

## Original Article

# Clinical study on the care bundles in ICU patient nursing to prevent catheter related urinary tract infection

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**Abstract:** Objective: The aim of this study was to analyze the role of care bundles in the prevention of catheter related urinary tract infection in ICU patient nursing. Methods: 125 patients admitted to the ICU of our hospital were divided into the group A (GA, n=65, care bundles) and the group B (GB, n=60, conventional nursing) according to the time of hospitalization. Nursing quality was compared between the two groups. Results: The incidence of catheter related urinary tract infection was 15.38% in GA and 31.67% in GB ( $P<0.05$ ), which rose positively in respond to the catheter indwelling time and had statistical intragroup significance at different time points ( $P<0.05$ ). Compared with GB, GA was reported with shorter duration of catheter indwelling and ICU length of stay (LOS), and lower medical expenses ( $P<0.05$ ). The number of colonies out of the catheter was smaller in the GA as compared with the GB immediately, at 6 h and 12 h after cleaning ( $P<0.05$ ). Age, disturbance of consciousness, history of diabetes, hypo-proteinemia, duration of catheter indwelling, use of broad-spectrum antibiotics, and time in bed were independent factors affecting the catheter related urinary tract infection in ICU patients with catheter indwelling ( $P<0.05$ ). The scores of quality of life (QOL) in the GA were higher than those in the GB ( $P<0.05$ ). Conclusion: Care bundles helped to cut down the incidence of catheter related urinary tract infection, accelerate the recovery, improve the QOL, and reduce the medical expenses related to ICU patients, which has good application values.

**Keywords:** ICU, care bundles, catheter related urinary tract infection, prevention

## Introduction

Catheter indwelling is an intuitionistic tool for medical staff to observe the dynamic changes of urinary production, and then evaluate patients' conditions, which is inevitable for most patients admitted to ICU. Although catheter indwelling plays an important role, long-term use can also lead to many complications, with the highest incidence of catheter related urinary tract infection [1]. Catheter related urinary tract infection refers to a type of symptoms of urinary tract infection that occurs 48 h after the catheter indwelling. According to studies, catheter indwelling is the main cause of urinary tract infection in hospital [2].

Patients transferred to ICU are in severe situation and complicated with multiple diseases which are highly complicated and demand diversified invasive operations. However, they also have low immunity and are susceptible to infection. According to statistics, catheter related urinary tract infection accounts for 2/5 of

the hospital infection cases. It will not only increase the medical expenses of patients and prolong their length of stay (LOS), but also lead to more sufferings and even a higher risk of death [3, 4]. Therefore, high-quality catheter control plays a vital role in the elimination of catheter related urinary tract infection in ICU patients with catheter indwelling. Nursing intervention is considered as an important management measure, while care bundles, the novel nursing model in clinic, are a series of nursing measures designed and implemented in a concentrated manner to solve some difficult problems subject to many factors [5]. Instead of simple combination of nursing measures, the care bundles are based on evidences, patients' specific conditions and the characteristics of each department [6].

In recent years, care bundles have been extensively applied in clinic, and studies have shown that they can significantly reduce the incidence of ventilator-associated pneumonia and have application values in the prevention of catheter

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related urinary tract infection [7]. However, these studies were not so strict with nursing measures, and some even failed to find supports based on evidence but resorted to the experience of medical staff. Furthermore, no unified standards were available to evaluate the nursing effects. On this basis, this study, taking 125 ICU patients in our hospital as the research subjects, explored the establishment of care bundles by referring to the previous literatures and experience, so as to provide more references for the nursing of ICU patients.

### Materials and methods

#### Materials

According to the explicit medical records, 125 ICU patients admitted to ICU of our hospital were divided into two groups, the group A (GA, n=65) and the group B (GB, n=60). All patients were informed of the study content, and signed on the consent form. The study was approved by the ethics committee of the hospital. Inclusion criteria: patients aged  $\geq 18$ ; those admitted to ICU with catheter indwelling for more than 2 days; those without life-threatening. Exclusion criteria: patients with signs of urinary tract infection upon admission to hospital; catheter indwelling upon admission to ICU; those with the expected duration of catheter indwelling less than 2 days; those with disturbance of consciousness; those with unstable vital signs to complete the entire study.

#### Methods

Patients in GB were conventionally nursed with catheters. All catheter-related operations were carried out with both hands disinfected. The time to remove catheters was determined according to the doctor's advices; catheters were fixed with balloons filled with 15-20 ml of normal saline. Secondary fixation was not addressed. After the catheter dwelling, urine bags were generally used, which were replaced every other day and discharged every 2-3 h by unplugging the stopper of the urine bag terminal with both hands in clean medical gloves, after which, the stop was inserted into the terminal.

Patients in the GA were served with catheter care bundles. A lot of literatures and materials were collected with keywords such as "catheter related urinary tract infection", "prevention" and "nursing". Nursing measures discussed in

these literatures were summarized, and a nursing scheme was made in combination with the specific conditions of the ICU department, the qualifications of medical staff, and the conditions of patients. Afterward, a checklist of care bundles was formulated, affixed to the foot of each patient's bed, and ticked by the responsible nurse according to the completion of nursing indices. The specific indices of nursing measures were as follows: hand washing: a yellow mark was set up by the bedside, where quick hand disinfectant was also provided. Nurses were required to wash their hands according to the 7 steps before and after catheter related operations. Duration of catheter indwelling: the catheter indwelling indications of each patient were evaluated after each shift nurse was on duty, and the catheter was removed after the indications disappeared. Secondary fixation of catheters: the first fixation was done with balloons filled with 15-20 ml of normal saline, and the second fixation was done with tapes. Air tightness of drainage tubes: anti-reflux composite urine bags were adopted, which were replaced once a week and discharged every 8 h. Terminal nursing of urine bags: the stopper opening was disinfected inside and outside before urine discharge, and closed after disinfection again after discharge.

#### Observation indices

Catheter related urinary tract infection: judgment criteria were formulated according to the *Guides for Medical Institutions to Prevent Catheter Related Urinary Tract Infection* [8]: for patients with clear consciousness and no signs of urinary tract infection, nosetiology and counts of white cells were used for judgment, and the case was confirmed in case of Gram-negative bacilli  $>10^5$  cfu/ml and Gram-positive bacilli  $>10^4$  cfu/ml in the urine bacterial culture medium. For patients with signs of urinary tract infection and purulent secretion at the urinary meatus, the case was confirmed if the count of white cells was at least 5/hpf. for males or 10/hpf. for females according to the analysis of urine and sediments. GA and GB were compared for the total incidence of catheter related urinary tract infection throughout and at different time points of catheter indwelling.

Duration of catheter indwelling: GA and GB were compared for the duration of catheter indwelling which is defined as the time elapsed from the intubation to drawing.

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**Table 1.** Intergroup comparison of general materials ( $\bar{x}\pm sd$ )/[n (%)]

| Materials                            |        | GA (n=65)         | GB (n=60)         | t/ $X^2$ | P     |
|--------------------------------------|--------|-------------------|-------------------|----------|-------|
| Gender                               | Male   | 43 (66.15)        | 40 (66.67)        | 0.004    | 0.952 |
|                                      | Female | 22 (33.85)        | 20 (33.33)        |          |       |
| Age (year)                           |        | 53.16 $\pm$ 15.82 | 55.31 $\pm$ 16.94 | 0.734    | 0.465 |
| BMI (kg/m <sup>2</sup> )             |        | 24.18 $\pm$ 2.63  | 23.98 $\pm$ 1.89  | 0.485    | 0.629 |
| APACHII score upon admission (score) |        | 20.32 $\pm$ 6.23  | 21.18 $\pm$ 6.29  | 0.768    | 0.444 |
| History of diabetes                  | Yes    | 38 (58.46)        | 35 (58.33)        | 0.000    | 0.988 |
|                                      | No     | 27 (41.54)        | 25 (41.67)        |          |       |
| Hypoproteinemia                      | Yes    | 16 (24.62)        | 19 (31.67)        | 0.770    | 0.380 |
|                                      | No     | 49 (75.38)        | 41 (68.33)        |          |       |

**Table 2.** Intergroup comparison of incidence of catheter related urinary tract infection [n (%)]

| Group | Cases | Catheter related urinary tract infection | Non-catheter related urinary tract infection | Infection rate |
|-------|-------|--|--|----------------|
| GA    | 65    | 10                                       | 55   | 15.38%         |
| GB    | 60    | 19                                       | 41   | 31.67%         |
| $X^2$ |       |  | 4.642  |                |
| P     |       |  | 0.031  |                |

ICU LOS: GA and GB were compared for ICU LOS which is defined as the time elapsed from transferring to ICU to leaving ICU.

Medical expenses: GA and GB were compared for total expenses during hospitalization, including costs related or not related to ICU.

Bacterial colonies out of the catheter: the number of colonies out of the catheter was measured in GA and GB before, immediately, at 6 h and 12 h after catheter cleaning.

Analysis of influencing factors: one-factor and multi-factor analyses were performed for the development of catheter related urinary tract infection in GA.

Quality of life (QOL): the health status questionnaire (SF-36) was used for evaluation before and after nursing. The scale has 8 dimensions: general health (GH), mental health (MH), physiological function (PF), emotional function (EF), role-physical (RP), body pain (BP), social function (SF), and vitality (VT). The highest score of each dimension is 100, and the higher score indicates the better QOL.

### Statistical analysis

Statistical analysis was performed with SPSS22.0. In case of numerical data expressed as mean  $\pm$  standard deviation, comparison

studies were carried out through independent-samples *t* test; in case of nominal data expressed as [n (%)], comparison studies were carried out through  $X^2$  test for intergroup comparison. Multi-factor analysis was done by the binary classification logistic regression analysis method. For all statistical comparisons, significance was defined as  $P < 0.05$ .

### Results

#### General materials

The two groups were not significantly different in the proportions of gender, average age, BMI, APACHII scores, rates of diabetes and hypoproteinemia ( $P > 0.05$ ) (Table 1).

#### Incidence of catheter related urinary tract infection

The incidence of catheter related urinary tract infection was 15.38% in GA and 31.67% in GB. The infection rate in GA was significantly lower than that in GB ( $X^2 = 4.642$ ,  $P = 0.031$ ) (Table 2).

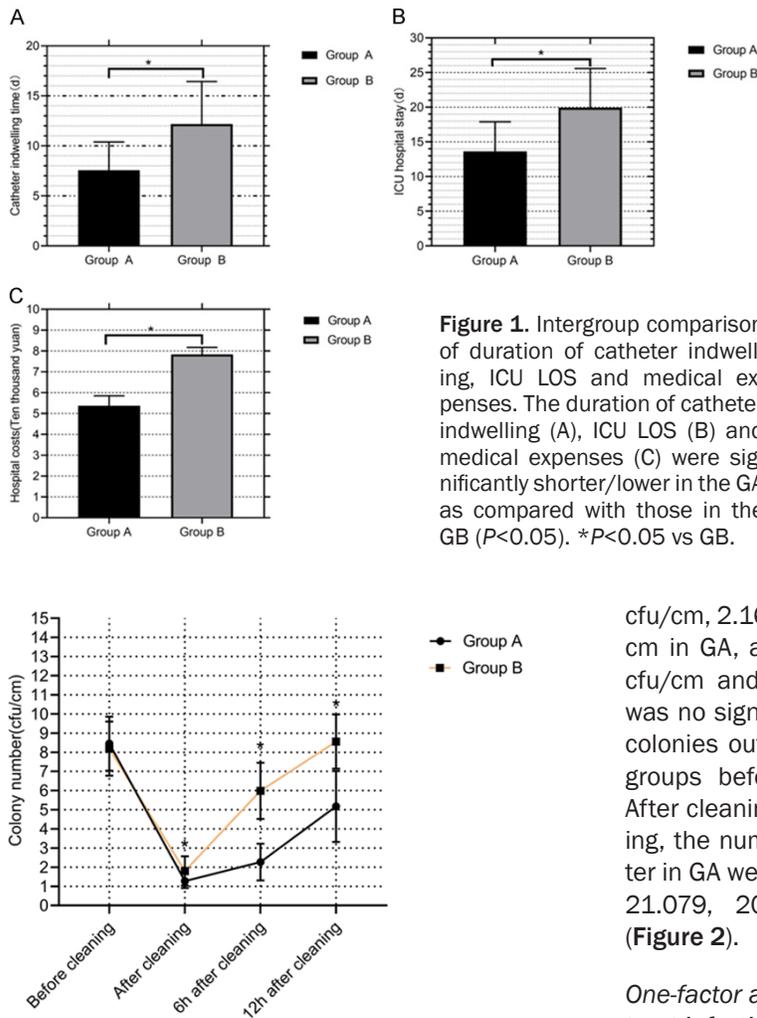
#### Duration of catheter indwelling and infection

By classifying the duration of catheter indwelling into four stages, the development of catheter related urinary tract infection in both groups was analyzed and positively related to the duration of catheter indwelling. Statistical intra-

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**Table 3.** Intergroup comparison of infection at different time of catheter indwelling [n (%)]

| Duration of catheter indwelling | GA |                | GB |                |
|---------------------------------|----|----------------|----|----------------|
|                                 | n  | Infection rate | n  | Infection rate |
| 1-3 d                           | 10 | 0 (0.00)       | 0  | 0 (0.00)       |
| 4-7 d                           | 30 | 2 (6.67)       | 30 | 5 (16.67)      |
| 8-14 d                          | 20 | 5 (25.00)      | 20 | 6 (30.00)      |
| Over 14 d                       | 5  | 3 (60.00)      | 10 | 8 (80.00)      |
| $\chi^2$                        |    | 4.629          |    | 5.207          |
| <i>P</i>                        |    | 0.017          |    | 0.039          |



**Figure 1.** Intergroup comparison of duration of catheter indwelling, ICU LOS and medical expenses. The duration of catheter indwelling (A), ICU LOS (B) and medical expenses (C) were significantly shorter/lower in the GA as compared with those in the GB ( $P < 0.05$ ). \* $P < 0.05$  vs GB.

**Figure 2.** Intergroup comparison of bacterial colonies out of catheter. The number of colonies out of the catheter was not significantly different between the two groups before cleaning but reduced sharply in GA immediately, at 6 h and 12 h after cleaning ( $P < 0.05$ ). \* $P < 0.05$  vs GB.

group significance was observed in terms of the incidence of catheter related urinary tract

infection at different time points ( $P < 0.05$ ) (Table 3).

### Duration of catheter indwelling time, ICU LOS and medical expenses

On an average basis, the catheter indwelling time and medical expenses were  $7.56 \pm 3.19$  days and RMB  $54200 \pm 3600$  in GA,  $12.19 \pm 4.85$  days and RMB  $78600 \pm 4100$  in the GB. The GA showed shorter duration of catheter indwelling, shorter ICU LOS, and less medical expenses than the GB, and all the differences were statistically significant ( $t = 6.352, 9.086, 35.419, P = 0.000, 0.000, 0.000$ ) (Figure 1).

### Bacterial colonies out of the catheter

The number of colonies out of the catheter was  $8.45 \pm 1.32$  cfu/cm in GA, and  $8.19 \pm 1.62$  cfu/cm in GB before cleaning ( $t = 0.987, P = 0.326$ ). Immediately, at 6 h and 12 h after cleaning, it was  $1.23 \pm 0.39$  cfu/cm,  $2.16 \pm 0.89$  cfu/cm and  $4.52 \pm 0.93$  cfu/cm in GA, and  $1.84 \pm 0.61$  cfu/cm,  $5.98 \pm 1.13$  cfu/cm and  $8.56 \pm 1.28$  cfu/cm in GB. There was no significant difference in the number of colonies out of the catheter between the two groups before cleaning ( $t = 0.987, P = 0.326$ ). After cleaning and at 6 h and 12 h after cleaning, the numbers of colonies out of the catheter in GA were lower than those in GB ( $t = 6.713, 21.079, 20.298, P = 0.000, 0.000, 0.000$ ) (Figure 2).

### One-factor analysis of catheter related urinary tract infection

One-factor analysis of catheter related urinary tract infection in GA showed that its incidence in ICU patients was related to age  $\geq 60$ , complications with disturbance of consciousness, history of diabetes and hypoproteinemia, duration of catheter indwelling  $\geq 5$  d, use of broad-spectrum antibiotics, and time in bed  $\geq 14$  d ( $P < 0.05$ ) (Table 4).

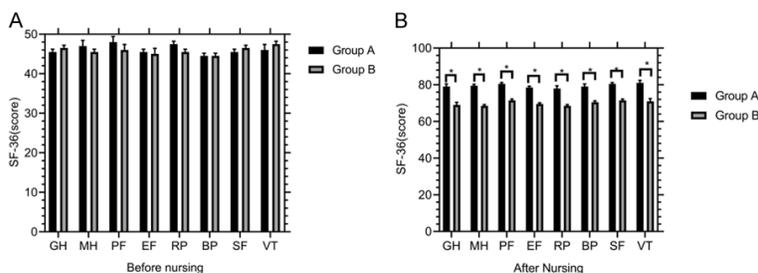
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**Table 4.** One-factor analysis of catheter related urinary tract infection in GA (n, %)

| Factor   |       | n (n=65) | Infection rate (%) | X <sup>2</sup> | P     |
|--|-------|----------|--------------------|----------------|-------|
| Age  | <60   | 25       | 1 (4.00)           | 4.045          | 0.044 |
|  | ≥60   | 40       | 9 (22.50)          |                |       |
| Complication with disturbance of consciousness | Yes   | 14       | 5 (35.71)          | 5.665          | 0.017 |
|  | No    | 51       | 5 (9.80)           |                |       |
| History of diabetes                            | Yes   | 38       | 9 (23.68)          | 4.841          | 0.028 |
|  | No    | 27       | 1 (3.70)           |                |       |
| Hypoproteinemia                                | Yes   | 16       | 6 (37.50)          | 7.974          | 0.005 |
|  | No    | 49       | 4 (8.16)           |                |       |
| Duration of catheter indwelling                | <5 d  | 43       | 3 (6.98)           | 6.899          | 0.009 |
|  | ≥5 d  | 22       | 7 (31.82)          |                |       |
| Use of broad-spectrum antibiotics              | Yes   | 14       | 6 (42.86)          | 10.345         | 0.001 |
|  | No    | 51       | 4 (7.84)           |                |       |
| Time in bed                                    | <14 d | 48       | 4 (8.33)           | 7.010          | 0.008 |
|  | ≥14 d | 17       | 6 (35.29)          |                |       |

**Table 5.** Multi-factor logistic analysis of catheter related urinary tract infection

| Factor                            | β     | OR    | Wald   | 95% CI      | P     |
|-----------------------------------|-------|-------|--------|-------------|-------|
| Age                               | 3.185 | 3.516 | 15.324 | 2.185-4.645 | 0.016 |
| Disturbance of consciousness      | 2.794 | 4.671 | 22.196 | 3.326-5.194 | 0.018 |
| History of diabetes               | 3.612 | 3.629 | 13.645 | 2.554-4.193 | 0.006 |
| Hypoproteinemia                   | 2.751 | 3.852 | 14.854 | 2.286-4.625 | 0.037 |
| Duration of catheter indwelling   | 4.168 | 5.164 | 22.431 | 4.658-6.289 | 0.022 |
| Use of broad-spectrum antibiotics | 3.196 | 4.127 | 20.187 | 3.127-5.169 | 0.019 |
| Time in bed                       | 2.798 | 3.021 | 9.831  | 2.324-4.185 | 0.040 |



**Figure 3.** Intergroup comparison of QOL. Before nursing, there was no significant difference in scores of QOL including GH, MH, PF, EF, RP, BP, SF, and VT between the two groups ( $P>0.05$ ). After nursing, the scores of QOL in the GA were significantly higher than those in the GB ( $P<0.05$ ). \* $P<0.05$  vs GB.

### Multi-factor analysis of catheter related urinary tract infection

Further multi-factor logistic regression analysis was carried out according to the above results of single-factor analysis, which showed that age, disturbance of consciousness, history of diabetes, hypoproteinemia, duration of catheter indwelling, use of broad-spectrum antibiotics, and time in bed were independent factors

accounting for the development of catheter related urinary tract infection ( $P<0.05$ ) (Table 5).

### QOL

There was no significant difference in the scores of QOL including GH, MH, PF, EF, RP, BP, SF and VT between the two groups before nursing ( $P>0.05$ ). After nursing, the scores of QOL of the two groups were higher than those before nursing, and those of the GA were higher than those of the GB ( $P<0.05$ ) (Figure 3).

### Discussion

Catheter indwelling in ICU is helpful to change the urination mode of patients with uroschisis and urinary incontinence. However, as an invasive operation, catheter indwelling is related to many complications, of which, catheter related

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urinary tract infection has the highest incidence [9, 10]. Studies revealed that pathogenic bacteria resulting in catheter related urinary tract infection included Gram-negative bacilli such as *Candida*, *E. coli*, and *Pseudomonas aeruginosa*, as well as fungi [11]. Under the influence of bacterial drug resistance, the incidence of urinary tract infection caused by some Gram-positive bacteria is increasing, along with higher difficulties in treatment [12]. In ICU where the incidence of infection is extremely high, conventional nursing schemes can no longer achieve the purpose of controlling catheter related urinary tract infection, and other more effective nursing schemes should be sought.

Care bundles are a group of operable and practical nursing measures [13, 14], which has been clinically proven to improve the prognosis of patients. Their development is to provide patients with more high-quality nursing services. In care bundles, at least three operative nursing measures should be combined to improve their continuity and integrity. They are performed at the same time and place, and are evidence-based to ensure the effectiveness of nursing [15, 16]. In this study, ICU patients with catheter indwelling (GA) were intervened with care bundles, and compared with the GB who received conventional nursing only. The incidence of catheter related urinary tract infection was lower in the GA, and the duration of catheter indwelling was positively related to the incidence of infection, indicating that it was a factor accounting for catheter related urinary tract infection, which was evidenced in the factor analysis. It was also found in this study that the longer the catheter related urinary tract infection, the higher the incidence of urinary tract infection [17]. The number of colonies out of the catheter was smaller in the GA immediately, at 6 h and 12 h after cleaning. Meanwhile, the duration of catheter indwelling and ICU LOS were shorter, and the medical expenses were lower in GA, indicating that subject to the intervention of care bundles, ICU patients with catheter indwelling manage to effectively control the bacterial out of the catheter, shorten the time to draw the catheter and the LOS, and reduce the medical expenses. These improvements shall be attributed to the five nursing measures of hand washing, reminding on catheter, sterile drainage, secondary fixation and standardized urine collection system, which supplement and promote each other to

jointly make contributions [18]. Furthermore, during the specific implementation process of nursing measures, the results were judged by the questions of “Yes” or “No”. As a result, the nursing goals were clarified and the nursing measures were directly incorporated into the results evaluation, which ensured the feasibility of nursing [19]. Similar studies also revealed that, after care bundles, the incidence of catheter related urinary tract infection declined to 15% or less, which was consistent with the findings of this study [20]. Hand washing before operation is considered the most direct means of controlling the urinary tract infection [21]. The difference in the assaying results of bacterial colonies out of the catheter at different time after cleaning was due to the reduction in the possibility of patients being exposed to pathogenic bacteria after care bundles, which fundamentally prevented infection. In the ward of GA patients, a yellow line was set up to remind the nurses to disinfect both hands before entering the area, and the quick hand disinfectant was provided at the foot of the bed for nurses to disinfect hands at any time. At present, the hand disinfectant applied clinically is slightly irritative but highly bactericidal. It is a very effective hand disinfection method that can clean our hands in less than 30 s [22]. Studies also found that care bundles were an effective means to control the number of colonies out of the catheter in patients with catheter indwelling [23]. According to factor analysis, age  $\geq 60$ , complications with disturbance of consciousness, history of diabetes, hypoproteinemia, duration of catheter indwelling  $\geq 5$  d, use of broad-spectrum antibiotics, and time in bed  $\geq 14$  d were factors leading to catheter related urinary tract infection. Multi-factor regression analysis showed that these factors were independent from each other, and should be taken into account in the development of clinical nursing intervention and on this basis to develop nursing measures to maximally control infection. The analysis on the factors related to catheter related urinary tract infection helps medical staff find the evidences and develop nursing schemes according to relevant factors to ensure the pertinence and operability of nursing measures [24].

In conclusion, the care bundles managed to effectively prevent catheter related urinary tract infection, shorten duration of catheter indwelling and LOS, reduce incidence of infec-

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tion rate in ICU patients with catheter indwelling and improve the patients' QOL. This study also proved the good application values of care bundles, but had some defects such as limited number of samples, omission of evidence-seeking process in the process of formulating the nursing schemes, incomplete analysis of factors, and biased results. Future studies shall be based on larger sample sizes, more comprehensive and in-depth study, so as to provide more references for the formulation of nursing schemes for ICU patients with catheter indwelling.

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### Disclosure of conflict of interest

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