**Developing and validating a questionnaire on Knowledge, Attitude, and Practice of Central Line-Associated Bloodstream Infection of ICU Nurses**

Fangping Dang1,2,3\*; Jing Gao3,4; Nannan Ding3,5; Tiantian Zhai3,4; Huiju Li3\*; Xingwu Ran1,2\*;

**Supplementary appendix**

**S1: The letter to the panel of experts**

Dear experts:

Thank you very much for taking the time to fill out this inquiry form during your busy schedule!

We are currently conducting the "Development and Application of the Questionnaire on the Status of ICU Nurses on central line-associated bloodstream infection" and we sincerely invited expert to propose amendments or supplementary opinions. Then we will summarize the opinions of each round and modify them based on expert opinions. Such repeated cycles make the opinions gradually converge to ensure the completeness, feasibility and importance of the content.

The following are the items established in our research. Each item is divided into five fractional segments, and please choose the score you think is appropriate. If you have any comments, suggestions or questions about this item, please write it in the last column.

This research is expected to conduct two rounds of expert consultation, and we guarantee that your opinions will be kept confidential and only for this research. Please feedback the completed opinions to us within 30 days.

Thank you for your support and dedication to this research in your busy schedule!

**1.1 The form of expert opinion**

**Instructions:** This questionnaire contains 3 dimensions of knowledge, attitude, and practice related to central line-associated bloodstream infection, with a total of 54 items. Please use the following 1 to 5 grades to evaluate the correlation of each item in this questionnaire, and tick “√” in the corresponding column (choose only one answer for each item). If you need to delete, add or modify, please write it in the last column.

**Table a1. Expert letter**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Items** | **1=very irrelevant** | **2=irrelevant** | **3=relevant** | **4=very relevant** | **5=totally****relevant** | **Opinions** |
| **Knowledge dimension** |  |  |  |  |  |  |
| K1. CLABSI refers to the infection that occurs during the indwelling of the catheter and how much hours after the catheter are removed?A. 8h B. 16h C. 24h D. 48h E. Unclear |
| K2. Catheter placement should comply with the maximum sterile barrier requirements, which should be selected?A. Sterile towel B. Hat and mask C. Sterile gloves D. Sterile surgical gown E. Unclear |  |  |  |  |  |  |
| K3. Which of the following disinfectants should be selected when disinfecting the skin at the puncture point? A. 75% or more alcohol B. Iodine-containing disinfectants such as iodophor or iodation C. Disinfectants containing chlorhexidine D. 75% or more alcohol and iodophor or disinfectant containing chlorhexidine E. Unclear |  |  |  |  |  |  |
| K4. How often does the sterile transparent dressing changeA. Once every 2 weeks B. Once a weekC. Once 3 days D. Once a day E. Unclear |  |  |  |  |  |  |
| K5. The correct frequency of catheter replacementA. Once every 2 weeks B. Once a weekC. Once every 4 weeks D. No replacement without indication E. Unclear |  |  |  |  |  |  |
| K6. If the patient is allergic to the transparent film, it can be replaced with a sterile gauze dressing. The frequency of replacement of the sterile gauze dressing isA. 12h B. 24h C. 48h D. Replace the catheter, when the dressing is wet, lose or contaminated, or its integrity is damaged. E. Unclear |  |  |  |  |  |  |
| K7. The replacement time of the drug delivery device for patients who do not infuse blood products or fat emulsion isA. Once a day B. Once every 2 days C. Once every 5 days D. Once every 7 days E. Unclear |  |  |  |  |  |  |
| K8. Replacement time of pressure transducer during pressure monitoringA.12h B.24h C.48h D.72h E. Unclear |  |  |  |  |  |  |
| K9. Which catheter puncture point should be avoided for patients with renal failure?A. Subclavian vein B. Femoral vein C. Internal jugular vein D. External jugular vein E. Unclear |  |  |  |  |  |  |
| K10. If there are signs of CLABSI, aseptically cut the tip of the catheter and place it in a sterile test tube after extubating, and send for bacterial culture immediately, how many centimeters should be taken from the tip?A.2cm B.3cm C.4cm D.5cm E. Unclear |  |  |  |  |  |  |
| K11. When the subclavian vein puncture and place the catheter, it is easy to damage the artery, so the length of the catheter isA. 7-8 cm B. 8-10cm C. 12-15cm D. 10-12cm E. Unclear |  |  |  |  |  |  |
| K12. The infection rate is high when the femoral vein puncture and catheterization is easy to form deep vein thrombosis, so the general catheterization length is?A.5-10cm B.10-15cm C.15-20cm D.20-25cm E. Unclear |  |  |  |  |  |  |
| K13. Internal jugular vein puncture catheterization has a small irritation and a long time. Generally, the catheterization length isA. 8-10cm B. 10-12cm C. 12-16cm D. 14-18cm E. Unclear |  |  |  |  |  |  |
| K14. If the catheter is placed in an emergency and the aseptic technique cannot be guaranteed, the catheter must be replaced immediately and can’t exceed how many hoursA.12h B.24h C.36h D.48h E. Unclear |  |  |  |  |  |  |
| K15. How often is the catheter maintained under normal circumstances?A.1 day B.3 days C.5 days D.1 week E. Unclear |  |  |  |  |  |  |
| K16. The coverage area of the sterile towel isA. Around the puncture point B. Flat connection between two nipples C. Around the puncture point and 2/3 of the patient's body D. Around the puncture point and half of the patient's body E. Unclear |  |  |  |  |  |  |
| K17. The disinfection range is how many centimeters outward from the center of the puncture point when changing the dressing filmA.5cm B.10cm C.15cm D.20cm E. Unclear |  |  |  |  |  |  |
| K18. How often should the infusion set be replaced during continuous infusionA.12h B.24h C.48h D. Irregular replacement E. Unclear |  |  |  |  |  |  |
| K19. The time for disinfection and wiping of the catheter connector isA.10s B.15s C.20s D.25s E. Unclear |  |  |  |  |  |  |
| K20. How often should the catheter connector be replaced?A.24h B.48h C.72h D. Once a week E. Unclear |  |  |  |  |  |  |
| K21. The items used to disinfect the catheter connector areA. Alcohol cotton swab B. Alcohol cotton ball C. Iodophor cotton swab D. Iodophor cotton ball E. Unclear |  |  |  |  |  |  |
| K22. When pulling out the catheter, the patient should be instructed to take a deep breath and take patientA. Supine position or vertical supine position B. Side position C. Semi-sitting position D. Head low and feet high position E. Unclear |  |  |  |  |  |  |
| K23. When it is suspected that the patient has CLABSI, or the patient has phlebitis or catheter failure, the doctor decides to extubate the tube. Which of the following test results can be diagnosed as CLABSI? A. Peripheral venous blood culture is negative for bacteria or fungi, and catheter end blood culture is positive for bacteria or fungi B. Cultivate the same kind of pathogenic bacteria at the catheter tip and peripheral bloodC. Different types of pathogenic bacteria with the same susceptibility results are cultured at the catheter end and peripheral bloodD. Catheter end and peripheral blood cultured the same kind of pathogenic bacteria with the same drug sensitivity resultE. Unclear |  |  |  |  |  |  |
| K24. For patients undergoing catheter, is it necessary to routinely replace catheter?Yes No Not sure |  |  |  |  |  |  |
| K25. Whether to use antibacterial catheters routinely when choosing catheters for patient placementYes No Not sure |  |  |  |  |  |  |
| K26. For patients after intubation, do they need to use antibacterial ointment routinely?Yes No Not sure |  |  |  |  |  |  |
| **Attitude dimension** |  |  |  |  |  |  |
| A1. I am interested in CLABSI learning. Strongly agree  Agree  Not sure  Disagree  Strongly disagree |
| A2. I think nurses who have knowledge of catheter infection can reduce the occurrence of CLABSI. Strongly agree  Agree  Not sure  Disagree  Strongly disagree |  |  |  |  |  |  |
| A3. I think palpation at the catheter site helps confirm signs of infection. Strongly agree  Agree  Not sure  Disagree  Strongly disagree |  |  |  |  |  |  |
| A4. I think the prevention of CLABSI is very important for the treatment and prognosis of patients' diseases. Strongly agree  Agree  Not sure  Disagree  Strongly disagree |  |  |  |  |  |  |
| A5. I think hand hygiene must be done before catheter placement and when changing catheter dressings. Strongly agree  Agree  Not sure  Disagree  Strongly disagree |  |  |  |  |  |  |
| A6. I think that regular replacement of catheter is an effective measure to prevent the occurrence of CLABSI. Strongly agree  Agree  Not sure  Disagree  Strongly disagree |  |  |  |  |  |  |
| A7. I think it is necessary to establish a complete catheter management system and work records in the hospital. Strongly agree  Agree  Not sure  Disagree  Strongly disagree |  |  |  |  |  |  |
| A8. I think the catheter should be removed in time when a fever is found in the catheterized patient. Strongly agree  Agree  Not sure  Disagree  Strongly disagree |  |  |  |  |  |  |
| A9. I think central line is a device that may cause serious infection complications. Strongly agree  Agree  Not sure  Disagree  Strongly disagree |  |  |  |  |  |  |
| A10. I don't think it is necessary to carry out CLABSI related education and training for nursing staff. Strongly agree  Agree  Not sure  Disagree  Strongly disagree |  |  |  |  |  |  |
| **Practice dimension** |  |  |  |  |  |  |
| P1. I will actively learn CLABSI related knowledge. Never  Occasionally  Sometimes  Often  Always |
| P2. I will assess the patient's skin and dressing condition daily to determine whether the patient is at risk of CLABSI. Never  Occasionally  Sometimes  Often  Always |  |  |  |  |  |  |
| P3. If a patient feels tenderness at the catheter site, I will remove the dressing and inspect the catheter site. Never  Occasionally  Sometimes  Often  Always |  |  |  |  |  |  |
| P4. I will regularly use a solution containing chlorhexidine to scrub patients with catheter intubation. Never  Occasionally  Sometimes  Often  Always |  |  |  |  |  |  |
| P5. During catheter infusion or replacement, I will use force and rotation to wipe the cross-section of the needleless connector, the catheter interface and the spiral part. Never  Occasionally  Sometimes  Often  Always  |  |  |  |  |  |  |
| P6. Before central lines administration, I will draw blood back and confirm the depth of the catheter.  Never  Occasionally  Sometimes  Often  Always |  |  |  |  |  |  |
| P7. When infusion or replacement of the needleless connection device, I will disinfect with the puncture point as the center. The disinfection range is ≥20 cm in diameter, and the disinfection time is ≥15 s. Never  Occasionally  Sometimes  Often  Always |  |  |  |  |  |  |
| P8. Before placing the tube, before the administration of central lines and after removing the old dressing, I will strictly perform hand hygiene and the time shall not be less than 15 s. Never  Occasionally  Sometimes  Often  Always |  |  |  |  |  |  |
| P9. When disinfecting with alcohol cotton ball, I will avoid the puncture point. Never  Occasionally  Sometimes  Often  Always |  |  |  |  |  |  |
| P10. I will try not to measure central venous pressure (CVP) and administration from the lumen of parenteral nutrition fluid infusion. Never  Occasionally  Sometimes  Often  Always |  |  |  |  |  |  |
| P11. When checking and palpating the catheter, I will wear sterile gloves after hand hygiene. Never  Occasionally  Sometimes  Often  Always |  |  |  |  |  |  |
| P12. When I find that the wound has bleeding, membrane contamination (or suspected contamination), dampness, shedding, loosening or endangering the catheter, I will immediately replace the membrane. Never  Occasionally  Sometimes  Often  Always |  |  |  |  |  |  |
| P13. If the patient is observed to have fever and other signs of infection, I will report to the doctor in time. Never  Occasionally  Sometimes  Often  Always |  |  |  |  |  |  |
| P14. I will explain the patient's catheter situation to the next nurse during the shift. Never  Occasionally  Sometimes  Often  Always |  |  |  |  |  |  |
| P15. When patrolling the ward, I will pay attention to whether the catheter is unobstructed, ask the patient's feelings and deal with it in time. Never  Occasionally  Sometimes  Often  Always |  |  |  |  |  |  |

Note: CLABSI: Central line-associated bloodstream infection;

**S2. The result of Delphi**

**Table a2.** **Expert revision opinions**

|  |  |  |
| --- | --- | --- |
| **Item**  | **Relevance evaluation\*** | **Expert revision opinions** |
| K5 | 3 | How often to change the dressing of the catheter? |
| K22 | 4 | You should describe what part was pulled out. |
| K5 | 5 | It is recommended to change the title to "What is the indwelling time of the catheter". |
| K7 | 5 | It is recommended to delete “no”. |
| K11 | 3 | CLABSI not only refers to catheter, it is defined as intravascular catheter, so the existence of this questions is of little significance, it is recommended to delete. |
| K12 | 3 | The existence is of little significance, it is recommended to delete. |
| K13 | 2 | It is recommended to delete. |
| K19 | 5 | Please changed catheter to central venous catheter. |
| K22 | 3 | It deviates from the theme "Central catheter-related bloodstream infection", it is recommended to delete. |
| K24 | 3 | This part is recommended to be placed in the basic information or practice dimension. |
| K25 | 3 | This part is recommended to be placed in the basic information or practice dimension. |
| K26 | 2 | Delete |
| K27 | 3 | This part is recommended to be placed in the basic information or practice dimension. |
| K4 | 5 | Changed to "The general indwelling of catheter should not exceed". |
| A2 | 5 | The description of "catheter infection" is too general and the definition is not clear, it should be changed to specifically refer to "CLABSI". |
| A7 | 4 | "In-hospital management system" refers to too broad a scope, and it is recommended to modify it to "in-hospital CVC management system" or "in-hospital management system related to CLABSI". |
| P10 | 4 | It is recommended to amend to "I will not measure CVP and administration from the lumen of parenteral nutrition solution infusion". |

Note: 1= ‘Very irrelevant’, 2= ‘Irrelevant’, 3= ‘Relevant’, 4= ‘Very relevant’, 5= ‘Totally relevant’.

CLABSI: Central line-associated bloodstream infection; CVC; Central venous catheters;

CVP: Central venous pressure;

**Table a2-1. Scores of each item of knowledge dimension**

|  |  |  |  |
| --- | --- | --- | --- |
| **Item** | **Mean** | **Standard deviation** | **Coefficient of variation** |
| K1 | 4.9 | 0.316 | 0.06 |
| K2 | 4.5 | 0.850 | 0.19 |
| K3 | 4.8 | 0.422 | 0.09 |
| K4 | 4.7 | 0.483 | 0.10 |
| K5 | 4.6 | 0.516 | 0.11 |
| K6 | 5.0 | 0 | 0 |
| K7 | 4.7 | 0.483 | 0.10 |
| K8 | 4.8 | 0.422 | 0.09 |
| K9 | 5.0 | 0 | 0 |
| K10 | 4.6 | 0.699 | 0.15 |
| K11 | 4.3 | 0.949 | 0.22 |
| K12 | 5.0 | 0 | 0 |
| K13 | 4.8 | 0.632 | 0.13 |
| K14 | 5.0 | 0 | 0 |
| K15 | 4.5 | 0.699 | 0.16 |
| K16 | 4.6 | 0.675 | 0.15 |
| K17 | 5.0 | 0 | 0 |
| K18 | 4.3 | 0.675 | 0.16 |
| K19 | 4.6 | 0.699 | 0.15 |
| K20 | 4.9 | 1.155 | 0.24 |
| K21 | 4.0 | 0.892 | 0.22 |
| K22 | 4.0 | 0.675 | 0.17 |
| K23 | 4.7 | 0.637 | 0.14 |
| K24 | 5.0 | 0 | 0 |
| K25 | 4.35 | 0.843 | 0.19 |
| K26 | 3.67 | 0.675 | 0.18 |
| K27 | 4.9 | 1.333 | 0.27 |

**Table a2-2. Score results of each item of attitude dimension**

|  |  |  |  |
| --- | --- | --- | --- |
| **Item** | **Mean** | **Standard deviation** | **Coefficient of variation** |
| A1 | 4.6 | 0.966 | 0.02 |
| A2 | 4.5 | 0.845 | 0.18 |
| A3 | 4.1 | 1.101 | 0.25 |
| A4 | 4.5 | 0.707 | 0.16 |
| A5 | 4.7 | 0.675 | 0.14 |
| A6 | 4.8 | 0.422 | 0.09 |
| A7 | 4.4 | 0.843 | 0.19 |
| A8 | 5 | 0 | 0 |
| A9 | 4.9 | 0.843 | 0.17 |
| A10 | 4.7 | 0.674 | 0.14 |
| A11 | 4.8 | 0.765 | 0.12 |

**Table a2-3. Score results of each item of practice dimension**

|  |  |  |  |
| --- | --- | --- | --- |
| **Item** | **Mean** | **Standard deviation** | **Coefficient of variation** |
| P1 | 4.8 | 0.421 | 0.08 |
| P2 | 4.3 | 0.674 | 0.15 |
| P3 | 5.0 | 0 | 0 |
| P4 | 4.1 | 0.875 | 0.21 |
| P5 | 4.5 | 0.527 | 0.12 |
| P6 | 4.4 | 0.843 | 0.19 |
| P7 | 4.2 | 0.788 | 0.18 |
| P8 | 4.5 | 0.707 | 0.16 |
| P9 | 4.5 | 0.707 | 0.16 |
| P10 | 4.9 | 0.316 | 0.06 |
| P11 | 4.6 | 0.516 | 0.11 |
| P12 | 4.5 | 0.850 | 0.18 |
| P13 | 4.2 | 0.632 | 0.15 |
| P14 | 4.4 | 0.843 | 0.19 |
| P15 | 4.5 | 0.708 | 0.15 |

**Table a2-4. The response rate of experts**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Number of experts who issue letter** | **Number of experts who responded** | **The response rate (%)** | **Opinion submission rate (%)** |
| First round | 10 | 9 | 90% | 88.89% |
| Second round | 10 | 8 | 80% | 37.50% |

**Table a2-5. The judgment basis of experts**

|  |  |
| --- | --- |
| **Basis for judgment** | **Degree of influence on expert judgment** |
| **Great** | **Moderate** | **Small**  |
| Clinical experience | 0.45 | 0.35 | 0.2 |
| theoretical analysis | 0.30 | 0.20 | 0.10 |
| Check domestic and foreign literature | 0.20 | 0.15 | 0.10 |
| Subjective feelings | 0.05 | 0.05 | 0.05 |
| Total  | 1.00 | 0.75 | 0.45 |

**Table a2-6. The familiarity of expert with the item**

|  |  |
| --- | --- |
| **Familiarity** | **Familiarity assignment（Cs）** |
| Very familiar | 0.9 |
| familiar | 0.7 |
| More familiar | 0.5 |
| Not familiar with | 0.3 |
| Completely unfamiliar | 0.1 |

**Table a2-7. Expert familiarity of self-evaluation**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Very familiar** | **familiar** | **More familiar** | **Not familiar** | **Completely unfamiliar** |
| First round | 10 | 0 | 0 | 0 | 0 |
| Second round | 8 | 2 | 0 | 0 | 0 |

**Table a2-8. Degree of coordination of expert opinions**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | **Number of items** | **Kendall's** | $$x^{2}$$ | **Df** | ***P*** |
| **First round** | Knowledge | 27 | 0.540 | 354.367 | 16 | 0.000 |
| Attitude | 10 | 0.483 | 178.355 | 9 | 0.000 |
| Practice | 15 | 0.266 | 152.505 | 14 | 0.000 |
| Total | 52 | 0.491 | 90.668 | 42 | 0.000 |
| **Second round** | Knowledge | 17 | 0.430 | 264.162 | 15 | 0.000 |
| Attitude | 12 | 0.334 | 109.391 | 8 | 0.000 |
| Practice | 20 | 0.641 | 420.959 | 17 | 0.000 |
| Total | 49 | 0.589 | 113.540 | 40 | 0.000 |

**S3. The result of interview**

**Table a3. Summary of opinions on the interview**

|  |  |
| --- | --- |
| **Items**  | **Opinions** |
| **K3** | Before disinfecting the skin of the puncture point, the disinfectant should be selected |
| **K4** | How often should the sterile transparent dressing be replaced? |
| **K5** | The indwelling time of the central venous catheter does not exceed how many hours |
| **K10** | It is recommended to delete. |
| **K14** | If the catheter is placed in an emergency (such as placing a catheter in an emergency department) and the aseptic technique cannot be guaranteed, the catheter must be replaced as soon as possible and not more than how much hours |
| **K16** | It is recommended to delete. |
| **K19** | What is the time for disinfection and wiping of the central lines’ connector? |
| **A3** | I think palpation at the catheterization site helps to confirm the signs of infection. |
| **A10** | I think it is necessary to carry out CLABSI related education and training for ICU nurses. |
| **P11** | When checking contact with catheter, I will wear sterile gloves after hand hygiene. |

**S4. The result of items analysis**

**Table a4. Ttest results**

|  |  |  |
| --- | --- | --- |
|  | **Levene test of variance equation** | **T test for the mean equation** |
| **F** | **Sig.** | **T** | **Df** | **Sig.****(Bilateral)** | **Mean difference** | **Standard error** | **95% confidence interval of difference** |
| **Lower limit** | **upper limit** |
| **K2** | Assuming equal variances | 23.276 | 0.000 | 6.466 | 199 | 0.000 | 0.834 | 0.129 | 1.089 | 0.580 |
| Assuming unequal variances |  |  | 6.375 | 177.794 | 0.000 | 0.834 | 0.130 | 1.093 | 0.576 |
| **K5** | Assuming equal variances | 83.115 | 0.000 | 5.782 | 199 | 0.000 | 0.803 | 0.138 | 1.077 | 0.529 |
| Assuming unequal variances |  |  | 5.595 | 143.752 | 0.000 | 0.803 | 0.143 | 1.086 | 0.519 |
| **K7** | Assuming equal variances | 2.904 | 0.090 | 8.183 | 199 | 0.000 | 1.354 | 0.165 | 1.680 | 1.027 |
| Assuming unequal variances |  |  | 8.133 | 189.419 | 0.000 | 1.354 | 0.166 | 1.682 | 1.025 |
| **K9** | Assuming equal variances | 81.091 | 0.000 | 9.436 | 199 | 0.000 | 1.364 | 0.144 | 1.649 | 1.079 |
| Assuming unequal variances |  |  | 9.701 | 181.741 | 0.000 | 1.364 | 0.140 | 1.641 | 1.086 |
| **K10** | Assuming equal variances | 32.562 | 0.000 | 6.340 | 199 | 0.000 | 1.014 | 0.159 | 1.329 | 0.698 |
| Assuming unequal variances |  |  | 6.239 | 174.704 | 0.000 | 1.014 | 0.162 | 1.335 | 0.693 |
| **K12** | Assuming equal variances | 2.140 | 0.145 | 3.661 | 199 | 0.000 | 0.320 | 0.087 | 0.493 | 0.148 |
| Assuming unequal variances |  |  | 3.738 | 191.828 | 0.000 | 0.320 | 0.085 | 0.489 | 0.151 |
| **K14** | Assuming equal variances | 38.948 | 0.000 | 7.556 | 199 | 0.000 | 1.321 | 0.174 | 1.665 | 0.976 |
| Assuming unequal variances |  |  | 7.754 | 184.784 | 0.000 | 1.321 | 0.170 | 1.657 | 0.984 |
| **A10** | Assuming equal variances | 0.000 | 0.987 | 47.321 | 212 | 0.000 | 12.328 | 0.260 | 12.842 | 11.814 |
| Assuming unequal variances |  |  | 48.425 | 210.397 | 0.000 | 12.328 | 0.254 | 12.830 | 11.826 |
| **P6** | Assuming equal variances | 214.846 | 0.000 | 13.747 | 184 | 0.000 | 1.490 | 0.108 | 1.704 | 1.276 |
| Assuming unequal variances |  |  | 13.324 | 92.109 | 0.000 | 1.490 | 0.111 | 1.712 | 1.268 |
| **P7** | Assuming equal variances | 179.274 | 0.000 | 14.647 | 184 | 0.000 | 1.513 | 0.103 | 1.717 | 1.309 |
| Assuming unequal variances |  |  | 14.226 | 97.879 | 0.000 | 1.513 | 0.106 | 1.724 | 1.302 |
| **P8** | Assuming equal variances | 151.451 | 0.000 | 14.434 | 184 | 0.000 | 1.424 | 0.098 | 1.618 | 1.229 |
| Assuming unequal variances |  |  | 14.003 | 94.657 | 0.000 | 1.424 | 0.101 | 1.626 | 1.222 |
| **P9** | Assuming equal variances | 205.788 | 0.000 | 12.963 | 184 | 0.000 | 1.512 | 0.116 | 1.742 | 1.282 |
| Assuming unequal variances |  |  | 12.562 | 91.677 | 0.000 | 1.512 | 0.120 | 1.751 | 1.273 |
| **P10** | Assuming equal variances | 36.486 | 0.000 | 9.992 | 184 | 0.000 | 1.486 | 0.148 | 1.780 | 1.193 |
| Assuming unequal variances |  |  | 9.866 | 152.887 | 0.000 | 1.486 | 0.150 | 1.784 | 1.189 |
| **P16\*** | Assuming equal variances | 0.148 | 0.700 | 1.103 | 184 | 0.271 |  0.118 | 0.107 | 0.331 | 0.093 |
| Assuming unequal variances |  |  | 1.105 | 183.937 | 0.271 | 0.118 | 0.107 | 0.330 | 0.093 |
| **P17\*** | Assuming equal variances | 0.002 | 0.964 |  0.026 | 184 | 0.980 | 0.002 | 0.108 | 0.216 | 0.210 |
| Assuming unequal variances |  |  | 0.026 | 183.285 | 0.980 | 0.002 | 0.108 | 0.216 | 0.210 |
| **P18\*** | Assuming equal variances | 3.116 | 0.079 | 1.095 | 184 | 0.275 | 0.115 | 0.105 | 0.323 | 0.092 |
| Assuming unequal variances |  |  | 1.092 | 180.731 | 0.276 | 0.115 | 0.105 | 0.323 | 0.092 |

Note: \*: The item to be deleted.

**Table a4-1. The critical ration of each item**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Item** | **Group** | **Mean**  | **SD** | **Critical ration** | ***P*** | **Item** | **Group** | **Mean**  | **SD** | **Critical ration** | ***P*** |
| **K1** | Low-score | 3.044 | 1.021 | 6.050 | 0.000 | **A6** | Low-score | 1.043 | 0.251 | 15.352 | 0.000 |
|  | High-score | 3.793 | 0.672 | 6.302 | 0.000 |  | High-score | 2.405 | 0.831 | 18.618 | 0.000 |
| **K2** | Low-score | 2.752 | 0.996 | 6.636 | 0.000 | **A7** | Low-score | 1.032 | 0.177 | 11.782 | 0.000 |
|  | High-score | 3.598 | 0.785 | 6.797 | 0.000 |  | High-score | 1.810 | 0.621 | 14.345 | 0.000 |
| **K3** | Low-score | 1.761 | 1.028 | 10.171 | 0.000 | **A8** | Low-score | 1.118 | 0.413 | 20.565 | 0.000 |
|  | High-score | 3.304 | 1.184 | 10.305 | 0.000 |  | High-score | 3.027 | 0.832 | 23.642 | 0.000 |
| **K4** | Low-score | 2.893 | 0.686 | 3.726 | 0.000 | **A9** | Low-score | 1.193 | 0.494 | 15.567 | 0.000 |
|  | High-score | 3.228 | 0.576 | 3.793 | 0.000 |  | High-score | 2.716 | 0.857 | 17.467 | 0.000 |
| **K5** | Low-score | 2.893 | 1.190 | 5.750 | 0.000 | **A10\*** | Low-score | 1.580 | 5.696 | 2.875 | 0.014 |
| High-score | 3.695 | 0.675 | 6.062 | 0.000 | High-score | 3.378 | 6.148 | 1.330 | 0.019 |
| **K6** | Low-score | 1.185 | 0.750 | 3.957 | 0.000 | **A11** | Low-score | 1.903 | 1.422 | 13.959 | 0.000 |
| High-score | 1.804 | 1.439 | 3.730 | 0.000 | High-score | 3.905 | 0.802 | 12.392 | 0.000 |
| **K7** | Low-score | 2.504 | 1.247 | 8.162 | 0.000 | **P1** | Low-score | 2.433 | 0.750 | 11.593 | 0.000 |
| High-score | 3.858 | 1.095 | 8.271 | 0.000 | High-score | 4.000 | 1.056 | 11.717 | 0.000 |
| **K8** | Low-score | 1.761 | 1.028 | 9.983 | 0.000 | **P2** | Low-score | 3.166 | 0.962 | 15.269 | 0.000 |
| High-score | 3.304 | 1.183 | 9.841 | 0.000 | High-score | 4.833 | 0.451 | 14.955 | 0.000 |
| **K9** | Low-score | 1.637 | 0.791 | 9.470 | 0.000 | **P3** | Low-score | 3.177 | 1.023 | 15.567 | 0.000 |
| High-score | 2.967 | 1.208 | 9.090 | 0.000 | High-score | 4.895 | 0.339 | 15.167 | 0.000 |
| **K10** | Low-score | 2.699 | 1.287 | 5.078 | 0.000 | **P4** | Low-score | 3.022 | 1.091 | 11.500 | 0.000 |
| High-score | 3.544 | 1.042 | 5.189 | 0.000 | High-score | 4.635 | 0.8094 | 11.392 | 0.000 |
| **K11** | Low-score | 2.681 | 1.011 | 6.996 | 0.000 | **P5** | Low-score | 3.155 | 1.069 | 15.31 | 0.000 |
| High-score | 3.598 | 0.826 | 7.141 | 0.000 | High-score | 4.927 | 0.362 | 14.92 | 0.000 |
| **K12** | Low-score | 1.761 | 0.486 | 3.797 | 0.000 | **P6** | Low-score | 3.488 | 1.051 | 13.747 | 0.000 |
| High-score | 2.087 | 0.736 | 3.647 | 0.000 | High-score | 4.979 | 0.143 | 13.324 | 0.000 |
| **K13** | Low-score | 2.044 | 0.573 | 2.778 | 0.006 | **P7** | Low-score | 3.455 | 0.984 | 14.647 | 0.000 |
| High-score | 2.304 | 0.766 | 2.698 | 0.008 | High-score | 4.968 | 0.227 | 14.226 | 0.000 |
| **K14** | Low-score | 1.469 | 0.907 | 8.798 | 0.000 | **P8** | Low-score | 3.544 | 0.950 | 14.434 | 0.000 |
| High-score | 2.935 | 1.458 | 8.406 | 0.000 | High-score | 4.968 | 0.174 | 14.003 | 0.000 |
| **K15** | Low-score | 2.097 | 1.274 | 8.461 | 0.000 | **P9** | Low-score | 3.466 | 1.133 | 12.963 | 0.000 |
| High-score | 3.544 | 1.142 | 8.556 | 0.000 | High-score | 4.979 | 0.143 | 12.562 | 0.000 |
| **K16** | Low-score | 1.380 | 0.523 | 4.252 | 0.000 | **P10** | Low-score | 3.211 | 1.203 | 9.992 | 0.000 |
| High-score | 1.728 | 0.647 | 4.161 | 0.000 | High-score | 4.697 | 0.796 | 9.866 | 0.000 |
| **K17** | Low-score | 1.469 | 0.907 | 7.556 | 0.000 | **P11** | Low-score | 3.177 | 1.107 | 15.039 | 0.000 |
| High-score | 2.935 | 1.459 | 7.544 | 0.000 | High-score | 4.927 | 0.261 | 14.609 | 0.000 |
| **K18\*** | Low-score | 1.319 | 0.468 | 2.487 | 0.014 | **P12** | Low-score | 3.655 | 0.901 | 14.616 | 0.000 |
| High-score | 1.510 | 0.637 | 2.412 | 0.017 | High-score | 5.000 | 0.000 | 14.149 | 0.000 |
| **K19\*** | Low-score | 1.469 | 0.780 | 0.200 | 0.842 | **P13** | Low-score | 3.800 | 0.914 | 12.862 | 0.000 |
| High-score | 1.446 | 0.893 | 0.197 | 0.844 | High-score | 5.000 | 0.000 | 12.451 | 0.000 |
| **A1** | Low-score | 1.139 | 0.348 | 11.252 | 0.000 | **P14** | Low-score | 3.766 | 0.948 | 12.198 | 0.000 |
| High-score | 1.872 | 0.562 | 12.465 | 0.000 | High-score | 4.968 | 0.174 | 11.834 | 0.000 |
| **A2** | Low-score | 1.022 | 0.145 | 11.803 | 0.000 | **P15** | Low-score | 3.722 | 0.861 | 13.478 | 0.000 |
| High-score | 1.729 | 0.566 | 14.463 | 0.000 | High-score | 4.958 | 0.247 | 13.113 | 0.000 |
| **A3** | Low-score | 1.118 | 0.385 | 16.614 | 0.000 | **P16\*** | Low-score | 1.600 | 0.715 | 1.103 | 0.271 |
| High-score | 2.723 | 0.879 | 19.425 | 0.000 | High-score | 1.718 | 0.749 | 1.105 | 0.271 |
| **A4** | Low-score | 1.011 | 0.103 | 12.550 | 0.000 | **P17\*** | Low-score | 1.455 | 0.736 | 0.026 | 0.980 |
| High-score | 1.757 | 0.566 | 15.599 | 0.000 | High-score | 1.458 | 0.738 | 0.026 | 0.980 |
| **A5** | Low-score | 1.000 | 0.000 | 7.589 | 0.000 | **P18\*** | Low-score | 1.822 | 0.743 | 1.095 | 0.275 |
| High-score | 1.432 | 0.549 | 9.580 | 0.000 | High-score | 1.937 | 0.693 | 1.092 | 0.276 |

Note: \*: The item to be deleted.

High-score: High-score Groups.

Low-score: Low-score Groups

**S5. The result of homogeneity test**

**Table a5. Correlation coefficient of each item and total score**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Items**  | **Pearson correlation** | ***P*** | **Items**  | **Pearson correlation** | ***P*** |
| **K1** | 0.249 | 0.011 | A5 | 0.419\*\* | 0.003 |
| **K2** | 0.375\* | 0.016 | A6 | 0.682\*\* | 0.000 |
| **K3** | 0.395\*\* | 0.005 | A7 | 0.453\*\* | 0.001 |
| **K4** | 0.311\* | 0.048 | A8 | 0.692\*\* | 0.000 |
| **K5** | 0.218 | 0.017 | A9 | 0.635\*\* | 0.000 |
| **K6** | 0.461\*\* | 0.002 | A10 | 0.052 | 0.748 |
| **K7** | 0.113 | 0.035 | P1 | 0.713\*\* | 0.000 |
| **K8** | 0.408\*\* | 0.008 | P2 | 0.779\*\* | 0.000 |
| **K9** | 0.333\* | 0.033 | P3 | 0.738\*\* | 0.000 |
| **K10** | 0.411\*\* | 0.008 | P4 | 0.683\*\* | 0.000 |
| **K11** | 0.140 | 0.384 | P5 | 0.640\*\* | 0.000 |
| **K12** | 0.303 | 0.054 | P6 | 0.869\*\* | 0.000 |
| **K13** | 0.231 | 0.046 | P7 | 0.915\*\* | 0.000 |
| **K14** | 0.418 | 0.013 | P8 | 0.811\*\* | 0.000 |
| **K15** | 0.245 | 0.023 | P9 | 0.738\*\* | 0.000 |
| **K16** | 0.279 | 0.078 | P10 | 0.566\*\* | 0.000 |
| **K17** | 0.255 | 0.008 | P11 | 0.793\*\* | 0.000 |
| **A1** | 0.654\*\* | 0.000 | P12 | 0.828\*\* | 0.000 |
| **A2** | 0.540\*\* | 0.000 | P13 | 0.713\*\* | 0.000 |
| **A3** | 0.645\*\* | 0.000 | P14 | 0.746\*\* | 0.000 |
| **A4** | 0.591\*\* | 0.000 | P15 | 0.479\*\* | 0.002 |

Note: \*\*. Significantly correlated at the 0.01 level (unilateral).

\*. Significantly correlated at the 0.05 level (unilateral).

**S6. The result of validity test**

**Table a6-1 Common factor variance results**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Items** | **Initial**  | **Extraction** | **Items** | **Initial**  | **Extraction** |
| K1 | 1 | 0.832 | A5 | 1 | 0.675 |
| K2 | 1 | 0.843 | A6 | 1 | 0.785 |
| K3 | 1 | 0.876 | A7 | 1 | 0.642 |
| K4 | 1 | 0.715 | A8 | 1 | 0.673 |
| K5 | 1 | 0.734 | A9 | 1 | 0.838 |
| K6 | 1 | 0.535 | A10 | 1 | 0.456 |
| K7 | 1 | 0.798 | P1 | 1 | 0.765 |
| K8 | 1 | 0.616 | P2 | 1 | 0.824 |
| K9 | 1 | 0.912 | P3 | 1 | 0.788 |
| K10 | 1 | 0.730 | P4 | 1 | 0.751 |
| K11 | 1 | 0.812 | P5 | 1 | 0.778 |
| K12 | 1 | 0.964 | P6 | 1 | 0.796 |
| K13 | 1 | 0.571 | P7 | 1 | 0.885 |
| K14 | 1 | 0.681 | P8 | 1 | 0.708 |
| K15 | 1 | 0.790 | P9 | 1 | 0.707 |
| K16 | 1 | 0.964 | P10 | 1 | 0.698 |
| K17 | 1 | 0.841 | P11 | 1 | 0.729 |
| A1 | 1 | 0.663 | P12 | 1 | 0.782 |
| A2 | 1 | 0.805 | P13 | 1 | 0.885 |
| A3 | 1 | 0.720 | P14 | 1 | 0.824 |
| A4 | 1 | 0.746 | P15 | 1 | 0.755 |

**Table a6-2 Component matrix after the first rotation**

|  |  |
| --- | --- |
| **Item** | **Component** |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** |
| P14 | 0.870 |  |  |  |  |  |  |  |  |  |  |
| P15 | 0.847 |  |  |  |  |  |  |  |  |  |  |
| P12 | 0.832 |  |  |  |  |  |  |  |  |  |  |
| P13 | 0.831 |  |  |  |  |  |  |  |  |  |  |
| P8 | 0.775 |  |  |  |  |  |  |  |  |  |  |
| P9 | 0.747 |  |  |  |  |  |  |  |  |  |  |
| P7 | 0.692 |  |  |  |  |  |  |  |  |  |  |
| P6 | 0.691 |  |  |  |  |  |  |  |  |  |  |
| P11 | 0.581 |  |  |  |  |  |  |  |  |  |  |
| P10 | 0.473 |  |  |  |  |  |  |  |  |  |  |
| A2 |  | 0.842 |  |  |  |  |  |  |  |  |  |
| A4 |  | 0.800 |  |  |  |  |  |  |  |  |  |
| A1 |  | 0.755 |  |  |  |  |  |  |  |  |  |
| A5 |  | 0.752 |  |  |  |  |  |  |  |  |  |
| A7 |  | 0.736 |  |  |  |  |  |  |  |  |  |
| A6 |  | 0.533 |  |  |  |  |  |  |  |  |  |
| A8 |  |  | 0.842 |  |  |  |  |  |  |  |  |
| A9 |  |  | 0.772 |  |  |  |  |  |  |  |  |
| A10 |  |  | 0.674 |  |  |  |  |  |  |  |  |
| A3 |  |  | 0.564 |  |  |  |  |  |  |  |  |
| P1 |  |  |  | 0.651 |  |  |  |  |  |  |  |
| P4 |  |  |  | 0.631 |  |  |  |  |  |  |  |
| P3 |  |  |  | 0.626 |  |  |  |  |  |  |  |
| P2 |  |  |  | 0.600 |  |  |  |  |  |  |  |
| P5 |  |  |  | 0.530 |  |  |  |  |  |  |  |
| K3 |  |  |  |  | 0.779 |  |  |  |  |  |  |
| K10 |  |  |  |  | 0.772 |  |  |  |  |  |  |
| K11 |  |  |  |  | 0.436 |  |  |  |  |  |  |
| K16 |  |  |  |  | 0.412 |  |  |  |  |  |  |
| K6 |  |  |  |  |  | 0.730 |  |  |  |  |  |
| K13 |  |  |  |  |  | 0.705 |  |  |  |  |  |
| K14 |  |  |  |  |  | 0.468 |  |  |  |  |  |
| K12 |  |  |  |  |  | 0.407 |  |  |  |  |  |
| K8 |  |  |  |  |  |  | 0.680 |  |  |  |  |
| K9 |  |  |  |  |  |  | 0.616 |  |  |  |  |
| K1 |  |  |  |  |  |  | 0.592 |  |  |  |  |
| K17 |  |  |  |  |  |  | 0.521 |  |  |  |  |
| K2 |  |  |  |  |  |  |  | 0.766 |  |  |  |
| K4 |  |  |  |  |  |  |  | 0.473 |  |  |  |
| P9 |  |  |  |  |  |  |  |  | 0.622 |  |  |
| P7 |  |  |  |  |  |  |  |  |  | 0.847 |  |
| P6 |  |  |  |  |  |  |  |  |  |  | 0.851 |

**Table a6-3 The component matrix after the second rotation**

|  |  |
| --- | --- |
| **Item**  | **Component** |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
| P14 | 0.882 |  |  |  |  |  |  |  |
| P15 | 0.853 |  |  |  |  |  |  |  |
| P13 | 0.836 |  |  |  |  |  |  |  |
| P12 | 0.821 |  |  |  |  |  |  |  |
| P8 | 0.747 |  |  |  |  |  |  |  |
| P9 | 0.713 |  |  |  |  |  |  |  |
| P6 | 0.684 |  |  |  |  |  |  |  |
| P7 | 0.662 |  |  |  |  |  |  |  |
| P11 | 0.528 |  |  |  |  |  |  |  |
| A2 |  | 0.832 |  |  |  |  |  |  |
| A4 |  | 0.806 |  |  |  |  |  |  |
| A5 |  | 0.765 |  |  |  |  |  |  |
| A7 |  | 0.750 |  |  |  |  |  |  |
| A1 |  | 0.738 |  |  |  |  |  |  |
| A6 |  | 0.547 |  |  |  |  |  |  |
| A8 |  |  | 0.839 |  |  |  |  |  |
| A9 |  |  | 0.766 |  |  |  |  |  |
| A10 |  |  | 0.684 |  |  |  |  |  |
| A3 |  |  | 0.578 |  |  |  |  |  |
| P1 |  |  |  | 0.648 |  |  |  |  |
| P3 |  |  |  | 0.645 |  |  |  |  |
| P2 |  |  |  | 0.639 |  |  |  |  |
| P4 |  |  |  | 0.629 |  |  |  |  |
| P5 |  |  |  | 0.540 |  |  |  |  |
| K3 |  |  |  |  | 0.792 |  |  |  |
| K10 |  |  |  |  | 0.769 |  |  |  |
| K11 |  |  |  |  | 0.441 |  |  |  |
| K17 |  |  |  |  | 0.430 |  |  |  |
| K13 |  |  |  |  |  | 0.732 |   |  |
| K6 |  |  |  |  |  | 0.695 |  |  |
| K12 |  |  |  |  |  | 0.475 |  |  |
| K14 |  |  |  |  |  | 0.462 |  |  |
| K9 |  |  |  |  |  |  | 0.647 |  |
| K1 |  |  |  |  |  |  | 0.628 |  |
| K8 |  |  |  |  |  |  | 0.628 |  |
| K16 |  |  |  |  |  |  | 0.576 |  |
| P10 |  |  |  |  |  |  |  | 0.595 |

**Table a6-4 Component matrix after the third rotation**

|  |  |
| --- | --- |
| **Item**  | **Component** |
| **1** | **2** | **3** | **4** | **5** |
| P14 | 0.868 |  |  |  |  |
| P15 | 0.846 |  |  |  |  |
| P13 | 0.823 |  |  |  |  |
| P12 | 0.821 |  |  |  |  |
| P8 | 0.785 |  |  |  |  |
| P9 | 0.766 |  |  |  |  |
| P7 | 0.699 |  |  |  |  |
| P6 | 0.688 |  |  |  |  |
| P11 | 0.586 |  |  |  |  |
| A2 |  | 0.831 |  |  |  |
| A4 |  | 0.806 |  |  |  |
| A5 |  | 0.753 |  |  |  |
| A1 |  | 0.739 |  |  |  |
| A7 |  | 0.732 |  |  |  |
| A6 |  | 0.496 |  |  |  |
| A8 |  |  | 0.756 |  |  |
| A10 |  |  | 0.678 |  |  |
| A9 |  |  | 0.672 |  |  |
| A3 |  |  | 0.552 |  |  |
| K6 |  |  | -0.402 |  |  |
| P3 |  |  |  | 0.646 |  |
| P1 |  |  |  | 0.643 |  |
| P4 |  |  |  | 0.610 |  |
| P2 |  |  |  | 0.605 |  |
| P5 |  |  |  | 0.522 |  |
| K12 |  |  |  |  | 0.611 |
| K10 |  |  |  |  | 0.592 |
| K14 |  |  |  |  | 0.549 |
| K11 |  |  |  |  | 0.462 |
| K16 |  |  |  |  | 0.436 |
| K9 |  |  |  |  | 0.435 |
| K1 |  |  |  |  | 0.422 |
| K17 |  |  |  |  | 0.417 |
| K13 |  |  |  |  | 0.416 |
| K3 |  |  |  |  | 0.387 |
| K8 |  |  |  |  | 0.346 |

**Table a6-5 The final component matrix**

|  |  |
| --- | --- |
| **Item**  | **Component** |
| **1** | **2** | **3** | **4** |
| P15 | 0.813 |  |  |  |
| P14 | 0.810 |  |  |  |
| P8 | 0.799 |  |  |  |
| P13 | 0.795 |  |  |  |
| P12 | 0.795 |  |  |  |
| P6 | 0.764 |  |  |  |
| P7 | 0.752 |  |  |  |
| P9 | 0.751 |  |  |  |
| P3 | 0.659 |  |  |  |
| P2 | 0.650 |  |  |  |
| P11 | 0.624 |  |  |  |
| P5 | 0.569 |  |  |  |
| P4 | 0.502 |  |  |  |
| A2 |  | 0.842 |  |  |
| A4 |  | 0.809 |  |  |
| A5 |  | 0.764 |  |  |
| A1 |  | 0.750 |  |  |
| A7 |  | 0.737 |  |  |
| A6 |  | 0.505 |  |  |
| A8 |  |  | 0.776 |  |
| A9 |  |  | 0.707 |  |
| A10 |  |  | 0.687 |  |
| A3 |  |  | 0.572 |  |
| K12 |  |  |  | 0.658 |
| K10 |  |  |  | 0.567 |
| K14 |  |  |  | 0.551 |
| K11 |  |  |  | 0.484 |
| K9 |  |  |  | 0.471 |
| K17 |  |  |  | 0.453 |
| K13 |  |  |  | 0.442 |
| K16 |  |  |  | 0.439 |
| K1 |  |  |  | 0.423 |

**S7. The result of confirmatory factor analysis**

**Table a7. Overall fitting coefficient**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| $x^{2}$**/df** | **RMSEA** | **CFI** | **IFI** | **TLI** | **NFI** |
| 2.578 | 0.084 | 0.780 | 0.882 | 0.962 | 0.921 |

**Table a7-1. Convergence validity factor loading**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Path** | **Estimate** | **P** | **AVE** | **CR** |
| K7 | <--- | Knowledge dimension | 0.345 | 0.000 | 0.7627 | 0.7661 |
| K6 | <--- | Knowledge dimension | 0.229 | 0.000 |
| K5 | <--- | Knowledge dimension | 0.778 | 0.000 |
| K4 | <--- | Knowledge dimension | 0.548 | 0.000 |
| K3 | <--- | Knowledge dimension | 0.578 | 0.000 |
| K2 | <--- | Knowledge dimension | 0.580 | 0.000 |
| K1 | <--- | Attitudde dimension | 0.607 | 0.000 |
| A10 | <--- | Attitudde dimension | 0.516 | 0.000 | 0.5563 | 0.8257 |
| A9 | <--- | Attitudde dimension | 0.536 | 0.000 |
| A8 | <--- | Attitudde dimension | 0.544 | 0.000 |
| A7 | <--- | Attitudde dimension | 0.743 | 0.000 |
| A6 | <--- | Attitudde dimension | 0.574 | 0.000 |
| A5 | <--- | Attitudde dimension | 0.709 | 0.000 |
| A4 | <--- | Attitudde dimension | 0.808 | 0.000 |
| A3 | <--- | Attitudde dimension | 0.540 | 0.000 |
| A2 | <--- | Attitudde dimension | 0.803 | 0.000 |
| A1 | <--- | Attitudde dimension | 0.690 | 0.000 | 0.5921 | 0.9239 |
| P1 | <--- | Practice dimension | 0.594 | 0.000 |
| P2 | <--- | Practice dimension | 0.582 | 0.000 |
| P3 | <--- | Practice dimension | 0.608 | 0.000 |
| P4 | <--- | Practice dimension | 0.507 | 0.000 |
| P5 | <--- | Practice dimension | 0.722 | 0.000 |
| P6 | <--- | Practice dimension | 0.705 | 0.000 |
| P7 | <--- | Practice dimension | 0.792 | 0.000 |
| P8 | <--- | Practice dimension | 0.738 | 0.000 |
| P9 | <--- | Practice dimension | 0.599 | 0.000 |
| P10 | <--- | Practice dimension | 0.814 | 0.000 |
| P11 | <--- | Practice dimension | 0.816 | 0.000 |
| P12 | <--- | Practice dimension | 0.839 | 0.000 |
| P13 | <--- | Practice dimension | 0.837 | 0.000 |

Note: Estimate: Standardized factor loading coefficient; AVE: Average extracted variance value; CR: Combined reliability

**S8. The final formal questionnaire**

**Questionnaire on the KAP of ICU nurses of Central Line-Associated Bloodstream Infections**

Hello! We are conducting a study on the "Survey on the Status of ICU Nurses' Knowledge, Attitude and Practice of Central of Central Line-Associated Bloodstream Infections (CLABSI)", and we invite you to participate in this study and fill out this questionnaire. This questionnaire consists of four parts: the first part is the basic information of ICU nurses (12 items); the second part is the knowledge part of ICU nurses’ CLABSI (9 items); the third part is the ICU nurse’s CLABSI attitude part (10 items); the fourth part is the practice part of ICU nurse central CLABSI (13 items). It will take you about 10 minutes, so please fill it out patiently. This research promises to respect your privacy anonymously, and will not have any adverse effects on your work, study and life. Thank you for your support.

**I. Basic information of nurses**

1. Your gender

🞎Male 🞎Female

2. What is your age?

3. Which ICU department do you work in?

🞎Comprehensive ICU 🞎Surgery ICU 🞎Internal Medicine ICU 🞎Neurology ICU 🞎Neurosurgery ICU 🞎Cardiology ICU 🞎Emergency ICU 🞎General Surgery ICU

🞎Respiratory Medicine ICU 🞎Others

4. How many years have you worked in ICU?

5. Your job title is

🞎Nurse 🞎Nurse practitioner 🞎Nurse-in-charge 🞎Vice professor of nursing

🞎 Professor of nursing

6. Which is your highest education level?

🞎College degree 🞎Bachelor’s degree 🞎Master’s degree 🞎Above

7. How many beds are there in your work place?

8. Does your hospital have an internal care plan or standard to CLABSI?

🞎Yes 🞎No

9. Have you participated in training related to CLABSI?

10.Which of the following ways do you obtain knowledge about CLABSI?

🞎Books and literature 🞎School education 🞎Academic conferences or lectures

🞎Department learning 🞎Self-study due to personal interests or work needs 🞎Never

11. Have you understood or studied the best practice guidelines for the prevention and control of CLABSI?

12. Do you think you need to learn more about CLABSI?

**II. Knowledge about CLABSI of ICU nurses**

1. CLABSI refers to the infection that occurs during the indwelling of the central catheter (CATHETER) or how much hours after the catheter is removed?

A. 8 hours

B. 16 hours

C. 24 hours

D. 48 hours

E. Not clear

2. Which CATHETER puncture point should be avoided for patients with renal failure?

A. Subclavian vein

B. Femoral vein

C. Internal jugular vein

D. External jugular vein

E. Not clear

3. If there are signs of CLABSI, aseptically cut the tip of the catheter and place it in a sterile test tube after extubating, and send for bacterial culture immediately, How many centimeters should be taken from the tip?

A.2cm

B.3cm

C.4cm

D.5cm

E. Not clear

4. If the catheter is placed in an emergency (such as placing a catheter in an emergency) and the aseptic technique cannot be guaranteed, the catheter must be replaced immediately and can’t exceed how many hours

A. 12 hours

B. 24 hours

C. 36 hours

D. 48 hours

E. Not clear

5. How often is the CATHETER maintained under normal circumstances?

A. 1 day

B. 3 days

C. 5 days

D. 1 week

E. Not clear

6. The disinfection range is how many centimeters outward from the center of the puncture point when changing the dressing film

A.5cm

B.10cm

C.15cm

D.20cm

E. Not clear

7. How often should the infusion set be replaced during continuous infusion?

A. 1 time in 12 hours

B. Once every 24 hours

C. Once in 48 hours

D. Irregular replacement

E. Not clear

8. How often should the central venous catheter connector be replaced?

A. Once in 24 hours

B. Once in 48 hours

C. Once in 72 hours

D. Once a week

E. Not clear

9. When it is suspected that the patient has CLABSI, or the patient has phlebitis or catheter failure, the doctor decides to extubate the tube. Which of the following test results can be diagnosed as CLABSI?

A. Peripheral venous blood culture is negative for bacteria or fungi, and catheter end blood culture is positive for bacteria or fungi

B. Cultivate the same kind of pathogenic bacteria at the catheter tip and peripheral blood

C. Different types of pathogenic bacteria with the same susceptibility results are cultured at the catheter end and peripheral blood

D. Catheter end and peripheral blood cultured the same kind of pathogenic bacteria with the same drug sensitivity result

E. Not clear

**III. Attitude about CLABSI of ICU nurses**

1. I am interested in knowledge about CLABSI.

🞎Strongly agree   🞎Agree 🞎Not sure 🞎Disagree 🞎Strongly disagree

2. I think nurses who have a good knowledge of catheter infections can reduce the incidence of CLABSI.

🞎Strongly agree   🞎Agree 🞎Not sure 🞎Disagree 🞎Strongly disagree

3. I think palpation at the catheter site helps confirm signs of infection.

🞎Strongly agree   🞎Agree 🞎Not sure 🞎Disagree 🞎Strongly disagree

4. I think the prevention of CLABSI is very important for the treatment and prognosis of the patient's disease.

🞎Strongly agree   🞎Agree 🞎Not sure 🞎Disagree 🞎Strongly disagre

5. I think hand hygiene must be done before catheter placement and changing catheter dressings.

🞎Strongly agree   🞎Agree 🞎Not sure 🞎Disagree 🞎Strongly disagree

6. I think that regular replacement of CATHETER is an effective measure to prevent the occurrence of CLABSI.

🞎Strongly agree   🞎Agree 🞎Not sure 🞎Disagree 🞎Strongly disagree

7. I think the CATHETER should be removed in time when a fever is found in patients with CATHETER.

🞎Strongly agree   🞎Agree 🞎Not sure 🞎Disagree 🞎Strongly disagree

8. I think the CATHETER is a device that may cause serious infection complications.

🞎Strongly agree   🞎Agree 🞎Not sure 🞎Disagree 🞎Strongly disagree

9. I think CATHETER is a device that may cause serious infection complications.

🞎Strongly agree   🞎Agree 🞎Not sure 🞎Disagree 🞎Strongly disagree

10. I think nurses should assess the necessity of indwelling catheters daily and remove unnecessary catheters in time.

🞎Strongly agree   🞎Agree 🞎Not sure 🞎Disagree 🞎Strongly disagree

**IV. Practice about CLABSI of ICU nurses**

1. I will evaluate the skin condition of the patient's catheterization site and the dressing condition daily to determine whether the patient is at risk of bloodstream infection.

🞎Never   🞎Occasionally 🞎Sometimes 🞎Often 🞎Always

2. If the patient feels tenderness at the catheter site, I will remove the dressing to thoroughly inspect the catheter site.

🞎Never   🞎Occasionally 🞎Sometimes 🞎Often 🞎Always

3. I will regularly bathe patients with CATHETER with a solution containing chlorhexidine.

🞎Never   🞎Occasionally 🞎Sometimes 🞎Often 🞎Always

4. When using CATHETER infusion or changing CATHETER, I will vigorously rotate and wipe the cross-section of the needleless connector, the catheter interface and the screw section.

🞎Never   🞎Occasionally 🞎Sometimes 🞎Often 🞎Always

5. I will draw back the blood and confirm the depth of the catheter before the administration through the CATHETER.

🞎Never   🞎Occasionally 🞎Sometimes 🞎Often 🞎Always

6. When infusion or replacement of the needleless connection device, I will disinfect with the puncture point as the center. The disinfection range is ≥20 cm in diameter, and time ≥ 15s

🞎Never   🞎Occasionally 🞎Sometimes 🞎Often 🞎Always

7. Before inserting the tube, administering through the CATHETER, and after removing the old dressing, I will strictly perform hand hygiene and the time shall not be less than 15s.

🞎Never   🞎Occasionally 🞎Sometimes 🞎Often 🞎Always

8. I will avoid the puncture point when disinfecting with alcohol cotton ball.

🞎Never   🞎Occasionally 🞎Sometimes 🞎Often 🞎Always

9. When viewing and palpating the CATHETER, I will perform hand hygiene and wear sterile gloves.

🞎Never   🞎Occasionally 🞎Sometimes 🞎Often 🞎Always

10. When I find that the wound has bleeding, film contamination (or suspected contamination), dampness, shedding, loosening or endangering the catheter, I will replace the film immediately and ask the patient's feelings.

🞎Never   🞎Occasionally 🞎Sometimes 🞎Often 🞎Always

11. If the patient is observed to have fever or other signs of infection, I will report to the doctor in time.

🞎Never   🞎Occasionally 🞎Sometimes 🞎Often 🞎Always

12. When I hand over the shift, I will explain the patient's catheter situation to the next nurse on duty.

🞎Never   🞎Occasionally 🞎Sometimes 🞎Often 🞎Always

13. When I patrol the ward, I will pay attention to whether the catheter is unobstructed, ask the patient's feelings and deal with it in time.

🞎Never   🞎Occasionally 🞎Sometimes 🞎Often 🞎Always