# ORIGINAL ARTICLE

# Development of a CAUTI risk factor evaluation index system for postoperative patients with gynecological malignant tumors

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## Summary

**Purpose:** In this study, we developed a CAUTI risk factor evaluation index system for postoperative patients with gynecologic malignant tumors and provided scientific evidence for the prevention of catheter-related urinary tract infection (CAUTI).

**Methods:** A comprehensive method, including literature review, group discussion and Delphi method, was adopted to establish a CAUTI risk factor evaluation index system for postoperative patients with gynecologic malignant tumors.

**Results:** Two rounds of expert consultations resulted in effective response rates of 100%, with authority coefficients of 0.94, and coordination coefficients of 0.473 and 0.388

respectively (p<0.01). The risk factor indicator system consisted of 4 first-level indicators, 13 second-level indicators, and 56 third-level indicators.

**Conclusion:** The experts showed high enthusiasm, good authority, and coordination. The CAUTI risk factor evaluation index system for postoperative patients with gynecologic malignant tumors is comprehensive and scientific, and could serve as an important guide for assessment and prevention of CAUTI in patients with gynecologic malignant tumor postoperatively.

*Key words:* gynecological malignant tumors, CAUTI, Delphi technique, risk factor

# Introduction

According to a previous study, an increasing (ICU) 4.02/1000 trend of prevalence is observed in the surgery for gynecologic malignancies [1], which is the dominant treatment for these patients, causing postoperative bladder dysfunction that induces catheter indwelling [2]. Catheter-associated urinary tract infection (CAUTI) refers to patients, indwelling catheter, or removal of catheter within 48 h of the infection of the urinary system. Data showed that the mean daily rate of CAUTI was 27.05/1000 catheter days in patients with gynecologic malignancy [3], which is worse than NSHN 3.1–7.5/1000 catheter days in the USA and intensive care unit

(ICU) 4.02/1000 catheter days in China [4,5]. CAUTI not only causes a decline in the patient physical and mental health, but also increases the financial burden, which improves the disease prognosis [6]. Although several studies have assessed the risk factors of CAUTI in patients with gynecologic malignancies after surgery, no integrated evaluation system is yet established. Based on the clinical practice guidelines and literature review, this study used the Delphi technique to establish the CAUTI risk factor evaluation index system for patients with gynecologic malignancies after surgery.

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### Methods

#### Establishment of research and coordination groups

The research group included 5 individuals, 2 senior professional titles, 2 intermediate professional title, and 1 junior professional title. The main assignment of this group was to establish an experts' pool according to the standard of expert selection, design a form for an expert consultation, and statistically analyze the consulting results.

#### Constructing expert consultation questionnaire

The risk factors of CAUTI in patients with gynecologic malignancies were determined by referring to the clinical guidelines and literature review as well as the clinical practice. Subsequently, 4 first-level indicators, 13 second-level indicators, and 58 third-level indicators were included in the final questionnaire. The research group independently designed the first round of expert consultation form. The consultation form was divided into three parts: Part one was to send an email about the research objective, the concept of risk factors of CAUTI, and the operational process to experts. Part two was about the evaluation scale. Experts were asked to score each item on its relevance to postoperative CAUTI risk factors in patients with gynecologic malignancies based on Likert 5 grading: 1–5 points, more points indicate importance. Part three was about the self-assessment scale, including the evaluation of the influence of judgment on experts. Experts were required to fill in the content of the familiarity of the score in addition to the expert general information questionnaire.

#### Selection and identification of consultants

According to the requirements and purposes of the Delphi method, experts were required to be familiar, authoritative, and be able to represent the subject as well as to cooperate with the investigation. The number of experts was determined based on the scope of research issues and available resources, and subsequently, 15 experts were included in the study. Expert selected criteria: Bachelor degree or above; Engaged in gynecologic oncology; specialist nursing work; gynecologic oncology specialist medical work; nursing management work for >10 years; Vice-senior or above professional title.

#### Implementation of expert consultation

Two rounds of expert consultation were completed in this study. The first round of questionnaires was sent to the experts by email. The experts were requested to return the questionnaires by mail within the specified time. After the first round of expert consultation, the questionnaires were recovered, and the researchers followed the principle of indicator screening and deleted the items with arithmetic mean < 3.5 or expert approval degree < 60% and coefficient of variation (CV) > 0.25. The items of opinions proposed by experts were added, modified or deleted subsequently along with the discussion and statistical results of the research group to form the second round of expert consultation table. Concurrently, the expert opinions of the first round were attached, including the reasons for the adoption and non-adoption of opinions. Experts referred to the feedback information for judgment and revision. After the second round of expert consultation, questionnaires were recovered, the research team sorted and conducted a statistical analysis of the expert opinions. When the experts' opinions reached a consensus, the consultation was ended.

#### Statistics

The database of expert consultation results was established by Excel, and SPSS 18.0 statistical software (SPSS Inc., Chicago, IL, USA) was used for data processing. The degree of expert opinion concentration was expressed by the mean, standard deviation, and expert recognition of index importance. The positive coefficient of the expert was expressed by the effective recovery rate of the questionnaire. The degree of expert authority was expressed by the degree of authority coefficient. The degree of coordination of expert opinions was expressed by the coefficient of variation and Kendall coefficient of coordination, and p<0.05 was considered statistically significant.

## Results

#### Positive co-efficient of experts

The degree of expert positivity was indicated by the response rate of each round of questionnaires and the proportion of experts making suggestions. The questionnaire recovery rate was 100.0% in both rounds of consultation, and the effective rate was also 100%. In the study, 12 experts put forward suggestions, and 4 experts gave modification opinions, accounting for 80% and 26.7% of the participants, respectively.

#### Degree of expert authority

Expert authority (Cr) is the arithmetic mean of the expert's familiarity coefficient (Cs) and judgment coefficient (Ca) of the consultation content. In this study, the Cs and Ca of expert consulting were 0.94 and 0.94, respectively, and the authority coefficient (Cr) of expert consultation was 0.94.

#### Degree of coordination of expert opinions

The Kendall coordination coefficients of the two rounds of consultations were 0.473 and 0.338, respectively, which differed significantly (p<0.01), as assessed by the chi-square test.

#### Screening and modification of indicators

The degree of concentration of expert opinions was expressed by average values, which were between 0 and 5 points. The greater the mean value, the more important the corresponding index. CV indicated the degree of coordination of all experts on the importance of an item. The smaller the CV, Table 1. Index system of postoperative CAUTI risk factors in patients with gynecologic malignant tumors

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| Primary indicators                              | Secondary indicators            | Tertiary indicators                   | Mean<br>value | Standard<br>deviation | CV    | Expert recognition<br>degree (%) |
|---|---------------------------------|---------------------------------------|---------------|-----------------------|-------|----------------------------------|
| Factors related to gynecologic malignant tumors | Disease                         | Tumor types                           | 3.80          | 0.77                  | 0.20  | 73.33                            |
|   |                                 | Neoplasm staging                      | 3.73          | 0.81                  | 0.22  | 60.00                            |
|   | Surgical related factors        | Surgery                               | 4.33          | 0.80                  | 0.18  | 93.33                            |
|   |                                 | Scope of surgery                      | 4.40          | 0.81                  | 0.18  | 93.33                            |
|   |                                 | Operation time                        | 4.53          | 0.50                  | 0.11  | 100.00                           |
|   |                                 | Intraoperative accessory nerve injury | 4.53          | 0.50                  | 0.11  | 100.00                           |
|   |                                 | Postoperative abdominal infection     | 4.33          | 0.80                  | 0.18  | 93.33                            |
|   |                                 | Postoperative Pelvic infection        | 4.53          | 0.50                  | 0.11  | 100.00                           |
|   | Postoperative complications     | Cyst hemorrhagia                      | 4.87          | 0.35                  | 0.07  | 100.00                           |
|   |                                 | Vesicovaginal fistula                 | 5.00          | 0.00                  | 00.00 | 100.00                           |
|   |                                 | Rectovaginal fistula                  | 4.80          | 0.41                  | 0.09  | 100.00                           |
|   |                                 | UT injury                             | 5.00          | 0.00                  | 0.00  | 100.00                           |
|   | Postoperative treatment factors | Bladder irrigation                    | 4.80          | 0.41                  | 0.09  | 100.00                           |
|   |                                 | Antibiotic use                        | 4.80          | 0.41                  | 0.09  | 100.00                           |
|   |                                 | Postoperative radiotherapy            | 4.53          | 0.62                  | 0.14  | 93.33                            |
|   |                                 | Postoperative chemotherapy            | 4.60          | 0.61                  | 0.13  | 93.33                            |
| Patient-related factors                         | Personal profile                | Age                                   | 4.47          | 06.0                  | 0.20  | 86.67                            |
|   |                                 | Immobilization                        | 4.73          | 0.45                  | 0.10  | 100.00                           |
|   |                                 | Water intake                          | 4.73          | 0.59                  | 0.12  | 93.33                            |
|   |                                 | Urine volume                          | 4.73          | 0.59                  | 0.12  | 93.33                            |
|   |                                 | Ureteral stent                        | 4.87          | 0.26                  | 0.05  | 100.00                           |
|   |                                 | Preoperative chemotherapy             | 4.33          | 0.81                  | 0.19  | 80.00                            |
|   |                                 | Preoperative radiotherapy             | 4.40          | 0.82                  | 0.19  | 80.00                            |
|   |                                 | Personal hygienic habit               | 4.80          | 0.41                  | 0.09  | 100.00                           |
|   |                                 | Menopause or not                      | 4.13          | 1.12                  | 0.27  | 73.33                            |
|   |                                 | Hospital stay                         | 4.20          | 1.06                  | 0.25  | 80.00                            |

Continued on the next page

| Patient-related factors   Accompanying diseases   Diabetes mellitus   473   559     Inhangturia   114hangturia   440   0.22     Inhangturia   480   0.22     Kidnoy falure   480   0.22     Pyeloneprintis   480   0.23     Pyeloneprintis   480   0.20     Pyeloneprintis   58   9.20   0.20     Pyeloneprintis   58   100   0.20     Pyeloneprintis   58   100   0.20     Pyeloneprintis   58   100   0.20     Pyeloneprintis   100   100   0.20     Pyeloneprintis   100   100 <t< th=""><th>Primary indicators</th><th>Secondary indicators</th><th>Tertiary indicators</th><th>Mean<br/>value</th><th>Standard<br/>deviation</th><th>CV</th><th>Expert recognition<br/>degree (%)</th></t<>  | Primary indicators        | Secondary indicators                | Tertiary indicators                               | Mean<br>value | Standard<br>deviation | CV   | Expert recognition<br>degree (%) |
|---|---------------------------|-------------------------------------|---|---------------|-----------------------|------|----------------------------------|
| Immune system disease   440     Lithanguria   640     Libaratory results   Pyelonephritis   640     Laboratory results   Serum neurophils   640     Laboratory results   Serum neurophils   640     Laboratory results   Serum neurophils   640     Naturi   Serum neurophils   640     Natiri   Naturi   640     Natiri   Naturi   640     Natiri   Naturi   640     Natiri   Nature   640     Natiri   Nature   640     Natiri   Nature   640     Nature   Nature   6   | Patient-related factors   | Accompanying diseases               | Diabetes mellitus                                 | 4.73          | 0.59                  | 0.12 | 93.33                            |
| Lithangiuria   Lithangiuria   460     Kidney failure   870     Ridney failure   870     Pyelonephritis   940     Pyelonephritis   940     Pyelonephritis   940     Pyelonephritis   940     Pyelonephritis   940     Serum neurophils   940     Medication-related factors   841     Nedication-related factors   941     Urethral catheter factors   941     Urethral catheter factors   941     Urethral catheter factors   941     Pyelonephritis   941     Pyelonephritis <t< td=""><td></td><td></td><td>Immune system disease</td><td>4.40</td><td>0.62</td><td>0.14</td><td>86.67</td></t<>   |                           |                                     | Immune system disease                             | 4.40          | 0.62                  | 0.14 | 86.67                            |
| Kidney failure   487     Liaboratory results   Disease of lower motor neuron injury   460     Pyelonephritis   Pyelonephritis   460     Pyelonephritis   85rum neutoophis   460     Medication-related factors   87rum hemoglobin   470     Medication-related factors   97 clureon injury   460     Urethral catheter factors   97 clureon incitoids   470     Urethral catheter factors   97 clureon incitoids   470     Drainage bag-related factors   97 position of catheter faction   470     Prainage bag-related factors   97 position of catheter faction   400     Position of catheter faction   400   400     Prainage bag-related factors   97 pos of drainage bag   400     Prainage bag-related factors   97 pos of drainage bag   400     Prainage bag-related factors   97 pos of drainage bag   400     Prainage bag-related factors   97 pos of drainage bag   400     Prainage bag-related factors   97 pos of drainage bag   400     Prainage bag-related factors   97 pos of drainage bag   400     Prainage bag-related factors   97 pos of drainage bag   400     Prainage bag-related factors   97 pos of drainage bag   400     Prainage bag-related factors   98 pos of  |                           |                                     | Lithangiuria                                      | 4.60          | 0.72                  | 0.16 | 86.67                            |
| Disease of lower motor neuron injury   460     Pyelonephritis   460     Pyelonephritis   460     Serum neurophils   440     Serum neurophils   420     Medication related factors   81burnin     Medication related factors   81burnin     Medication related factors   910     Urethral catheter factors   9147     Urethral catheter factors   9147     Medication related factors   9147     Urethral catheter factors   9147     Minution for catheter factors   9147     Maintenon for catheter revisites   91   |                           |                                     | Kidney failure                                    | 4.87          | 0.35                  | 0.07 | 100.00                           |
| Pyelonephritis   Pyelonephritis   640     Laboratory results   Serum neutrophils   440     Serum neutrophils   220     Ahhumin   Serum neutrophils   440     Medication-related factors   Estrogen level   440     Medication-related factors   Ciluccorticoids   440     Medication-related factors   Urethral catheter material   440     Medication-related factors   Urethral catheter material   440     Direthral catheter factors   Number of catheter fraction   440     Drainage bag-related factors   Number of catheter fraction   440     Propeorition of catheter fraction   440     Maintain the catheter ranterial   440     Maintain the catheter fraction   440     Maintain the catheter fraction   440     Maintain the catheter ranteriad   440     Maintenarce-related factors   440  M  |                           |                                     | Disease of lower motor neuron injury              | 4.60          | 0.82                  | 0.18 | 93.33                            |
| Laboratory resultsSerum neutrophils440Serum neutrophils840Serum neutrophils840Serum neutrophils840Medication-related factors840Medication-related factors940Urethral catheter factors940Urethral catheter factors940Urethral catheter factors940Urethral catheter factors940Urethral catheter factors940Drainage bag-related factors940Position of catheter cavities940Position of catheter fraction940Drainage bag-related factors940Position of catheter fraction940Position of catheter related factors940Position of catheter reprovider raining940Position of drainage bag replacement940Prequency of catheter reprovider related factors940Prequency of catheter reprovider related factors940Prequency of catheter related factors940Position of perineum940Position Position provider rineum940Pos  |                           |                                     | Pyelonephritis                                    | 4.60          | 0.82                  | 0.18 | 93.33                            |
| Serum neurophils     640       Serum hemoglobin     230       Malumin     547       Nedication-related factors     Estrogen level     447       Medication-related factors     Calucocrticoids     447       Urethral catheter factors     Urethral catheter material     447       Urethral catheter factors     Urethral catheter material     447       Drainage bag-related factors     Urethral catheter factors     400       Position of catheter fixation     473       Drainage bag-related factors     Type of drainage bag     473       Maintain the catheter patency     473       Position of catheter fixation     473       Prainage bag-related factors     Type of drainage bag     473       Maintain the catheter patency     473       Prainage bag-related factors     Type of drainage bag     473       Prainage bag-related factors     Hand hygiene     473       Prainage bag-related factors     Prainage bag     473       Prainage bag-related factors     Prainage bag     473       Prainage bag     Prainage bag     473       Prainage bag     Prainage bag     473       Prainage bag  |                           | Laboratory results                  | Serum leukocyte                                   | 4.40          | 0.81                  | 0.18 | 93.33                            |
| Serum hemoglobin     2.00       Albumin     2.00       Medication-related factors     Estrogen level     2.00       Medication-related factors     Urethral catheter material     4.47       Urethral catheter factors     Urethral catheter material     4.47       Urethral catheter factors     Urethral catheter material     4.07       Urethral catheter factors     Urethral catheter material     4.07       Drainage bag-related factors     Position of catheter factors     4.07       Drainage bag-related factors     Type of drainage bag     4.07       Position of catheter fixation     4.07     4.01       Intubation factors     Type of drainage bag     4.01       Maintein the catheter patency     4.03     4.03       Prequency of drainage bag     4.04     4.03       Maintein the catheter fixation     4.04     4.04       Prequency     Areptic operation during intubation     4.04       Maintenance-related factors     Healthcare provider training     4.04       Maintenance-related factors     Healthcare provider training     4.04       Maintenance-related factors     Healthcare provider training     4.04       Maintenance-related f   |                           |                                     | Serum neutrophils                                 | 4.40          | 0.81                  | 0.18 | 93.33                            |
| Albumin   300     Betrogen level   420     Medication-related factors   Estrogen level   420     Urethral catheter factors   Urethral catheter material   447     Urethral catheter factors   Urethral catheter material   447     Urethral catheter factors   Urethral catheter material   440     Drainage bag-related factors   Number of catheter faction   400     Position of catheter faction   400     Position of catheter faction   400     Intubation factors   Type of drainage bag fluction   400     Intubation factors   Type of drainage bag fluction   400     Healthcare provider-related factors   Parenetic operation during intubation   400     Healthcare provider-related factors   Healthcare provider training   400     Maintenance-related factors   Prequency of catheter replacement   400     Maintenance-related factors   Prequency of catheter replacement   400     Prequency of drainage bag replacement   400   400     Prequency of catheter replacement   400     Prequency of drainage bag replacement   400     P  |                           |                                     | Serum hemoglobin                                  | 4.20          | 0.86                  | 0.20 | 73.33                            |
| Batrogen level     20       Medication-related factors     Estrogen level     47       Urethral catheter factors     Urethral catheter material     47       Drainage bag-related factors     Maintain the catheter factors     400       Drainage bag-related factors     The position of catheter fration     401       Intubation factors     The position of drainage bag fration     401       Healthcare     Primary success rate of intubation     401       Healthcare provider-related factors     Healthcare provider training     403       Maintenance-related factors     Healthcare provider training     403       Healthcare provider-related factors     Healthcare provider training     403       Maintenance-related factors     Healthcare provider training     403       Maintenance-related factors     Healthcare provider training     404       Maintenance-related factors     Healthcare provider training     403       Maintenance-related factors     Healthcare provider training     404  |                           |                                     | Albumin   | 3.80          | 0.96                  | 0.25 | 60.00                            |
| Medication-related factors   Gluccocrticoids   47     Urethral catheter factors   Urethral catheter material   47     Urethral catheter factors   Urethral catheter material   47     Urethral catheter factors   Urethral catheter material   47     Drainage bag   Eatheter factors   40     Drainage bag-related factors   Type of catheter factors   47     Drainage bag-related factors   Type of drainage bag   53     Intubation factors   Hand hygiene   47     Mainten ne catheter patency   47     Presented factors   Type of drainage bag   47     Mainten factors   Hand hygiene   47     Mainten factors   Hand hygiene   47     Mainten patency   Frequency of catheter relation   47     Mainten factors   Healthcare provider training   47     Mainten actorererererer   10   10     Prequency of drainage bag replacement   48     Mainten actorerer indwelling time   48     Mainten actorerer indwelling time   48   |                           |                                     | Estrogen level                                    | 4.20          | 1.06                  | 0.25 | 80.00                            |
| Immusupressor   467     Urethral catheter factors   Urethral catheter material   447     Catheter diameter   435     Rumber of catheter raticies   40     Position of catheter raticies   40     Position of catheter factors   40     Drainage bag-related factors   7type of drainage bag   40     Intubation factors   Type of drainage bag   40     Intubation factors   7type of drainage bag   40     Intubation factors   The position of drainage bag   40     Intubation factors   Aseptic operation during intubation   40     Maintain the catheter replacement   40     Intubations   7the position of drainage bag   40     Maintenance-related factors   Aseptic operation during intubation   40     Maintenance-related factors   Frequency of drainage bag replacement   40     Maintenance-related f   |                           | Medication-related factors          | Glucocorticoids                                   | 4.47          | 0.73                  | 0.16 | 86.67                            |
| Urethral catheter factors   Urethral catheter material   447     Catheter diameter   435     Catheter diameter   436     Number of catheter cavities   40     Position of catheter ration   40     Drainage bag-related factors   Type of drainage bag   40     Intubation factors   Type of drainage bag   50     Intubation factors   Hand hygiene   40     Maintennecerelated factors   Resplit operation during intubation   40     Healthcare provider-related factors   Healthcare provider training   40     Maintenance-related factors   Frequency of catheter replacement   40     Maintenance-related factors   Prequency of catheter replacement   40     Maintenance-related factors   Frequency of catheter replacement   40     Maintenance-related factors   Prequency of catheter replacement   40     Maintenance-related factors   Frequency of catheter replacement   40     Maintenance-related factors   Prequency of catheter replacement   40     Maintenance-related factors   Prinary catheter indwelling time   40     Maintenance-related factors   Prinary catheter indwelling time   40     Maintenance-related factors   Prinary catheter replacement   40     Maintenance-related factors   Prinary   |                           |                                     | Immunosuppressor                                  | 4.67          | 0.72                  | 0.15 | 86.67                            |
| 433       Number of catheter fixation     430       Position of catheter fixation     400       Position of catheter fixation     4.07       Drainage bag-related factors     700     700       Drainage bag-related factors     700     700     4.07       Drainage bag-related factors     700     700     4.07       Drainage bag-related factors     700     700     4.00       Intubation factors     700     700     4.00       Intubation factors     700     700     4.00       Healthcare provider-related factors     700     700     700       Maintenance-related factors     700     700     70  | Device-related factors    | Urethral catheter factors           | Urethral catheter material                        | 4.47          | 0.73                  | 0.16 | 86.67                            |
| Number of catheter cavities400Position of catheter fixation4.07Drainage bag-related factors7.79Drainage bag-related factors7.79The position of drainage bag fixation4.00Intubation factors7.70The position of drainage bag fixation4.00Intubation factors7.70Healthcare provider related factors4.00Healthcare provider related factors7.70Maintenance-related factors7.70Maintenance-related factors7.70Maintenance-related factors7.70Provider training4.00Disinfection of perineum4.00Disinfection of perineum4.00Prinary sucters indwelling time4.00Periodically emptying of urine from the drain bag4.00   |                           |                                     | Catheter diameter                                 | 4.33          | 0.81                  | 0.19 | 80.00                            |
| Position of catheter fixation4.07Drainage bag-related factorsAmintain the catheter patency4.07Drainage bag-related factorsThe position of drainage bag4.00Intubation factorsThe position of drainage bag fixation4.00Intubation factorsAmend hygiene4.00Amender factorsAmend hygiene4.00Healthcare provider-related factorsPerimary success rate of intubation4.05Maintenance-related factorsFrequency of catheter replacement4.05Maintenance-related factorsFrequency of drainage bag replacement4.05Maintenance-related factorsPrinary catheter replacement4.05Maintenance-related factorsFrequency of drainage bag replacement4.05Amintenance-related factorsPrinary catheter replacement4.05Amintenance-related factorsPrequency of arinage bag replacement4.05Amintenance-related factorsPrinary catheter indwelling time4.05Amintenance-related factors< |                           |                                     | Number of catheter cavities                       | 4.00          | 0.65                  | 0.16 | 80.00                            |
| Maintain the catheter patency     4.75       Drainage bag-related factors     Type of drainage bag     3.93       Intubation factors     The position of drainage bag fixation     4.00       Intubation factors     Hand hygiene     4.87       Reptic operation during intubation     5.00     4.05       Healthcare provider-related factors     Healthcare provider training     4.95       Maintenance-related factors     Frequency of catheter replacement     4.86       Maintenance-related factors     Frequency of catheter replacement     4.05       Maintenance-related factors     Trimary catheter individuent     4.05       Prinary success rate of intubation     4.05       Maintenance-related factors     Healthcare provider training     4.05       Prequency of catheter replacement     4.05       Prequency of facinage bag replacement     4.87       Disinfection of perineum     4.87       Prinary catheter indivelling time     4.05       Prinary catheter reduction of perineum     4.87       Prinary catheter indivelling time     4.87       Prinary catheter reduction of perineum     4.87       Prinary catheter indivelling time     4.80       Prinary catheter reduction of  |                           |                                     | Position of catheter fixation                     | 4.07          | 0.76                  | 0.19 | 86.67                            |
| Drainage bag-related factorsType of drainage bag3.93Intubation factorsThe position of drainage bag fixation4.00Intubation factorsHand hygiene4.87Aseptic operation during intubation5.00Primary success rate of intubation4.75Healthcare provider-related factorsHealthcare provider training4.95Maintenance-related factorsFrequency of catheter replacement4.80Maintenance-related factorsFrequency of drainage bag replacement4.60Disinfection of prineumDisinfection of prineum4.81Urinary catheter indwelling time5.00Periodically emptying of urine from the drain bag4.00  |                           |                                     | Maintain the catheter patency                     | 4.73          | 0.59                  | 0.12 | 93.33                            |
| The position of drainage bag fixation4.00Intubation factorsHand hygiene4.87Aseptic operation during intubation5.00Primary success rate of intubation4.73Healthcare provider-related factorsHealthcare provider training4.93Maintenance-related factorsFrequency of catheter replacement4.60Disinfection of perineum0.01100Primary catheter indwelling time0.010.01Prinary catheter indwelling time0.010.01Periodically emptying of urine from the drain bag4.60   |                           | Drainage bag-related factors        | Type of drainage bag                              | 3.93          | 0.99                  | 0.25 | 60.00                            |
| Intubation factorsHand hygiene4.87Intubation5.00Reptic operation during intubation5.00Primary success rate of intubation4.73Healthcare provider-related factorsHealthcare provider training4.93Maintenance-related factorsFrequency of catheter replacement4.80Primary success rate of intubation1.801.93Maintenance-related factorsFrequency of catheter replacement4.60UninstructureDisinfection of perimeum4.80Urinary catheter indwelling time5.00Periodically emptying of urine from the drain bag4.60   |                           |                                     | The position of drainage bag fixation             | 4.00          | 0.80                  | 0.20 | 66.67                            |
| Aseptic operation during intubation5.00Primary success rate of intubation4.73Healthcare provider training4.93Frequency of catheter replacement4.80Frequency of drainage bag replacement4.60Disinfection of perineum4.87Urinary catheter indwelling time5.00Periodically emptying of urine from the drain bag4.60  | Operation-related factors | Intubation factors                  | Hand hygiene                                      | 4.87          | 0.35                  | 0.07 | 100.00                           |
| Primary success rate of intubation4.73Healthcare provider training4.93Frequency of catheter replacement4.80Frequency of drainage bag replacement4.60Disinfection of perineum4.87Urinary catheter indwelling time5.00Periodically emptying of urine from the drain bag4.60   |                           |                                     | Aseptic operation during intubation               | 5.00          | 0.00                  | 0.00 | 100.00                           |
| Healthcare provider training4.93Frequency of catheter replacement4.80Frequency of drainage bag replacement4.60Disinfection of perineum4.87Urinary catheter indwelling time5.00Periodically emptying of urine from the drain bag4.60   |                           |                                     | Primary success rate of intubation                | 4.73          | 0.45                  | 0.10 | 100.00                           |
| Frequency of catheter replacement4.80Frequency of drainage bag replacement4.60Disinfection of perineum4.87Urinary catheter indwelling time5.00Periodically emptying of urine from the drain bag4.60   |                           | Healthcare provider-related factors | Healthcare provider training                      | 4.93          | 0.26                  | 0.05 | 100.00                           |
| 4.60<br>4.87<br>5.00<br>4.60  |                           | Maintenance-related factors         | Frequency of catheter replacement                 | 4.80          | 0.41                  | 0.09 | 100.00                           |
| 4.87<br>5.00<br>4.60  |                           |                                     | Frequency of drainage bag replacement             | 4.60          | 0.49                  | 0.11 | 100.00                           |
| 5.00<br>4.60  |                           |                                     | Disinfection of perineum                          | 4.87          | 0.26                  | 0.05 | 100.00                           |
| 4.60  |                           |                                     | Urinary catheter indwelling time                  | 5.00          | 0.00                  | 0.00 | 100.00                           |
|   |                           |                                     | Periodically emptying of urine from the drain bag | 4.60          | 0.49                  | 0.11 | 100.00                           |
| Maintenance of closed drainage 4.87 0.52  |                           |                                     | Maintenance of closed drainage                    | 4.87          | 0.52                  | 0.11 | 93.33                            |

CV: coefficient of variation

the higher the degree of coordination of experts. Typically, the average value of importance assignment >3.00 and CV <0.35 were acceptable [7]. Expert recognition referred to the proportion of experts who proposed that the index and the rate of importance in the total number of experts were critical parameters. The greater the proportion of experts, the greater the importance. After the first round of expert consultation, 14 items were deleted, 12 items were added, and 8 items were modified. After the second round of expert consultation, 2 items were deleted and 4 items were modified. In addition, no objection was placed on the contents of the indicators revised in the first round. After two rounds of consultation, experts rated the importance of each indicator. The mean score of the index was 3.73-5 points. The variation coefficient of the index score was 0-0.27. The expert recognition degree was  $\geq 60\%$ . The final formation included 4 primary indicators, 13 secondary indicators, and 54 tertiary indicators (Table 1).

#### Discussion

Delphi method is a consulting and decisionmaking technique developed on the basis of the expert conference method. It widely solicits and converges the opinions of experts through anonymous methods after several cycles of information exchange and feedback modification. Thus, the scope of the application of this study predicts the objective in this study. It has the characteristics of anonymity, extensiveness, and interwheel information feedback, and the results were analyzed statistically [8]. When applying the Delphi method, the choice of experts and the quality of expert consultation need to be considered. The survey is deemed good if the response rate is >70% [9]. The higher the response rate, the larger the proportion of experts making the suggestions, which indicated that the experts were enthusiastic. In this study, the effective recovery rate of the two rounds of questionnaires was 100%. Furthermore, experts put forward valuable opinions on the questionnaires, and the participation rate was 80% and 26.7%, respectively, indicating that experts were concerned about and supported this study. In addition, the enthusiasm of participation was high. Typically, the level of  $Cr \ge 0.7$  is acceptable, while Cr>0.8 indicates that experts have great confidence in the selection of content [10]. The expert authority coefficient of this study reaches 0.94, which indicated that the expert authority of this study was high, and the consulting quality was good, which laid the foundation for the credibility and reliability of this index sys-

tem. The degree of expert opinion coordination could be used to judge the marked difference in the evaluation of the index between experts, as reflected by the Kendall coordination coefficient: 0.473 and 0.338, respectively. The difference was found to be statistically significant, as assessed by the chi-square test, indicating that the expert opinion is consistent and the result is desirable.

Prevention strategies for CAUTI, by the American Academy of Healthcare Epidemiology, proposed that the risk assessment should recognize the need for clinical monitoring. In addition, the risk factors were determined, and then targeted intervention was implemented to reduce the occurrence of CAUTI. Currently, a postoperative unified risk factor evaluation index system for CAUTI is lacking for patients with gynecologic malignant tumors in China. The present study collected the risk factors of CAUTI in postoperative patients with gynecologic malignant tumors during the hospital stay. According to the risk factors of CAUTI prevention and control technology guidelines, the review of the Chinese and foreign databases provided information along with research group discussion. Next, we classified and summarized the information with the objective of establishing an evaluation index system based on comprehensive scientific and feasible principles. This system would select the representative and accessible factors as the index based on the Delphi expert inquiry. Moreover, this study constructed a risk factor evaluation index system of CAUTI that encompassed different aspects of medical care for postoperative patients with gynecologic malignant tumors. Four first-level indicators, including factors related to gynecologic malignant tumors, device, and operation, were identified, while 13 second-level indicators detected the baseline condition of the patients, operation factors, medication, laboratory index, catheter maintenance. This evaluation system is comprised of reasonable structure and comprehensive content, which enables health care providers to respond rapidly to the risk factors of CAUTI with appropriate and effective prevention.

Limitations also existed in this study. The Delphi method adopted in this study is subjective. The experts consulted by letter belong to different fields from seven 3As-grade hospitals in Zhejiang province. Although the subject representation of the experts is good, the geographical representation may not be appropriate. The critical risk factors of postoperative CAUTI in patients with gynecologic malignant tumors were screened. However, the indicators were not defined quantitatively. Thus, the quality and feasibility of the index system need to be explored further and verified in practice.

# Conclusions

In conclusion, the CAUTI risk factor evaluation index system for postoperative patients with gynecologic malignant tumors is comprehensive and scientific, and could serve as an important guide for assessment and prevention of CAUTI in patients with gynecologic malignancies postoperatively.

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### **Conflict of interests**

The authors declare no conflict of interests.

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