



**Relationship Between Knowledge, Attitude, and Practice of  
Surgical Site Infection Prevention Among Operating Room Nurses  
in Guizhou Province, China**

**Wen Feng**

**A Thesis Submitted in Partial Fulfillment of the Requirements for the  
Degree of Master of Nursing Science in Adult and Gerontological  
Nursing (International Program)**

**Prince of Songkla University**

**2019**

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<b>Thesis Title</b>	Relationship Between Knowledge, Attitude, and Practice of Surgical Site Infection Prevention Among Operating Room Nurses in Guizhou Province, China
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### ABSTRACT

This descriptive correlation study aimed to examine the level of knowledge, attitude, and practice of SSI prevention and the relationship between knowledge, attitude, and practice of SSI prevention among 999 operating room nurses working in 124 hospitals in Guizhou Province, China. Knowledge, attitude, and practice of SSI prevention were examined using a Knowledge Questionnaire, an Attitude Questionnaire, and a Practice Questionnaire, respectively.

The English version questionnaires yielded the content validity index of .83, .89, and .94 for the Knowledge Questionnaire, the Attitude Questionnaire, and the Practice Questionnaire, respectively. The Kuder-Richardson formula 20 (KR-20) was used to test the reliability of the Knowledge Questionnaire. The Cronbach alpha internal reliability test was used for the Attitude Questionnaire and the Practice Questionnaires. The reliability of Knowledge, Attitude, and Practice Questionnaires were .72, .84, and .97, respectively. The descriptive statistics and Pearson product-moment correlation were used to analyze the data.

The result illustrated that the operating room nurses' level of knowledge regarding SSI prevention was at a low level ( $M = 67.98\%$ ,  $SD \pm 7.96\%$ ), the level of attitude regarding SSI prevention was positive ( $M = 81.26\%$ ;  $SD \pm 7.55\%$ ), and the level of practice regarding SSI prevention was at a high level ( $M = 83.81\%$ ,  $SD \pm 13.50\%$ ). Results also showed that knowledge was positively related to attitude ( $r = .137$ ,  $p < .01$ ). A significant positive correlation between practice and attitude was found ( $r = .302$ ,  $p < .01$ ). However, there was no significant correlation between knowledge and practice ( $r = .058$ ,  $p = .065$ ). Therefore, knowledge of SSI prevention among operating room nurses should be improved to ensure better care of SSI prevention.

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## CONTENTS

	<b>Page</b>
ABSTRACT .....	v
ACKNOWLEDGMENTS .....	vii
LIST OF TABLES .....	xiv
LIST OF FIGURES .....	xv
CHAPTER 1 INTRODUCTION.....	1
Background and Significance of the Problem .....	1
Objectives of Study.....	7
Research Questions.....	8
Conceptual Framework.....	8
Hypotheses.....	9
Definition of Terms .....	10
Scope of the Study .....	11
Significance of the Study .....	11
CHAPTER 2 LITERATURE REVIEW.....	13
Overview of Surgical Site Infection .....	14
Evidence-based Practice for Surgical Site Infection in Intraoperative Phase.....	19
Knowledge, Attitude, and Practice Model.....	29

**CONTENTS (continued)**

	<b>Page</b>
Nurses' Knowledge, Attitude, and Practice Regarding Prevention of Surgical Site Infection.....	30
Measurement of Nurses' Knowledge, Attitude, and Practice of Surgical Site Infection Prevention .....	43
Surgical Site Infection Prevention in Hospitals in China .....	46
Summary of Literature .....	49
<b>CHAPTER 3 RESEARCH METHODOLOGY.....</b>	<b>51</b>
Research Design .....	51
Setting .....	51
Population and Sample .....	51
Instruments.....	53
Translation of the Questionnaires .....	57
Validity and Reliability of the Instruments.....	58
Ethical Consideration.....	58
Data Collection Procedures .....	60
Data Analysis .....	63
<b>CHAPTER 4 RESULTS AND DISCUSSION .....</b>	<b>65</b>
Results.....	65

**CONTENTS (continued)**

	<b>Page</b>
Discussion.....	75
<b>CHAPTER 5 CONCLUSION AND RECOMMENDATIONS.....</b>	<b>89</b>
Conclusion .....	89
Recommendations.....	91
<b>REFERENCES.....</b>	<b>93</b>
<b>APPENDICES.....</b>	<b>110</b>
A. The Rationale and Range of Recommendations.....	111
B. Invitation Letter (English Version and Chinese Version) .....	113
C. Informed Consent (English Version and Chinese Version).....	116
D. Surgical Site Infection Questionnaire in Operating Room (English Version and Chinese Version) .....	124
E. The Number of Participants and Related Information of Selected Hospitals.....	139
F. Approval Letters .....	146
G. Experts for Validation.....	150
H. Experts for Back Translation Instruments .....	151
I. Frequency and Percentage of Responses to Each Item of Knowledge, Attitude, and Practice on Surgical Site Infection Prevention .....	152

**CONTENTS (continued)**

	<b>Page</b>
J. Test Assumption of Normality of Knowledge, Attitude, and Practice of Surgical Site Infection (SSI) .....	161
K. Frequency and Percentage of the Main Answer Related to Knowledge, Attitude, and Practice of Surgical Site Infection Prevention from Open-end Questions .....	163
VITAE .....	169

**LIST OF TABLES**

<b>Table</b>		<b>Page</b>
1	Summary of Worldwide and Chinese Surgical Site Infection Prevention Guidelines.....	27
2	The Level of Knowledge, Attitude, and Practice and Their Relationship on SSI Prevention Among Chinese Operating Room Nurses .....	32
3	Demographic Characteristics and Relative Information of Participants.....	65
4	Knowledge, Attitude, and Practice of SSI Prevention of Participants Categorized by Each Domain.....	68
5	Frequency and Percentage of Participants' Knowledge, Attitude, and Practice Categorized by Each Level.....	69
6	Three Items with Highest and Three Items with Lowest Frequency and Percentage of Knowledge, Attitude, and Practice Regarding to SSI Prevention Among Participants.....	73
7	Correlation Between Knowledge, Attitude, and Practice of Surgical Site Infection Among Operating Room Nurses.....	74

**LIST OF FIGURES**

<b>Figure</b>		<b>Page</b>
1	Conceptual Framework of the Study.....	10
2	Histogram Evaluation Result of Sum Knowledge Percentage of Surgical Site Infection Prevention.....	161
3	Histogram Evaluation Result of Sum Attitude Percentage of Surgical Site Infection Prevention.....	162
4	Histogram Evaluation Result of Sum Practice Percentage of Surgical Site Infection Prevent.....	162



## **Chapter 1**

### **Introduction**

This chapter consists of the background and significance of the problem, objectives of the study, research questions, conceptual framework, hypothesis, definition of terms, scope of the study, and significance of the study.

#### **Background and Significance of the Problem**

Surgical site infection (SSI) is defined as an infection that happens on the patient within 30 days after operation without implant (Berríos-Torres et al., 2017; Mangram et al., 1999). SSI is a common and complex problem after surgery, but it could be prevented. The World Health Organization (WHO) pointed out that the incidence of SSI was lower in developed countries, but the rate was also going up to 1.2% (WHO, 2016, 2018). It was reported that the incidence of SSI in colon surgery was the highest one with up to 9.5% and following in second place was coronary artery bypass graft with 3.5%. The third-highest incidence of SSI (2.9%) was caesarean section operations in European countries (WHO, 2016, 2018). In Europe, there were about 1.89% of SSIs that happened in 967,191 surgical procedures. The data showed that 0.6% to 9.5% of SSIs happened in every 100 surgical procedures in 2013 and 2014, respectively (European Centre for Disease Prevention and Control, 2016). In China, the pooled average incidence of SSI was 4.5% and the higher rate (4.6%) was found in the western area from 2001 to 2012. Most SSIs happened in abdominal surgery (8.3%) (Fan et al., 2014). In a survey conducted among 65,885

patients in Guizhou Province, there were 17.29% of surgical site infections out of 1,643 nosocomial infection (Zhang et al., 2015).

SSIs could lead to patients' physical discomfort (such as pain, fever, and skin redness), prolonged stay in the hospital, extra cost of medical treatment, need for additional financial support, and deaths. Patients with SSI would stay longer (around 7 to 23 days) in the hospital than patients without SSI (around 1 to 11 days). It also leads to a waste of medical resources, such as bed turnover rate decrease (Bhangu et al., 2018; Silvestri et al., 2018). The average cost incurred by hospitals spent for those patients with SSI (£217,416) was more than for patients without SSI (£108,852) (Atkinson, Jones, Ousey, & Stephenson, 2017). It was reported that the patient with SSI spent extra money of around £5,239 for treatment in England (Jenks, Laurent, McQuarry, & Watkins, 2014). In China, for every case of SSI extra money was spent in an amount within the range of 396 to 5237 dollars in the Second People's Hospital of Foshan, Guangdong (Fan et al., 2014). A previous study also revealed that 4% of deaths after vascular surgery and 6% of deaths after repair of the neck of femur resulted from SSI (Public Health England, 2017). The pooled mortality of SSI patients was 1.9% in 66 countries, while the highest mortality in the low-income countries (4.8%) was more than three times that of the high-income countries (1.5%) (Bhangu et al., 2018). In China, SSI prolonged patients' hospital stay around 11.75 days (95% CI: 6.24,22.52),and led to the extra cost of SSI treatment in the case of craniocerebral surgery in the amount of around \$3,412.28 (95% CI: \$1,680.65, \$5,879.89) (Zhou & Ma, 2015).

Factors leading to SSI include patients' risk factors and operative risk factors. Patients risk factors include age, diabetes, nicotine use, obesity, malnutrition, and

hypoalbuminemia (Ejaz, Schmidt, Johnston, Frank, & Pawlik, 2017; Lubega, Joel, & Lucy, 2017; Ma et al., 2018; Silvestri et al., 2018; Son, Roh, Choi, Nam, & Kim, 2018; Vallejo et al., 2017). The operative risk factors could be classified into three types according to the source of infection, as follows: environmental factor (such as: ventilation in operating room and sterilisation of surgical instruments), surgical equipment factor (such as surgical drains) and healthcare providers' factor (such as: preoperative patients' skin preparation, surgical hand antisepsis, duration of operation, antimicrobial prophylaxis and antibiotic prophylaxis, and hypothermia) (Mujagic et al., 2018; Oriel, Chen, & Itani, 2017; Poirot, Roy, Badrikian, & Slim, 2018; Privitera et al., 2017).

Operating room nurses are among the important healthcare providers during the perioperative period. The operating room nurses who work with surgeons and anaesthetist as a team are responsible for caring for patients during the intraoperative period. Operating room nurses work as a bridge to link preoperative and postoperative nursing care and are crucial for the prevention of SSI. It has been documented that the quality of nursing care is crucially related to nurses' knowledge, attitude, and practice to deliver evidence-based nursing care to patients.

Based on the existing guidelines, prevention of SSI in the intraoperative period were as follows: operating room environment, sterilization of surgical attire and drapes, asepsis surgical technique, and risk factors for patients related to SSI (Berríos-Torres et al., 2017; Mangram et al., 1999; WHO, 2016, 2018). In China, the National Health Commission of the People's Republic of China developed the Surgical Site Infection Prevention and Control Guideline (Trial) in 2010. In this trial guideline, risk factors for patients related to SSI were not mentioned. The Chinese Nursing

Association Operating Room Professional Committee developed a “Guide to Operating Room Nursing Practice” (Chinese Nursing Association Operating Room Professional Committee, 2018) from 2014 and updated it every year based on the national infection prevention and control regulations and experts’ consensus. In this operating room nurses’ practice guideline, the main contents consisted of nurses’ aseptic technique practice. The two existing Chinese guidelines have been widely used to prevent SSI in Chinese hospitals.

The knowledge, attitude, and practice (KAP) survey model was first applied in dealing with family planning issues by Launiala in the 1950s (Launiala, 2009). The KAP model was used to understand the knowledge, attitude, and practice in various groups of people including for pregnancy (Launiala, 2009), disaster management among emergency medical personnel (Ahayalimudin & Osman, 2016), food safety and hygiene (Al-Shabib, Husain, & Khan, 2017; Zanin, Cunha, Rosso, Capriles, & Stedefeldt, 2017), and tobacco cessation (Kattoor, Thomas, Abraham, Bahia, & Kenchaiah, 2017). Besides, the KAP model was used to understand the link between knowledge, attitude, and practice. All of these three variables were proposed to be related to each other (Launiala, 2009).

Literature reviews showed that the operating room nurses’ knowledge, attitude, and practice of SSI prevention were inconsistent. The operating room nurses had a moderate level of knowledge, a positive attitude, and a high level of practice regarding SSI prevention in one tertiary hospital in Southern Thailand (Saksri, Naka, & Sae-Sia, 2018). In India (Abraham, Deva, & Babu, 2016) and Sweden (Wistrand, Falk-Brynhildsen, & Nilsson, 2018), the operating room nurses had a high level of knowledge and good practice on sterile and aseptic technique. In China, only 45.7% of

the operating room nurses pass the knowledge questionnaire and mean percentage of practice regarding SSI prevention was 55.1% in one tertiary hospital in Zhejiang Province (Chen, Dong, Huang, & Gao, 2013). In Beijing (the capital city of China) most of the operating room nurses got a lower score than the average score in knowledge, but got a higher score than the average score in practice of SSI prevention in four tertiary hospitals (Yang & Cheng, 2014). The discrepancy of the different findings might be due to differences of care context, policy of infectious control, or workloads.

However, the relationship between nurses' knowledge, attitude, and practice of SSI prevention showed inconsistency. In southern Thailand, there was a positive correlation between knowledge and attitude; however, there was no correlation between knowledge and practice and no correlation between attitude and practice of SSI prevention among operating room nurses (Saksri et al., 2018). In Nigeria, the authors found that there was a positive and moderate correlation between knowledge and attitude ( $r = .70, p < .01$ ), a positive and moderate correlation ( $r = .57, p < .01$ ) between knowledge and practice and a positive correlation between attitude and practice ( $r = .76, p < .01$ ) of SSI prevention among surgical ward nurses (Kolade, Abubakar, Adejumo, Funmilayo, & Tijani, 2017). In Pakistan, there was a strong significant positive correlation between knowledge and practice ( $p < .05$ ) of SSI prevention among surgical ward nurses (Sadaf, Inayat, Afzal, & Hussain, 2018). In south India, Abraham et al. (2016) revealed that there was a weak negative correlation between knowledge and practice ( $r = -.27, p = .03$ ) of sterile technique, which indicated that the conversion of operating room nurses' knowledge into practice required regular reinforcement and motivation.

Currently, a total of seven articles related to SSI prevention were based on research conducted by the KAP survey in China. Six studies related to SSI were published in Chinese, and one study was published in English. Only three of them focused on operating room nurses and all of their questionnaires were developed based on the Chinese national SSI prevention trial guideline (2010) (Chen et al., 2013; Jing & Bai, 2011; Yang & Cheng, 2014). Three out of seven studies examined only the knowledge of SSI prevention. The results showed that the knowledge scores concerning SSI prevention of nurses either working in the operating room, or neurosurgical wards were lower than the average scores. The percentage of nurses who passed the knowledge average score ranged from 19.3% to 57.78% (Hao, Meng, Han, & Shang, 2018; Jing & Bai, 2011; Tao, Wu, & Xu, 2009). It was found that operating room nurses had the lowest knowledge score of blood glucose monitoring and appropriate antimicrobial use (Jing & Bai, 2011; Tao et al., 2009). The neurosurgical wards nurses had the lowest knowledge score of hair removal and blood glucose monitoring during the perioperative phase (Hao et al., 2018). Three out of seven studies determined the knowledge and practice of SSI prevention in operating room nurses (Chen et al., 2013; Jing & Bai, 2011; Yang & Cheng, 2014). It was found that 69.1% of operating room nurses adhered to the SSI prevention protocol or guideline (Yang & Cheng, 2014). Besides, it was found that only 25% of operating room nurses followed the hand hygiene protocol (Chen et al., 2013) and 31.5% of them did not wash their hand after using the computers and desks in the staff station (Zhou et al., 2014). Two out of seven studies examined medical staffs' knowledge, attitude, and practice of SSI prevention (Zhou, Huang, & Lei, 2014) and healthcare-associated infections (Zhou et al., 2014). These two studies also found that knowledge,

attitude, and practice were less than the average level. Although 91.7% of nurses considered unsterile needles as a source of contamination, 71.4% of them claimed to have sustained used needle stick injuries. Adherence to the standard precautions of nurses was suboptimal for prevention of infectious diseases. More than 79.9% of nurses would not report if they had contracted infectious diseases, such as herpes zoster, influenza, or acute haemorrhagic conjunctivitis (Zhou et al., 2014).

Based on the review, there was still no study to examine Chinese operating room nurse's knowledge, attitude, and practice on SSI prevention based on the up to date evidence and no study has examined the relationship between knowledge, attitude, and practice. Exploring the level of knowledge, attitude, and practice of SSI prevention in operating nurses and their relationships in Guizhou Province will provide the operating room organization in China with rich information that would be used for conducting intervention studies to promote knowledge, attitude, and practice for SSI prevention in operating room nurses to enhance quality of nursing care especially in the perioperative phase.

### **Objectives of Study**

1. To examine the level of knowledge, attitude and practice on prevention of SSI among operating room nurses.
2. To examine the relationship between nurses' knowledge and their practice on the prevention of SSI in the operating room.
3. To examine the relationship between nurses' knowledge and their attitude on the prevention of SSI in the operating room.

4. To examine the relationship between nurses' attitude and their practice on the prevention of SSI in the operating room.

### **Research Questions**

1. What is the level of knowledge, attitude, and practice on prevention of SSI among operating room nurses?
2. Is there a positive relationship between operating room nurses' knowledge and their attitude on the prevention of SSI?
3. Is there a positive relationship between operating room nurses' knowledge and their practice on the prevention of SSI?
4. Is there a positive relationship between operating room nurses' attitudes and their practice on the prevention of SSI?

### **Conceptual Framework**

The conceptual framework of this study was developed based on the Knowledge-Attitude-Practice (KAP) model (Launiala, 2009), and the evidence-based practice for SSI prevention proposed by the Centres for Disease Control and Prevention (CDC) (Berríos-Torres et al., 2017; Mangram et al., 1999) and WHO (WHO, 2016, 2018). The knowledge, attitude, and practice were the main components in the KAP survey model (Launiala, 2009). All of them were considered so that they could interact with each other in the KAP survey model, such as 1) the participants' level of knowledge might influence their level of attitude; 2) the participants' level of knowledge might influence their level of practice, and 3) the participants level of attitude might influence their level of practice (Launiala, 2009). The KAP model as a

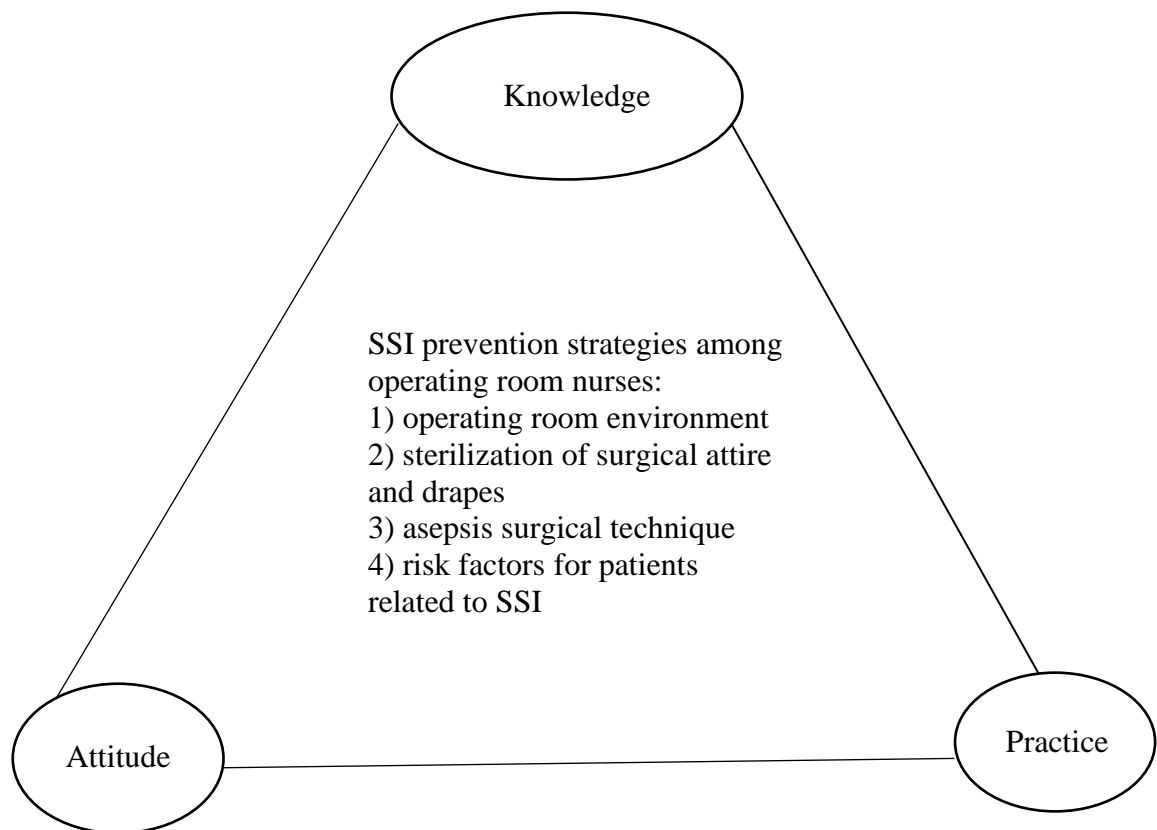


study framework was first used to identify the target populations' knowledge, attitude, and practice on family planning and research problems (Launiala, 2009; Rav-Marathe, Wan, & Marathe, 2016). Rav-Marathe et al. (2016) revealed that there was a relationship between individuals' knowledge, attitude, and practice, and identified that an individuals' knowledge and attitude could impact people's practice.

The prevention of SSI in the CDC and WHO guideline includes pre-operative, intra-operative, and post-operative preventive strategies. Based on the review, the operating room nurses had lowest knowledge of some parts of SSI prevention in the previous decade in China. This study will focus on intra-operative prevention strategies of SSI among operating room nurses. The intra-operative SSI prevention strategies are as follows: 1) operating room environment; 2) sterilization of surgical attire and drapes; 3) asepsis surgical technique; and 4) risk factors for patients related to SSI (Berríos-Torres et al., 2017; Mangram et al., 1999; WHO, 2016, 2018). The conceptual framework of the study is shown in Figure 1.

## **Hypotheses**

1. There is a positive correlation between operating room nurses' knowledge and their practice on the prevention of SSI.
2. There is a positive correlation between operating room nurses' knowledge and their attitude on the prevention of SSI.
3. There is a positive correlation between operating room nurses' attitudes and their practice on the prevention of SSI.



*Figure 1. Conceptual Framework of the Study*

### **Definition of Terms**

**Knowledge of SSI prevention.** Knowledge of SSI prevention means that the operating room nurses understand the prevention strategies in the intra-operative period. Knowledge of SSI prevention includes four components as follows: 1) operating room environment, 2) sterilization of surgical attire and drapes, 3) asepsis surgical technique, and 4) risk factors for patients related to SSI. Knowledge about the prevention of SSI is measured by the structured questionnaire modified from the Knowledge Questionnaire (Saksri et al., 2018). The high scores indicate a high level of knowledge.

**Attitude of SSI prevention.** Attitude of SSI prevention means the operating room nurses' view and feeling about the prevention of SSI in the intra-operative period. Attitude of SSI prevention includes four components as follows: 1) operating room environment, 2) sterilization of surgical attire and drapes, 3) asepsis surgical technique, and 4) risk factors for patients related to SSI. Attitude about the prevention of SSI is measured by the questionnaire modified from the Attitude Questionnaire (Saksri et al., 2018). The high scores indicate a positive level of attitude.

**Practice of SSI prevention.** Practice of SSI prevention means the operating room nurses' manipulation on the prevention of SSI in the intra-operative period. Practice of SSI prevention includes four components as follows: 1) operating room environment, 2) sterilization of surgical attire and drapes, 3) asepsis surgical technique, and 4) risk factors for patients related to SSI. Practice about the prevention of SSI is measured by the questionnaire modified from the Practice Questionnaire (Saksri et al., 2018). The high scores indicate a high level of practice.

### **Scope of the Study**

This descriptive correlational study attempted to find the relationships between operating room nurses' knowledge, attitude, and practice of SSI prevention. The participants of the study were nurses in the operating rooms in Guizhou Province, China. This study was conducted between May 2019 and August 2019.

### **Significance of the Study**

This study was the first provincial-level survey related to operating room nurses' knowledge, attitude, and practice on SSI prevention based on the updated

high-quality guidelines. The outcomes of the study could provide critical information to improve the knowledge, attitude, and practice about the prevention of SSI in the intra-operative period to prevent the occurrence of SSI. Future specific intervention studies will need to be applied to improve operating room nurses' knowledge, attitude, and practice of SSI prevention based on the data of this proposed study.

## **Chapter 2**

### **Literature Review**

In this chapter, a review is presented of previous studies related to information of SSI and nurses' knowledge, attitude, and practice and relationships between nurses' knowledge, attitude, and practice, as follows:

1. Overview of Surgical Site Infection (SSI)
  - 1.1 Definition of SSI
  - 1.2 Pathophysiology of SSI
  - 1.3 Incidence of SSI
  - 1.4 Impacts of SSI
2. Evidence-based Practice for SSI in Intraoperative Phase
  - 2.1 Operating room environment
  - 2.2 Surgical attire and drapes
  - 2.3 Asepsis surgical technique
  - 2.4 Risk factors for patients related to SSI
  - 2.5 Evidence-based practice for SSI in intraoperative phase in China
3. Knowledge, Attitude, and Practice (KAP) Model
4. Nurses' Knowledge, Attitude, and Practice Regarding Prevention of SSI
  - 4.1 The level of nurses' knowledge, attitude, and practice in other countries
  - 4.2 The level of nurses' knowledge, attitude, and practice in China
  - 4.3 The relationships between nurses' knowledge, attitude, and practice
  - 4.4 Factors related to nurses' knowledge, attitude, and practice
5. Measurement of Nurses' Knowledge, Attitude and Practice of SSI Prevention

6. Surgical Site Infection Prevention in Hospitals, China
7. Summary of Literature

### **Overview of Surgical Site Infection**

**Definition of SSI.** Surgical site infection (SSI) is defined as an infection that happens on the patient within 30 days after an operation without implant (Berríos-Torres et al., 2017; Borchardt & Tzizik, 2018; Mangram et al., 1999). For patients with implant, the SSI might happen within 90 days after surgery, and might even happen within 1 year (Berríos-Torres et al., 2017; Borchardt & Tzizik, 2018; Mangram et al., 1999). According to the classification of SSI, there are three categories of SSI: superficial incisional SSI, deep incisional SSI, and organ/space SSI (Berríos-Torres et al., 2017; Mangram et al., 1999). Superficial incisional SSI refers to patients acquiring an infection of skin or the subcutaneous tissue within 30 days after surgery. Deep incisional SSI happens in the deep soft tissue which is located in the operating incision after surgery around 30 days for patients without implants or within 90 days up to 1 year for patients with implant. For the organ/space SSI, it is related to the organ or space developed infection around 30 days after the operation without implants or within 90 days and prolonged with implant within 1 year and related to the operation (Berríos-Torres et al., 2017; Borchardt & Tzizik, 2018; Mangram et al., 1999).

**Pathophysiology of SSI.** Surgical site infection is caused by four important and relevant components: the number of bacteria (especially resident bacteria), bacterial infection ability, incisional environment (especially for contaminated and dirty wound), and the host's ability to resist infection. When the skin is opened in the

surgical procedure, the first defence line of the human body has a defect and the bacteria enter the body from the surgical incision. The human, as the host, starts to defend him/herself naturally and produces a corresponding inflammatory response from the bacterial infection. When the neutrophils successfully clear the infection, the wound starts healing. If the neutrophils failed to clear the infection, it would lead to surgical wound infection (Mcguire-Wolfe, 2018; Mockford & O'Grady, 2017).

There are two types of bacteria on human skin: transient and resident.

Transient bacteria are more of a risk than resident bacteria for infection (Mcguire-Wolfe, 2018). According to previous literature, the normal pathogens associated with SSI are *Staphylococcus aureus*, coagulase-negative staphylococci, *Enterococcus spp.*, and *Escherichia coli* (Berríos-Torres et al., 2017; Mangram et al., 1999; WHO, 2016, 2018).

According to the contamination condition of the surgical incision, the wound was categorised into four types: clean; clean-contaminated; contaminated, and dirty or infected wound (Berríos-Torres et al., 2017; Mangram et al., 1999; WHO, 2016, 2018). Clean wound means that the surgical incision was not showing inflammation and the procedure of operation did not involve contaminated tracts. And the surgical incision must be primarily closure. Clean-contaminated wound means that the surgical incision invaded in the respiratory, alimentary, genital, or urinary tracts but without contamination. Contaminated wound means that the tissue around the surgical incision was open, fresh, and accidental. Contaminated wound also includes that of surgery involved in gastrointestinal and acute infection without purulent inflammation. Dirty or infected wound means that the tissue around the surgical incision has acquired an

infection before surgery (Berríos-Torres et al., 2017; Mangram et al., 1999; WHO, 2016, 2018).

**Incidence of SSI.** The World Health Organization (WHO) reported that the incidence of SSI in colon surgery was the highest one, up to 9.5%, and the coronary artery bypass graft occupied the second-highest place (3.5%), the third-highest occurrence (2.9%) was caesarean section operations in European countries (WHO, 2016, 2018). The incidence of SSI in developed countries was lower than that in developing countries, but the rate was also up to 1.9% in the USA, 2.6% in Italy, 2.7% in Australia, and 3% in France (WHO, 2016, 2018). In Europe, about 1.89% of SSIs happened in 967,191 surgical procedures, as the incidence ranged from 0.6% to 9.5% in every 100 surgical procedures in 2013 and 2014 (ECDC, 2016). In New York, a survey pointed out that the incidence of SSI decreased, but researchers still found 1.4% in the observation period (Hogle, Cohen, Hyman, Larson, & Fowler, 2014). Even in the developed countries which have adequate medical resources, cases of SSI were still found after surgery.

In China, the pooled average incidence of SSI was 4.5% from 2001 to 2012. The highest rate (4.6%, 95% CI: 4.0, 5.3) was in remote western areas compared with the eastern coastal areas (3.0%, 95% CI: 2.4, 3.5) and midlands (3.8%, 95% CI: 1.4, 6.7), because the economic status of eastern area was better than that of western area in China. According to the data, SSIs mainly happened in abdominal surgery (8.3%, CI: 6.5, 10.0) compared to gynaecology and obstetrics (5.7%, CI: 0.9, 13.9), neurosurgery(3.6%, CI: 1.4, 5.8), general surgery (3.1%, CI: 1.0, 5.2), thoracic surgery(3.0%, CI: 2.7, 3.3), and orthopaedic surgery(1.0%, CI: 0.5, 1.6) (Fan et al., 2014). The authors also illustrated that the significant difference of SSI occurrence



between contaminant wounds (abdominal surgery, 8.3%) and clean wounds (orthopaedic surgery, 1.0%) (Fan et al., 2014). One article showed that the incidence of SSI was 22% in 159 Crohn's disease patients who underwent bowel resection (Hu et al., 2018). For the orthopaedic surgery, the data pointed out that the incidence of SSI ranged from 2.5% to 5.7% in patients who underwent open reduction and internal fixation in trauma and emergency centre in the Third Hospital of Hebei Medical University and the 6th Hospital of Xinjiang Medical University (Li et al., 2018; Ma et al., 2018). One systematic review showed that SSI was still in third place of all infections and it accounted for 9.86% of all healthcare-associated infections, especially in oncology hospital, where SSI was up to 12.26% (Wang et al., 2018).

In Guizhou Province, a survey conducted among 65,885 hospitalized patients showed that there were 17.29% of SSIs that developed in 1643 nosocomial infections (Zhang, Mou, et al., 2015). Comparing the data of SSI of nosocomial infection for 2010 (17.12% of 1063 patients), 2012 (19.67% of 1556 patients), and 2014 (17.29% of 1643 patients) in Guizhou Province, the incidence of SSI has always been in the second place of nosocomial infection (Zhang, Yang, et al., 2015). From these data, it was found that SSI in Guizhou Province is still a common and serious problem after surgery.

**Impacts of SSI.** Surgical site infections could lead to the patients feeling uncomfortable, prolonged stay in the hospital, extra medical treatment, need for additional financial support, and deaths. Besides, SSI caused delayed wound healing, readmission, and reoperation (Mangram et al., 1999; WHO, 2016, 2018).

A study conducted in England pointed out that SSI could prolong the patient's length of stay at the hospital by around 7-13 days after major surgery (Jenks et al.,

2014). The patients with SSI had to stay more than 3 times longer at the hospital than patients without SSI (Bhangu et al., 2018). In Japan, the data showed that SSI prolonged patients' stay in the hospital up to 23 days longer than the 10 days for patients without SSI after colorectal surgery (Silvestri et al., 2018). A study in China reported that patients with SSI stayed at hospital a longer time (34.4 days) than patients without SSI (18.1 days) after open reduction and internal fixation (Li et al., 2018).

Regarding the financial issue, a study conducted in England showed that each patient spent extra money (£5,239) for SSI treatment than the patient without SSI (Jenks et al., 2014). The patients with SSI cost the health system (mean: £217,416) more than the patients without SSI (mean: £108,852) in patients undergoing surgery for spinal metastasis (Atkinson et al., 2017). In China, for every case of SSI extra money was spent amounting to around 396 to 5237 dollars in the Second People's Hospital of Foshan, Guangdong (Fan et al., 2014).

Around 4% of deaths after vascular surgery and 6% deaths after repair of the neck of femur were attributed to SSI (Public Health England, 2017). A study conducted at Johns Hopkins Hospital showed that 2.3% of the patients' deaths were caused by SSI (Ejaz et al., 2017). The pooled mortality rate of SSI patients was 1.9% in 66 countries, and the highest mortality rate in the low-income countries (4.8%) was more than three times higher compared to that in the high-income countries (1.5%) (Bhangu et al., 2018).

In conclusion, SSI could not only cause patients' discomfort, but could also lead to death, waste of medical resources, and depletion of financial resources.

### **Evidence-based Practice for SSI in Intraoperative Phase**

The existing guidelines for preventing SSI can be categorized into preoperative issues, intraoperative issues, and postoperative issues for SSI prevention (Berríos-Torres et al., 2017; Mangram et al., 1999; WHO, 2016, 2018). These guidelines with good quality could guide medical staff to prevent SSI (Gillespie et al., 2018).

Operating room nurses perform an important part of the medical team in the perioperative period to provide nursing care for patients and operating cooperation to surgeons. In this section, the review focused on operating room nurses' strategies for preventing SSI based on the existing guidelines (Berríos-Torres et al., 2017; Mangram et al., 1999; WHO, 2016, 2018). The SSI prevention recommendations from CDC were categorized into category IA, category IB, category IC, category II, and no recommendation/unresolved (Appendix A). Category IA, IB, and IC were considered effective by the Health Infection Control Practices Advisory Committee (HICPAC) and experts' reviews. The difference is that fewer existing data exist to support category II than category IA, IB, and IC. In the CDC update guideline (Berríos-Torres et al., 2017), the recommendations were modified not only by category IA, IB, IC, II, and no recommendation but also by strong and weak. In terms of WHO categories, recommendations for SSI prevention were classified into high, moderate, low, and very low by GRADE (Appendix A).

Based on the guidelines, operating room nurses prevent SSI as follows: 1) operating room environment, 2) surgical attire and drapes, 3) asepsis surgical technique, and 4) risk factors for patients related to SSI

**Operating room environment.** The strategies to prevent SSI in the operating room environment issues include ventilation in the operating room, environment surface in the operating room, and sterilization of surgical instrument.

***Ventilation in the operating room.*** The operating rooms must keep the positive-pressure ventilation (Category IB). Air should be changed 15 times per hour, fresh air should be changed at least 3 times out of 15 times (Category IB). During the operation, the door should be closed except for transporting equipment, medical staff, and patients (Category IB). Controlling the number of the members of the medical team in the operating room is necessary (Category II). For total arthroplasty surgery, the laminar airflow ventilation system cannot reduce the incidence of SSI (Low to very low) (Berríos-Torres et al., 2017; Mangram et al., 1999; WHO, 2016, 2018).

***Environment surface in the operating room.*** The visible contaminated surface or equipment in the perioperative period must be cleaned by disinfectant (Category IB). Tacky mats should not be put in front of the operating room to prevent infection (Category IB). For contaminated or dirty surgery, there is no need to specially clean or close the operating room (Category IB). Appropriate hospital disinfectant should be used to clean the floor after the last operation (Category II) (Ban et al., 2017; Mangram et al., 1999).

***Sterilization of surgical instrument.*** All surgical instruments must be sterilized (Category IB). Flash sterilized instruments must be used immediately in emergency need (Category IB) (Mangram et al., 1999).

**Surgical attire and drapes.** To prevent SSI, the surgical team members need to wear a mask which should fully cover the mouth and nose, wear a cap to fully cover the hair, and they cannot wear shoe covers when they go in the operating room. For

the operation team members, they should wear sterile gowns and gloves after scrubbing hands. When visible contamination is found in the suit, it must be changed immediately (Category IB) (Berríos-Torres et al., 2017; Mangram et al., 1999).

**Asepsis and surgical technique.** In the asepsis and surgical technique, the strategies for the prevention of SSI include surgical hand antisepsis, surgical technique, surgical site preparation in the operating room, and antimicrobial prophylaxis.

***Surgical hand antisepsis.*** Before the operation, the medical staff should perform hand hygiene and forearms antisepsis while following recommendations: 1) nails must be short and decoration of nails removed (Category IB); 2) an appropriate agent (soap and water or alcohol-based agent) must be used to rub hands / forearms at least 2 to 5 minutes (Category IB, Moderate); 3) to prevent the water flow from elbows to finger hands must be kept up and away from the body, a sterile towel is used to dry hands before putting on the sterile gown and gloves (Category IB, Moderate); 4) hand or arm jewellery should be taken off before hand washing (Category II) (Berríos-Torres et al., 2017; Mangram et al., 1999; WHO, 2016, 2018).

***Surgical technique.*** All medical staff taking part in the operation must obey principles of asepsis. Preparing intravascular devices and intravenous drugs needs to follow principles of asepsis. Steps must be taken to prevent surgical patients from developing hypothermia (temperature < 36°C) during the operation. This could prevent SSI by decreasing vasoconstriction and increasing tissue oxygen (Mangram et al., 1999).

***Surgical site preparation in the operating room.*** Povidone-iodine, alcohol-containing products, and chlorhexidine gluconate are common and effective for patients' skin preparation in the operating room except when the patients has an allergy (Category IB, Low to moderate) (Berríos-Torres et al., 2017; Mangram et al., 1999; WHO, 2016, 2018). A systematic review of 19 randomized controlled trials (RCT) confirmed that chlorhexidine was more effective as an antimicrobial agent that reduces the incidence of SSI in skin preparation than other skin antiseptics. The authors showed that chlorhexidine had a statistically significant difference (risk ratio [RR] =.70; 95% CI: 0.52, 0.92) in reducing SSI from iodophor (Privitera et al., 2017).

***Antimicrobial prophylaxis.*** Existing guidelines pointed out that: 1) Choosing antimicrobial prophylaxis to prevent SSI depends on the clinical practice guidelines (Category IA, Low); 2) Antimicrobial prophylaxis should be provided within 2 hours before surgery, agent half-life, blood loss of more than 1,500ml (Category IA, Moderate); 3) For the caesarean section, the antimicrobial drugs could be provided before the operation (Category IA); and 4). Extra antimicrobial agents should not be given after skin closure in clean and clean-contaminated surgery (Category IA). For nonparental antimicrobial prophylaxis, antimicrobial agents should not be used in surgical site (Category IB) (Allegranzi et al., 2016; Ban et al., 2017; Berríos-Torres et al., 2017; Keely Boyle, Rachala, & Nodzo, 2018; Mangram et al., 1999).

***Risk factors for patients related to SSI.*** For the patient-related risk factors, they included age, diabetes, nicotine use, steroid use, obesity, malnutrition, hypoalbuminemia, long preoperative hospital stay, preoperative nares colonization with *Staphylococcus aureus*, and perioperative transfusion (Berríos-Torres et al., 2017; Mangram et al., 1999; WHO, 2016, 2018).

**Age.** The patients' age was an unmodifiable risk factor that might be related to patients' comorbidities or immune function. The data from England showed that the elderly patient ( $\geq 65$  years) had a high incidence rate of SSI (Public Health England [PHE], 2017). One article reported that 62% of patients out of 302 participants were more than 60 years old, and among them, 22.1% of participants developed SSI. Nearly half (49.3%) of the SSI patients were elderly (more than 60 years old) and after abdominal surgery, the advanced age was a risk factor contributing to SSI (Aga et al., 2015). After coronary artery bypass grafting (CABG), 5.08% of advanced age patients ( $\geq 65$  years old) significantly developed SSI as compared with those with ages less than 65 years old ( $p < .01$ ) (Pan, Tan, Cao, & Feng, 2018).

**Diabetes.** Diabetes could lead to hyperglycaemia and immune suppression after surgery. It was a significant risk factor, which related to the increased incidence of SSI after surgery (Mangram et al., 1999; Martin et al., 2016). It was found that diabetes could increase two times the incidence of SSI after spinal surgery (Fei et al., 2016). The patients with poorly controlled diabetes in posterior spine surgery had a higher incidence of SSI (Ojo, Owolabi, Oseni, Kanu, & Bankole, 2016). Another study found that 2.92% of patients with diabetes ( $n = 137$ ) had a high risk to develop SSI after CABG (Pan et al., 2018).

**Nicotine use.** Nicotine could cause tissue hypoxemia and decrease blood flow, which was a potential risk factor for SSI after fracture surgery (Scolaro et al., 2014). There was evidence that smokers need more time to heal the wound after acute fracture surgery and open fractures than non-smokers. The tobacco consumption was one risk factor for SSI in tibial plateau fracture surgery (Li et al., 2018). A study

reported that pregnant women who used tobacco had a higher risk (42.2%) to develop SSI than the control group (32.9%) after caesarean section (Vallejo et al., 2017).

Patients who smoked more than 30 packs per year as compared to those who smoked less than 30 packs per year could expect an increase in the incidence of SSI after major head and neck cancer surgery, as observed in one Korean tertiary referral hospital ( $p = .03$ ) (Son et al., 2018).

**Obesity.** Obesity could lead to tissue oxygenation decrease and prolonged wound healing (Ri, Aikou, & Seto, 2018). A meta-analysis pointed out that patients' BMI  $> 35 \text{ kg/m}^2$  could increase the incidence of SSI by two times as compared to patients with BMI between 30 to 35  $\text{kg/m}^2$  after spinal surgery (Fei et al., 2016). Patients' BMI  $> 35 \text{ kg/m}^2$  was an a risk factor ( $OR = 1.60$ , 95% CI:1.10,2.34,  $p = .02$ ) related to incidence rate of SSI after posterior cervical spine surgery (Sebastian et al., 2016). A study reported that the BMI of patients ( $30.0 \pm 8.5 \text{ kg/m}^2$ ) was one risk factor of SSI ( $OR = 1.03$ , 95% CI: 1.01, 1.04,  $p < .001$ ) (Wathen et al., 2016). In neurosurgery, Wathen et al. (2016) pointed out that patients with SSI had higher BMI ( $30.0 \pm 8.5 \text{ kg/m}^2$  as compared to those with BMI less than  $30 \text{ kg/m}^2$ ,  $p < .001$ ). A study conducted in a teaching hospital in Xinjiang China, showed that higher BMI ( $> 26.0 \text{ kg/m}^2$ ) ( $OR = 1.58$ , 95% CI: 1.09, 3.27,  $p = .03$ ) had nearly two times higher risk of developing deep SSI as compared to those with BMI less than  $26.0 \text{ kg/m}^2$ . The same study also found that 70.5% of patients (12 of 17) with deep SSI had higher BMI ( $> 26.0 \text{ kg/m}^2$ ) (Ma et al., 2018).

**Malnutrition.** Malnutrition was a risk factor associated with SSI, it could be examined by lost weight ( $> 4.5\text{kg}$ ), low BMI ( $< 20.5 \text{ kg/m}^2$ ) and hypoalbuminemia



(cut-off level: 3 g/dL). The data showed that 65 (62.5%) patients who had lost weight (> 5%) before surgery in 104 patients developed SSI after head and neck cancer surgery (Son et al., 2018). A study from the Johns Hopkins Hospital reported that 10 patients (7.6%) who had lost weight by more than 4.5 kg preoperative in 132 patients developed SSI after abdominal surgery (Ejaz et al., 2017). In Norway, 170 (14.2%) patients out of 1194 surgical patients were at risk of having nutrition problems, and among them 92 (7.7%) had low BMI (< 20.5 kg/m<sup>2</sup>). The authors pointed out that for patients who had lost weight (> 4.5kg, OR = 2.12, CI: 1.06-4.25, *p* = .003) during the preoperative phase, this was related to the SSI after abdominal surgery in Johns Hopkins Hospital (Ejaz et al., 2017). It was found that 11.8% of patients who had nutrition risks (such as low BMI, recent weight loss, food intake reduced recently, and critical illness) had a higher occurrence of SSI than patients without nutrition risk (7.0%) (Skeie et al., 2018).

***Hypoalbuminemia.*** The previous study showed that 22 (21%) patients (n = 137) who were diagnosed with hypoalbuminemia (< 3 g/dL) developed SSI after colorectal surgery and 6.3% of patients with low serum albumin (< 3 g/dL) developed SSI after posterior cervical spine surgery (Sebastian et al., 2016; Silvestri et al., 2018). A study conducted in Uganda illustrated that low serum albumin was associated with SSI (*p* = .004) after emergency surgery (Lubega et al., 2017). According to the review, hypoalbuminemia was a risk factor that was associated with SSI.

**Evidence-based practice for SSI in intraoperative phase in China.** In China, there were two existing guidelines for SSI prevention. One guideline (National Health Commission of the People's Republic of China, 2010) for all the medical staff members was posted in 2010, and the other guideline (Chinese Nursing Association

Operating Room Professional Committee, 2018) for operating room nurses was posted in 2014 and updated annually.

Compared with worldwide SSI prevention guidelines (Berríos-Torres et al., 2017; Mangram et al., 1999; WHO, 2016, 2018) and Chinese guidelines (CNAORPC, 2018; NHCPRC, 2010), in operating room environment strategies, Chinese guidelines did not mention the details about how to evaluate the quality of air in the operating room, the flash sterilization of dropped instruments for emergency use, and changing of surgical instruments before closure. In the domain of sterilization of surgical attire and drapes, there were no details about shoe covers and time to change surgical gowns/drapes in Chinese guidelines. In the domain of asepsis surgical technique, placement of intravascular devices and anaesthesia catheters, negative pressure wound therapy, and oxygen supply were not mentioned. In the domain of risk factors for patients related to SSI in the intra-operative period, Chinese guidelines did not provide more information except for patients with diabetes and prolonged preoperative hospital stay (CNAORPC, 2018; NHCPRC, 2010). The National Health Commission of the People's Republic of China (2010) pointed out that the sterile saline for incision flash should be around 37 °C and antibacterial drugs should be used when the operation lasts for more than 3 hours and blood loss is more than 1,500ml in the intra-operative period. A more detailed summary of similarities and differences among worldwide guidelines and Chinese guidelines is shown in Table 1.

Table 1

*Summary of Worldwide and Chinese Surgical Site Infection Prevention Guidelines*

Intra-operative phase		CDC, 1999, 2017	WHO, 2016, 2018	Chinese Nurses' Practice Guideline, 2018	Chinese SSI Prevention Guideline, 2010
Domain 1:	- To maintain positive-pressure ventilation	√	√	√	√
Operating Room Environment	- Limit the number of the operation staff	√	-	√	√
	- Clean surface of operating room	√	-	√	√
	- Microbiologic sampling	√	-	-	-
	- Sterilize surgical instruments	√	-	√	√
	- Perform flash sterilization only for patient care items that will be used	√	-	-	-
	- Changing of surgical instruments at the time of wound closure	-	√	-	-
Domain 2:	- Mask	√	-	√	√
Sterilization of surgical attire and drapes	- Cap	√	-	√	√
	- Do not wear shoe covers	√	-	-	-
	- Sterile gloves	√	√	√	√
	- Change gowns and drapes when wet	√	√	√	-
	- Change scrub suits when contaminated	√	-	√	-
	- Do not use plastic adhesive incision drapes	-	√	-	-

Table 1 (continued)

Intra-operative phase		CDC, 1999, 2017	WHO, 2016, 2018	Chinese Nurses' Practice Guideline, 2018	Chinese SSI Prevention Guideline, 2010
Domain 3 asepsis surgical technique	- Solution for skin preparation	√	√	√	√
	- Hair removal	√	√	-	√
	- Short nails	√	-	√	-
	- Do not wear jewellery	√	-	√	-
	- Placing all intravascular devices, spinal or epidural; anaesthesia catheters following the asepsis principle	√	-	-	-
	- Surgical scrub hand time	√	-	√	-
	- Hand washing water temperature	-	-	√	-
	- The steps of surgical hands scrub	√	-	√	√
	- Prophylactic negative pressure wound therapy	-	√	-	-
	- Patients skin preparation	√	√	√	√
	- The scope of skin disinfection	-	-	√	√
	- Prevent hypothermia	√	√	√	√
	- Oxygen therapy	-	√	-	-
	- Antibacterial prophylaxis before incision	√	√	-	√
	- Temperature of sterile physiological saline for incision	-	-	-	√

Table 1 (continued)

Intra-operative phase		CDC, 1999, 2017	WHO, 2016, 2018	Chinese Nurses' Practice Guideline, 2018	Chinese SSI Prevention Guideline, 2010
Domain 3	- Medical staff	√	√	√	√
asepsis	follow the aseptic				
surgical	technical				
technique	principles and				
	hand hygiene				
	standards				
	- Provide	-	-	-	√
	antibacterial more				
	if op is more than				
	3 hours or blood				
	loss is more than				
	1,500 ml				
Domain 4:	- Diabetes	√	√	-	√
Risk factors	- Nicotine use	√	-	-	-
for patients	- Steroid use	√	√	-	-
	- Malnutrition	√	√	-	-
	- Prolonged	√	√	-	√
	preoperative				
	hospital stays				
	- Preoperative	√	-	-	-
	transfusion				

*Note.* Symbol “-” = not mentioned, symbol “√” = mentioned.

### **Knowledge, Attitude, and Practice (KAP) Model**

It has been documented that the quality of nursing care is crucially related to nurses' knowledge, attitude, and practice to deliver evidence-based nursing care to patients. The knowledge, attitude, and practice (KAP) survey was first applied in connection with the family planning issue by Launiala in the 1950s (Launiala, 2009). The Launiala KAP model was used to understand the knowledge, attitude, and practice in various groups of people including pregnancy (Launiala, 2009), disaster

management among emergency medical personnel (Ahayalimudin & Osman, 2016), and food safety and hygiene (Al-Shabib et al., 2017; Zanin et al., 2017).

In addition, Rav-Marathe et al. (2016) revealed that there was a relationship between individuals' knowledge, attitude, and practice, and they identified that individuals' knowledge and attitude could impact their practice. In Malaysia, university students had a high level of knowledge. While they had only an average level of attitude and practice of sustainable consumption, strong relationships were found among their knowledge, attitude, and practice of sustainable consumption (Ahamad & Ariffin, 2018). The KAP model was used to understand the link between knowledge, attitude, and practice for caesarean SSI of Indonesia ward nurses (Novelia et al, 2017). In the United States, perioperative register nurses' knowledge and attitude could impact their practice of covering sterile tables based on existing guidelines. There was a positive significant relationship between perioperative register nurses' knowledge and practice, and their attitude and practice of covering sterile tables (Wicklin, 2018).

### **Nurses' Knowledge, Attitude, and Practice Regarding Prevention of SSI**

Depending on the review, nurses' knowledge, attitude, and practice of SSI prevention were inconsistent in other countries and in China as well.

#### **The level of nurses' knowledge, attitude, and practice in other countries.**

In Nigeria, a study showed that the surgical wards and operating room nurses in a teaching hospital had a high level of knowledge regarding SSI prevention but low level of practice, and poor attitude of prevention SSI (Kolade et al., 2017). The poor level of practice was mainly in the following aspects: 1) change wound dressing, 2)

compliance with surgical wound guidelines, 3) using gloves and protective devices, and 4) hand washing (Kolade et al., 2017). In Nepal, a previous study showed that 62.5% of operating room nurses had a high level of knowledge regarding aseptic technique at three hospitals in Bharatpur (Dhakal, Angadi, & Lopchan, 2016).

Regarding the nurses' knowledge of infection control, the authors pointed out that 53.9% of nurses had a good level of knowledge (score > 80%) and 91.1% of nurses had a good level of practice (score > 80%) in four Palestinian hospitals (Fashafsheh, Ayed, Eqtaït, & Harazneh, 2015). An Indian study showed that 54.69% of operating room nurses had very good knowledge of sterile technique and 68.75% of operating room nurses had good practice (Abraham et al., 2016). In Sweden, a national study showed that operating room nurses had a good level of knowledge and practice of aseptic technique and SSI prevention (Wistrand et al., 2018). In Bangladesh, 70% of surgical ward nurses had a low level of knowledge while 98.3% of them had a high level of practice regarding SSI prevention in one acute care hospital (Sickder, Sae-Sia, & Petpichetchian, 2014). Recently; however, there were only 44.5% of surgical nurses practiced SSI prevention regularly in three tertiary hospitals (Sickder, Lertwathanawilat, Sethabouppha, & Viseskul, 2017).

**The level of nurses' knowledge, attitude, and practice in China.** Based on the literature review, limited articles about operating room nurses' knowledge, attitude, and practice on SSI prevention were published in China. The researcher reviewed more previous studies about ward nurses' knowledge, attitude, and practice on SSI prevention (Table 2).

Table 2

*The Level of Knowledge, Attitude, and Practice and Their Relationship on SSI Prevention among Chinese Operating Room Nurses*

Citation	Setting/ location/ type	Sample size	Knowledge	Attitude	Practice	Relationship of KAP
(Jing & Bai, 2011)	- Southwest - Government republic tertiary hospital	N = 90	- 57.78% of nurses passed the average score	-	-	-
(Chen et al., 2013)	- East - Government and teaching tertiary hospital	N = 35	- 45.7% of nurses passed the average score	-	- 55.1% of nurses followed the Chinese SSI prevention guidelines for joint replaceme nt surgery	-
(Yang & Cheng, 2014)	- Capital city of China - Tertiary hospital	N = 245	- 49.7% of nurses passed the average score	-	- 69.1% of nurses passed the average score	-
(Zhou et al., 2014)	- The central region of China - Primary hospitals	N = 220 (20 operating room nurses)	- Only 10% of operating room nurses correctly answered risk factors, pathogens, antibiotic use, and skin preparation	- None of the medical staff was concerned about body microbial colonizatio n - More than 95% of medical staff was concerned about the importance of SSI prevention	- 39.2% of medical staff followed the Chinese practice guidelines of SSI prevention	-

*Note.* Symbol “-” = not measure



The operating room nurses' average score of SSI prevention knowledge was  $7.45 \pm 0.34$  points of 15 points, 49.7% of them got the average score in four tertiary hospitals in Beijing, but 69.1% of operating room nurses got the average score in practice (Yang & Cheng, 2014). Yang and Cheng (2014) pointed out that the most common weaknesses of operating room nurses' knowledge of SSI prevention involved the time when SSI (with implants) occurred after surgery (Table 2).

Among operating room nurses, 57.78% of them passed the average score of the SSI prevention knowledge test in Sichuan Provincial People's Hospital (Jing & Bai, 2011). In Zhejiang province, 45.7% of operating room nurses got an average score in the knowledge test regarding SSI prevention in joint replacement surgeries, but 55.1% of their practice obeyed the SSI prevention strategies according to observation (shown in Table 2) (Chen et al., 2013). The operating room nurses' knowledge and practice was weak in hand hygiene (Chen et al., 2013).

The previous study showed that surgical nurses' average score of SSI was  $6.33 \pm 2.20$  of 15 points, for only 52 (19.3%) nurses working in two hospitals in Beijing (Tao et al., 2009). The most common weakness of nurses' knowledge of SSI prevention was about antimicrobial prophylaxis (Tao et al., 2009). A survey was conducted at 12 primary hospitals in Hubei province, revealing that the medical staff (including 86 surgeons, 100 nurses, 20 operating room nurses, and 14 anaesthesiologist) had inadequate knowledge of SSI prevention. The average correct answer rate of surgeons was 46.1%; for surgical nurses it was 29.8%; and anaesthesiologist got 38.1% (Zhou et al., 2014). Medical staff working in different departments had a significant difference in knowledge regarding SSI prevention, as only 16.67% of nurses (20 out of 120 nurses) showed their highest level of knowledge

on SSI prevention (the details shown in Table 2) (Zhou et al., 2014). The study also found that 39.2% of medical staff (120 nurses and 100 doctors) passed the average score in practice tests of SSI prevention. Although 97.7% of them thought SSI prevention was important, none of them paid attention to patient's preoperative microbial colonization (Zhou et al., 2014). In Shanxi province, the researchers developed questionnaires based on the guidelines from CDC (Berríos-Torres et al., 2017; Mangram et al., 1999), WHO (WHO, 2016), and China (NHCPRC, 2010), 63.08% of nurses got the average score ( $9.35 \pm 1.24$  of 12 points), which ranged from 5 to 12 (Hao et al., 2018). The nurses' knowledge weakness was about hair removal, only 63.08% of nurses provided the correct answer (Hao et al., 2018).

In Shanghai city, a study was conducted in six hospitals which pointed out that 448 nurses out of 647 clinicians had a high level of knowledge (cut off level was  $43.48 \pm 9.9$  of 100 points) on healthcare-associated infections (Zhou et al., 2014). The nurses' knowledge weakness were healthcare-associated infection pathogen identification, isolation precautions, and personal protective equipment (PPE) use (Zhou et al., 2014). Based on the results of self-reported practice, 35% of nurses did not do hand hygiene after using computers and desks, 60% of them disinfected their stethoscopes and pocket watches to prevent infection, and 13.8% of nurses did not do medical waste management well (Zhou et al., 2014). According to the result of the attitude of safety and standard precaution, nurses were more aware of self-protection in preventing infection than they did to protect patients, as only 39.5% of nurses wear masks in the process of transporting patients (Zhou et al., 2014). Although 91.7% of nurses considered unsterile needles as a source of contamination, 71.4% of them

claimed to have sustained used needle stick injuries. Adherence to the standard precautions of nurses was suboptimal for prevention of infectious diseases. More than 79.9% of nurses would not report if they had contracted infectious diseases, such as herpes zoster, influenza, or acute haemorrhagic conjunctivitis (Zhou et al., 2014).

Chinese nurses either worked in the wards, ICU or operating room, and less than 80% of nurses had accepted knowledge scores of SSI prevention knowledge. There were no more than 60% of operating room nurses who passed the average score of knowledge questionnaire test in a previous study, either in the capital city or in other areas of China (Chen et al., 2013; Jing & Bai, 2011; Yang & Cheng, 2014; Zhou et al., 2014). For the SSI prevention practice test, more than 50% of operating room nurses could practice following the Chinese SSI prevention guideline in government tertiary hospitals (Chen et al., 2013; Jing & Bai, 2011; Yang & Cheng, 2014). However, only 39.2% of medical staff could follow the Chinese SSI prevention guideline in primary hospitals (Zhou et al., 2014). Moreover, the practice of SSI prevention also did not attain the recommendations of the guideline. In addition, most previous studies were only concerned about the level of knowledge (Hao et al., 2018; Jing & Bai, 2011; Tao et al., 2009), and only some article focused on nurses' knowledge and practice (Chen et al., 2013; Yang & Cheng, 2014; Zhou et al., 2014). Only one article reports about conducting research on nurses' knowledge, attitude and practice on health-associated infection (Zhou et al., 2014).

Based on the review, nurses' knowledge of SSI prevention was not ideal, and their level of practice and attitude on SSI prevention was unclear in China, especially among operating room nurses. Most of studies about knowledge, attitude and practice of SSI were conducted in the north and midlands of China (Chen et al., 2013; Tao et

al., 2009; Yang & Cheng, 2014; Zhou et al., 2014), and only one study was performed in southwest of China (Sichuan province) (Jing & Bai, 2011). There were limited studies about the nurses' knowledge, attitude, and practice of SSI prevention in rural southwest areas in China.

**The relationship between nurses' knowledge, attitude, and practice.** From the previous study, the researcher found that there was a correlation between knowledge and attitude among operating room nurses in Southern Thailand, but no correlation between knowledge and practice and no correlation between practice and attitude (Saksri et al., 2018). A study conducted in India also showed that operating room nurses' knowledge and practice of sterile technique had a weak negative relationship ( $r = -.27, p = .03$ ) (Abraham et al., 2016). However, a study conducted in Pakistan showed a strong significantly negative relationship ( $r = -.56, p = .000$ ) between nurses' knowledge and practice of SSI prevention in the surgical ward (Sadia, Kousar, Azhar, Waqas, & Gilani, 2017). In Pakistan, a study showed that a strong significant positive correlation ( $p < .001$ ) exists between surgical and operating room nurses' low level of knowledge and practice of SSI prevention (Sadaf et al., 2018). Sickder et al. (2014) showed that there was a weak and negative correlation between surgical ward nurses' knowledge and practice on SSI prevention ( $r = -.18, p = .04$ ). In Nigeria, a study illustrated that there was a significant positive relationship between attitude and practice ( $r = .76, p < .01$ ), a positive, moderate and significant relationship between knowledge and attitude ( $r = .70, p < .01$ ), and the same relationship between knowledge and practice ( $r = .57, p < .01$ ) of SSI prevention among surgical wards and operating room nurses (Kolade et al., 2017). In an Indian study, there was no statistically significant association between nurses' knowledge and practice of

infection prevention ( $r = .02, p = .90$ ) and faculty members' knowledge and practice ( $r = .08, p = .55$ ), even though there was a statistically significant relationship between interns and residents' knowledge and practice ( $r = .29, p = .03$ ) (Patil, Raval, & Chavan, 2018).

In China, a limited number of articles examined operating room nurses' knowledge, attitude, and practice of SSI prevention. There was only one article that examined health care workers' (including 10 operating room nurses) knowledge, attitude, and practice of SSI prevention (Zhou et al., 2014). Another article examined physicians' and nurses' knowledge, attitude, and practice on health associated infection (Zhou et al., 2014). Some authors were only concerned about one or two issues out of knowledge, attitude, and practice (Chen et al., 2013; Tao et al., 2009; Yang & Cheng, 2014). Based on the published articles, there was still no study conducted to measure the operating room nurses' knowledge, attitude, and practice on SSI prevention based on the worldwide guideline combined with national guidelines, and that categorized their level and explored the relationships between them, either for ward nurses or operating room nurses. Exploring the relationship between knowledge, attitude, and practice of SSI prevention in operating nurses in China could provide rich information that would be used for conducting intervention studies to promote knowledge, attitude, and practice for SSI prevention in operating room nurses to enhance the quality of nursing care especially in the perioperative phase.

**Factors related to nurses' knowledge, practice, and attitude.** The factors which could influence nurses' knowledge, practice and attitude include age, gender, education level, working experience, training courses, work demand, and medical facilities.

**Age.** According to the previous studies, the nurses who were more than 25 years old might have a high level of knowledge and practice. In Nepal, a previous study showed that 88.9% of nurses were more than 25 years old and had a high level of aseptic technique knowledge (Dhakal et al., 2016). A Jordanian study showed that nurses' age was associated with their total knowledge score of SSI prevention (Qasem & Hweidi, 2017). A survey showed that nurses who were more than 30 years old ( $OR = 1.79$ , 95% CI: 1.08, 2.97) had good practice of SSI prevention (Teshager, Engeda, & Worku, 2015). Desta et al. (2018) showed that both knowledge and practice of infection prevention was higher in the nurses aged 31 years old and more than was the case for younger nurses (age range from 21 to 25) in one hospital in northwest Ethiopia.

**Gender.** Based on the review, male nurses had a higher level of knowledge than female nurses. But the relationship between nurses' gender and their practice was still unclear. The authors pointed out that male nurses ( $F = 4.21$ ,  $p = .04$ ) had statistically significant differences on knowledge and practice of infection control from female nurses (Fashafsheh et al., 2015). A survey demonstrated that male nurses had a higher level of knowledge ( $OR = 3.22$ , 95% CI: 2.09, 4.95) than female nurses on SSI prevention in Ethiopia, but female nurses ( $OR = 2.35$ , 95% CI: 1.58, 3.50) had better practice than male nurses (Teshager et al., 2015). In Ethiopia, a study conducted in one teaching hospital showed that male health care workers had better practice performance than females ( $OR = 0.38$ , 95% CI: 1.12, 3.01,  $p = .02$ ) (Hussein, Estifanos, Melese, & Moga, 2017). Desta et al. (2018) pointed out that male medical staff members had a higher level of knowledge than females in infection prevention in northwest Ethiopia ( $OR = 2.05$ , 95% CI: 2.14, 5.82).

**Education level.** Based on the review, the results revealed that high educational level was statistically significant in nurses' level of knowledge. In four Palestinian hospitals, nurses with master's degrees had a high level of knowledge regarding infection control ( $F = 4.53, p = .01$ ) (Fashafsheh et al., 2015). In a study conducted in three Nepalese hospitals, 90.9% of nurses had a high level of aseptic knowledge for those with Bachelor and Master of nursing degrees ( $p = .04$ ) (Dhakal et al., 2016). Sadia et al. (2017) reported that nurses' education level could influence nurses' knowledge of SSI prevention, and in their study, nurses showed poor knowledge of SSI prevention and (91.6%) most of nurses had a nursing diploma in Pakistan.

A previous study revealed that 78.6% of nurses had a diploma certificate, which might be related to the low level of nurses' knowledge regarding caesarean section prevention on SSI in Indonesia (Novelia et al., 2017). A study was conducted in Jordan, where the data showed that 92% of nurses possessed a Bachelor-prepared degree, which may contribute to the low level of knowledge of SSI prevention (Qasem & Hweidi, 2017). A study conducted in Ethiopia claimed that the participants with Master's degree had the highest level of knowledge ( $OR = 3.03, 95\% CI: 1.86, 4.76$ ) and practice ( $OR = 4.15, 95\% CI: 1.38, 7.41$ ) in infection prevention as compared to Bachelor-degree participants and diploma certificate holders (Desta et al., 2018). In China, a survey conducted in five tertiary hospitals in Shanxi province showed that neurosurgical nurses with Bachelor degree are more knowledgeable of SSI prevention than nurses with Diploma ( $t = -2.87, p = .004$ ) (Hao et al., 2018).

In conclusion, the higher the level of educational the nurses had, the higher the level of knowledge they might have.

**Working experience.** The nurses who have worked for more than five years might increase their knowledge. A study in Pakistan showed that the working experience (less than 5 years) could influence nurses' knowledge regarding the prevention of SSI (Sadia et al., 2017). In ten Indonesian hospitals, 49.8% of nurses who had worked for no more than 5 years, might be one reason for nurses' low level of knowledge of SSI prevention (Novelia et al., 2017). In Jordan, the nurses' total work experience ( $M = 5.3$  years,  $SD \pm 2.94$ ,  $p < .01$ ) and surgical ward work experience ( $M = 3.3$  years,  $SD \pm 2$ ,  $p < .01$ ) potentially influenced the nurses' low level of knowledge of SSI prevention (Qasem & Hweidi, 2017).

Teshager et al. (2015) pointed out that nurses who had served more than 5-years ( $OR = 1.81$ , 95% CI: 1.12, 2.94) had more adequate knowledge of SSI prevention than those who worked five years or less. 52.7% of nurses with more than 5-year work experience had a high level of knowledge, but only 26.6% of nurses with five years or less work experience were knowledgeable (Teshager et al., 2015). Desta et al. (2018) showed that the participants working more than 10 years not only were more knowledgeable ( $OR = 4.03$ , 95% CI: 1.23, 5.68), but also had better practice than others who worked less than 5 years ( $OR = 3.17$ , 95% CI: 1.98, 5.67). In China, a study conducted in Taiyuan city, Shanxi province, showed that neurosurgical nurses had a good level of knowledge with more than 5 years' working experience, and nurses with more than 15 years working experience had the highest level of knowledge, which indicated that working experience was related with nurses' level of knowledge of SSI prevention (Hao et al., 2018). To sum up, the nurses who had more than five years working experience might have increased their level of knowledge and practice.



**Training course.** Training courses could improve nurses' level of knowledge and practice. In Indonesia, 83.1% of 201 nurses had a low level of knowledge which was associated with the fact that they did not attend to SSI prevention training classes (Novelia et al., 2017). A Jordanian study showed that nurses having a low level of knowledge regarding SSI prevention was related to whether they had been attending training courses and credit hours ( $M = 8.91$  hours,  $SD \pm 21.83$ ,  $p < .01$ ) (Qasem & Hweidi, 2017). In four Jordanian hospitals, 75% of nurses did not attend the training courses, which led to a low level of knowledge (Qasem & Hweidi, 2017). A study conducted in Northwest Ethiopia confirmed that the participants who participated in training ( $OR = 1.95$ , 95% CI: 1.27, 2.99) about infection prevention were more knowledgeable than those who did not attend (Teshager et al., 2015). In an Ethiopian teaching hospital, the health care workers with infection prevention training had better practice than others without training (Hussein et al., 2017).

In Nigeria, surgical and operating room nurses' lack of knowledge regarding postoperative wound infection was due to a lack of relevant training. It was reported that only 6% of nurses were educated about perioperative nursing (Famakinwa, Bello, Oyeniran, Okhiah, & Nwadike, 2014). In India, a study conducted in a medical center found that the low level of knowledge on SSI prevention among nurses was related to inadequate training (Patil et al., 2018). Health care workers with training of infection prevention also had higher level of knowledge ( $OR = 0.25$ , 95% CI: 1.69, 3.95) and practice ( $OR = 3.97$ , 95% CI: 2.58, 5.46). than without training (Desta et al., 2018). Tao et al. (2009) demonstrated that surgical nurses' poor knowledge of SSI prevention was related to the training course ( $p = .025$ ) in Beijing, China. Neurosurgical nurses with training had a higher level of knowledge than those who did not attend the

training ( $p < .001$ ) (Hao et al., 2018). In conclusion, the related training course could increase nurses' level of knowledge and practice.

**Work demand.** Work demand was one factor related to nurses' low level of knowledge and poor practice. Famakinwa et al. (2014) pointed out that 24.6% of nurses not having good knowledge of wound infection prevention was due to work demand. A study that was conducted in two hospitals in Vietnam illustrated that high workload was associated with poor practice of hand hygiene, 58.3% of poor practice on non-compliance with hand hygiene occurred in a rural hospital and 57.4% of poor practice on non-compliance with hand hygiene developed in an urban hospital (Chuc et al., 2018).

**Medical facilities.** Patil et al. (2018) claimed that 70.96% of nurses not having a high level of practice was related to the lack of surgical material. In northwest Ethiopia, medical staff (55.3% of them were nurses) working in the hospital with enough medical supply ( $OR = 2.16$ , 95% CI: 1.90, 4.36) had higher level of practice than those with limited medical facilities supply (Desta et al., 2018). In India, a study found that the reason that health caregivers' practice could not follow the infection control guidelines well might be associated with surgical material limitation (Patil et al., 2018). In Vietnam, inadequate medical facilities (such as surgical equipment or soap) might be one predictor of the poor practice of infection prevention (Chuc et al., 2018). In conclusion, the limited medical facilities might lead to nurses' low level of practice.

### **Measurement of Nurses' Knowledge, Attitude, and Practice of SSI Prevention**

To measure knowledge, attitude, and practice of SSI prevention among the ward nurses, the components of most of the knowledge questionnaires included time for aseptic technique, preoperative shower, hair removal, sterile dressing during intraoperative period, hand washing before and after surgery, and sterile technique used (Kolade et al., 2017; Novelia et al., 2017; Patil et al., 2018; Qasem & Hweidi, 2017; Sadaf et al., 2018; Sadia et al., 2017). Most of the response formats of knowledge questionnaires were multiple choice (Kolade et al., 2017; Labeau et al., 2010; Qasem & Hweidi, 2017; Saksri et al., 2018). There were four alternative answers to respond to the question, including one correct answer, two incorrect answers, and "I don't know" (Labeau et al., 2010; Qasem & Hweidi, 2017). The internal consistency of the knowledge questionnaires ranged from .69 (Desta et al., 2018) to .90 (Fashafsheh et al., 2015).

For the attitude questionnaires, the components of the attitude questionnaires were composed of the perception of implication of guideline, sterile dressing during intraoperative period, hand washing before and after surgery, and sterile technique usage (Kolade et al., 2017). The response format of the attitude questionnaires followed the 4-point Likert scale as "strongly disagree", "disagree", "agree", and "strongly agree" (Hussein et al., 2017; Kolade et al., 2017) and 5-point Likert scale as "strongly disagree", "disagree", "uncertain", "agree", and "strongly agree" (Saksri et al., 2018). The internal consistency of the attitude questionnaire yielded a Cronbach alpha coefficient of .70 (Saksri et al., 2018). For the practice questionnaires, the components of most of the questionnaires were related to those in the knowledge questionnaires. The response formats followed a 4-point Likert scale (Kolade et al.,

2017; Novelia et al., 2017; Saksri et al., 2018). The Cronbach alpha coefficient of practice questionnaires ranged from .70 (Saksri et al., 2018) to .88 (Kolade et al., 2017).

For the questionnaires to measure SSI prevention in operating room nurses in Thailand, Saksri et al. (2018) developed a series of questionnaires of knowledge, attitude, and practice among SSI prevention among operating room nurses based on guidelines (Berríos-Torres et al., 2017; Mangram et al., 1999; WHO, 2016). These questionnaires were tested by 105 operating room nurses in Southern Thailand. The components of knowledge, attitude, and practice questionnaires were categorized into four domains, as follows 1) operating room environment (5 items); 2) sterilization of surgical attire and drapes (5 items); 3) asepsis surgical technique (5 items); and 4) risk factors for patients related to SSI (5 items). The scale content validity index of the knowledge, attitude, and practice questionnaires were .87, .93 and .90, respectively (Saksri et al., 2018), whereas the test-retest reliability of knowledge was .70. The attitude and practice questionnaires yielded the Cronbach alpha coefficient of .70 and .70, respectively (Saksri et al., 2018). The multiple-choice knowledge scores ranged from 0 to 20 and were transformed into percentage. The researcher categorized the knowledge, attitude, and practice scores into five levels, as follows: < 60% = very low, 60% - 69.99% = low, 70% - 79.99% = moderate, 80% - 89.99% = high, and 90% - 100% = very high level of knowledge (McDonald, 2002).

For the attitude questionnaire (Saksri et al., 2018), it consisted of 31 items. The authors used positive and negative words to describe the questions consisting of 19 positive and 12 negative items. A 5-item Likert scale, ranging from strongly agree

(score = 5) through strongly disagree (score = 1), was used to examine the operating room nurses' feelings about the prevention of SSI. The negative scores were recoded and were then summed with the positive scores. The total score ranged from 31 to 155. Then, the interpreted scores were transformed to percentage after which the transformed scores were categorized into three levels as follows: < 50% = low, 50% - 79.99% = moderate, and 80% - 100% = high level of attitude (McDonald, 2002).

The practice questionnaire covered 24 items – 20 positive and 4 negative items (Saksri et al., 2018). The rating scale used for this questionnaire ranged from never practiced (score =0) through always practiced (score = 3). The negative scores were recoded and then were summed with the positive scores. The total score ranged from 0 to 72. Then, the interpreted scores were transformed to percentage after which the transformed scores were categorized into five levels as follows: < 60% = very low, 60%-69.99% = low, 70%-79.99% = moderate, 80%-89.99% = high, and 90%-100% = very high level of practice (McDonald, 2002).

In China, only two articles showed the reliability and validity of the knowledge questionnaire, but both of them only focused on surgical wards nurses. Tao et al. (2009) stated that the knowledge questionnaire items' Cronbach' alpha was .83, and the internal consistency of this knowledge questionnaire was .93. The questionnaire included 15 items based on CDC guidelines 1999. Hao et al. (2018) showed that the content validity index (CVI) was .88, and the test validity was .90. Chen et al. (2013) used their self-developed questionnaire and checklist to examine and observe the operating room nurses' level of knowledge and their practice in 120 joint replacement

operations. The researchers developed the questionnaire based on “Prevention of SSI in China, 2010”, “Basic Principle of Clinical Application of Antibacterial Drugs, 2004” and “Nosocomial Infection Prevention and Control Guideline” (Chen et al., 2013). This questionnaire included two parts (knowledge and practice of SSI prevention), and ten questions in each part (Chen et al., 2013). Yang and Cheng (2014) used a 5-point Likert scale to examine nurses’ practice. Only one article examined the health care workers’ attitude by asking ten questions, but the authors did not show the method of calculating the score (Zhou et al., 2014). In conclusion, previous studies were limited in examining knowledge, attitude, and practice of SSI prevention while at the same time categorizing their level of knowledge, attitude, and practice of SSI prevention to find out their correlation in China, especially for operating room nurses.

In this study, the knowledge, attitude, and practice questionnaires were modified from the questionnaires from the previous study (Saksri et al., 2018), because the series of questionnaires were developed based on the worldwide evidence of SSI prevention from well-established organizations including WHO (WHO, 2016, 2018) and CDC (Berríos-Torres et al., 2017; Mangram et al., 1999).

### **Surgical Site Infection Prevention in Hospitals in China**

In China, there are three grades of hospitals, which are graded by the scale of the hospital (such as number of beds, staff, and departments), the technical level of the hospital, medical equipment, the management level of the hospital, and hospital quality (Wikipedia, 2011). Those three grades of hospitals are tertiary, secondary, and primary hospital. Tertiary hospitals are comprehensive and general hospitals with more than 500 beds and all of them should provide specialist health services, medical

education, and research (Ministry of Health of the People's Republic of China [MHPRC], 1994; National Health Commission of the People's Republic of China [NHCPRC], 2016a; Wikipedia, 2011). The tertiary hospital was the highest-grade hospital in China. The secondary hospitals have more than 100 beds but less than 500 beds with comprehensive medical service for multiple communities. The primary hospitals have more than 20 beds but less than 100 beds and provide medical service for communities. The operating room is made available in the tertiary and secondary hospitals in China (MHPRC, 1994; NHCPRC, 2016a; Wikipedia, 2011).

To prevent SSI, Ministry of Health of People's Republic of China (now known as the National Health Commission of the People's Republic of China (NHCPRC)) published the government documents related to the training regulation of nosocomial hospital infection in 2006. This regulation guides all levels of hospital to develop and regularly provide training on nosocomial hospital infection including SSI prevention (NHCPRC, 2018). The hospitals developed a relevant training plan and, according to this regulation, the frequency of infection control training should not be less than four times per year (NHCPRC, 2018).

NHCPRC published the guideline named "Prevention of SSI in China, 2010", this guideline included classification of SSI, definition of SSI, and prevention of SSI. The prevention of SSI was separated into preoperative prevention, intraoperative prevention, and postoperative prevention. Comparing the existing Chinese nursing practice guideline (CNAORPC, 2018) with WHO (WHO, 2016, 2018) and CDC (Berríos-Torres et al., 2017; Mangram et al., 1999) guidelines for SSI prevention (Table 1), the data showed that Chinese operating room nursing practice guideline is mostly similar to those worldwide guidelines except for the domain of the risk factors

of patient-related to SSI. The CNAORPC guideline is used as an indicator to the daily work and specific operational behaviour of the operating room nurses. In the Chinese operating room nurses' practice guideline, the strategies of prevention of SSI include controlling operating room environment, sterilization of surgical attire and drape, and asepsis surgical technique.

Although the number of operating room nurses increased from 48,342 to 55,955 (Guo et al., 2017), the shortage of operating room nurses still persists. Therefore, this shortage of nurses would be related to the quality of SSI prevention in operating room. Although, 57.76% of hospitals trained operating room nurses every month in 94.56% of the hospitals in order to provide advanced training to improve the level of professional knowledge, but the contents were not specifically intended for SSI prevention.

The Chinese Nursing Association of Operating Room Professional Committee (CNAORPC) started the operating room specialist nurses training since 2008 (CNAORPC, 2018). Till 2017, 1,574 operating room specialist nurses have been trained and got the certification. However, unification of training materials, the application of specialist nurses, and the management still need improvement in China (Guo et al., 2017). For the operating room nurses' training, the first version of the operating room nurses' practice guideline was published in 2014 and updated every year by CNAORPC. All Chinese operating room nurses were trained by the same guideline of "Guide to Operating Room Nursing Practice, 2018" until now. This guideline includes aseptic technique, surgical position, electrosurgical safety, surgical isolation technique, patient safety management, instrument management, and infection control (CNAORPC, 2018). Based on the existing Chinese Nurses' Practice



Guidelines (CNAORPC, 2018), the operating room nurses from 39 hospitals accepted the same training by standardized operating criteria, hierarchical training, multi-station examination, and skills competition in Hunan province (Liu, Wang, Cao, & Zeng, 2016). This training method has been adopted nationwide and used since 2017.

In China, operating room nurses received training by the same above guideline and method. The operating room standardized specialist nurse training was started in 2009 in Guizhou Province. When the Chinese Nurses' Practice Guidelines were published, all the operating room nurses were trained by this guideline in Guizhou Province. Every year since 2017, at least two representatives of operating room nurses need to attend the city level of knowledge and skill competition from each hospital in nine prefectures and cities of Guizhou Province. The city-level competition winner would attend the provincial level competition, and then the winner could advance to the national level of knowledge and skill competition. The winners will become the instructors for training operating room nurses based on the guideline nationwide. Other participants would become lecturers in their city and province to provide standardized knowledge and practice to train operating room nurses in order to allow more operating room nurses to get the most standardized training in the shortest time.

### **Summary of Literature**

Surgical site infection (SSI) is a common and complicated problem after surgery. It could lead to extra medical cost, prolonged stay in the hospital, patients' discomfort, morbidity, and even mortality. Various factors could cause SSI, such as patients' health conditions, healthcare providers' behaviors, and environment in the operating room. The nurses play an important role in the prevention of SSI in the

perioperative period. Nurses who are knowledgeable, with a positive attitude and good at practice on SSI prevention could prevent SSI effectively. Operating room nurses work as a bridge to connect preoperative nursing care and postoperative nursing. In the operating room, nursing care includes ventilation; operating room environment; surgical hand antisepsis; sterilization of surgical instrument; surgical attire and drapes; and asepsis surgical technique.

The level of knowledge, attitude, and practice regarding prevention SSI in the operating room was inconsistent and their relationship was unclear. Intraoperative nursing practice on SSI prevention in China is based on standard precaution, nosocomial infection prevention regulations, Prevention and Control of SSI in China 2010, and operating room nurses' practice guideline (CNAORPC, 2018). According to the review, operating room nurses 'knowledge of SSI was below the average score and had some points of practice of SSI prevention that did not follow the updated guidelines.

To examine the nurses' level of knowledge, attitude, and practice (KAP), a questionnaire could be used to capture the operating room nurses' knowledge, attitude, and practice of SSI prevention. The outcome might find out not only the level of nurses' knowledge, attitude, and practice, but also the relationship between knowledge, attitude, and practice of SSI prevention among operating room nurses. It could also provide rich information that could be used for conducting intervention studies to promote knowledge, attitude, and practice for SSI prevention in operating room nurses to enhance the quality of nursing care, especially in the perioperative phase.

## **Chapter 3**

### **Research Methodology**

This chapter includes the research design, setting, population and sample, instruments, translation of the questionnaires, validity and reliability of instruments, ethical consideration, data collection, and data analysis to detect the level of operating room nurses' knowledge, attitude, and practice and their relationships.

#### **Research Design**

This study was a descriptive correlational design. The study was conducted at the operating rooms in 124 hospitals in Guizhou Province, China.

#### **Setting**

In this study, the setting for the survey consisted of operating rooms of nine prefectures' and cities' hospitals in Guizhou Province, China. The number of operating rooms was 1,038 and operating room nurses was around 2,481 which was shown in Table 3 (Appendix E). All 49 tertiary and 75 secondary care hospitals were recruited. All hospitals used the same guideline to train operating room nurses.

#### **Population and Sample**

**Target population.** In this study, the target population was the nurses working in the operating room in Guizhou Province, China. In Chinese hospitals, all operating room nurses are trained by the same practice guideline "Guide to Operating Room Nursing Practice, 2018", which was developed by Chinese Nursing Association

Operating Room Professional Committee (CNAORPC). This guideline includes aseptic technique, surgical position, electrosurgical safety, surgical isolation technique, patient safety management, instrument management, and infection control.

**Inclusion criteria.** The samples were selected if they met the following inclusion criteria as (1) having the diploma certificate in nursing at least and (2) having working experience in the operating room for more than half a year.

**Sample and sample technique.** Based on the previous study of SSI prevention, the correlation between knowledge, attitude and practice ranged from .18 to .76 (Kolade et al., 2017; Saksri et al., 2018; Sickder et al., 2014). In this study, the minimum correlation of .18 was chosen due to different setting, environment, and population. The sample size of this study was estimated for a desired significance level of .05 and power of .80 (Polit & Beck, 2012). Therefore, a minimum sample size of 194 could provide a significant correlation between knowledge, attitude, and practice among operating room nurses (Polit & Beck, 2012).

The convenience sampling technique was used in this study. The researcher provided the questionnaires to all 2,481 operating room nurses in nine prefectures' and cities' hospitals in Guizhou Province, China through the Wen Juan Xing plus WeChat platform. The participants were recruited from 124 hospitals including 49 tertiary hospitals and 75 secondary hospitals in Guizhou Province, China (Appendix E). The questionnaire was distributed to all 124 hospitals through Wen Juan Xing plus WeChat platform. There were approximately 50 % ( $n = 1,215$ ) of operative nurses who uploaded the questionnaires by Wen Juan Xing. Based on the including criteria, 1,036 participants (85.27%) were recruited in the analysis. However, there were 37

participants with extreme outlier data; therefore, only 999 data were used for final data analysis.

### **Instruments**

The set of questionnaires consisted of four parts: Part A was the Demographic Characteristic Questionnaire; Part B was the Knowledge on SSI Prevention Questionnaire; Part C was the Attitude on SSI Prevention Questionnaire; Part D was the Practice on SSI Prevention Questionnaire; and Part E was the Additional Open-ended Question (Appendix B).

**Part A: Demographic Characteristics Questionnaire.** There were 12 items including age, gender, level of hospital, education level, working experience in the operating room, expertise area in the operating room, weekly and daily working hours, current work demand, application of SSI prevention guideline, infection control training situation, methods of training, and policies (Appendix B).

**Part B: Knowledge on SSI Prevention Questionnaire.** The Knowledge Questionnaire was modified from the Knowledge Questionnaire (Saksri et al., 2018) and the latest guidelines (CNAORPC, 2018; WHO, 2018), it was used to examine the knowledge about prevention of SSI among operating room nurses. There were 20 multiple choice questions in the original questionnaire. The response format for the question was changed from multiple choices into True/False response format. The item number 10 in original questionnaire was separated into 3 items to enable participants to understand the question easily and choose the answer. Item No. 14 was changed from “Traumatic surgical closure of the abdomen with Jackson trachea

drainage means use the fixomull, transpore or micropore to separate the wound between the surgical incision and the Jackson pack drain” into “Use adhesive tape to cover the traumatic incision wound separated from the tube drainage”. The questionnaire covered 4 components (22 items): 1) operating room environment (5 items); 2) sterilization of surgical attire and drapes (7 items); 3) asepsis surgical technique (5 items); and 4) risk factors for patients related to SSI (5 items). The response format was a True/False format (Appendix B). There were two alternative answers for each item. The correct response for each item had a score of 1. The incorrect one got 0 score. The total score ranged from 0 to 22. The score was transformed into a percentage. The higher score illustrated the higher level of knowledge. The transform percentage score was categorized into five levels as follows (McDonald, 2002):

Mean percentage of total score	Level of knowledge
< 60%	very low
60% - 69.99%	low
70% - 79.99%	moderate
80% - 89.99%	high
90% - 100%	very high

**Part C: Attitude on SSI Prevention Questionnaire.** The attitude questionnaire was modified from the Attitude Questionnaire (Saksri et al., 2018) and the latest guidelines (CNAORPC, 2018; WHO, 2018). The attitude questionnaire used a 5-item Likert scale to examine the operating room nurses’ perception and feeling about the prevention of SSI. There were 31 items in the original questionnaire,

including 22 positive items and 9 negative items. The researcher also modified the questionnaires to make it easy to understand the statement of each item. The questionnaire covered 4 components (31 items): 1) operating room environment (9 items); 2) sterilization of surgical attire and drapes (6 items); 3) asepsis surgical technique (6 items); and 4) risk factors for patients related to SSI (10 items). The questionnaire included 23 positive and 8 negative items (Appendix B). For the positive items, the score was as follows: (1) Strongly agree = 5; (2) Agree = 4; (3) Uncertain = 3; (4) Disagree = 2; and (5) Strongly disagree = 1. On the other hand, the score for negative items was as follows: (1) Strongly agree = 1; (2) Agree = 2; (3) Uncertain = 3; (4) Disagree = 3; and (5) Strongly disagree = 5. The negative scores were recoded and were then summed with the positive scores. The total score ranged from 31 to 155. The score was transformed into percentage and then the transformed score was categorized into three levels as follows (McDonald, 2002):

Mean percentage of total score	Level of attitude
< 50%	negative
50% - 79.99%	neutral
80% - 100%	positive

**Part D: Practice on SSI Prevention Questionnaire.** The practice questionnaire was modified from the Practice Questionnaire (Saksri et al., 2018) and the latest guidelines (CNAORPC, 2018; WHO, 2018), it was used to examine the practice about prevention of SSI among operating room nurses. There were 24 items in the original questionnaire. Based on experts' suggestions, item 13 and item 20 were removed because both of them were the general idea for SSI prevention. The

questionnaire included 22 items (Appendix B). The questionnaire covered 4 components (22 items): 1) operating room environment (9 items); 2) sterilization of surgical attire and drapes (5 items); 3) asepsis surgical technique (4 items); and 4) risk factors for patients related to SSI (4 items). The 4-rating scale was used for practice questionnaire as follow: (1) Never practice = 0; (2) Seldom practice = 1; (3) Sometimes practice = 2; and (4) Always practice = 3. The total score ranges from 0 to 66. The researcher converted the score into percentage and categorized the transformed score into five levels as follows (McDonald, 2002):

Mean percentage of total score	Level of practice
< 60%	very low
60% - 69.99%	low
70% - 79.99%	moderate
80% - 89.99%	high
90% - 100%	very high

**Part E: Additional open-ended questions.** To get more understanding of the facilitating and obstacle issues related to the knowledge, attitude, and practice of SSI prevention in operative nurses, nine additional open-ended questions were added to ask the participants who agreed to do this additional session after they submitted the main questionnaires online. The 9 additional open-ended questions were developed based on the qualitative survey literature review (Al-Khateeb, Safadi, Najjar, & Adwan, 2018; Sickder et al., 2017). The additional open-ended questions included the following: 1) the importance of SSI prevention and the reason for the importance of SSI prevention; 2) the operating room nurses' practice of SSI prevention; 3) the



facilitated factors to improve operating room nurses' knowledge of SSI prevention and the reason; 4) the barriers to impede operating room nurses' knowledge of SSI prevention and the reason; 5) the facilitating factors to improve operating room nurses' attitude of SSI prevention and the reason; 6) the barriers to impede operating room nurses' attitude of SSI prevention and the reason; 7) the facilitating factors to improve operating room nurses' practice of SSI prevention and the reason; 8) the barriers to impede operating room nurses' practice of SSI prevention and the reason; and 9) suggestions for improving SSI prevention (Appendix B).

### **Translation of the Questionnaires**

Back translation technique was used to translate all of the questionnaires (Polit & Beck, 2012). The original questionnaires were in the Thai language. The steps of back-translation were as followed. Firstly, the Thai version of Knowledge, Attitude, and Practice of SSI prevention Questionnaires were translated into English language by the researcher's thesis advisor (Asso. Prof. Dr. Wipa Sae-Sia) who was one of original questionnaire developer. Secondly, the English version of the questionnaires was translated into the Chinese language by the researcher. Thirdly, the Chinese version of questionnaires was translated back into English version by a medical lecturer with a Doctor's degree in China. Finally, the original English versions and the back-translated English version were evaluated in terms of the accuracy of the translation, cross-cultural issues and equivalency of the meaning by a bilingual English expert, who is an English language lecturer with a master's degree in China.

### **Validity and Reliability of the Instruments**

The content validity of the English version questionnaires (Appendix B) was assessed by a panel of five experts. One expert is a nursing educator from the Faculty of Nursing in Thailand, Prince of Songkla University; the other four experts were from China, one was an expert operating room nursing educator and a head nurse of operating room from Guizhou Provincial People's Hospital, one was a medical educator with Doctor degree in Guizhou Medical University, one was a head nurse of operating room in 363 Hospital in Sichuan Province with a ten-year working experience, and the last one was a operating room nurse and nursing educator in Sichuan Provincial Hospital for Woman and Children with a ten-year working experience. The content validity of the English version questionnaires was .83, .89, and .94 for Knowledge Questionnaire, Attitude Questionnaire, and Practice Questionnaire, respectively. For internal reliability, the questionnaires were tested with 20 nurses who worked in two public hospitals (more than 501 beds) in Guiyang city. The Kuder-Richardson formula 20 (KR-20) was used to test the internal consistency reliability of the Knowledge Questionnaire. The Cronbach Alpha internal reliability was used for Attitude and Practice Questionnaires. The reliability of Knowledge, Attitude, and Practice Questionnaires were .72, .84, and .97, respectively. Therefore, the reliability of more than .80 for all questionnaires was accepted (Polit & Beck, 2012).

### **Ethical Consideration**

With regard to the rights of human subjects, this study obtained approval and permission both from the Social and Behavioral Science, Institutional Review

Board (IRB), Prince of Songkla University (PSU), Thailand and the IRB of Guizhou Provincial People's Hospital. The survey was conducted using two mobile Applications, one was Wen Juan Xing, the other one was WeChat. After obtaining approval from all relevant institutions, the researcher contacted the head nurses, or one nurse of the operating rooms and explained the objectives of this study by the WeChat platform. The researcher sent out the Invitation Letter to all participants by Wen Juan Xing before starting the survey.

After the contact person understood the meaning of this survey, the researcher provided the quick response (QR) code and link of the questionnaire to the head nurse or one nurse working in the operating room and asked them to distribute it to their operating room nurses through Wen Juan Xing plus WeChat platform. An Informed Consent Form (Appendix C) was sent to the participants explaining the objective and details of the research to them through the application Wen Juan Xing. When the participants pressed the agree button after reading and understanding the Informed Consent Form in Wen Juan Xing, this proved the participants were willing to join this study. The questionnaire was provided to the participants. When the first two participants submitted the questionnaire in each hospital, they were provided the QR code and link of an open-ended questionnaire through WeChat plus Wen Juan Xing. They could fill out this questionnaire based on their willingness. The researcher kept the information and identity of the respondents confidential by using a coding system.

## **Data Collection Procedures**

Data collection was conducted among all operating room nurses in Guizhou Province in China, from May 2019 to August 2019. The steps for collecting data were as follow:

**Preparation phase.** Two mobile applications were used in this study to collect data. One was the WeChat platform to communicate with the participants; the other was Wen Juan Xing to provide the questionnaire and to collect data. The preparation phase consisted of the following steps: 1) obtaining approval from the Social and Behavioral Science, Institutional Review Board , Prince of Songkla University , Thailand; 2) acquiring official permission for collecting data from the IRB of Guizhou Provincial People’s Hospital; 3) informing the head nurses or one nurse in the operating room about the objectives and details of the study by WeChat platform; 4) Using WeChat platform to communicate with the head nurses or one nurse in the operating room in Guizhou Province, and ask them to pass on the information and provide the QR code and link with Informed Consent Form (Appendix C) to the population, and to explain the objectives and details of the research to the participants by application WeChat platform plus Wen Juan Xing; 5) getting permission and approval from the participants through the application Wen Juan Xing (When the participants press the “agree” button referred to, they agree to join in the research); 6) the participants filled out and submitted the questionnaire through Wen Juan Xing; 7) the first two participants in each hospital who submitted the questionnaire were provided with the open-ended questionnaire; 8) evaluating the completed outcome of the responses received through application Wen Juan Xing.

The application Wen Juan Xing is an application controlled by a private company, which is used for distributing questionnaires, exams, and voting. Wen Juan Xing can support six kinds of questionnaires: 1) questionnaires, 2) online exams, 3) online voting, 4) registration forms, 5) assessments, and 6) online evaluation. Using WeChat platform and Wen Juan Xing provided questionnaires to examine nurses training result, as this type of paperless test could reduce the cost for education materials, reducing location limitations, and save time in examining nurses' cognitive of patients' falling (Xi & Liu, 2017). The researcher set the limit for terminal and IP address entered on the questionnaire to avoid the participants' location would be outside of Guizhou Province. The researcher used the WeChat platform to provide questionnaires to collect the data on Wen Juan Xing.

The questionnaire-tested process was controlled by the researcher using computer and mobile phone. The researcher set the process in such a manner that the incomplete questionnaires cannot be submitted, which was to ensure the integrity of the questionnaire response. The researcher set the limitation of location in Guizhou Province to eliminate participants who did not work in Guizhou Province. The researcher determined that the participants needed to use WeChat ID to answer the questionnaire. This ascertained that when the participants were interrupted due to various reasons, they could return to the position where the question was last answered. The data collection started from June 10th until August 7th. Firstly, the researcher uploaded the Invitation Letter, Informed Consent Form (Appendix C), and the questionnaires into the application Wen Juan Xing. Secondly, the researcher tested the procedure and process of the questionnaire in Wen Juan Xing by WeChat ID. Thirdly, the researcher provided

QR code and link to a contact person in the operating room in each hospital in Guizhou Province. Lastly, the researcher was ensured adherence of the nurses to know the essence of the study and the time to complete the questionnaires in WeChat.

**Implementation phase.** The implementation phase consisted of the following steps:

1. The researcher communicated and explained the purpose of the study to the contact nurses working in the operating room by WeChat.
2. The researcher used the inclusion criteria to select the target participants from the demographic data.
3. The researcher asked the contact nurses to explain the purpose of this study through the WeChat platform and provided a quick response (QR) code and link of Invitation Letter and Informed Consent Form (Appendix C) to every participant before giving the questionnaire through the application Wen Juan Xing.
4. After reading the Invitation Letter and Informed Consent Form (Appendix C), if the participants were willing to join the survey and pressed the “agree” button, the questionnaires were shown instantly by Wen Juan Xing.
5. When participants submitted the questionnaire, the system recorded the time they submitted.
6. Based on upload time, the first two participants in each hospital were provided open-ended questionnaires.
7. The researcher contacted the head nurse or one of the operating room nurses in their hospital again and asked them to send the QR code of open-end questionnaire to the first two participants by WeChat plus Wen Juan Xing.

8. The researcher asked all the participants to complete and to submit the questionnaires before the end date.

9. The researcher checked the completion of all questionnaires by computer and mobile phone.

10. The researcher gave a code to every participant instead of their real information, and an assurance that all the data would be destroyed 3 to 5 years after the research will be published.

### **Data Analysis**

There was a total of 1,215 operating room nurses who submitted the questionnaires until the researcher closed the questionnaire transmission channel in Wen Juan Xing. Based on inclusion criteria, 1036 participants were included in this survey. Data were analyzed using descriptive and inferential statistics. The assumption of normality, linearity, and homoscedasticity were tested. In the Practice Questionnaire, the assumption was not met. There were 37 participants with an extreme percentage (less than 25 percentage points) in the Practice Questionnaire. Based on the abnormal distribution of assumption, the researcher rechecked the original questionnaires. 16 participants only selected 'never practice' for their response for all items. The researcher removed these participants, because these participants might have unintentionally response to the Practice Questionnaire at the end of the survey. Then, the data of 21 participants were included into the analysis. However, the skewness results of mean score and mean score percentage of Knowledge Questionnaire, Attitude Questionnaire, and Practice Questionnaire were huge. When the distribution of mean score and mean score percentage of Practice

Questionnaire were tested, the assumption of normality was not met. Therefore, the other 21 participants were also removed for data analysis. After having removed the 37 participants, the researcher tested the distribution of mean score and mean score percentage of the Knowledge Questionnaire, Attitude Questionnaire, and Practice Questionnaire again, the assumption of normality was met. Finally, 999 data were enrolled in the final analysis.

The researcher used descriptive statistics to test the frequency, mean, standard deviation (*SD*), and the range among the demographic characteristics, knowledge, attitude, and practice scores. The level of knowledge, attitude, and the practice of SSI prevention were interpreted in percentage and described with percentage-mean score and percentage-standard deviation. Pearson product-moment correlation was used to examine the correlation between knowledge and attitude, the correlation between knowledge and practice, and the correlation between attitude and practice. The assumption of normality, linearity, and homoscedasticity were tested. The assumptions were met.

For the data of additional open-ended questions, the Ecological Systems Theory was used to analyze this additional information (Onwuegbuzie, Collins, & Frels, 2013). The additional information was categorized into personal level, organizational level, and policy/national level (Onwuegbuzie et al., 2013).



## Chapter 4

### Results and Discussion

This chapter includes the results and discussion of this study. The results are composed of three parts: 1) participants' demographic characteristics; 2) the operating room nurses' knowledge, attitude, and practice of SSI prevention; and 3) the relationship between knowledge, attitude, and practice of SSI prevention among operating room nurses.

#### Results

**Participants' demographic characteristics and relative information.** There were 999 participants in this study. The demographic data and relative information are shown in Table 3.

Table 3

*Demographic Characteristics and Relative Information of Participants (N = 999)*

Variables	<i>n</i>	%
Age (years) ( <i>M</i> = 31.30, <i>SD</i> ± 6.47, <i>Min-Max</i> = 20-57)		
20-29	469	47.0
30-39	427	42.7
40-49	83	8.3
50-59	20	2.0
Gender		
Female	829	83.0
Male	170	17.0
Location of hospital		
Guiyang	277	27.7
Zunyi	157	15.7
Tongren	121	12.1
Qianxinan State	117	11.7
Anshun	75	7.6

Table 3 (continued)

Variables	<i>n</i>	%
Location of hospital (continued)		
Qiannan State	74	7.4
Bijie	72	7.2
Qiandongnan State	56	5.6
Liupanshui	50	5.0
Level of hospital		
Tertiary	647	64.8
Secondary	352	35.2
Education		
Diploma's degree	389	39.0
Bachelor's degree	566	56.6
Master's degree	4	0.4
Ph.D.	1	0.1
No specify	39	3.9
Working experience (years)		
<i>(M = 7.32, SD ± 6.13, Min-Max = 0-40)</i>		
< 5	378	37.9
5-10	440	44.0
11-15	87	8.7
16-20	52	5.2
21-25	21	2.1
26-30	12	1.2
31-35	7	0.7
36-40	2	0.2
Expertise area of surgery		
Abdominal	274	27.4
Orthopaedic	251	25.1
Obstetrics and gynaecology	211	21.1
Urinary system	65	6.5
Other (General, Laparoscope, etc.)	50	5.0
Neurosurgery	47	4.7
Cardiothoracic surgery, thoracic	37	3.7
Ophthalmology	19	2.0
Ear, Nose, and Throat	17	1.7
Paediatric surgery	13	1.3
Oral	10	1.0
Plastic surgery	3	0.3
Vascular surgery	2	0.2
Level of workload		
High	390	39.0
Appropriate	600	60.1
Low	9	0.9

Table 3 (continued)

Variables	<i>n</i>	%
Guidelines in hospitals		
No	328	32.8
Yes	671	67.2
Infection Control Department		
No	85	8.5
Yes	914	91.5
Practice follow Chinese guidelines		
No	375	37.5
Yes	624	62.5
Frequency of training SSI prevention (from 2017 to 2019)		
< 5	666	66.7
5-10	188	18.8
> 10	145	14.5

*Note:* *n* = frequency; *M* = Mean; *SD* = Standard deviation; *Min* = Minimum; *Max* = Maximum

The participants' age ranged from 20 to 57 years old, with a mean age of 31.30 ( $SD \pm 6.47$ ) years old. 83% of participants were female and 17% of participants were male. The participants were recruited from 9 different prefectures' and cities' hospitals in Guizhou Province. Only tertiary and secondary care hospitals were included. From those 9 prefectures and cities with 124 hospitals, 49 hospitals were tertiary care hospitals and 75 hospitals were secondary care hospitals. More than half (64.8%) of the participants were from tertiary care hospitals. Majority of the participants ( $n = 277$ , 27.7%) were from Guiyang city. The smallest number of participants' responses was from Liupanshui city ( $n = 50$ , 5.0%).

In terms of the level of education, 56.6% ( $n = 566$ ) of participants got a bachelor's degree, followed by 39.0% ( $n = 389$ ) of them who got a Diploma certificate. The participants' working experience was from 6 months to 40 years with a mean working experience of 7.32 ( $SD \pm 6.13$ ) years. The top three expertise areas in

operating room of the participants were abdominal surgery ( $n = 274$ , 27.4%), followed by orthopaedic surgery ( $n = 251$ , 25.1%), and obstetrics and gynaecology ( $n = 211$ , 21.1%). For the current workload, 39.0% ( $n = 390$ ) of participants thought it was high. In these 9 prefectures' and cities' hospitals, 91.5% ( $n = 914$ ) of participants knew that there was the infection control department to control and evaluate their quality of SSI prevention practice. However, only 62.5% ( $n = 624$ ) of participants indicated their practice following the guideline.

For the relative SSI prevention training, there were 66.7% of participants who took part in the training program less than 5 times from 2017 to 2019.

Table 4

*Knowledge, Attitude, and Practice of SSI Prevention of Participants Categorized by Each Domain (N = 999)*

SSI Prevention	M (%)	SD (%)	Level
<b>Knowledge of SSI prevention</b>			
Domain 1	73.77	12.88	Moderate
Domain 2	77.88	12.99	Moderate
Domain 3	64.50	17.75	Low
Domain 4	51.79	18.80	Very low
Total	67.98	7.96	Low
<b>Attitude of SSI prevention</b>			
Domain 1	84.95	9.73	Positive
Domain 2	84.92	12.56	Positive
Domain 3	77.94	9.65	Neutral
Domain 4	77.60	9.68	Neutral
Total	81.26	7.55	Positive
<b>Practice of SSI prevention</b>			
Domain 1	82.12	18.91	High
Domain 2	94.17	15.52	Very high
Domain 3	93.39	15.10	Very high
Domain 4	69.68	22.22	Low
Total	84.65	13.50	High

*Note:* Domain 1 = Operating room environment; Domain 2 = Sterilization of surgical attire and drapes; Domain 3 = Asepsis surgical technique; Domain 4 = Risk factors for patients related to SSI.

### The operating room nurses' knowledge, attitude, and practice of SSI

**prevention.** As shown in Table 4, the overall operating room nurses' level of knowledge regarding SSI prevention was at a low level ( $M = 67.98\%$ ,  $SD \pm 7.96\%$ , 95% CI: 67.48, 68.47). It was found that domain 4 of risk factors for patients related to SSI was at a very low level ( $M = 51.79\%$ ,  $SD \pm 18.80\%$ ). The overall operating room nurses' level of attitude regarding SSI prevention was positive ( $M = 81.26\%$ ,  $SD \pm 7.55\%$ , 95% CI: 80.75, 81.69). When considering each domain, the participants had the attitude in domain 3 of asepsis surgical technique ( $M = 77.94\%$ ,  $SD \pm 9.65\%$ ) and domain 4 of risk factors for patients related to SSI ( $M = 77.60\%$ ,  $SD \pm 9.68\%$ ) both at neutral levels. In addition, the overall level of practice regarding SSI prevention was at a high level ( $M = 83.81\%$ ,  $SD \pm 13.50\%$ , 95% CI: 83.81, 85.48). However, the participants had a low practice level on domain 4 of risk factors for patients related to SSI ( $M = 69.68\%$ ,  $SD \pm 22.22\%$ ).

Table 5

*Frequency and Percentage of Participants' Knowledge, Attitude, and Practice Categorized by Each Level (N = 999)*

Level	Knowledge <i>n</i> (%)	Attitude <i>n</i> (%)	Practice <i>n</i> (%)
Very low	180 (18.0)	-	55 (5.5)
Low/Negative*	434 (43.5)	4 * (0.4)*	39 (3.9)
Moderate/Neutral*	323 (32.3)	401 *(40.1)*	142 (14.2)
High/Positive*	58 (5.8)	594 *(59.5)*	376 (37.6)
Very high	4 (0.4)	-	387 (38.8)

*Note:* \* refers to Attitude level

***Frequency and percentage of participants with each level of knowledge, attitude, and practice.*** 61.5% ( $n = 614$ ) of participants had low to very low levels of knowledge including 18% ( $n = 180$ ) of them having a very low level of knowledge regarding of SSI prevention. Based on the results, 59.5% ( $n = 594$ ) of participants had a high level of, or in other words positive, attitude in SSI prevention. In terms of practice, 76.4% ( $n = 763$ ) of participants had their practice of SSI prevention in the high to very high levels as shown in Table 5.

***The highest and lowest levels of knowledge, attitude, and practice of SSI prevention.*** The top three issues for correctness of knowledge were: 1) surgical caps/hoods should be used when entering the operating room ( $n = 989, 99.0\%$ ); 2) keep the operating room door closed ( $n = 980, 98.1\%$ ); and 3) replaced surgical gowns and drapes when wet or permeable ( $n = 978, 97.9\%$ ). The top three incorrect issues of knowledge were: 1) ventilation system maintains positive pressure and air replacements 30 rounds per hour ( $n = 901, 90.2\%$ ); 2) patients receiving complete nutrition can increase metabolic rate and promote wound healing ( $n = 760, 76.1\%$ ); and 3) wearing a mask to cover the nose is to prevent blood and secretion splashing during surgery ( $n = 651, 65.2\%$ ) (Table 6).

***The highest and lowest levels of attitude of SSI prevention among operating room nurses.*** The operating room nurses had a positive attitude on SSI prevention. The top three positive attitude issues on SSI prevention were: 1) air filters should be regularly inspected and replaced ( $n = 767, 76.8\%$ ); 2) the air in the operating room should pass air filter and meet the quality standards ( $n = 695, 69.5\%$ ); and 3) strictly limit the number of people entering the operating room during operation. ( $n = 686, 68.7\%$ ). All of the top three positive attitude issues were in Domain 2.

On the other hand, the top three negative attitude issues on SSI prevention were: 1) no need to store hair into a surgical cap, when entering the operating room ( $n = 709$ , 71.0%); 2) no need to change surgical gowns and drapes, when wet or permeable ( $n = 619$ , 62.0%); and 3) no need to change bed linen when new surgery ( $n = 547$ , 54.8%) (Table 6).

For the response of uncertain attitude, the top three uncertain items were as follows: 1) providing 80% oxygen to patient during and after surgery could reduce surgical site infection ( $n = 314$ , 31.4%), 2) making tools and equipment warm could reduce surgical site infection ( $n = 307$ , 30.7%), and 3) compliance with guidelines to prevent surgical site infection is difficult due to lack of equipment ( $n = 168$ , 16.8%). The top two uncertain attitudes were in Domain 4, the third one was in Domain 3 (Table 6).

***The highest and lowest levels of practice of SSI prevention among operating room nurses.*** Based on the results, the top three items of regular practice of SSI prevention were: 1) wearing a mask when entering the operating room ( $n = 940$ , 94.1%); 2) storing hair into a surgical cap when entering the operating room ( $n = 940$ , 94.1%); and 3) wearing sterilized gloves after wearing surgical gown ( $n = 926$ , 92.7%). All of the top three regularly practiced items are from Domain 2, sterilization of surgical attire and drapes. The top three never practiced items of SSI prevention were: 1) use an electric razor instead of a normal razor to hair removal ( $n = 305$ , 30.5%), 2) no need to remove hair if not interfering with surgery ( $n = 255$ , 25.5%), and 3) inspecting the quality of air to check if it meets quality standard certification in operating room ( $n = 121$ , 12.1%) (Table 6). Two of the three items were from Domain 4 risk factors for patients related to SSI.

Table 6

*Three Items with Highest and Three Items with Lowest Frequency and Percentage of Knowledge, Attitude, and Practice Regarding to SSI Prevention Among Participants (N = 999)*

Variables	Items	Domain	n	%
	<i>The top three correct items</i>			
Knowledge	1. Surgical caps/hoods should be used when entering the operating room	Domain 2	989	99.0
	2. Keep the operating room door closed	Domain 1	980	98.1
	3. Replace surgical gowns and drapes, when wet or permeable	Domain 2	978	97.9
	<i>The top three incorrect items</i>			
	1. Ventilation system maintains positive pressure and air replacements 30 rounds per hour	Domain 1	901	90.2
	2. Patients receiving complete nutrition can increase metabolic rate and promote wound healing	Domain 4	760	76.1
	3. Wearing a mask to cover the nose is to prevent blood and secretion splashing during surgery	Domain 2	651	65.2
	<i>The top three positive attitude items</i>			
Attitude	1. Air filters should be regularly inspected and replaced	Domain 1	767	76.8
	2. The air in the operating room should pass air filter and meet the quality standards	Domain 1	695	69.5
	3. Strictly limit the number of people entering the operating room during operation	Domain 1	686	68.7
	<i>The top three uncertain attitude items</i>			
	1. Providing 80% oxygen to patient during and after surgery could reduce surgical site infection	Domain 4	314	31.4
	2. Making tools and equipment warm could reduce surgical site infection	Domain 4	307	30.7
	3. Compliance with guidelines to prevent surgical site infection is difficult due to lack of equipment	Domain 3	168	16.8
	<i>The top three negative attitude items</i>			
	1. No need to store hair into a surgical cap, when entering the operating room	Domain 2	709	71.0
	2. No need to change surgical gowns and drapes, when wet or permeable	Domain 2	619	62.0
	3. No need to change bed linen when new surgery	Domain 4	547	54.8



Table 6 (Continued)

Variables	Items	Domain	<i>n</i>	%
<i>The top three regularly practiced items</i>				
Practice	1. Wearing a mask when entering the operating room	Domain 2	940	94.1
	2. Storing hair into a surgical cap when entering the operating room	Domain 2	940	94.1
	3. Wearing sterile gloves after wearing surgical gown	Domain 2	926	92.7
<i>The top three never practiced items</i>				
	1. Use an electric razor instead of a normal razor to hair removal	Domain 4	305	30.5
	2. No need to remove hair if not interfering with surgery	Domain 4	255	25.5
	3. Inspecting the quality of air in the operating room	Domain 1	121	12.1

*Note.* Domain 1 = Operating room environment; Domain 2 = Sterilization of surgical attire and drapes; Domain 3 = Asepsis surgical technique; Domain 4 = Risk factors for patients related to SSI.

Table 7

*Correlation Between Knowledge, Attitude, and Practice of Surgical Site Infection Among Operating Room Nurses (N = 999)*

Variables	Knowledge	Attitude	Practice
Knowledge	1		
Attitude	.137**	1	
Practice	.058	.302**	1

*Note.* \*\*  $p < .01$

**The relationship between knowledge, attitude, and practice of SSI prevention among operating room nurses.** Correlational analysis was used to examine the relationship between knowledge, attitude, and practice of SSI prevention. The results are presented in Table 7. It was shown that knowledge was passively related to attitude ( $r = .137, p < .01$ ). A significant positive correlation between

practice and attitude was found ( $r = .302, p < .01$ ). However, there was no significant correlation between knowledge and practice ( $r = .058, p = .065$ ) (Table 7).

**Additional Results.** The additional information was analyzed by the Ecological System Theory (Onwuegbuzie et al., 2013). The data of nine open-ended questions with 120 participants showed that many facilitating factors were related to knowledge, attitude, and practice of SSI prevention among operating room nurses. These data were categorized into personal level, organization level, and policy and/or national level.

The personal level data were categorized as facilitating factors as follow: 1) awareness of SSI prevention, including increasing awareness of SSI prevention ( $n = 23, 27.7\%$ ) and perception of important of SSI prevention ( $n = 94, 79.0\%$ ); 2) comply with practice regulations such as strictly compliance with the aseptic technique ( $n = 84, 71.2\%$ ), surgical hand disinfection ( $n = 26, 22.0\%$ ), and prevention of hypothermia ( $n = 15, 12.7\%$ ); and 3) concern adverse effects of SSI on patients, including pain ( $n = 31, 26.5\%$ ), increasing length of hospital stay ( $n = 30, 25.6\%$ ), financial constraints ( $n = 21, 17.9\%$ ), and increased mortality ( $n = 12, 10.3$ ). The barrier of SSI was inadequate learning and update knowledge ( $n = 25, 27.8\%$ ) (Appendix K).

The organization level of facilitating factors comprised the recommendation of preoperative antibiotic use ( $n = 30, 25.4\%$ ), limited the number of people entered the operating room ( $n = 21, 17.8\%$ ), and patients' skin preparation ( $n = 14, 11.7\%$ ). The barriers were nonadherence of other staff to follow aseptic technique ( $n = 21, 23.1\%$ ), inadequate leaders' concern ( $n = 17, 16.3\%$ ), and inadequate staff training ( $n = 15, 15.6\%$ ).

The policy and/or national level of facilitating factors was having regulation of SSI prevention guidelines ( $n = 6, 6.0\%$ ). The barriers in this level were related to the working overload of operating room nurses ( $n = 22, 20.0\%$ ) and inadequate medical resources ( $n = 7, 6.7\%$ ) (Appendix K).

In conclusion, having training in SSI prevention, sufficient operative room staff, normal workload and adherence to the existing guidelines were the main factors related to improving operating room nurses' knowledge, attitude, and practice.

## **Discussion**

This part discusses the research questions and hypotheses based on the results obtained by the study. The discussion contains 1) the operating room nurses' knowledge, attitude and practice of SSI prevention; 2) the relationship between knowledge and attitude of SSI prevention among operating room nurses; 3) the relationship between practice and attitude of SSI prevention among operating room nurses; and 4) the relationship between knowledge and practice of SSI prevention among operating room nurses.

**The operating room nurses' knowledge, attitude, and practice of SSI prevention.** Based on the result, the operating room nurses' knowledge was at a low level. Attitude was at a positive level, and the practice of SSI prevention was at a high level.

*The level of knowledge of SSI prevention among operating room nurses.* In this study, the overall knowledge of SSI prevention among operating room nurses was at the low level. When considering the domains, it showed that Domain 3 (asepsis surgical technique) and Domain 4 (risk factors for patients related to SSI) were at a

low level and very low level, respectively. The low level of knowledge of SSI prevention among operating room nurses might be related to the level of education, working experience, update knowledge, and current Chinese nursing education material of SSI prevention. The next section will explain those factors.

Firstly, the level of education might be one factor for a low level of knowledge of SSI prevention. In this study, there were 56.6% of participants with a bachelor's degree and 39.0% of participants with diploma certificates. In Chinese nursing education, the diploma certificate was the lowest level of nursing education. There were two methods to get a diploma certificate. The first method is for the students who graduated from their primary school, to complete three years of nursing professional knowledge training, and then pass the national nurse professional qualification examination to get the nurse license, then they are certified for obtaining the diploma certificate. Another method is that the students graduate from high school and enter into nursing college to undergo three years of nursing professional knowledge training, and then pass the national nurse professional qualification examination to get the nurse license for the diploma certificate. Chinese nursing bachelor's degree is also having two methods to be certified. The first method is a four- to five-year full-time undergraduate school and another method is a part-time undergraduate school. The full-time undergraduate students spend more time on study at school and will have practiced more than 8 months at hospitals when they finished all professional classes. For the part-time undergraduate nursing students, they work in the hospital while they acquire the professional knowledge. Most of the part-time undergraduate students have the diploma certificate. They study all classes by themselves, after achieving the assessment results they could pass the self-study examination and obtain the

corresponding undergraduate degree (NHCPRC, 2016b). Differences in lengths of professional study might lead to different levels of knowledge of SSI prevention. In this study, the bachelor's degree included the two kinds of getting a bachelor's degree. However, to prevent the participants from being pressured due to different academic qualifications, they were not divided in detail when they accepted to participate in this study.

The result of this study was similar to a previous study conducted in Indonesia in which nurses and midwives with diploma certificates had a low level of knowledge of caesarean section of SSI prevention (Novelia et al., 2017). In Northwest Ethiopia, the healthcare workers who had a low level of education had a low level of knowledge regarding infection prevention (Desta et al., 2018). In Bangladesh, the surgical ward nurses having a low level of knowledge regarding SSI prevention might be related with 93.3% of participants only having a diploma certificate (Sickder et al., 2014). So, it might be supported that the different levels of education would impact the level of operating room nurses' knowledge of SSI.

Secondly, working experience would be another factor of a low level of knowledge. In this study, it has been proposed that knowledge was related to working experience (Novelia et al., 2017). Novelia et al. (2017) proposed that a person with working experience greater than five years would have more knowledge than those with working experience of less than five years. The result of this study showed that 47.8% of the participants had working experience of less than five years. Therefore, this factor would affect the low level of knowledge. The finding of this study was similar to the previous studies that showed that working experience of less than five years was one important factor related to the low level of nurses' knowledge regarding

SSI prevention (Sadia et al., 2017; Teshager et al., 2015). In Northwest Ethiopia, Desta et al. (2018) found that healthcare workers with less than five years of working experience had a lower level of knowledge than those who had working experience for more than ten years. In China, the operating room nurses with less than five years working experience had a lower score in SSI prevention knowledge questionnaire in Sichuan Provincial People's Hospital (Jing & Bai, 2011). The researcher found that the medical staff (including 24 operating room nurses) who had more than five year working experience were more knowledgeable of CDC SSI prevention guidelines (Zhang, Wei, Yang, & Jin, 2018).

Thirdly, updated knowledge will periodically enhance knowledge. In this study, there were 66.6% of operating room nurses who attended SSI prevention training less than five times during 2017 to 2019, and 22.2% of participants who only attended the SSI prevention training once during these two years. For those who had only participated in one training in two years, it was very likely that the knowledge of SSI prevention had been forgotten. This was the reason why the Infection Control Department and operating room in China have a policy for providing training related to infection control every year. Although, in this study, 91.5% of participants reported that they had infection control departments in their hospitals, the contents of SSI prevention might not be specifically emphasized into the infection control document. Moreover, for those who had a lecture related to infection control, it was evident that most of the lecture was related to general infection control but did not specify SSI prevention. It might be inferred that the low level of knowledge might be related to nonspecific lectures of SSI prevention and low participation of operating room nurses into the SSI prevention training.

The last factor might be the current Chinese nursing educational material of SSI prevention. For the nursing students' education, there was only one chapter related to nosocomial infection control and prevention, not specific to SSI prevention in the textbook (Li & Shang, 2017). For the registered nurses, each hospital holds the annual examination for nurses to test the nurses' knowledge, but such tests are for basic nursing care rather than for specialized nursing care. The contents of the examination were based on basic nursing care including environment, patients' comfort and safety, activities and handling, prevention and control of nosocomial infections, observation, and care for vital signs, application of cold and heat therapy, patient hygiene, etc. (Li & Shang, 2017). For the operating room nurses' educational material of SSI prevention, the Chinese Nursing Association Operating Room Professional Committee already published the guidelines in 2014 and updated it every year. In April 2019, the updated Chinese guideline for the prevention of SSI was published, which was based on the current studies and combined with Chinese national conditions (Chinese Society of Surgical Infection and Intensive Care et al., 2019). Comparing the Chinese existing guidelines and international guidelines, there were still some difference in the contents related to the relevance of SSI prevention compared with the updated guidelines from World Health Organization (WHO) and Centres for Disease Control and Prevention (CDC), such as the risk factors of patient-related to SSI (Berríos-Torres et al., 2017; CNAORPC, 2018; WHO, 2018). This updated Chinese guideline has just been published and was not yet widely used in national SSI prevention education. In this study, the researcher modified the questionnaire based on the updated international guidelines from WHO and CDC and the previous study (Saksri

et al., 2018). This might be one factor leading to the low level of knowledge regarding SSI prevention.

The results showed that the top three incorrect answers regarding knowledge of SSI prevention were related to controlling the ventilation system in the operating room, promoting wound healing with complete nutrition, and wearing a mask to cover the nose to prevent blood and secretion splashing during surgery. These incorrect answers could be due to the fact that some special assistants are responsible to maintain and manage the ventilation system in the operating room. Therefore, the responsibility of nurses in the operating room is only to turn it on and adjust the air conditioner every working day based on the rule. If an abnormality occurred, the corresponding staff would immediately intervene and carry out a repair in China. For promoting wound healing with complete nutrition, this would be paid less attention to than promoting the immune system, so this might make the participants confused. Besides, the nutrition treatment for patients might be more relevant to surgical ward nursing care than operating room nursing care.

For the operating room nurses, even though there was one section of infection control and prevention in the Guide to Operating Room Nursing Practice, but it was not specific in SSI (CNAORPC, 2018). Most of the information was related to surgical sterilization dressing, environment, and sterilization of surgical instruments. When talking about aseptic technique, the authors focused on the details of how to practice aseptic techniques. So, the operating room nurses might pay less attention to the purpose of the practice, such as wearing a mask covering the nose. When considering the Domain, the participants showed their very low level of knowledge in risk factors for patients related to SSI. Based on the experience of the researcher, in the basic



nursing education curriculum in China, there was only one section on SSI prevention, which belongs to the chapter of nosocomial infection, but the information did not include the risk factors related to patient for SSI prevention (Li & Shang, 2017).

*The level of attitude of SSI prevention among operating room nurses.* In this study, 59.5% of the operating room nurses had a positive level of attitude and only 0.4% of participants had a negative level of attitude of SSI prevention. The positive level of attitude was shown in Domain 1 (operating room environment) and Domain 2 (sterilization of surgical attire and drapes). In Domain 3 (asepsis surgical technique) and Domain 4 (risk factors for patients related to SSI), the participants showed a neutral level of attitude as shown in Table 5. The positive level of attitude might be related to the level of hospital, the level of education, working experience, the presence of the Infection Control Department, and the training program.

Firstly, all of the participants were from tertiary hospitals and secondary hospitals in this study. Based on the Chinese hospital-grade classification, the tertiary hospitals and secondary hospitals had higher access standards for the introduction of talents, more learning opportunities, and a better academic exchange platform (Li & Shang, 2017). Secondly, 56.6% of participants had a bachelor's degree or above and 52.2% of participants had more than 5-year working experience. The more knowledge they acquire, the more their awareness of SSI prevention will increase, based on the KAP model and learning theory (Krathwohl, Bloom, & Masia, 1964; Launiala, 2009). Thirdly, the presence of the Infection Control Department could be conducive in giving all-round guidance, providing lectures related to SSI prevention and supervising infection control to the operating room nurses. Due to the training, monitoring and spot checks of the Infection Control Department, the operating room

nurses also were made awareness of SSI prevention during day-to-day work. All these factors had a positive impact on the positive attitude of the operating room nurses in terms of SSI prevention.

The top three positive attitude items were: 1) air filters should be regularly inspected and replaced; 2) the air in the operating room should pass air filter and meet the quality standards; 3) strictly limit the number of people entering the operating room during operation. It was impacted by the training of the Infection Control Department, the current practice guidelines in China (CNAORPC, 2018), and current nursing educational material (Li & Shang, 2017). All these items were mentioned in the section of prevention and control of nosocomial infections, it might be due to the positive level of attitude in Domain 1 and Domain 2. The top three uncertain attitude items were: 1) providing 80% oxygen to patients during and after surgery could reduce SSI; 2) prepare equipment in warm condition could reduce SSI; and 3) compliance with guidelines to prevent SSI is difficult due to lack of equipment. Two of three items were in Domain 4 and might be illustrated by the neutral level of attitude in Domain 4. Based on the result of the additional open-ended questions, all of the participants thought that SSI prevention was important. It was confirmed that all the operating room nurses had a positive attitude towards SSI prevention. Based on the additional data, Chinese operating room nurses were concerned more about the adverse effect of the occurrence of SSI. They reported that SSI occurrence could lead to financial impact, pain, increased length of hospital stays, and increased mortality rate. The awareness of SSI prevention might be related to their working experience. When they practiced day by day, they could meet various cases of SSI. The result of these cases might be ironed in the operating room nurses' mind.

The result was supported by the previous studies, which were conducted in Southern Thailand, Southeast Ethiopia, and Zambia. Saksri et al. (2018) showed that the operating room nurses had a high level of attitude of SSI prevention. Hussein et al. (2017) showed that the healthcare workers had a positive attitude toward infection prevention due to the awareness of participants. A study conducted in a Zambia tertiary hospital likewise showed that the nurses had a positive attitude toward infection prevention (Chitimwango, 2017).

***The level of practice of SSI prevention among operating room nurses.*** For the practice of SSI prevention, 76.4% of operating room nurses scored a high level to very high level of practice, especially in the Domain 2 (sterilization of surgical attire and drapes) and Domain 3 (asepsis surgical technique), even though the level of practice was high, it was at a low level in Domain 1 (operating room environment) and Domain 4 (risk factors for patients related to SSI), respectively. The previous studies could be supporting this result (Novelia et al., 2017; Patil et al., 2018; Sadaf et al., 2018). Age and working experience might influence the level of participants' practice.

Firstly, 53% of participants were 30 years old and above. The high level of practice might be related to the participants' practice every day and the fact that they improved their practice based on age-related experience. Desta et al. (2018) pointed out that the older age group (31 years old and above) of healthcare workers practiced infection prevention more than the young age group (21 to 25 years old). Secondly, 62.1% of participants had more than five years of working experience in this study. The result could be supported by the survey conducted in Northwest Ethiopia. The nurses with more than 5-year working experience had better practice of SSI prevention

than nurses with less than 5-year working experience (Woldegioris, Bantie, & Getachew, 2018).

In addition, the operating room nurses practice regularly in these items of the Practice Questionnaire as follows: 1) the practice of mask-wearing when entering the operating room; 2) the practice of storing hair into a surgical cap when entering the operating room; and 3) the practice of sterile gloves wearing after wearing surgical gown. All these items were in Domain 2 (sterilization of surgical attire and drapes). Based on the researcher's experience, these items were the routine operating room practice, the operating room nurses must practice assisting in operations every day. The routine work might be forming a habit to make the practice perfect. The Infection Control Department took an important role in infection training and supervision. The infection prevention training for nurses and doctors was carried out by the Infection Control Department at least once every three months based on their schedule. Every month, the Infection Control Department must report the infection information for last month including the rate of SSI and find out the source of the infection. This might be the cause of operating room nurses' regular practice and having a high level of practice of SSI prevention.

The top three never practiced activities of some participants were using an electric razor instead of a normal razor blade, not removing hair if not interfering with surgery, and inspecting all air in the operating room through an air filter that has passed the quality standard certification. These issues might be related to the content about hair removal stated in the Chinese practice guidelines (CNAORPC, 2018; NHCPRC, 2010). The hair removal of operation patients must be prepared before arriving at the operating room except for emergency operations. However, the hair

removal tools were not provided in the recommendations of Chinese guidelines (CNAORPC, 2018; NHCPRC, 2010). This might be the reason for operating room nurses' practicing differently in hair removal and the choice of hair removal tools.

**Relationship between knowledge, attitude, and practice of SSI prevention among operating room nurses.** Based on the results, there was a positive significant correlation between knowledge and attitude, and practice and attitude. There was no significant correlation between knowledge and practice.

*The relationship between knowledge and attitude of SSI prevention among operating room nurses.* There was a positive significant correlation between operating room nurses' knowledge and attitude of SSI prevention in this study. Based on the knowledge, attitude, and practice (KAP) model, the knowledge and attitude could be mutually influential (Launiala, 2009). A Nigerian survey confirmed that there was a positive association between knowledge and attitude of SSI prevention among surgical nurses similar to this current study (Kolade et al., 2017). Also, among the Indian nurses' knowledge and attitude regarding infection control measures, there was a linear relationship (Lobo, Sams, & Fernandez, 2019). The higher level of knowledge could change the attitude toward SSI prevention. The positive level of attitude also could encourage learning knowledge. In the previous study related to infection control and prevention, a negative significant correlation between knowledge and attitude was found among nursing students in South Africa (Rahiman, Chikte, & Hughes, 2018). However, the population and the setting were totally different, so it was hard to compare with this study. It meant that the nurses' knowledge and attitude of SSI prevention could impact each other.

In additional data, the participants mentioned that higher awareness of SSI prevention might be caused by enough training to gain the knowledge. Enough knowledge of SSI prevention could improve the awareness of SSI. The lack of training might be a barrier to impact the operating room nurses' attitude of SSI prevention. In conclusion, the knowledge and attitude of SSI prevention could be interacted.

*The relationship between attitude and practice of SSI prevention among operating room nurses.* There was a positive significant correlation between attitude and practice. Based on the KAP model, there was a correlation between attitude and practice (Launiala, 2009). The positive attitude could improve individual practice, while the high level of practice could interact with the personal attitude.

KAP model indicates that attitude also relates to practice. In this study, the attitude of SSI prevention was positively related to practice of SSI. Since the participants had awareness of adverse effects of the occurrence of SSI; therefore, they performed their daily work in the operating room with caution for the prevention of SSI. Based on the learning theory, the attitude is linked with practice (Krathwohl et al., 1964). However, the degree of correlation of attitude and practice of SSI prevention in this study was moderate ( $r = .30$ ). Consequently, there still could be other factors that would relate to the practice of SSI prevention. Therefore, a future study is recommended to explore other factors related to the practice of SSI prevention. In southern Thailand, there was a significant correlation between knowledge and attitude of SSI prevention among operating room nurses (Saksri et al., 2018). Kolade et al. (2017) illustrated the Nigeria nurses' attitude and practice of SSI prevention after surgery with a high correlation. In this study, the target participants, the sample size,

and the demographics were different from previous studies, so that the results might lead to different findings.

*The relationship between knowledge and practice of SSI prevention among operating room nurses.* There was no significant correlation between knowledge and practice in this study. Although the KAP model identifies the link between knowledge and practice; it was not found in this study. It could be explained that the high level of practice of SSI was related to the supervision of senior nurses of SSI prevention on the day by day basis and due to its socially desirable effect. Since the participants were asked to fill out the answer via online by themselves; therefore, this self-report answer would lead to a socially desirable effect, when the participants reporting their practice might give a description based more on the regulation. Moreover, the SSI prevention knowledge was specifically related to updated guidelines of SSI prevention, whereas the participants were unfamiliar with these since what they learned in hospitals and during infection control training was not yet updated, which might be leading to a low level of knowledge. Therefore, there was no significant relationship between knowledge and practice of SSI prevention in this study. The finding of this study was similar to previous studies.

The previous studies revealed that there was no significant correlation between knowledge and practice of SSI prevention among operating room nurse in southern Thailand (Saksri et al., 2018) and among nurses' staffs in India (Patil et al., 2018). Patil et al. (2018) also found that the consultants working in the hospital also showed their knowledge and practice were not significantly correlated. Besides, the Zambian nurses' knowledge of infection control did not correlate with their practice (Chitimwango, 2017). In Iran, there was no relationship between nurses' knowledge

and practice of hospital-acquired infection(Sarani, Balouchi, Masinaeinezhad, & Ebrahimitabs, 2016).

Abraham et al. (2016) pointed out that there was a negative correlation between knowledge and practice on sterile technique in south India. In Pakistan, Sadaf et al. (2018) found that there was a strong, significant positive correlation between knowledge and practice on SSI prevention. However, both studies were surveyed in only one hospital, it was hard to compare with this provincial level study.



## Chapter 5

### Conclusion and Recommendations

This chapter includes the summary of finding, strength, limitation, and recommendation of this study.

#### Conclusion

This descriptive correlation study examined the level of knowledge, attitude, and practice of SSI prevention among operating room nurses, the relationship between knowledge and attitude of SSI prevention, the relationship between knowledge and practice of SSI prevention, and the relationship between knowledge and attitude of SSI prevention among operating room nurses. It was conducted in nine prefectures' and cities' hospitals in Guizhou Province, China. The conceptual framework of this survey was based on KAP model (Launiala, 2009). The researcher distributed the questionnaire to 124 hospitals, to around 2,481 operating room nurses in these hospitals. There were 1,215 operating room nurses who submitted the completed questionnaire, based on the inclusion criteria having at least the nursing diploma certificate and working for more than 6 months. Finally, 999 operating room nurses were included in this survey. A set of questionnaires was used to conduct the data from May to August in 2019. The questionnaires included Demographic data, Knowledge Questionnaire, Attitude Questionnaire, and Practice Questionnaire. The summary of the findings, the strengths of the study, limitation of the study, and the recommendation based on the result are discussed in this part.

**Summary of the findings.** The operating room nurses had an overall low level of knowledge, a positive level of attitude, and a high level of practice regarding SSI prevention. There was a positive significant correlation between knowledge and attitude of SSI prevention among operating room nurses, a positive significant correlation between attitude and practice of SSI prevention among operating room nurses. However, there was no significant correlation between knowledge and practice of SSI prevention among operating room nurses.

The operating room nurses showed that the shortages of knowledge were related to maintaining positive pressure and air replacements 15 rounds per hour, promoting wound healing with adequate nutrition, and wearing proper technique of a mask to prevent blood and secretion splashing during surgery. The negative attitude that showed up in some participants; reports were no need to store hair into a surgical cap when entering the operating room, no need to change surgical gowns and drapes when wet or permeable, and no need to change bed linen with new surgery. In addition, the items that some participants never practiced were related to the use of an electric razor instead of a normal razor for hair removal and inspecting the quality of air in the operating room.

**Strengths of the study.** The strengths of this study are as follow: 1) the study was the first study to gather data about SSI prevention among operating room nurses in provincial level including the tertiary and secondary hospitals; 2) this study has a high response rate (85.27%); 3) this study used two mobile applications to conduct the data with paperless investigation and reducing pollution; 4) this study collected quantitative data and the additional open-ended information to better understand the factors related to the knowledge, attitude, and practice of SSI prevention. The results

could guide the future advanced nursing education, especially in SSI prevention in Guizhou Province, improve the cognition and use of SSI prevention guidelines and improve the operating room nurse's knowledge in the perioperative period.

**Limitations of the study.** Some limitations of this study could be addressed. First, although the SCVI of the attitude and practice questionnaires were acceptable, two ideas appearing in one question item were still found in some items of attitude and practice questionnaires. This issue would lead to an unclear answer to those items. Second, the online data collection technique could preclude the high accessibility of the expected target population. Thirdly, the open-ended questions did not check the validity of the items. Lastly, the uncertain attitude response item was still used in the Attitude Questionnaire which could preclude the true phenomenon of SSI prevention attitude being reported with a self-report questionnaire.

### **Recommendations**

The recommendations provide three aspects of nursing education, nursing practice, and nursing research.

**Nursing education.** Based on the results, the weakness for knowledge and practice of SSI prevention in operating room nurses involved the risk factors for patients related to SSI. The shortage of knowledge could guide the operating room nurses' future education in Guizhou Province, China, especially for the nursing education materials to update contents based on the international guidelines and national guidelines of SSI prevention. For nursing education materials, it included two levels as follow: 1) for the nursing student education material, the contents of SSI prevention could be enhanced in the textbook; and 2) for the registered nurses, the

short courses and SSI prevention training programs could be provided by each hospital, the Provincial Operating Room Professional Committee, and National Operating Room Professional Committee. For the nursing administrators, the contents of the annual examination could include the contents of SSI prevention. The training of SSI prevention might be provided by different methods to train the operating room nurses, such as online classes or zoom conferences. It could be convenient and economic for training.

**Nursing practice.** The operating room nurses had an overall high level of SSI prevention practice based on a self-report questionnaire in this study. However, the operating room nurses had a low level of practice of SSI prevention especially for the hair removal using razor. The updated Chinese SSI Prevention Guideline (Chinese Society of Surgical Infection and Intensive Care et al., 2019) has only just endorsed the recommendation of using electric clipper for hair removal instead of razor. Therefore, all operating nurses should be informed about the updated information of hair removal technique.

**Nursing research.** This study provided the basic level of the operating room nurses' knowledge, attitude, and practice regarding SSI prevention. The results of the study illustrated the shortage of knowledge of SSI prevention in Guizhou Province, China. It would be useful to do an intervention study about improvement of the level of operating room nurses' knowledge. It was recommended that the national operating room nurses' guideline could be reviewed based on this study. Modification of questionnaires is suggested before repeated studies in other provinces in China. Observation of data collection in addition to online data collection is recommended for warranting the validity of the study.

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## **Appendices**

## **Appendix A**

### **The Rationale and Range of Recommendations**

All the recommendations were considered effective by the Hospital Infection Control Practices Advisory Committee (HICPAC). It was categorized into IA, IB, IC and II (Berríos-Torres et al., 2017; Mangram et al., 1999). In the latest guideline (Berríos-Torres et al., 2017) the committee added strong and weak by GRADE to categorize the recommendations.

WHO categorized the level of evidence by high, moderate, low, and very low (WHO, 2016, 2018).

#### **Category I Recommendations**

Category I recommendations include IA, IB and IC. Category IA infers to a strong recommendation for application and supported by the high level of design experimental, clinical, or epidemiological studies. Category IB infers to a strong recommendation for application and supported by experimental, clinical, or epidemiological studies and strong theoretical rationale. Category IC infers to a strong recommendation required by state or federal regulation.

#### **Category II Recommendations**

Category II infers to suggestion for implementation and supported by suggestive clinical or epidemiological studies or theoretical rationale.

**GRADE of the Level of Evidence**

High: The committee was confident that the true effect was close to the estimate of the outcome.

Moderate: The committee was moderately confident in the effect estimate. The true effect is close to the estimate of the effect, but they might not be different.

Low: The committee was limitedly confident in the effect estimate. The true effect might be substantially different from the estimate of the effect.

Very low: The committee has very little confidence in the effect estimate. The true effect is likely to be substantially different from the estimate of the effect.



## **Appendix B**

### **Invitation Letter (English Version and Chinese Version)**

Dear Sir/Madam,

I am Wen Feng, a student of Master Nursing Science at Faculty of Nursing, Prince of Songkla University, Thailand. It is my distinct pleasure to invite you to join the WeChat group “Survey of Knowledge, Attitude, and Practice Regarding Surgical Site Infection Prevention”. Please read this invitation letter carefully and feel free to contact me in WeChat prior before joining the WeChat group, if you have any questions. Your participation is strictly voluntary and anonymous.

The WeChat group will do a survey about operating room nurses’ knowledge, attitude, and practice regarding surgical site infection in the intra-operative phase in May 2019. If you decide to attend to the WeChat group, you will be asked to fulfil the Informed Consent Letter and questionnaire by mobile application Wen Juan Xing. You can voluntarily join the WeChat group within one week according to your own wishes. You have right to exit the WeChat group at any time. Deciding not to join or choosing to exit the WeChat group, will not harm your working experience in the hospital.

If you are willing to join the survey, you could join the WeChat group within one week. When you attend the WeChat group and decide to join the survey, I will provide QR and link of “Wen Juan Xing” in WeChat group, which is related to the survey “Knowledge, Attitude, and Practice Regarding on Surgical Site Infection Prevention”. Some of you will be asked to answer open-ended questions related to

attitude and practice of surgical site infection via WeChat application. You have the right to stop the survey at any time before you submit the questionnaire.

Considering your interest and expertise in this field of work, I hope to welcome you to the WeChat group for this study. The survey will offer the up to date surgical site infection prevention guideline, when you complete and submit the questionnaire by mobile.

Best regards,

Wen Feng

Principal Investigator

## 邀请函

尊敬的先生/女士，

您好！我是冯雯，泰国宋卡王子大学护理学院护理学硕士研究生。我很高兴邀请您加入微信小组“外科手术部位感染预防的知识，态度和实践调查小组”。如果您有任何疑问，请在加入微信小组之前，仔细阅读此邀请函并随时在微信中与我联系。您的参与完全是自愿和匿名的。

微信小组将于 2019 年 5 月对手术室护士对手术部位感染的知识，态度和行为进行调查。如果您决定加入微信小组，您会获得问卷星二维码和链接，在问卷星上阅读签署知情同意书并填写问卷。您可以根据自己的意愿在一周内自愿加入微信小组。您有权随时退出微信小组。决定不加入或选择退出微信群，不会损害您在医院的工作经验。

如果您愿意参加调查，可以在一周内加入微信小组。当您参加微信小组并决定参加调查时，我将在微信小组中提供“问卷星”的二维码和链接，该调查与“关于手术部位感染预防的知识，态度和实践”有关。你们中的一些人将被要求通过微信回答与手术部位感染的态度和行为相关的开放式问题。在提交问卷之前，您有权随时停止调查。

考虑到您对该领域的兴趣和专业知识，我非常希望欢迎您来到微信小组进行本研究。当您通过手机填写并提交问卷时，该调查将提供最新版电子版的手术部位感染预防指南作为回馈。

此致

敬礼

冯雯  
首席研究员

## **Appendix C**

### **Informed Consent (English Version and Chinese Version)**

#### **Part I: Information Sheet**

Dear Nurse,

I am Wen Feng, a student of the Master in Nursing Science program at the Faculty of Nursing, Prince of Songkla University, Thailand. You are invited to participate in a research project entitled “Relationship between Knowledge, Attitude, and Practice of Surgical Site Infection Prevention among Operating Room Nurses in Guiyang City, China” at selected hospitals in Guiyang City Guizhou Province, China. Please read this form carefully, and feel free to contact the researcher prior to the beginning of the study if you have any questions.

If you decide to participate, you will be asked to fill out the questionnaire by mobile application Wen Juan Xing. Meanwhile, the researcher may stop the study or take you out of the study at any time they judge it is in your best interest. They may also remove you from the study for various other reasons. They can do this without your consent. Also, you can stop participating at any time. If you stop the process, you will not lose any benefits.

During this study, you will be asked to complete a set of questionnaires concerning knowledge, attitude, and practice regarding to SSI prevention in the intraoperative phase as well as your personal information by Wen Juan Xing. I will also request some demographic information. Your participation will take approximately 40 minutes of your precious time.

Your participation is strictly voluntary and anonymous. You have the right not to participate at all or to leave the study at any time. Deciding not to participate or choosing to leave the study will not result in any penalty or loss of benefits to which you are entitled, and it will not harm your working experience in the hospital. Your answer will be grouped with other participants' answers and reported as a part of a research study which I am conducting for my thesis requirement in the graduate nursing curriculum at Prince of Songkla University.

By participating in this study, the research findings will be helpful to provide critical information for improve the knowledge, attitude, and practice about SSI prevention in intra-operative period. Future specific intervention studies would be applied to improve operating room nurses' knowledge, attitude, and practice of SSI prevention based on the data of this proposed study. From such a research advantage, you will be helping to increase the understanding in SSI prevention.

You are welcome to contact me and my advisor, in case you have any questions or concerns regarding the survey. Thank you for your time and consideration in assisting me to better understand your self-reported knowledge, attitude, and practice on SSI prevention in operating room.

## **Part II: Certificate of Consent**

I have read and understand the informed consent above. I agree to be a participant in the study "Relationship between Knowledge, Attitude, and Practice of Surgical Site Infection Prevention among Operating Room Nurses in Guiyang City, China". I have understood that all information will be kept confidential while the results can be used for publication. I had an opportunity to ask questions, contact the

researcher and the advisor, and all my questions have been answered. Finally, I have the right to withdraw from the study at any time without penalty.

.....

(Signature of Participant)

.....(Date)

.....

(Signature of Researcher)

.....(Date)

If you have any inquiries, please contact:

Researcher:

Miss Wen Feng, Master of Nursing Science (International Program), Faculty of Nursing,  
Prince of Songkla University, Thailand.

Mobile: 095-481-1505 (Thailand)

+8618685016523 (China)

Email: 84387307@qq.com

Advisor:

Asst. Prof. Dr. Wipa Sae-Sia, Adult and Elderly Nursing Department, Faculty of  
Nursing, Prince of Songkla University, Thailand.

Email: wipa.sa@psu.ac.th

**Part III: Researcher's Statement**

I have explained this study to the above subject and have sought his/her understanding.

I confirm that all the questions asked to have been answered correctly and I also provide the contact address, in case the participant has any questions.

..... (Signature of Researcher)

..... (Date)

## 知情同意书

### 第一部分：信息表

尊敬的护士：

我是冯雯，泰国宋卡王子大学护理学院护理学硕士研究生。我很高兴邀请您通过邀请函的电子版加入微信小组。当您在阅读邀请函后参加微信小组时，它表示您被邀请参加一个名为“中国手术室护士的手术部位感染预防知识，态度和实践的关系”的研究项目。请仔细阅读此知情同意书并慎重做出是否参与本项研究的决定。您有权拒绝参加本研究，也可随时退出研究，且不会受到处罚，也不会失去您应有的权利。如果您有任何疑问，请在研究开始前与研究人员联系。

当您阅读完整的知情同意书后，如果您决定参加，请单击“同意”按钮。它表明您同意参加该研究。问卷将在您点击同意按钮后显示，您将在问卷星上填写调查问卷。您们中的一些人将被要求通过微信回答与手术部位感染的态度和行为相关的开放式问题。您有权在任何时候选择停止填写并提交问卷。

同时，研究人员可以随时停止研究或将您移出研究。他们可能出于其他原因，不需要征得您的同意，将您从研究中删除。此外，您可以随时停止参与研究。如果您在此过程中停止参与，不会对于您造成任何损失。

在本研究中，您将被要求在问卷星上填写相关个人信息和一套关于术中手术部位感染预防的知识，态度和实践的问卷调查。我会要求您提供一些个人信息。您的参与将花费大约 40 分钟的宝贵时间。



您的参与完全是自愿和匿名的。您有权拒绝参加本研究，也可随时退出研究，且不会受到处罚，也不会失去您应有的权利，也不会损害您在医院的工作经验。您的答案将与其他参与者的答案进行密码分组，作为我在宋卡王子大学研究生护理课程中的论文，其内容的一部分将进行报告。当文章发表3年后，所有数据都将被研究人员销毁。

通过参与本研究，该研究结果将有助于提供关键信息，以提高术中手术部位感染预防的知识，态度和实践。根据本研究的数据，未来的具体干预研究将用于改善手术室护士对手术部位感染预防的知识，态度和实践。从这样的研究优势，您将有助于增加对手术部位感染预防的理解。

当您对调查有任何问题或疑惑时，欢迎您与我，我的顾问以及社会和行为科学，机构审查委员会（SBSIRB）联系。感谢您的时间和考虑，以帮助我更好地了解您在手术室中自我报告的手术部位感染预防知识，态度和实践。

## 第二部分：同意书

我已阅读并理解上述知情同意书。我同意参加“中国手术室护士手术部位感染预防知识，态度和实践的关系”研究。我了解所有信息都将保密，而结果可用于发布。我有权利提问联系研究员和顾问，我的所有问题都已得到解答。最后，我有权随时退出研究而不受处罚。

.....

(参加者签名)

..... (日期)

.....

(研究员签名)

..... (日期)

如果您有任何疑问，请联系：

研究员：

冯雯女士，泰国宋卡王子大学护理学院护理学（国际项目）。

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手机：+66 074-286-510（泰国）

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社会和行为科学 IRB 官员：

Chayanit Pudpong 小姐，泰国宋卡王子大学护理学院研究室

电子邮件：chayanit.p@psu.ac.th

第三部分：研究员的声明

我已经将这项研究解释为上述主题，并寻求他/她的理解。我确认所有要求的问题都已正确回答，如果参与者有任何问题，我也会提供联系地址。

..... (研究员签名)

..... (日期)

## Appendix D

### Surgical Site Infection Questionnaire in Operating Room

(English Version and Chinese Version)

No.: .....

#### Part A: Demographic characteristics questionnaire

Please fill in the blank or put a check mark “√” into the page that corresponds to your information as much as possible, or fill it out in the actual space.

1. Age ..... years
2. Gender  
 1. Female                       2. Male
3. Level of hospital  
 1. Tertiary hospital  
 2. Secondary hospital  
 3. Primary hospital
4. Education  
 1. Diploma's degree  
 2. Bachelor's degree or equivalent, Bachelor's degree  
 3. Master's degree  
 4. Ph.D.  
 5. Others (please specify.....)
5. Work experience in the operating room for ..... Year ..... Month
6. Please choose the most expertise area of surgeries you are expertise in operating room.  
 1. General surgery  
 2. Neurosurgery  
 3. Orthopedic surgery  
 4. Cardiothoracic surgery, thoracic  
 5. Ophthalmology  
 6. Plastic surgery  
 7. Pediatric Surgery  
 8. Ear, Nose and Throat  
 9. Urinary system  
 10. Obstetrics and gynecology  
 11. Vascular surgery  
 12. Other (please specify.....)
7. You work in operating room around..... hours/per day.....day/each week.
8. What is the level of your current workload in operating room?  
 1. High  
 2. Appropriate  
 3. Low

9. Does your operating room follow an SSI prevention guideline?  
(        ) 1. No        (        ) 2. Yes, please identify the guideline.....
10. Is there an infection control department to control and evaluate the quality of SSI prevention practice in your hospitals?  
(        ) 1. No        (        ) 2. Yes
11. Do you use the guideline on SSI prevention to guide your practice in the operating room?  
(        ) 1. No  
What kinds of resource do you use to guide your SSI prevention? (please specify.....)  
(        ) 2. Yes  
The guideline you use was issued in..... year, endorsed by.....
12. You receive SSI prevention training / conference ..... times in 2017-2019

### Part B: Knowledge on Surgical Site Infection Prevention Questionnaire

Use sign “√” to choose true and false to show your correct answer

Knowledge	Items	True	False
1. Operating room environment	1. Not leaving the operating room door open could prevent infection. Except for patient access, surgical teams, equipment and instruments used in surgery.		
	2. For the ventilation system to work in the operating room, the air inside the operating room should have a positive pressure. There are at least 30 rounds of air exchange in the operating room per hour.		
	3. Making sure to use sterile surgical instruments, flash sterilization of surgical instruments is only used in the case of tools needed urgently such as ground fall.		
...	...		
4. Risk factors for patients related to SSI	20. Hyperglycaemia in the surgical period results in increased chances of infection, in the surgical location, because it inhibits the phagocytosis process (phagocytosis).		
	21. Caring for patients to receive complete nutrition could increase the metabolic rate in the body and this makes the wound healing process faster.		
	22. Antibiotic treatment needs to be used 15 minutes before surgery to reduce the risk of surgical infection.		

### Part C: Attitude on Surgical Site Infection Prevention Questionnaire

This questionnaire aims to examine your attitude on surgical site infection prevention. Please read each item carefully and consider how you feel about each statement. There are no right or wrong answer to any of these statements. Use sign “√” to choose your answer.

Strongly disagree = you strongly disagree with this statement.

Disagree = you disagree with this statement.

Uncertain = you neither agree nor disagree with this statement.

Agree = you agree with this statement.

Strongly agree = you strongly agree with this statement.

Attitude	Items	Strongly disagree	Disagree	Uncertain	Agree	Strongly agree
1 Operating room environment	1.1 The air inside the operating room should have a positive pressure.					
	1.2 All air in the operating room should pass the air filter that meets the quality certification standards.					
...	...					
4 Risk factors for patients related to SSI	4.8 If hair removal is necessary, use an electric razor instead of a normal razor blade.					
	4.9 There is no need to change bed linen every time when having new surgery.					

Attitude	Items	Strongly disagree	Disagree	Uncertain	Agree	Strongly agree
	4.10 Determining whether the patient has antibiotics ready for the patient or not or checking if they have already received it according to the treatment plan before entering the operating room is not the role of a surgical room nurse.					



### Part D: Practice on Surgical Site Infection Prevention Questionnaire

This questionnaire aims to examine your practice on surgical site infection prevention. Please read each item carefully and consider the rate how often you perform each practice by using the sign “√” in the appropriate column. There are no right or wrong answers to any of these statements. You could choose the answer following description:

Never practiced = you have never performed this practice in your daily working in the operating room.

Seldom practiced = you have performed this practice only a few times or with a few patients in your daily working in the operating room.

Sometimes practiced = you have performed this practice sometimes or with some patients in your daily working in the operating room.

Practiced regularly = you have performed this practice every time with every patient in your daily working in the operating room.

Practice	Items	Never practiced	Seldom practiced	Sometimes practiced	Practiced regularly
1. Operating room environment	1.1 Maintain / check the air in the operating room. It should have positive pressure.				
	1.2 Inspect all air in the operating room through an air filter that has passed the quality standard certification.				

<b>Practice</b>	<b>Items</b>	<b>Never practiced</b>	<b>Seldom practiced</b>	<b>Sometimes practiced</b>	<b>Practiced regularly</b>
	1.3 Ensure that the air filter is changed regularly.				
...	...				
4. Risk factors for patients related to SSI	4.2 Do not remove hair if not interfering with surgery.				
	4.3 Check whether the patient has complete antibiotics according to the treatment plan or not, or if s/he has already received it before operation started.				
	4.4 Keep the patient's body temperature warm during surgery, such as washing the wound with a warm solution. Covering cloth for patients and open the patient's cover only when needed.				

**Part E: Additional Open-ended Questions**

**Instruction:** The purpose of these open-ended questions is to explore more and better understand the participants' 'opinions of surgical site infection (SSI) prevention in the operative phase. The information you provide would be beneficial to promote quality of care for SSI prevention in the operative phase. Please kindly provide short answers in these following questions.

1. In your opinion, do you think SSI prevention is important? Please provide your rationale.
2. As an OR nurse, how do you prevent SSI in the operating room?
3. What are the facilitated factors to improve nurses' knowledge about SSI prevention in the operating room? and Why?
4. What are the barriers that impede nurses' knowledge about SSI prevention in the operating room? and Why?
5. What are the facilitating factors to promote nurses' attitude about SSI prevention in the operating room? and Why?
6. What are the barriers to block nurses' attitude about SSI prevention in the operating room? and Why?
7. What are the facilitating factors to promote nurses' practice about SSI prevention in the operating room? and Why?
8. What are the barriers to block nurses' practice about SSI prevention in the operating room? and Why?
9. Do you have any other suggestions for improvement OR nurses' role for SSI prevention in operating room? Please provide your suggestions.

## 手术室感染情况调查问卷

编号: .....

### 第一部分: 背景调查

请在与您信息相符的括号前打“√”或根据您的实际情况在空白处填写

1. 年龄\_\_\_\_\_岁
2. 性别  
(     ) 1). 女                      (     ) 2). 男
3. 医院等级  
(     ) 1) 三级医院  
(     ) 2) 二级医院  
(     ) 3) 一级医院
4. 受教育情况/文化水平  
(     ) 1) 专科  
(     ) 2) 本科  
(     ) 3) 硕士  
(     ) 4) 博士  
(     ) 5) 其他 (请补充说明\_\_\_\_\_)
5. 手术室工作经验\_\_\_\_\_年/\_\_\_\_\_月
6. 请选择您在手术室专业中最专业/擅长的手术  
(     ) 1) 普外科/胃肠外科  
(     ) 2) 神经外科  
(     ) 3) 骨科  
(     ) 4) 心胸外科  
(     ) 5) 眼科  
(     ) 6) 整形外科  
(     ) 7) 儿外科  
(     ) 8) 耳鼻喉科  
(     ) 9) 泌尿外科  
(     ) 10) 妇产科  
(     ) 11) 血管外科  
(     ) 12) 其他专科 (请补充说明\_\_\_\_\_)
7. 您在手术室每天工作平均大概\_\_\_\_\_小时, 每周工作\_\_\_\_\_天
8. 您在手术室每天的工作量是什么水平?  
(     ) 1) 高  
(     ) 2) 合适  
(     ) 3) 低
9. 您所在的手术室有按照手术切口感染预防指南进行操作吗?  
(     ) 1. 没有                      (     ) 2. 有, 指南名称是\_\_\_\_\_

10. 您们医院院感科是否对手术切口感染预防的质量进行控制和评估?  
( ) 1. 没有 ( ) 2. 有
11. 您有没有使用手术切口感染预防指南指导您在手术室的操作?  
( ) 1. 没有  
那您是使用哪种资料来指导您的手术部位感染预防操作的呢?  
请明确说明\_\_\_\_\_
- ( ) 2. 有  
请您注明指南的名称\_\_\_\_\_
- 您使用的指南出版于\_\_\_\_\_年, 由\_\_\_\_\_出版/认可。
12. 您在 2017 到 2019 年接受过\_\_\_\_\_次手术部位感染预防相关的培训/讲座

## 第二部分：关于手术部位感染预防知识的问卷

根据你认为正确的选项，使用“√”符号选择对和错

知识	题目	对	错
1. 手术室环境	1. 手术过程中除了患者，手术团队，设备和器械的运输之外，请不要将手术门打开。		
	2. 对于手术室的通风系统，手术室内的空气应该为正压状态。手术室每小时至少进行 30 轮空气交换。		
	3. 为确保使用手术器械的灭菌效果，快速蒸汽灭菌仅在紧急情况下使用，例如术中器械坠落地面。		
...	...		
2. 与手术部位感染相关的患者的风险因素	20. 手术期间的高血糖会导致手术部位感染的机会增加，因为高血糖症禁止了细菌的吞噬过程（吞噬作用）。		
	21. 为患者接受完全营养可以增加体内代谢率，促进伤口愈合过程更快。		
	22. 手术前 15 分钟需要使用抗生素治疗，以降低手术感染的风险。		

### 第三部分：关于手术部位感染预防态度的问卷

本调查问卷旨在检查您对手术部位感染预防的态度。请仔细阅读每个项目，并考虑您对每个陈述的感受。任何这些陈述都没有正确或错误的答案。使用“√”符号选择你的答案。

非常同意是指您完全同意该陈述。

同意是指您在某种程度同意该陈述。

不确定的是指您认为此陈述是正确的但不完全正确。

不同意，是指在某些情况下，您认为此陈述是错误的。

非常不同意指的是你认为此陈述是完全错误的。

态度	题目	非常同意	同意	不确定	不同意	非常不同意
1. 手术室环境	1. 手术室的空气应该为正压通气。					
	2. 手术室内的所有空气应通过符合质量认证标准的空气过滤器。					
	3. 应定期检查和更换空气过滤器。					
...	...					
4. 与手术部位感染相关的患者的风险因素	29. 如果需要脱毛，请使用电动剃须刀代替普通的剃须刀片。					
	30. 无需每次进行新手术时更换床单。					

态度	题目	非常同意	同意	不确定	不同意	非常不同意
4. 与手术部位感染相关的患者的风险因素	31. 检查患者从病房带入手术室的抗生素药物, 或者是否在进入手术室前已经在病房进行输入, 这不是手术护士的责任。					



#### 第四部分：关于手术部位感染预防操作的问卷

本调查问卷旨在检查您在手术部位感染预防方面的操作。 请仔细阅读每个项目，并在相应栏中使用“√”符号考虑每个操作的频率。 任何这些陈述都没有正确或错误的答案。 您可以选择以下描述的答案：

从未操作是指您在日常的手术室工作中从未进行过这种操作。

很少操作是指您在手术室的日常工作中只进行过几次或只对少数患者进行该项操作。

有时操作是指您有时或在日常工作中对某些患者一起进行该项操作。

经常操作是指您每次或对每位手术患者都会进行此操作。

注意：一些问题需要你补充选择从不操作的原因。

操作	题目	从未操作	很少操作	有时操作	经常操作
1. 手术室环境	1. 维护/检查手术室内的空气应为正压通气状态。				
	2. 通过空气过滤器监督/检查手术室内的所有空气，已达到质量标准认证的。				
	3. 确保定期更换空气过滤器。				
...	...				
4. 与手术部位感染相关的患者的风险因素	20. 如果不干扰手术，请勿备皮。				
	21. 根据治疗计划检查患者是否有抗生素，或在手术开始前已经进行输入。				
	22. 术中注意患者保暖，例如用温热的溶液冲洗伤口。为病人盖上敷料，只在需要时打开病人的敷料。				

### 第五部分：关于手术部位感染预防的开放式问卷

说明：这些开放式问题的目的是探索对参与者在手术阶段预防手术部位感染（SSI）的看法的更多了解。您提供的信息将有助于提高手术阶段预防 SSI 的护理质量。请在以下问题中提供简短答案。

1. 您认为手术部位感染预防是否重要？请提供您的理由。
2. 作为手术室护士，您是如何在手术室中预防手术部位感染的呢？
3. 促进手术室护士增长手术部位感染预防知识的有利因素有哪些？为什么？
4. 阻碍手术室护士增长手术部位感染预防知识的障碍是什么？为什么？
5. 促进手术室护士提升手术部位感染预防态度的有利因素有哪些？为什么？
6. 阻碍手术室护士提升手术部位感染预防的态度的障碍有哪些？为什么？
7. 促进手术室护士实施手术部位感染预防操作的有利因素有哪些？为什么？
8. 阻碍手术室护士实施手术部位感染预防操作的障碍有哪些？为什么？
9. 您是否还有其他关于手术室护士对于改善手术部位感染预防的建议？请提供您的建议。

## Appendix E

### The Number of Participants and Related Information of Selected Hospitals

*The Number of Participants and Related Information of Selected Hospitals*

No.	Name of hospital	Level of hospitals		Number of operating rooms	Number of operating room nurses	Number of participants
		Tertiary	Secondary			
1	Anshun Maternal and Child Health Hospital	*		8	18	17
2	Anshun Xixiu District People's Hospital		*	8	23	9
3	The Third of People's Hospital of Bijie City		*	5	12	9
4	The First of People's Hospital of Bijie City	*		13	38	29
5	Bijie Qixingguan District Maternal and Child Health Hospital		*	4	10	2
6	The Traditional Chinese Medicine Hospital of Bijie City	*		6	15	2
7	Maternal and Child Health Hospital of Bozhou District		*	2	5	3
8	People's Hospital of Bozhou District	*		12	40	21
9	The Traditional Chinese Medicine Hospital of Bozhou District		*	9	16	14
10	Boda Hospital		*	8	12	2
11	The People's Hospital of Ceheng County		*	6	16	11
12	The People's Hospital of Cengong county		*	6	12	2
13	The People's Hospital of Chishui City	*		8	21	3
14	The Traditional Chinese Medicine Hospital of Chishui City		*	3	6	2
15	Congjiang People's Hospital		*	6	13	1

Table 3 (continued)

No.	Name of hospital	Level of hospitals		Number of operating rooms	Number of operating room nurses	Number of participants
		Tertiary	Secondary			
16	Danzhai County People's Hospital		*	5	12	2
17	Daozhen County People's Hospital		*	8	15	2
18	Dejiang County Hospital of Traditional Chinese Medicine for Ethnic Minorities	*		7	12	2
19	Dejiang County People's Hospital	*		10	28	9
20	Duyun People's Hospital		*	6	12	5
21	Dushan People's Hospital		*	5	16	14
22	Fuquan First People's Hospital		*	10	20	1
23	Fuquan Traditional Chinese Medicine Hospital		*	6	10	3
24	Guanling County People's Hospital		*	5	11	8
25	Guihang 302 Hospital	*		12	28	24
26	Guihang 303 Hospital		*	9	12	1
27	Guiyang Second People's Hospital	*		9	25	15
28	Guiyang Sixth People's Hospital		*	7	13	4
29	Guiyang Third People's Hospital	*		6	15	5
30	Guiyang Fourth People's Hospital	*		11	30	1
31	Guiyang First People's Hospital	*		8	28	16
32	Guiyang Maternal and Child Health Hospital	*		17	50	36
33	Guiyang Stomatological Hospital	*		4	7	3
34	People's Hospital of Nanming District, Guiyang City		*	6	10	6
35	People's Hospital of Wudang District, Guiyang City		*	4	10	9

Table 3 (continued)

No.	Name of hospital	Level of hospitals		Number of operating rooms	Number of operating room nurses	Number of participants
		Tertiary	Secondary			
36	Guizhou Second People's Hospital	*		4	11	5
37	Guizhou Third People's Hospital	*		4	10	5
38	Guizhou Orthopaedic Hospital	*		6	24	10
39	Guizhou Provincial People's Hospital	*		29	93	66
40	Guizhou Provincial Staff Hospital		*	2	7	3
41	Second Affiliated Hospital of Guizhou University of Traditional Chinese Medicine	*		8	21	12
42	Second Affiliated Hospital of Guizhou University of Traditional Chinese Medicine	*		11	22	16
43	Guizhou Cancer Hospital	*		10	27	5
44	General Hospital of Guizhou Water Mine Holding Liability Co., Ltd.	*		16	28	5
45	Second Affiliated Hospital of Guizhou Medical University	*		11	30	20
46	Third Affiliated Hospital of Guizhou Medical University	*		8	24	18
47	Dental Hospital Affiliated to Guizhou Medical University	*		6	13	3
48	Wudang Hospital Affiliated to Guizhou Medical University	*		7	15	11
49	Affiliated Hospital of Guizhou Medical University	*		42	108	10
50	Hezhang County People's Hospital		*	8	20	5
51	Huaxi District Hospital		*	2	8	1
52	Jinsha County Hospital of Traditional Chinese Medicine		*	7	17	2

Table 3 (continued)

No.	Name of hospital	Level of hospitals		Number of operating rooms	Number of operating room nurses	Number of participants
		Tertiary	Secondary			
53	Kaiyang County Maternal and Child Health Hospital		*	2	4	4
54	Kaiyang People's Hospital		*	5	22	8
55	Kaili First People's Hospital		*	5	13	9
56	Liping County People's Hospital		*	6	15	2
57	Liping County Hospital of Traditional Chinese Medicine		*	3	6	1
58	Libo County Hospital of Traditional Chinese Medicine		*	2	6	1
59	Liupanshui Maternal and Child Health Hospital	*		10	26	5
60	Liupanshui Second People's Hospital		*	9	15	1
61	Liupanshui Liangdu Hospital		*	21	8	1
62	Liupanshui People's Hospital	*		14	34	9
63	Longli County People's Hospital		*	6	12	3
64	Luodian County People's Hospital		*	5	13	4
65	Majiang County People's Hospital		*	6	11	1
66	People's Hospital of Meitan County		*	12	18	1
67	Nayong County People's Hospital		*	5	15	1
68	Nayong County Hospital of Traditional Chinese Medicine		*	2	7	4
69	Panzhou Second People's Hospital		*	7	16	9
70	Panzhou People's Hospital		*	17	26	18
71	Panzhou Hospital of Traditional Chinese Medicine		*	3	6	1
72	Panzhou Xinxing Hospital		*	7	19	2

Table 3 (continued)

No.	Name of hospital	Level of hospitals		Number of operating rooms	Number of operating room nurses	Number of participants
		Tertiary	Secondary			
73	Pingtang County People's Hospital		*	6	16	3
74	Pu'an County People's Hospital		*	5	16	3
75	Puding County People's Hospital		*	6	17	1
76	Puding County Hospital of Traditional Chinese Medicine		*	4	9	2
77	People's Hospital of Qiandongnan Prefecture	*		24	50	3
78	Qiandongnan Prefecture Hospital of Traditional Chinese Medicine	*		6	12	2
79	Qiannan Prefecture People's Hospital	*		12	32	23
80	People's Hospital of Southwest Guizhou	*		30	62	7
81	Qianxi Southwest Prefecture Hospital of Traditional Chinese Medicine	*		7	21	16
82	Qingzhen First People's Hospital	*		6	17	12
83	Qingzhen Maternal and Child Health Hospital		*	4	10	6
84	Qingzhen Traditional Chinese Medicine Hospital		*	5	13	10
85	Renhuai People's Hospital	*		14	29	23
86	Renhuai Traditional Chinese Medicine Hospital	*		5	17	11
87	Rongjiang County People's Hospital		*	4	11	2
88	People's Hospital of Sandu Shui Autonomous County		*	4	11	1
89	Sansui County People's Hospital		*	6	10	6
90	Sansui County Hospital of Traditional Chinese Medicine		*	4	10	3

Table 3 (continued)

No.	Name of hospital	Level of hospitals		Number of operating rooms	Number of operating room nurses	Number of participants
		Tertiary	Secondary			
91	Shibing County People's Hospital		*	4	10	3
92	Shiqian People's Hospital	*		6	14	14
93	Shiqian County Hospital of Traditional Chinese Medicine		*	4	11	8
94	Shuicheng People's Hospital		*	6	10	2
95	Sinan People's Hospital	*		8	22	15
96	Sinan County Hospital of Traditional Chinese Medicine		*	4	14	12
97	Maternal and Child Health Hospital of Songtao County		*	4	7	5
98	Songtao County People's Hospital	*		10	25	16
99	Songtao County Hospital of Traditional Chinese Medicine		*	5	12	6
100	Suiyang County People's Hospital		*	6	17	10
101	Tongren Maternal and Child Health Hospital	*		4	8	3
102	Tongren People's Hospital	*		23	52	19
103	Wangmo County People's Hospital		*	4	12	12
104	Weining County People's Hospital	*		7	21	18
105	Xifeng County People's Hospital		*	7	16	1
106	Xifeng County Hospital of Traditional Chinese Medicine		*	6	12	2
107	Xishui County Hospital of Traditional Chinese Medicine		*	7	12	11
108	Xingren People's Hospital		*	8	13	6
109	Xingren Zhenwu Hospital		*	4	17	8
110	Xingyi People's Hospital	*		20	63	57



Table 3 (continued)


No.	Name of hospital	Level of hospitals		Number of operating rooms	Number of operating room nurses	Number of participants
		Tertiary	Secondary			
111	Xiuwen People's Hospital		*	6	17	1
112	Yanhe County People's Hospital		*	8	18	18
113	Yinjiang County Hospital of Traditional Chinese Medicine		*	4	7	2
114	Yuqing People's Hospital		*	9	15	13
115	Zhenfeng People's Hospital		*	6	14	2
116	Zheng'an County People's Hospital		*	7	23	2
117	Zhijin People's Hospital		*	8	24	1
118	Ziyun People's Hospital		*	5	12	11
119	The First People's Hospital of Zunyi City	*		27	56	18
120	Zunyi Maternal and Child Health Hospital	*		7	16	13
121	Zunyi Honghuagang District People's Hospital		*	9	21	1
122	The Second Affiliated Hospital of Zunyi Medical University	*		10	18	9
123	The Oral Hospital Affiliated to Zunyi Medical University	*		3	9	5
124	The Affiliated Hospital of Zunyi Medical University	*		43	109	3
Total		49	75	1,038	2,481	1,036

*Note.* The name of the hospitals was sorted alphabetically. Symble “\*” refers to the level of hospitals

## Appendix F

### Approval Letters

1. Ethics Approval from the Health and Social Science Institutional Review Board (SBS-IRB), Prince of Songkla University



Certificate of Approval of Human Research Ethics  
Center for Social and Behavioral Sciences Institutional Review Board,  
Prince of Songkla University

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Document Number: 2019 Nst - Qn 014

Research Title: Relationship between Knowledge, Attitude and Practice of Surgical Site Infection Prevention among Operating Room Nurses in China.

Research Code: PSU IRB 2019 – Nst 004

Principal Investigator: Wen Feng

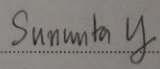
Workplace: Master of Nursing Science (International Program), Faculty of Nursing,  
Prince of Songkla University


Approved Document: 1. Human Subjects  
2. Instrument  
3. Invitation and Informed Consent

Approved Date: 24 April 2019

Expiration Date: 24 April 2021

This is to certify that the Center for Social and Behavioral Sciences Institutional Review Board, Prince of Songkla University approved for Ethics of this research in accordance with Declaration of Belmont.

  
 (Assoc. Prof. Dr. Sununta Youngwanichsetha)  
 Committee Vice-Chairman of Center for Social and Behavioral Sciences  
 Institutional Review Board, Prince of Songkla University



## 2. Ethics Approval from the IRB of Guizhou Provincial People's Hospital

伦理审查批件（科研）

贵州省人民医院伦理委员会  
EC of Guizhou Provincial People's Hospital

## 伦理审查批件

Ethical Review Approval

伦审字（科研）（2019）38号


审查日期：2019/05/20

申报课题名称全称（含课题编号及版本号）	中国手术室护士对手术部位感染预防的知信行相关性调查		
申办者（主要研究者）/承担科室	麻醉科 冯雯		
项目类别	<input type="checkbox"/> 国际合作项目（具体说明：_____） <input type="checkbox"/> 国家级基金项目（具体说明：_____） <input type="checkbox"/> 省部级科研项目（具体说明：_____） <input type="checkbox"/> 厅局级科研项目（具体说明：_____） <input type="checkbox"/> 院基金项目（具体说明：_____） <input type="checkbox"/> 企业资助研究（企业名称：_____） <input checked="" type="checkbox"/> 学位课题研究（ <input checked="" type="checkbox"/> 硕士 <input type="checkbox"/> 博士） <input type="checkbox"/> 其他（请填写： 自费 _____）		
审查文件	科研课题（项目）伦理审查申请表； 研究方案（版本号：V1.0，版本日期：2019年05月08日）； 知情同意书； 邀请函； 伦理审查申请人责任声明； 主要研究者利益冲突声明； 研究者简历； 研究组成员及分工表； 手术室感染情况调查问卷。		
审查方式	会议审查 <input checked="" type="checkbox"/>	紧急会议审查 <input type="checkbox"/>	快速审查 <input type="checkbox"/>
审查类别	初始审查 <input checked="" type="checkbox"/>	跟踪审查 <input type="checkbox"/>	复审 <input type="checkbox"/>
会议时间	2019年5月20日	会议地点	伦理委员会会议室
到会委员	详见伦理审查会议签到表		邀请专家 无
委员人数	11人	到会委员 7人	回避委员 0人
表决结果	批准		7票
	不批准		0票
	修改后批准		0票

## 2. Ethics Approval from the IRB of Guizhou Provincial People's Hospital

(continued)

伦理审查批件 (科研)

	修改后再审	0 票
	暂停或终止研究	0 票
讨论结果	批准	<input checked="" type="checkbox"/>
	不批准	<input type="checkbox"/>
	修改后批准	<input type="checkbox"/>
	修改后再审	<input type="checkbox"/>
	暂停或终止研究	<input type="checkbox"/>
审查决定	<p>1. 递交的研究方案等资料 (详见审查文件), 经本伦理委员会审查, 符合伦理规范及相关法律, 同意开展该项研究, 同意免除签署知情同意书。</p> <p>2. 跟踪审查频率:  <input checked="" type="checkbox"/> 12 个月      <input type="checkbox"/> 6 个月      <input type="checkbox"/> 其他:</p> <p>科研及实验动物伦理分委员会主任委员或副主任委员签名: </p> <p>贵州省人民医院伦理委员会 (盖章) </p> <p>2019/05/21</p>	
声明	本伦理委员会人员构成和工作程序符合中国 GCP 及国家相关规定	
备注	<p>1. 本批件有效期为 1 年。研究应当在伦理委员会同意之日起 1 年内实施, 逾期未实施的, 本审查批件自行废止。</p> <p>2. 研究应须遵循本伦理委员会批准的方案执行, 须符合 GCP 和《赫尔辛基宣言》的原则。</p> <p>3. 自同意研究之日起, 请根据本伦理委员会的定期跟踪审查频率, 在审查日到期前一个月提交年度/定期跟踪审查报告。</p> <p>4. 研究过程中, 对研究方案和知情同意书等文件的任何修改, 均需提交修正案审查, 经伦理委员会审查同意后方可实施。</p> <p>5. 暂停/提前终止临床研究, 请及时向伦理委员会提交报告。</p> <p>6. 发生严重不良事件及影响研究风险受益比的非预期事件, 请及时报告本伦理委员会。</p> <p>7. 发现违反试验方案情况须及时报告本伦理委员会。</p> <p>8. 完成临床研究, 请向伦理委员会提交结题报告、中心小结进行审查。</p> <p>9. 凡涉及中国人类遗传资源管理办公室批准的研究项目, 需获得遗传办公室批准后才能开始研究。</p>	

附件: 科研及实验动物伦理分委员会成员表

地址: 贵州省贵阳市中山东路 83 号      邮编: 550002  
 电话 / 传真: 0851—85600570

### 3. Permission for Using and Revising Instrument

000101/304/62  
ของนักศึกษา

Form 1

Faculty of Nursing Prince of Songkla University

#### A Request Form for Thesis-Related Procedures

Subject: Request for Permission Letter for Data Collection

To: The Chairperson of the Graduate Studies Committee, Faculty of Nursing

I am Ms Wen Feng, Student ID 6010420013 is conducting a thesis entitled "Relationship Between Knowledge, Attitude, and Practice of Surgical Site Infection Prevention Among Operating Room Nurses in China".

The thesis proposal has been approved on 23/03/2019. I have made the revision according to the suggestions from the proposal examining committee. Thereby, I request to further precede the following related action(s):

Try-out research instruments at (Place, Sample, Amount, Duration)

- 1. Guizhou Provincial Nursing Quality Control Center, Guizhou, China, 20 operating room nurses, May 2019.

This/these instrument(s) have been revised according to the suggestions of the experts and approved by the advisory thesis committee.

Collect the data at ((Place, Sample, Amount, Duration)

- 1. Ethic Review Committee of Guizhou Provincial People's Hospital, Guizhou, China, during May 2019 to July 2019.
- 2. Guizhou Provincial Nursing Quality Control Center, Guizhou, China, all operating room nurses in Guizhou Province, during May 2019 to July 2019.

The instruments used for data collection were content validated from five experts and the result of CVI is .89.

Please kindly consider to proceed to any further needful action.

Yours Sincerely,

Wen Feng

Wen Feng  
(Student)

Date: 23. 04. 2019  
Email: 84387307@qq.com  
Mobile No.0954811505

เรียน รองคณบดีฝ่ายวิจัย วิทยาลัยการพยาบาล  
เพื่อขอทำเรื่องขอใช้เครื่องมือวิจัย และขอทำเรื่องขอใช้สถานที่  
และขอทำเรื่องขอใช้ชื่อ MS. WEN FENG  
นาง. พญ. นภาพรศรี สว่างนรินทร์

1. ขอใช้เครื่องมือ  
25/11.4. 62  
พญานภา  
25/11.4. 62

Wipa Sae-Sia

Asst. Prof. Dr. Wipa Sae-Sia  
(Major Advisor)

Date: 23. 04. 2019

**Appendix G**  
**Experts for Validation**

1. Dr. Ratjai Vachprasit

Nursing educator, Department of Surgical Nursing, Faculty of Nursing, Prince of Songkla University, Hat Yai, Thailand

2. Dr. Prof. Kaiyun Fang

Medical educator, Deputy Director of Anesthesiology Department, Guizhou Provincial People's Hospital, Guizhou, China

3. RN. Meimei Luo

Head nurse and nursing educator, Operating Room, Guizhou Provincial People's Hospital, Guizhou, China

4. RN. Jie Zhou

Head nurse, Operating Room, AVCI 363 Hospital, Sichuan, China

5. RN Yuhua Wu

Nursing' Educator, Operating Room, Sichuan Provincial Hospital for Women & Children, Sichuan, China

## **Appendix H**

### **Experts for Back Translation Instruments**

1. Thai version translated into English Version  
Assco. Prof. Dr. Wipa Sae-Sia, Nursing educator, Department of Surgical  
Nursing, Faculty of Nursing, Prince of Songkla University, Hat Yai, Thailand
  
2. Chinese version translated from the English version  
RN, Wen Feng, Master's Prepared Nursing Student  
Faculty of Nursing, Prince of Songkla University, Hat Yai, Thailand
  
3. Back translation from Chinese version to English Version  
Dr. Li Zhang, Medical Educator, Surgeon, Gastrointestinal Surgical  
Department, Guizhou Provincial People's Hospital, Guiyang, Guizhou, China
  
4. Evaluate original English version and back translated into English version of  
questionnaire  
Assoc. Prof. Jingdong, Jiao, English for Academic Purposes Lecture, The  
International College, Xiamen University

## Appendix I

### Frequency and Percentage of Responses to Each Item of Knowledge, Attitude, and Practice on Surgical Site Infection Prevention

Table A

*Frequency and Percentage of Responses to Each Item of Knowledge on Surgical Site Infection Prevention (N=999)*

Items	Incorrect <i>n</i> (%)	Correct <i>n</i> (%)
<i>Operating room environment</i>		
1. Do not leave the operating room door open could prevent infection. Except with patient access, surgical teams, equipment and instruments used in surgery.	19 (1.9)	980 (98.1)
2. For the ventilation system to work in the operating room, the air inside the operating room should have a positive pressure. There are at least 30 rounds of air exchange in the operating room per hour.	901 (90.2)	98 (9.8)
3. Making sure sterile surgical instruments are used, flash sterilization of surgical instruments only used in the case of urgent need of tools such as ground fall.	168 (16.8)	831 (83.2)
4. When cleaning the surface of the operating room, including the operating table, surgical bed, surgical lamp and wall in the operating room (environmental surfaces), wipe the surface of the operating room, operating table, surgical bed, surgical lamp and wall in the operating room every time before performing daily surgery.	50 (5.0)	949 (95.0)
5. Using the fan in the operating room could prevent infection and control the environmental in the operating room during surgery.	172 (17.2)	827 (82.8)
<i>Sterilization of surgical attire and drapes</i>		
6. For sterilization of surgical gowns and veils one can choose sterile, non-sterile, single-use green fabrics or sterile synthetic fabrics for surgery to prevent surgical placement in the operating room.	542 (54.3)	457 (45.7)
7. The purpose of wearing a mask to cover the nose (the mask) in the operating room is to prevent the secretions or blood that occur during surgery, splash, contaminate the nurse, and tools or other personnel.	651 (65.2)	348 (34.8)
8. The practice in wearing gloves during surgery is necessary to prevent surgical infection, such as, wearing 2-layer gloves and changing gloves during surgery when tearing gloves.	109 (10.9)	890 (89.1)



Table A (continued)

Items	Incorrect <i>n</i> (%)	Correct <i>n</i> (%)
<i>Sterilization of surgical attire and drapes</i>		
9. For all personnel entering the operating room, although not the room being operated in, surgical caps/hoods for personnel must be used.	10 (1)	989 (99)
10. Wearing a mask to cover the nose (mask) in every step of the surgery strictly could prevent surgical site infection in the surgical stage.	81 (8.1)	9181.9)
11. When surgical gowns or gowns and drapes are wet or permeable, they should be replaced, which could prevent surgical site infection.	21 (2.1)	9787.9)
12. Wearing 2-layer gloves or changing gloves during surgery or using special gloves could prevent surgical site infection.	133 (13.3)	866 (86.7)
<i>Asepsis surgical technique</i>		
13. Procedures for washing hands for surgery: 1) Use antiseptic, rub the palm clean, back of hands and fingers, Followed by palms, rub the palms and fingers; 2) Rub the fingertip, rub the palm, followed by rub around the wrist. Until both elbows, 3) Rub, clean after fingers, rub the palms, followed by rub the thumb around with the palm; 4) Rinse all disinfectants with clean water. By letting the water flow from the tip of the finger to the elbow always; 5) Walk into the operating room by raising the hands above the elbow, wipe your hands dry with sterile cloth or hand towel. Domain 3	275 (27.5)	724 (72.5)
14. The period of hand washing to prevent infection in the surgical location during the surgery should take at least 5-7 minutes.	630 (63.1)	369 (36.9)
15. Indications for use of alcohol-based hand washers that do not require washing with water in urgent surgery.	469 (46.9)	530 (53.1)
16. Use adhesive tape to cover the traumatic incision wound separated from the tube drainage.	208 (20.8)	791 (79.2)
17. IV fluid, medications and the solution for washing the wound can be prepared for no more than 30 minutes could prevent surgical infection.	191 (19.1)	808 (80.9)
<i>Risk factors for patients related to SSI</i>		
18. Clipper is the recommended device to remove hair in the surgical site and to remove hair immediately before entering the operating room or less than 2 hours before surgery is the best time to shaving (skin shaving) to prevent surgical infection.	354 (34.4)	645 (64.6)

Table A (continued)

Items	Incorrect <i>n</i> (%)	Correct <i>n</i> (%)
<i>Risk factors for patients related to SSI</i>		
19. Low blood pressure is one of the personal factors of patients that do not result in infection of surgical locations.	628 (62.9)	371 (37.1)
20. Hyperglycemia in the surgical period that results in increased chances of infection, surgical location, because it inhibits the phagocytosis process (phagocytosis).	133 (13.3)	867 (86.7)
21. Caring for patients to receive complete nutrition could increase the metabolic rate in the body makes the wound healing process faster.	760 (76.1)	239 (23.9)
22. Antibiotic treatment needs to be used 15 minutes before surgery to reduce the risk of surgical infection.	533 (53.4)	466 (46.6)

Table B

*Frequency and Percentage of Responses to Each Item of Attitude on Surgical Site Infection Prevention (N=999)*

Items	Strongly disagree <i>n</i> (%)	Disagree <i>n</i> (%)	Uncertain <i>n</i> (%)	Agree <i>n</i> (%)	Strongly agree <i>n</i> (%)
<i>Operating Room Environment</i>					
1. The air inside the operating room should have a positive pressure.	31 (3.0)	55 (5.5)	97 (9.7)	379 (38.0)	437 (43.8)
2. All air in the operating room should pass the air filter that meets the quality certification standards.	12 (1.2)	10 (1.0)	9 (0.9)	274 (27.4)	694 (69.5)
3. Air filter should be checked and changed regularly.	12 (1.2)	7 (0.7)	9 (0.9)	204 (20.4)	767 (76.8)
4. The opening of the door is unavoidable, especially in the case of patient access, surgical teams, equipment and tools used in surgery.	29 (2.9)	45 (4.5)	44 (4.4)	479 (48.0)	402 (40.2)
5. During operation, the number of people entering - leaving the operating room should be limited to minimum.	16 (1.6)	6 (0.6)	27 (2.7)	264 (26.4)	686 (68.7)
6. The blood-stained area in operating room should be cleaned and destroyed, including the secretions from the patient's body before surgery, new patients.	30 (3.0)	35 (3.5)	29 (2.9)	310 (31.0)	595 (59.6)
7. There should be a wiping of the operating room every time when the last patient is out of surgery.	14 (1.4)	13 (1.3)	21 (2.1)	272 (27.2)	679 (68.0)
8. Verifying that the surgical instruments are sterilized or not should be observed from coloured strips for sterilization and nurses should have the ability to interpret the correct results.	208 (20.9)	220 (22.0)	81 (8.1)	197 (19.7)	293 (29.3)
9. Sterile surgical instruments with flash sterilization method should be used if there is an urgent need to use tools such as ground-fall tools.	30 (3.0)	61 (6.1)	68 (6.8)	440 (44.1)	400 (40.0)
<i>Sterilization of Surgical Attire and Drapes</i>					
10. Wearing a mask to cover the nose when entering the operating room is not related to the incidence of surgical infection.	530 (53.1)	273 (27.3)	53 (5.3)	72 (7.2)	71 (7.1)

Table B (continued)

Items Domain	Strongly disagree <i>n</i> (%)	Disagree <i>n</i> (%)	Uncertain <i>n</i> (%)	Agree <i>n</i> (%)	Strongly agree <i>n</i> (%)
<i>Sterilization of Surgical Attire and Drapes</i>					
11. When entering the operating room, no need to store the hair into the hat.	709 (71.0)	173 (17.3)	13 (1.3)	41 (4.1)	63 (6.3)
12. Surgical team should wear sterile gloves after wearing surgical gown.	30 (3.0)	21 (2.1)	19 (1.9)	304 (30.4)	625 (62.6)
13. The selection of the appropriate surgical cover will reduce the rate of surgical infection.	16 (1.6)	22 (2.2)	46 (4.6)	394 (39.4)	521 (52.2)
14. Using surgical gowns and drapes could prevent the seepage of various secretions.	58 (5.8)	102 (10.2)	135 (13.5)	383 (38.3)	321 (32.1)
15. If there is a permeability or wetting of the surgical gown or surgical cover, sometimes there is no need to change it again.	619 (62.0)	224 (22.4)	29 (2.9)	56 (5.6)	71 (7.1)
<i>Asepsis Surgical Technique</i>					
16. Hand washing should be strict according to the antiseptic technique by bleaching the hands and arms to the elbow for at least 3-5 minutes using the appropriate solution.	34 (3.4)	47 (4.7)	21 (2.1)	431 (43.1)	466 (46.6)
17. After washing the hands, you should raise your hands, not allowing the water to flow from the elbows to the fingers.	55 (5.5)	44 (4.4)	20 (2.0)	335 (34.5)	545 (54.6)
18. Hand washing in strict accordance with the practice of hand washing in 7 steps that have been used to waste more time than necessary.	141 (14.1)	166 (16.6)	119 (11.9)	353 (35.4)	220 (22.0)
19. Water should not be prepared. Vascular medicine, local anaesthesia and aqueous solution should be prepared and used immediately.	13 (1.3)	13 (1.3)	28 (2.8)	349 (34.9)	596 (59.7)
20. No need to use sterilization techniques in all surgical procedures.	529 (53.0)	279 (27.9)	49 (4.9)	70 (7.0)	72 (7.2)
21. Compliance with guidelines to prevent infection surgical position is difficult due to lack of equipment.	94 (9.4)	115 (11.5)	168 (16.8)	362 (36.3)	260 (26.0)

Table B (continued)

Items	Strongly disagree <i>n</i> (%)	Disagree <i>n</i> (%)	Uncertain <i>n</i> (%)	Agree <i>n</i> (%)	Strongly agree <i>n</i> (%)
<i>Risk Factors for Patients Related to SSI</i>					
22. Assessment of nutritional status in patients who underwent preoperative surgery helps in assessing risk and screening risk groups for surgical location infection.	4 (0.4)	16 (1.6)	42 (4.2)	464 (46.5)	473 (47.3)
23. Patients receiving 80 percent oxygen during surgery and after the surgery for another 2-6 hours will help reduce surgical infection.	27 (2.7)	76 (7.6)	314 (31.4)	343 (34.4)	239 (23.9)
24. Making tools and equipment in a warm condition in the operating room could reduce surgical infection.	106 (10.6)	225 (22.5)	307 (30.8)	207 (20.7)	154 (15.4)
25. Keeping the temperature of the patient's body always warm during surgery will reduce surgical infection.	8 (0.8)	27 (2.7)	91 (9.1)	492 (49.3)	381 (38.1)
26. Controlling blood sugar levels not to exceed the specified threshold during surgery is important to prevent surgical site infection.	6 (0.6)	15 (1.5)	37 (3.7)	414 (41.4)	528 (52.8)
27. Maintaining normal blood flow throughout the surgery will reduce surgical infection.	12 (1.2)	30 (3.0)	129 (12.9)	453 (45.4)	375 (37.5)
28. No need for hair removal in the surgical area, except if it is disturbing surgery.	179 (17.9)	166 (16.6)	80 (8.0)	336 (33.7)	238 (23.8)
29. If hair removal is necessary, use an electric razor instead of a normal razor blade.	82 (8.2)	134 (13.4)	175 (17.5)	366 (36.7)	242 (24.2)
30. There is no need to change bed linen every time when having new surgery.	547 (54.8)	287 (28.7)	18 (1.8)	67 (6.7)	80 (8.0)
31. Determining whether the patient has antibiotics ready for the patient or not. Or check if they have already received it according to the treatment plan before entering the operating room is not the role of a surgical room nurse.	433 (43.3)	299 (30.0)	50 (5.0)	109 (10.9)	108 (10.8)

Table C

*Frequency and Percentage of Responses to Each Item of Practice on Surgical Site Infection Prevention (N=999)*

Items	Never practice n (%)	Seldom practice n (%)	Sometime s practice n (%)	Practice regularly n (%)
<i>Operating Room Environment</i>				
1. Maintain / check the air in the operating room. It should have positive pressure.	105 (10.5)	155 (15.5)	195 (19.5)	544 (54.5)
2. Supervise / inspect all air in the operating room through an air filter that has passed the quality standard certification.	121 (12.1)	164 (16.4)	198 (19.8)	516 (51.7)
3. Ensure that the air filter is changed regularly.	117 (11.7)	129 (12.9)	175 (17.5)	579 (57.9)
4. Keep the door closed, except in the case of patient access, surgical teams, equipment and tools used in surgery.	42 (4.2)	79 (7.9)	123 (12.3)	755 (75.6)
5. Take care to limit the number of people entering - leaving the operating room to a minimum.	22 (2.2)	47 (4.7)	88 (8.8)	842 (84.3)
6. Inspect, care and clean, destroy the blood-stained area, including the secretions from the patient's body before surgery, new patients.	24 (2.4)	50 (5.0)	61 (6.1)	864 (86.5)
7. Ensure that the operation areas of the operating room are wiped every time when the last patient is out of surgery.	20 (2.0)	47 (4.7)	82 (8.2)	850 (85.1)
8. Check whether surgical instruments are sterilized or not. By observing the colour bands, for sterilization and correct interpretation of results.	18 (1.8)	34 (3.4)	43 (4.3)	904 (90.5)
9. Choose to use sterile surgical instruments with flash sterilization. If there is an urgent need to use tools such as ground-fall tools.	104 (10.4)	253 (25.3)	222 (22.2)	420 (42.0)
<i>Sterilization of Surgical Attire and Drapes</i>				
10. Wear a mask to cover the nose when entering the operating room.	14 (1.4)	21 (2.1)	24 (2.4)	940 (94.1)
11. Keep the hair in the hat when entering the operating room.	15 (1.5)	25 (2.5)	19 (1.9)	940 (94.1)

Table C (continued)

Items	Never practice <i>n</i> (%)	Seldom practice <i>n</i> (%)	Sometime s practice <i>n</i> (%)	Practice regularly <i>n</i> (%)
<i>Sterilization of Surgical Attire and Drapes</i>				
12. Wear sterile gloves after wearing surgical gowns.	18 (1.8)	30 (3.0)	25 (2.5)	926 (92.7)
13. Use surgical gowns and drapes that prevent the absorption of various secretions.	32 (3.2)	57 (5.7)	121 (12.1)	789 (79.0)
14. Replacing a surgical gown or surgical cape if there is seepage or wetting during surgery.	12 (1.2)	37 (3.7)	72 (7.2)	878 (87.9)
15. Wash hands according to the antiseptic procedure by bleaching the hands and arms to the elbow for at least 3-5 minutes using the appropriate solution.	14 (1.4)	29 (2.9)	33 (3.3)	923 (92.4)
16. After washing your hands and lifting your hands, do not let the water flow from the elbows to the fingers.	35 (3.5)	35 (3.5)	26 (2.6)	903 (90.4)
17. Wipe and dry your hands before wearing surgical gowns, followed by wearing sterile surgical gloves.	61 (6.1)	32 (3.2)	35 (3.5)	871 (87.2)
18. Use IV solution or drug solution immediately after preparing.	14 (1.4)	32 (3.2)	71 (7.1)	882 (88.3)
19. Use an electric razor instead of a normal razor blade.	305 (30.5)	238 (23.9)	155 (15.5)	301 (30.1)
20. Do not remove hair if it is not interfering with surgery.	255 (25.5)	239 (24.0)	159 (15.9)	346 (34.6)
21. Check whether the patient has complete antibiotics according to the treatment plan or not or check if they have already received it before operation started.	21 (2.1)	56 (5.6)	101 (10.1)	821 (82.2)
22. Keep the patient's body temperature warm during surgery, such as washing the wound with a warm solution. Covering cloth for patients when open the patient's cover as long as needed.	48 (4.8)	70 (7.0)	127 (12.7)	754 (75.5)

## APPENDIX J

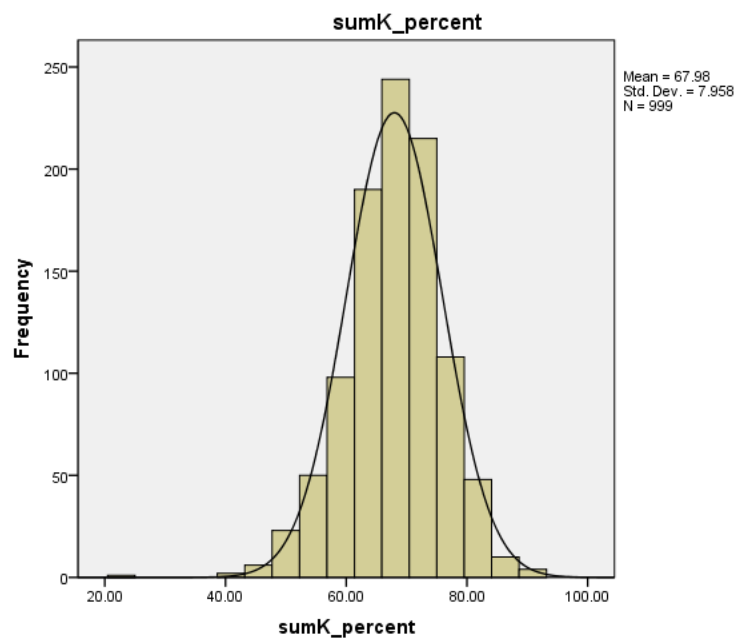
### Test Assumption of Normality of Knowledge, Attitude, and Practice of Surgical Site Infection (SSI).

Table D

#### *Skewness and Kurtosis of the Studied Variables*

Variables	Skewness / SE	Z <sub>Skewness</sub>	Kurtosis/ SE	Z <sub>Kurtosis</sub>	Distribution
Knowledge	-.383/0.77	-.50	1.124 / .155	7.25	Normal
Attitude	-1.060/0.77	-2.09	3.751/.155	24.2	Normal
Practice	-1.998/0.77	-2.59	5.116/.155	33.0	Normal

Note. SE = standard error.



*Figure 2.* Histogram Evaluation Result of Sum Knowledge Percentage of SSI Prevention



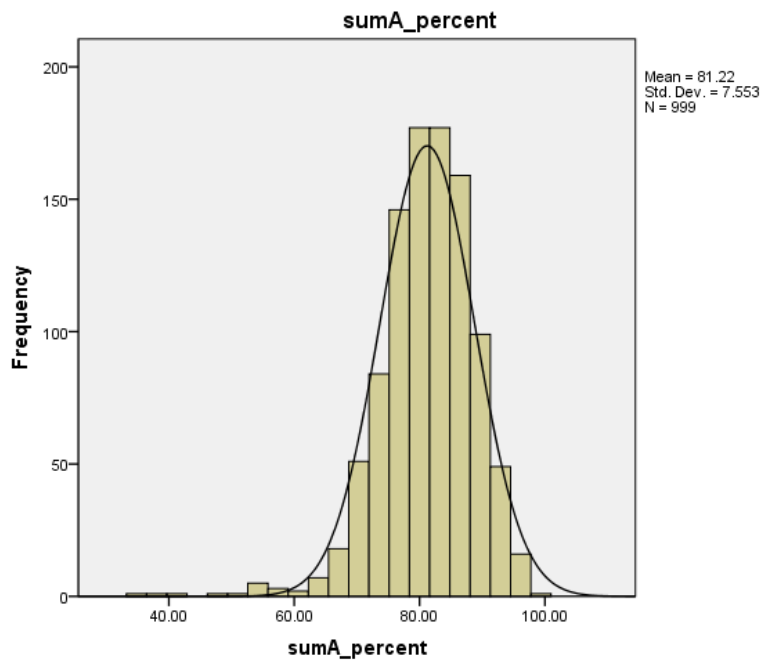


Figure 3. Histogram Evaluation Result of Sum Attitude Percentage of SSI Prevention

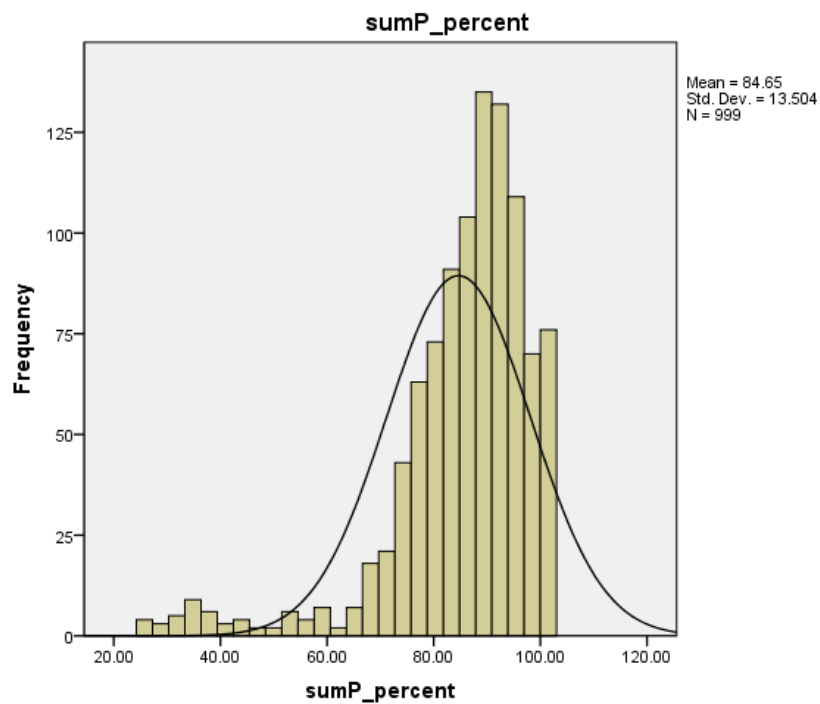


Figure 4. Histogram Evaluation Result of Sum Practice Percentage of SSI Prevention

## APPENDIX K

### Additional Data of the Factors Related to Knowledge, Attitude, and Practice from Open-end Questions

*Table E*

*Frequency and Percentage of the Main Answer Related to Knowledge, Attitude, and Practice of Surgical Site Infection Prevention from Open-end Questions*

Questions	Main answer	n (%)	Level
<i>Knowledge of Surgical Site Infection Prevention</i>			
1.1 What are the facilitating factors to improve nurses' knowledge about SSI prevention in operating room? (N = 79)	- Increase the training	59 (74.7%)	Organization
	- Increase awareness of SSI prevention	13 (16.5%)	Personal
	- Awareness of harm to patients	10 (12.6%)	Personal
	- Comply with the hospital regulations	3 (3.8%)	Policy
	- Comply with the government guidelines	1 (1.3%)	Policy
1.2 Why do you think are the facilitating factors that could improve nurses' knowledge about SSI prevention in operating room? (N = 79)	- Improve knowledge	25 (31.6%)	Personal
	- Reduce the rate of SSI	12 (15.2%)	Organization/ National
	- Increase the awareness of aseptic	9 (11.4%)	Personal
	- Leaders' supervision of SSI prevention	4 (5.1%)	Organization
	- Improve practice	3 (3.8%)	Personal
2.1 What are the barriers to impede nurses' knowledge about SSI prevention in operating room? (N = 110)	- Inadequate own learning	27 (24.5%)	Personal
	- Working overload	22 (20.0%)	Organization/ National
	- Lack of awareness of aseptic	11 (10.0%)	Personal
	- Lack of leaders' concern	10 (9.1%)	Organization
	- Limited training	10 (9.1%)	Organization
	- Lack of SSI prevention awareness of surgeons and leaders	8 (7.3%)	Personal

Table E (continued)

Questions	Main answer	n (%)	Level
<i>Knowledge of Surgical Site Infection Prevention</i>			
2.2 Why do you think they are barriers to impede nurses' knowledge about SSI prevention in operating room? (N = 106)	- Lack of awareness of SSI	25 (23.6%)	Personal
	- Lack of learning	19 (17.9%)	Personal
	- Working overload	12 (9.4%)	Organization
	- Lack of leaders' concern	4 (3.8%)	Organization
	- Incorrect aseptic technique	3 (2.8%)	Personal
<i>Attitude of Surgical Site Infection Prevention</i>			
3.1 Do you think prevention of infection at the surgical site is important? (N = 119)	- Yes	25 (21.0%)	Personal
	- Important	61 (51.3%)	Personal
	- Very important	33 (27.7%)	Personal
3.2 Please provide your reasons. (N = 117)	- Decrease the rate of SSI	73 (62.4%)	Organization/ National
	- Reduce the pain of patients	31 (26.5%)	Personal
	- Decrease the length of hospital stay	30 (25.6%)	Organization
	- Decrease the patients' economical expend	21 (17.9%)	Personal
	- Reduce the mortality related to SSI	12 (10.3%)	Organization/ National
	- Successful of operation	10 (8.5%)	Organization
	4. As an operating room nurse, how do you prevent surgical site infection in the operating room? (N = 118)	- Strictly implementation of aseptic techniques	84 (71.2%)
- Appropriate antibiotic use		30 (25.4%)	Organization
- Surgical hand disinfection		26 (22.0%)	Personal
- Limited the number of people entered the operating room		21 (17.8%)	Organization
- Prevention hypothermia		15 (12.7%)	Personal
- Patients' skin preparation		14 (11.9%)	Organization
- Environment disinfection		13 (11.0%)	Organization
- Sterilization of surgical instruments		9 (7.6%)	Organization

Table E (continued)

Questions	Main answer	n (%)	Level
<i>Attitude of Surgical Site Infection Prevention</i>			
5.1 What are the facilitating factors to promote nurses' attitude about SSI prevention in operating room? (N = 104)	- Increase own learning of SSI prevention	34 (32.7%)	Personal
	- Increase training of SSI prevention	16 (15.4%)	Organization
	- Leaders' attention of infection control and management	16 (15.4%)	Organization
	- Nurses' high responsibility	6 (5.8%)	Personal
	- Awareness of SSI incidence	2 (1.9%)	Personal
5.2 Why do you think they are facilitating factors to promote nurses' attitude about SSI prevention in operating room? (N = 83)	- Reduce rate of SSI	32 (38.6%)	Organization
	- High awareness of SSI prevention	23 (27.7%)	Personal
	- Enough learning and experience of SSI	21 (25.3%)	Personal
	- Leaders' attention of SSI prevention and management	8 (9.6%)	Organization
	- Promote the patients' recover	3 (3.6%)	Personal
	- Nurses' sense of achievability	1 (1.2%)	Personal
6.1 What are the barriers to block nurses' attitude about SSI prevention in operating room? (N = 104)	- Inadequate leader concern	17 (16.3%)	Organization
	- Inadequate learning and training	15 (14.4%)	Organization/ Personal
	- Low of SSI prevention awareness of surgeons	12 (11.5%)	Personal
	- Working overload	11 (10.6%)	Organization
	- Low of SSI prevention awareness of nurses	7 (6.7%)	Personal
	- Inadequate medical resources	7 (6.7%)	National/ Police
	- Work stress	2 (1.9%)	Personal

Table E (continued)

Questions	Main answer	n (%)	Level
<i>Attitude of Surgical Site Infection Prevention</i>			
6.2 Why do you think they are barriers to block nurses' attitude about SSI prevention in operating room? (N = 90)	- Inadequate learning and update knowledge	25 (27.8%)	Personal
	- Working overload	10 (11.1%)	Organization
	- Inadequate leaders' concern	9 (10.0%)	Organization
	- Cooperation of surgeons	7 (7.8%)	Personal
	- Low awareness of SSI prevention	4 (4.4%)	Personal
	- Inadequate medical resources	1 (1.1%)	Organization
<i>Practice of Surgical Site Infection Prevention</i>			
7.1 What are the facilitating factors to promote nurses' practice about SSI prevention in operating room? (N = 100)	- Strictly implementation of aseptic techniques	41 (41.0%)	Personal
	- Standard training	23 (23.0%)	Organization
	- Leaders' concern	5 (5.0%)	Organization
	- Guidelines and regulations	6 (6.0%)	National/ Policy
	- Awareness of patients	4 (4.0%)	Personal
	- Highly awareness of aseptic and infection prevention	3 (3.0%)	Personal
	- Cooperating of surgical team	2 (2.0%)	Personal
	- Adequate human resources	1 (1.0%)	Personal
7.2 Why do you think they are facilitating factors to promote nurses' practice about SSI prevention in operating room? (N = 95)	- Avoid of hair removal	1 (1.0%)	Personal
	- Reduce the rate of SSI	35 (36.8%)	Organization/ National
	- Training and learning	16 (16.8%)	Organization/ Personal
	- Increase awareness of SSI prevention	3 (3.2%)	Personal
	- Guidelines and regulations	2 (2.1%)	National/ Policy
	- Leaders' concern	1 (1.1%)	Organization
	- Reduce the skin injury	1 (1.1%)	Personal

Table E (continued)

Questions	Main answer	n (%)	Level
<i>Practice of Surgical Site Infection Prevention</i>			
7.2 Why do you think they are facilitating factors to promote nurses' practice about SSI prevention in operating room? (N = 95)	- Supervision of Infection control department	1 (1.1%)	Organization
	- Reasonable environment layout	1 (1.1%)	Organization
8.1 What are the barriers to block nurses' practice about SSI prevention in operating room? (N = 96)	- Lack of nurses' knowledge and working experience	15 (15.6%)	Personal
	- Low aseptic awareness of surgeons'	15 (15.6%)	Personal
	- Lack of awareness of SSI prevention	10 (10.4%)	Personal
	- Inadequate of training	7 (7.3%)	Organization
	- Leaders' concern	7 (7.3%)	Organization
	- Reasonable environment layout	6 (6.3%)	Organization
	- Working overload	4 (4.2%)	Organization
	- Patients' risk factors	3 (3.1%)	Personal
8.2 Why do you think they are barriers to block nurses' practice about SSI prevention in operating room? (N = 91)	- Inappropriate antibiotic use	2 (2.1%)	Personal
	- Non-compliance of aseptic technique by other staff	21 (23.1%)	Personal
	- Lack of awareness of SSI prevention	18 (19.8%)	Personal
	- Increase the rate of SSI	17 (18.7%)	Organization
	- Limited learning and training	8 (8.8%)	Organization/ Personal
	- Leaders' concern and supervision	4 (4.4%)	Organization
<i>Suggestions for Surgical Site Infection Prevention</i>			
9.1 Do you have any other suggestions for improvement OR nurses' role for SSI prevention in operating room? (N = 25)	- Training	13 (52.0%)	Organization
	- Promote standard guidelines and supervision	8 (32.0%)	Organization

Table E (continued)

Questions	Main answer	n (%)	Level
<i>Suggestions for Surgical Site Infection Prevention</i>			
9.1 Do you have any other suggestions for improvement OR nurses' role for SSI prevention in operating room? (N = 27)	- Provide education for patients	2 (8.0%)	Organization
	- Increase the awareness of SSI	2 (8.0%)	Personal
9.2 Please provide your suggestions for improvement OR nurses' role for SSI prevention in operating room? (N = 49)	- Training	24 (49.0%)	Organization
	- Strictly compliance standard guidelines and supervision	15 (30.6%)	Organization
	- Appropriate environment and medical resources	4 (8.2%)	Organization
	- Provide appropriate antibiotic use	4 (8.2%)	Organization
	- Provide education for patients	2 (4.0%)	Organization

## VITAE

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### **List of Publications and Proceedings**



- Feng, W. (2015). Modified postures of esophageal cancer radical surgery nursing operation cooperation. *Chinese Journal of Nursing of Integrated Traditional Chinese and Western Medicine*, 8(2).
- Feng, W. (2018, April). Knowledge, attitude, and practice (KAP) on prevention of surgical site infection (SSI) in operating room nurse. Abstract poster presented at 2018 The First Academic Fair, Fulfilling the Royal Wish “Benefit of Mankind”, Faculty of Nursing, Prince of Songkla University, Thailand.
- Feng, W., Duan, H.J., Luo, M.M., & Wang, X.Q. (2019). Surgical cooperation of laparoscopic splenectomy with Covidien laparoscopic stapler. *Chinese Journal of Medical and Science*, 11.