheter was removed when no longer necessary.

The control group received routine nursing care, including the use of aseptic technique, timely sealing of the catheter, and film replacement.

2.4. Use of a standard checklist

In the study group, a standard checklist was used to monitor for any infections. Any violation of the operating rules was stopped in a timely manner and corrected. In the control group, the standard checklist was not used.

CRI diagnosis and classification criteria [11] were used to determine the following conditions: 1) local infection: defined as skin with redness, tenderness, or any secretion around the intubation; 2) phlebitis: defined as painful and diffuse erythema occurring at the subcutaneous site along the catheter that was not related to physical or chemical factors; 3) catheter colonization: defined when the insertion site had no signs of infection and the distal part of the catheter had pathogens amounting to ≥ 15 colony-forming units (CFU)/tablet, with semiquantitative cultures or pathogens amounting to ≥ 1000 CFU on the quantitative culture; and 4) CRBSI: defined when the same pathogen was isolated on quantitative or semiquantitative catheter cultures and other blood cultures.

2.5. Data collection

Patients without clinical CRI symptoms [12] underwent routine alcohol and Anerdian disinfection around the catheter

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