



Belitung Nursing Journal

E-ISSN: 2477-4073 | P-ISSN: 2528-181X

Volume 8 , Issue 2
March - April 2022

Edited by Assoc. Prof. Dr. Yupin Aungsuroch & Dr. Joko Gunawan

The Official Publication of
Belitung Raya Foundation
Department of Publication, Indonesia





Knowledge, attitude, and practice of surgical site infection prevention among operating room nurses in southwest China

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Abstract

Background: Surgical site infection has become a problem in the operating room, and the nurses' knowledge, attitude, and practice could impact the incidence of the infection. Unfortunately, there is a dearth of studies on this issue in China. Therefore, determining nurses' knowledge, attitude, and practice of surgical site infection prevention is necessary.

Objectives: This study aimed to examine the knowledge, attitude, and practice of surgical site infection prevention and their relationships, as well as to identify differences in knowledge, attitude, and practice of surgical site infection prevention according to nurses' demographic characteristics.

Methods: A sample of 999 operating room nurses participated in 49 tertiary hospitals and 75 secondary hospitals in Guizhou Province, Southwest China. Data were collected using validated questionnaires through a Chinese survey website. Data were analyzed using descriptive statistics, One-Way Analysis of Variance, and Pearson product-moment correlation.

Results: The knowledge of surgical site infection prevention was at a low level, the attitude was positive, and the practice was at a high level. Approximately 39% of the nurses passed knowledge scores of $\geq 70\%$, 60% gave a positive attitude score of $\geq 80\%$, and 76% achieved a practice score of $\geq 80\%$. The nurses' attitude was positively related to knowledge ($p < .01$), and practice ($p < .01$), respectively. However, knowledge and practice did not significantly relate. The age group of 30-39 years old had significant higher knowledge than other age groups. The nurses with working experience of 6-15 years had significant higher knowledge scores than other groups. In addition, the nurses with one time of training frequency had significant lower attitude and practice scores than those with six to ten times of training frequency.

Conclusion: Approximately 60% of operating room nurses still had inadequate knowledge regarding surgical site infection prevention, but they had a positive attitude and high level of practice. The findings of this study might serve as an input for nurse administrators or policymakers to provide updated knowledge or guideline, closed supervision, and in-service training on surgical site infection prevention for operating room nurses.

Keywords

surgical site infection; operating room nurse; knowledge; attitude; practice; China

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Article info:

Received: 26 December 2021

Revised: 29 January 2022

Accepted: 1 April 2022



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Background

Surgical site infection is defined as an infection that may occur in a patient within 30 days after an operation without an implant (Berríos-Torres et al., 2017; Mangram et al., 1999). Surgical site infections are the most common and complex healthcare-associated infections. Surgical site infections could lead to patient mortality and increased cost of care (Bhangu et al., 2018; Purba et al., 2020; Silvestri et al., 2018). Although surgical site infections have declined in the past decade, their rate in China is still problematic, especially during operations.

In a survey conducted among 65,885 patients in Guizhou Province, located in Southwest China, 17.29% contracted surgical site infections out of 1,643 nosocomial infections (Zhang et al., 2015). Recently, a national cross-section study revealed that the incidence of surgical site infection within postoperative 30 days was 7.1% of 1046 colorectal surgery patients in 55 hospitals in China (Zhang et al., 2020). Meanwhile, the occurrence rate of surgical site infection was 7.4% of 953 patients after emergency abdominal surgery in 47 hospitals in China (Li et al., 2021).

Factors leading to surgical site infection include patient and operative factors. Patient factors include advanced age,

metabolic diseases, nicotine use, obesity, malnutrition, hypoalbuminemia, and high blood glucose level (Li et al., 2021; Wang et al., 2019). Operative risk factors are classified into three types: 1) environment, including the ventilation in an operating room and sterilization of surgical instruments, 2) surgical equipment, including surgical drains; and 3) healthcare providers, including the knowledge, attitude, and practice of nurses (Mujagic et al., 2019; Poirrot et al., 2018).

It has been documented that the quality of nursing care is significantly related to nurses' knowledge, attitude, and practice to deliver evidence-based nursing care to patients (Lin et al., 2019). A recent qualitative study found barriers to nurses' adherence to surgical site infection prevention included their knowledge and skills regarding applying aseptic technique principles in practice (Lin et al., 2019). Previous studies in China indicated that nurses who passed the average knowledge score ranged from 19.3% to 57.78% (Chen et al., 2013; Yang & Cheng, 2014; Zhou et al., 2014). A study in China revealed that 63.08% of nurses got the average score of 9.35 from a total score of 12, and only 63.08% of nurses provided the correct answer of hair removal using electric razors instead of normal razor blades (Hao et al., 2018). A recent study showed that operating room nurses had a moderate level of knowledge, positive attitude, and low level of practice in terms of the terminal disinfection of infected operations (Zhang et al., 2019).

Based on the review, age, working experience, and frequency of training were related factors of knowledge, attitude, and practice of infection prevention. The participants younger than 30 years had a low level of knowledge in India (Patil et al., 2018). A study showed that 44.4% of nurses younger than 25 years had a low level of knowledge (Sadaf et al., 2018), and the participants were older than 31 years had a higher level of knowledge and practice than younger groups (Desta et al., 2018). In addition, the less working experience (less than five years) was related to the low level of knowledge of surgical site infection prevention (Patil et al., 2018; Sadaf et al., 2018). The participants with less working experience had a low level of practice (Sadaf et al., 2018). The study showed that nurses with more than ten years of working experience had a high level of knowledge and practice than the group working less than five years (Desta et al., 2018). Besides, the participants who attended the training courses were related to their high level of knowledge (Desta et al., 2018). The operating room nurses with three times or more above training had a higher knowledge of terminal disinfection of infection than others (Zhang et al., 2019).

The latest Chinese surgical site infection prevention guideline (Chinese Society of Surgical Infection and Intensive Care of Chinese Society of Surgery in Chinese Medical Association et al., 2019) was modified from the international guideline (Berríos-Torres et al., 2017; World Health Organization, 2018). In addition, the Chinese Nursing Association Operating Room Professional Committee published the "Guide to Operating Room Nursing Practice" in 2014 and updated it every year (Chinese Nursing Association Operating Room Professional Committee, 2021). The operation room nurses' practice is based on this nursing practice guideline. However, the surgical site infection prevention content in the operating room was similar to the latest Chinese surgical site infection prevention guideline.

To date, no study has examined Chinese operating room nurses' knowledge, attitude, and practice on surgical site infection prevention based on up-to-date evidence or studied the relationship between these variables. This study was the first provincial-level survey on surgical site infection prevention among operating room nurses working in tertiary and secondary hospitals in southwest China. Exploring this subject in Guizhou Province will provide the operating room organization in China with rich information that can be used for conducting intervention studies to enhance the quality of nursing care, especially in the perioperative phase. This study has two objectives: 1) to examine the level of knowledge, attitude, and practice of surgical site infection prevention and their relationships among operating room nurses working in Guizhou Province, China; 2) to identify differences in knowledge, attitude, and practice of surgical site infection prevention according to nurses' demographic characteristics.

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 surgical site infection prevention proposed by the Centers for Disease Control (CDC) (Berríos-Torres et al., 2017; Mangram et al., 1999) and the World Health Organization (World Health Organization, 2016, 2018). It was proposed that knowledge, attitude, and practice could interact with each other in the KAP model (Rav-Marathe et al., 2016). It revealed that there was a relationship between individuals' knowledge, attitude, and practice, and an individual's knowledge and attitude could impact practice. The prevention of surgical site infection in the CDC and WHO guidelines includes pre-operative, intra-operative, and post-operative preventive strategies. Based on the review, the operating room nurses had a very low grasp of some aspects of surgical site infection prevention in previous decades in China. This study focused only on intra-operative prevention strategies, and the knowledge, attitude, and practice of surgical site infection prevention covered the following areas: 1) the operating room environment; 2) sterilization of surgical attire and drapes; 3) asepsis surgical techniques; and 4) surgical site infection-related risk factors for patients (Berríos-Torres et al., 2017; Mangram et al., 1999; World Health Organization, 2016, 2018).

Methods

Study Design

A descriptive correlational design was chosen for this study, which was conducted between May 2019 and August 2019.

Participants

The participants of this study were all population of operating room nurses who worked in the operating room in Guizhou Province, China. A convenience sampling method was used to invite 2,481 operating room nurses working in 124 hospitals composed of 49 tertiary hospitals and 75 secondary hospitals. Data were collected online using the questionnaires through the Chinese survey website (Wen Juan Xing) plus WeChat, a popular social application in China. There were approximately

50 % ($n = 1,215$) of operative nurses who uploaded the questionnaires by Wen Juan Xing. Based on the criterion of having working experience in operating room for more than half a year, 1,036 participants (85.27%) were recruited for the analysis. However, there were 37 participants with extreme outlier data; therefore, only 999 nurses were used for the final data analysis. This sample size has met the power of .99-1.00 for correlation between attitude and knowledge, and between attitude and practice, with a significant level of .05 using the G Power Program (Polit & Beck, 2017). The inclusion criteria of the participants were (1) having at least a diploma certificate in nursing and (2) having working experience in the operating room for more than six months in Guizhou Province.

Instruments

Data were collected by using self-administration questionnaires. The questionnaires were developed by Saksri et al. (2018) based on the guidelines from Berríos-Torres et al. (2017); Mangram et al. (1999); World Health Organization (2016). The authors obtained approval from questionnaire developers and modified the questionnaires based on the updated Chinese practice guidelines (Chinese Nursing Association Operating Room Professional Committee, 2018; World Health Organization, 2018).

The questionnaires were translated using the back-translation technique (Polit & Beck, 2017). Firstly, the questionnaires were translated from Thai to English by the second author, one of the original questionnaire developers. Secondly, the Chinese version of the questionnaires was translated from English by the first author. Thirdly, the Chinese version of the questionnaires was translated back into English by a Doctor's degree medical lecturer in China. Finally, the original English version and back-translated English version were evaluated by a bilingual English expert, an English language lecturer with a master's degree in China.

The questionnaires were composed of 1) Demographic Characteristics, which included socio-demographic information, work-related information, application of surgical site infection prevention guidelines, and infection control training; 2) The Knowledge, Attitude, and Practice (KAP) questionnaires were developed based on the KAP model (Launiala, 2009), CDC (Mangram et al., 1999), and WHO (World Health Organization, 2018), which consisted of three parts: (i) Knowledge of surgical site infection prevention, which was tested using 22 true/false items covering the operating room environment, sterilization of surgical attire and drapes, asepsis surgical technique, and risk factors for patient-related surgical site infection; (ii) Attitude to surgical site infection prevention, which was composed of 31 items related to the issues of perception and feelings about prevention; and (iii) Practice on surgical site infection prevention, which included 22 questions about prevention of surgical site infection among operating room nurses.

The scoring method used for the knowledge, attitude, and practice questionnaires included 1) correct answer or "0" for an incorrect one, with a total score between 0 and 22; 2) for each item of the attitude questionnaire, a 5-point Likert scale was employed, ranging from "strongly agree" (5 points) to "strongly disagree" (1 point) with a total score between 31 and 155; 3) a 4-rating scale was used for the practice questionnaire from never practice (0 point) to always practice (3 points) with

a total score between 0 and 66. Knowledge and practice were categorized into five levels; very low (<60%), low (60% - 69.99%), moderate (70% - 79.99%), high (80% - 89.99%), and very high (90% - 100%); attitude was categorized into three levels as negative (< 50%), neutral (50% - 79.99%), and positive towards surgical site infection prevention (80% - 100%) (McDonald, 2002).

The content validity of the KAP questionnaires was assessed by a panel of five experts. The first expert was a nursing educator in Thailand, the second one was a medical educator from Guizhou Medical University, and the other three experts were operating room head nurses from Guizhou Provincial People's Hospital, 363 Hospital in Sichuan Province, and Sichuan Provincial Hospital for Women and Children. The content validity index of the KAP questionnaires were .83, .89, and .94 for the Knowledge (K) Questionnaire, the Attitude (A) Questionnaire, and the Practice (P) Questionnaire, respectively.

For internal reliability, the questionnaires were tested on 20 nurses who worked in two public hospitals 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 the Attitude and Practice Questionnaires. The reliability of the Knowledge, Attitude, and Practice Questionnaires were .72, .84, and .97, respectively. After that, the KAP questionnaires were translated into Chinese using the back-translation technique (Polit & Beck, 2017).

Data Collection

Data were collected online using the Wen Juan Xing website (www.sojump.com) and WeChat social application. The invitation letter and the quick response (QR) code of questionnaires from WeChat were provided to the operating room head nurses of the study settings and asked them to distribute to their nurses, particularly to those willing to participate. All participants accessed the questionnaires online and answered individually using the Wen Juan Xing website via smartphones. A WeChat account was allowed to submit the questionnaires only once to avoid duplication.

Data Analysis

Data were coded and analyzed by SPSS 20 (IBM Corp, Armonk, New York). Knowledge, attitude, and practice were analyzed by descriptive and inferential statistics of Pearson product-moment correlation between knowledge, attitude, and practice. Differences in knowledge, attitude, and practice in each subgroup of demographic characteristics were analyzed using a one-way analysis of variance. The significant level was set as $p < .05$. The distribution of studied variables met the assumptions of normality and linearity.

Ethical Consideration

This study was approved by the Social and Behavioural Science, Institutional Review Board (IRB), Prince of Songkla University, Thailand (2019 Nst – Qn 014), and acquired official permission from the IRB of Guizhou Provincial People's Hospital to collect data. The informed consent was presented on the first page of the online survey through the Wen Juan Xing application. In addition, the participants were informed regarding the study objective, voluntary and anonymous

participation, and the right to exit filling the questionnaire at any time. The researchers kept the information and identity of the participants confidential by using a coding system.

Results

Participants' Characteristics

The participants' age ranged from 20 to 57 years, with a mean age of 31.30 ($SD \pm 6.47$). Most of them were female (83%).

More than half (64.8%) of the participants were from tertiary care hospitals. Around half of the participants (56.6%) had a bachelor's degree. The mean working experience was 7.32 ($SD \pm 6.13$) years. Most of the participants (91.5%) indicated that the infection control department controlled and evaluated the quality of surgical site infection prevention practice. For the relative surgical site infection prevention training, 66.7% of participants had taken part in the training program fewer than five times during the last two years ([Table 1](#)).

Table 1 Demographic characteristics of participants ($N = 999$)

Variables	<i>n</i> (%)
Gender	
Male	829 (83.0)
Female	170 (17.0)
Age (years) ($M = 31.30$, $SD \pm 6.47$, $Min-Max = 20-57$)	
20-29	469 (47.0)
30-39	427 (42.7)
40-49	83 (8.3)
50-59	20 (2.0)
Level of hospital	
Tertiary	647 (64.8)
Secondary	352 (35.2)
Education	
Diploma	389 (39.1)
Undergraduate	566 (56.5)
Graduate	5 (0.5)
Not specified	39 (3.9)
Working experience (years) ($M = 7.32$, $SD \pm 6.13$, $Min-Max = 0-40$)	
< 5	378 (37.9)
5-10	440 (44.0)
11-20	139 (13.9)
21-30	33 (3.3)
31-40	9 (0.9)
Frequency of training in surgical site infection prevention (last two years)	
< 5 times	666 (66.7)
5-10 times	188 (18.8)
> 10 times	145 (14.5)
Having guidelines in hospitals	
No	328 (32.8)
Yes	671 (67.2)
Having an infection control department	
No	85 (8.5)
Yes	914 (91.5)

Level of Knowledge, Attitude, and Practice of Surgical Site Infection Prevention

It is shown that 43.5% of participants had a low level of knowledge, and 59.5% had a positive attitude toward surgical site infection prevention. In addition, 37.6% of participants had a high level and 38.8% had a very high level of surgical site infection prevention practice ([Table 2](#) and [Table 3](#))

Table 2 Mean, standard deviation, and levels of knowledge, attitude, and practice of surgical site infection prevention ($N = 999$)

Surgical Site Infection Prevention	<i>M</i> (%)	<i>SD</i> (%)	Level
Knowledge	67.98	7.96	Low
Attitude	81.26	7.55	Positive
Practice	84.65	13.50	High

Table 3 Level, frequency, and percentage of participants categorized by knowledge, attitude, and practice ($N = 999$)

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

Correlation of Knowledge, Attitude, and Practice of Surgical Site Infection Prevention

[Table 4](#) shows that knowledge was positively correlated with attitude ($r = .14$, $p < .01$), and attitude was positively correlated with practice ($r = .30$, $p < .01$). However, no correlation was found between knowledge and practice ($p = .07$).

Table 4 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: ** $p < .01$

Mean Differences of Knowledge, Attitude, and Practice According to Demographic Characteristics

Table 5 shows that different working experiences significantly differ in surgical site infection prevention knowledge. It was

demonstrated that participants with working experience of 0-5 years had significant lower knowledge scores than those of 6-15 years. Conversely, the participants with working experience of 6-15 years had significant higher knowledge scores than those of 16-25 years. In addition, the training frequency of surgical site infection prevention also illustrated different attitudes and practice scores. Participants with one time of training experience had significant lower attitude scores than those with 6-10 times of training experience. Similarly, participants with one training experience had significant lower practice scores than those with 2-5 times of training experience and those with 6-10 times of training experience.

Table 5 Differences of knowledge, attitude, and practice in each subgroup of demographic characteristics ($N = 999$)

Demographic characteristics	Knowledge		Attitude		Practice	
	<i>M (SD)</i>	<i>p-value</i>	<i>M (SD)</i>	<i>p-value</i>	<i>M (SD)</i>	<i>p-value</i>
Education level		.68		.14		.94
Diploma	14.99 (1.82)		125.29 (11.90)		55.93 (8.75)	
Bachelor	14.92 (1.69)		126.28 (11.56)		55.81 (9.07)	
Graduation	15.40 (1.14)		133.60 (7.77)		57.00 (7.03)	
Age (years)		.03		.49		.90
20-29	14.88 (1.73)*		126.39 (11.34)		56.06 (9.01)	
30-39	15.12 (1.73)+		125.22 (12.44)		55.69 (8.66)	
40-49	14.64 (1.86)		126.28 (9.75)		55.52 (9.10)	
50-59	14.50 (1.96)		126.60 (11.52)		56.40 (11.36)	
Working experience (years)		.008		.98		.96
0-5	14.88 (1.67)**		125.98 (11.59)		55.89 (8.77)	
6-15	15.13 (1.79)++		125.83 (12.23)		55.82 (9.09)	
16-25	14.47 (1.86)		125.42 (9.75)		55.74 (8.07)	
26-40	14.57 (1.99)		126.48 (10.45)		56.86 (11.49)	
Frequency of surgical site infection prevention training		.83		.02		<.001
1 time	15.01 (1.61)		124.28(12.08)***		53.88 (10.07)****	
2-5 times	14.93 (1.78)		125.92 (11.94)		56.08 (8.48)	
6-10 times	14.96 (1.75)		127.27 (10.68)		57.20 (8.43)+++	

Note: *age group of 20-29 years old had significant lower knowledge than those of 30-39 years old; + age group of 30-39 years old had significant higher knowledge than those of 40-49 years old; **working experience 0-5 years had significant lower knowledge score than those of 6-15 years; ++working experience 6-15 years had significant higher knowledge score than those of 16-25 years; ***1 time of training experience had significant lower attitude score than those of 6-10 times of training experience; ****1 time of training experience had significant lower practice score than those of 2-5 times of training experience; +++1 time of training experience had significant lower practice score than those of 6-10 times of training experience.

Discussion

The results of this study revealed that operating room nurses' knowledge was at a low level. However, the attitude was at a positive level, and the practice of surgical site infection prevention was at a high level. A detailed explanation is described in the following sections.

Knowledge, Attitude, and Practice of Surgical Site Infection Prevention

The low level of knowledge of surgical site infection prevention might be related to working experience and the contents of guidelines. Additional analysis revealed that operating room nurses who had working experience of less than five years had lower knowledge than those with working experience of 6-15 years. This study showed that 47.8% of the participants had less than five years of work experience. According to a previous study, a person with more than five years of work experience has more knowledge than those with less than five years' experience (Novelia et al., 2017). However, this claim

was not the case in this current study. It was found that participants who had working experience of 16-25 years had significantly lower knowledge scores than those with working experience of 6-15 years. It might be due to the fact that nurses who have long working experience might take less time to inquire about up-to-date evidence of surgical site infection prevention.

Another factor might be related to the contents of the current Chinese nursing educational material. Educational material on surgical site infection prevention guidelines for operating room nurses in China is based on the Chinese Nursing Association Operating Room Professional Committee, which still has somewhat different contents as compared to the international guidelines of the Centers for Disease Control and World Health Organization (Mangram et al., 1999; World Health Organization, 2018). Using different guidelines seems to be one factor leading to the low level of knowledge regarding surgical site infection prevention.

Although the frequency of attending training courses on surgical site infection prevention might affect the new knowledge of surgical site infection prevention, this is not the

case in this current study since no significant different knowledge exists from different frequencies of training courses. However, it affects the attitude and practice of surgical site infection prevention. Participants with more attendance frequencies had higher attitude and practice scores than those with fewer training frequencies. Due to the training, the operating room nurses also became aware of surgical site infection prevention during day-to-day work. Then, the more awareness they acquired, the higher practice of surgical site infection prevention based on the knowledge, attitude, and practice (KAP) model (Launiala, 2009). In addition, additional analysis showed that participants aged between 20 and 29 years old had significantly lower knowledge than those between 30 and 39 years old, but not different from those with age greater than 39 years old. The high level of practice of middle-aged adults might be related to more daily practice and more acquired evidence-based practice from any resources other than other age groups. Desta et al. (2018) pointed out that the middle-aged group of healthcare workers practiced infection prevention more than the younger nurses.

However, there are still some areas recommended in the international guidelines that operating room nurses do not practice, such as using electric razors instead of normal razor blades for hair removal, removing hair even though it does not interfere with a surgery site, and inspecting all air in the operating room through an air filter that has passed standard quality certification. Unfortunately, these issues are not stated clearly in the Chinese national practice guidelines (Chinese Nursing Association Operating Room Professional Committee, 2018; National Health Commission of the People's Republic of China, 2010). This might be the reason why operating room nurses in China have a different way of carrying out these procedures.

Relationships Between Knowledge, Attitude, and Practice of Surgical Site Infection Prevention

Based on the KAP model, knowledge and attitude can be mutually influential and linked to practice (Launiala, 2009). Higher standards of knowledge can change the attitude toward surgical site infection prevention. On the other hand, a positive level of attitude can encourage learning and bring about better practice, as proposed by learning theory (Krathwohl et al., 1964). The results revealed that there was a positive correlation between knowledge and attitude, and between attitude and practice of surgical site infection prevention. This finding was similar to previous studies (Kolade et al., 2017; Lobo et al., 2019).

Although the KAP model identifies the link between knowledge and practice, it was not verified in this study. It can be explained that the high level of practice of surgical site infection was related to the supervision by senior nurses in surgical site infection prevention on a day-to-day basis and their greater work experience. Surgical site infection prevention knowledge was specifically associated with updated surgical site infection prevention guidelines that did not relate to common daily work. Therefore, there was no significant relationship between knowledge and practice of surgical site infection prevention in this study. The findings of this study were similar to previous studies (Chitimwango, 2017; Patil et al., 2018).

Implications of the Study

The operating room nurses had an overall high level of surgical site infection prevention practice based on a self-report questionnaire in this study. However, they had a low level of practice in surgical site infection prevention, especially in using razors for hair removal. Therefore, they are encouraged to follow the updated information on hair removal techniques. It would be useful to do an intervention study in the future regarding the improvement of the level of operating room nurses' knowledge, especially for surgical site infection prevention. It is also recommended that the national operating room nurses' guidelines be reviewed based on this study. A limitation of the online data collection technique could preclude high accessibility of the expected target population; therefore, observation of future data collection is recommended for warranting the study's validity.

Conclusion

The finding of this study was evidenced that knowledge of surgical site infection prevention among operating room nurses in one province of China was inadequate, but they had a positive attitude and a high level of practice. There was a significant association between knowledge and attitude, attitude and practice, but not between knowledge and practice. The findings of this study could offer basic information for nursing administrators or policymakers at the local and national levels to consider strategies to provide updated knowledge of surgical site infection prevention or updated guideline for operating room nurses. Close supervision by experienced nurses and in-service training of surgical site infection prevention to operating room nurses are also recommended. Future research to examine the effectiveness of intervention enhancing surgical site infection prevention knowledge will be needed.

Declaration of Conflicting Interest

All contributing authors declare that no conflicts of interest exist.

Funding

The study was partially supported by a thesis grant from Thailand's Education Hub for the Southern Region of ASEAN Countries (TEH-AC) Scholarship through Prince of Songkla University, Thailand.

Acknowledgment

The principal investigator acknowledged Thailand's education hub for the southern region of ASEAN countries (TEH-AC) scholarship for granting a study scholarship. Also, all authors thanked all participants and research assistants.

Authors' Contributions

WF made significant contributions to the research proposal, the literature review, data collection, data analysis and interpretation, and drafting of the article. WS and LK made substantial contributions to the research proposal, the literature review, study conception and design, data analysis and interpretation, drafted the article, and critical revision of the article.

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Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Cite this article as: Feng, W., Sae-Sia, W., & Kitrungrote, L. (2022). Knowledge, attitude, and practice of surgical site infection prevention among operating room nurses in southwest China. *Belitung Nursing Journal*, 8(2), 124-131. <https://doi.org/10.33546/bnj.2018>