Original Article
2024; 14(1): 42-50
DOI: 10.22038/EBCJ.2024.72318.2870

Received: 17/05/2023
Accept & ePublished: 09/03/2024

Evidence Based Care Journal
http://ebcj.mums.ac.ir
Online ISSN: 2008-370X

The Effect of Continuous Care Model on Surgical Site Infection in Patients Undergoing Spine Surgery: A Quasi-Experimental Study

Fatemeh Faghani [1], Sima Zohari Anboohi [2]*, Marzieh Pazokian [3], Malihe Nasiri [4]

Abstract

Background: Surgical site infection is an irreversible complication of spine surgery. Postoperative care instructions are of utmost significance and can decrease surgical complications, including surgical site infection.

Aim: The present study was performed with aim to evaluate the impact of the continuous care model on surgical site infection in patients undergoing spine surgery.

Method: This quasi-experimental study was conducted on seventy spine surgery patients referred to a teaching hospital in Tehran, Iran. The sampling process lasted from June 1 until November 30, 2022.The patients were assigned into two equal groups. The intervention involved education to patients undergoing spine surgery from admission until four weeks post-discharge based on a four-stage continuous care model. Bluebelle Wound Healing Questionnaire (BWHQ) was completed in both groups four weeks after discharge.

Results: Despite the non-significant statistical difference in demographic and clinical information between the two groups, the mean total score of post-intervention infection was 9.37±5.93 in the control group and 2.65±1.43 in the intervention group. This finding indicates a significant reduction in surgical site infection in the intervention group compared to the control group (p<0.001).

Implications for Practice: This study suggests that patient education based on the continuous care model following spine surgery is effective in decreasing surgical complications, specifically surgical site infection in these patients. Thus, the design and implementation of such postoperative care models are recommended for patients undergoing spine surgery.

Keywords: Continuous care model, Spine Surgery, Surgical site Infection

1. Student Research Committee, Department of Medical Surgical Nursing, School of Nursing and Midwifery, Shahid Beheshti University of Medical Sciences, Tehran, Iran
2. Assistant Professor, Department of Medical Surgical Nursing, School of Nursing and Midwifery, Shahid Beheshti University of Medical Sciences, Tehran, Iran
3. Associate Professor of Nursing, School of Nursing and Midwifery, Clinical Research Development Center, Loghman Hakim Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran
4. Assistant Professor, Department of Basic Sciences, School of Nursing and Midwifery, Shahid Beheshti University of Medical Sciences, Tehran, Iran

* Corresponding Author Email: Simazohari@gmail.com

Introduction

Historically, spine and spinal cord surgeries have been an integral part of neurosurgery, dating back to before the 19^{th} century. However, it was not until the 1900s that neurosurgery was introduced as a separate academic discipline worldwide (1). Neurosurgery has achieved remarkable growth over the last two decades, and around 1-1.5 million neurosurgical procedures are performed annually worldwide and among them, spine surgery has been one of the most common surgical interventions over the last thirty years (2,3). As any other surgery, complications can occur following a spinal surgical procedure despite respecting all postoperative precautionary protocols, therefore, as the number of spine surgeries are increasing, so their associated complications are also increased (4,5). Spine surgery-related complications fall into two categories: specific and general, the specific complications include intraoperative neurovascular damage, paresthesia and plegia of limbs and urinary and fecal incontinence, but the general complications common in most surgical procedures include deep vein thrombosis, embolism, especially Pulmonary Thromboembolism (PTE), cardiac effects, and surgical site infection; among the mentioned complications, surgical site infection is one of the most potentially disabling post-spine surgery sequels (5-7). Therefore, postoperative infections are associated with numerous complications, which result in prolonged hospital stay, re-hospitalization, and frequent follow-ups, thereby increasing healthcare costs and affecting the patient's quality of life (8,9), but infections caused by spinal surgeries, in addition to the mentioned complications, cause some of the most debilitating complications which will lead to abnormality, weakness of the organs and eventually paralysis of the organs and even death (2,10).

Some studies have demonstrated that up to 60% of surgical site infections are preventable using evidence-based approaches. Educating the patient and family, patients' following up after discharge and monitoring home care and infection control require a broad multi-disciplinary team system (11-13). Since nurses spend the most time with patients, they play a central role within this team and incorporating health care services in terms of follow-up models can facilitate the implementation of preventive care for nurses (14). Continuous care model is one of the effective models to prevent the complications of acute and chronic diseases, which will involve the patient and family in home care due to its interconnected process (15).

Continuous care model is a nursing model first developed by Ahmadi et al. in 2001 (16) and consists of four interconnected stages: familiarization, sensitization, control, and evaluation (17). The familiarization stage is performed in the hospital by explaining the research objectives to the patients for almost 20-40 minutes, followed by obtaining the informed consent form and completing the demographic questionnaire. The sensitization stage involves educational content delivered in person or virtually to the patients (17). The control stage is essential for maintaining healthy behaviors and can be implemented by various approaches, such as weekly calls or reminder messages, according to the follow-up duration (15). The evaluation as the final step of the care model will be carried out by the researcher at the end of the follow-up period to assess the education and caregiving process. Given to the dynamic nature of this model and the continuity of its process, it is one of the effective care models for following up patients after discharge (18,19). Therefore, applying a continuous care model will result in enhanced self-awareness and self-care in patients (20,21). Various studies in this area have established the effectiveness of the care model in improving the quality of life of diabetic patients, promoting self-care in heart failure patients, and reducing mother and child anxiety in the pediatric surgical ward (20,22). Moreover, a study by Tang et al. (2019) in China found that follow-up care could promote self-care and improve the quality of life in patients with neurogenic bladder dysfunction, but no specific study has been conducted on the effect of continuous care model on surgical site infection in spine surgery patients in Iran (23).

Despite the health system emphasizes on in-home education and care, the in-home continuous care model has not been fully addressed and the quality of postoperative healthcare services is still an unsolved problem (14,24). More importantly, spine surgery-associated infection is a serious complication growing at an increasing rate (2,10) and although various studies have shown the positive effect of the continuous care model in various diseases, but no study has been conducted on the effect of the model on the wound healing process. Thus, the present study was performed with aim to determine the effect of the continuous care model on the surgical site infection in patients undergoing spine surgery.

Methods

This study quasi-experimental study was designed with two control and intervention groups. Sampling was done in a non-random available method in such a way that the patients of the control group were selected based on the odd number of the clinical file and the patients of the intervention group based on the even number of the clinical file. To ensure no exposure, first the control group and then the intervention group were included in the study. At the beginning of the study, the objectives of the research were explained to the participants, they were asked to provide informed consent and were assured that all of their information would remain confidential and they would be given access to the findings upon request.

The participants included candidates for spine surgery referred to the hospital clinic or emergency department. The sampling process lasted from June 1 until November 30, 2022. Following the study by Kermansaravi et al. in 2019 and based on the variable of the continuous care model and according to the sample size formula in the intervention studies and also considering α=0.05 and a test power of 90%, a sample size of sixty-four patients was determined and considering a possible drop-out rate of 10%, a final sample of seventy patients was adopted for this study (24). Considering the inclusion and exclusion criteria, participants entered the study using purposive sampling. The inclusion criteria were the ability to read and write in Persian, the absence of infection symptoms on discharge, and a lack of mental illnesses. The exclusion criteria were patient's reluctance to continue cooperation during the study, patient's death, contracting the COVID-19 infection, and experiencing any emotional crisis, including loss of close ones and divorce. A total of 110 patients were admitted for surgery during the sampling period, of which 75 met the inclusion criteria and were recruited for the study. Among them, five patients dropped out of the study: one in the control group due to COVID-19 development, one in the intervention group due to being discharged and not requiring surgery, one due to unwillingness to continue, and two due to the presence of surgical site at discharge, which is a common sign of infection. Finally, seventy patients were equally divided into intervention and control groups of 35 each in a non-random manner based on their clinical record numbers (Figure 1).

The following data-collecting instruments were utilized in this study:

1. Demographic information and clinical features questionnaire (including age, gender, marital status, education level, occupation, body mass index (BMI), economic status, underlying diseases, surgery type, and time of surgery), which was designed by reviewing the literature regarding the contributory factors to infections and its validity was assessed by ten experts in this field, including neurosurgeons and nursing faculty members.
2. Bluebelle Wound Healing Questionnaire (BWHQ), which was designed by Macefield et al. (2017) in the United Kingdom to assess surgical site infection in patients after hospital discharge (25). This questionnaire has 18 items, of these, two items contain additional components to collect further detail regarding the infection signs and symptoms (if present) and the other sixteen are separated across two domains, eight related to signs and symptoms of surgical site infection and eight related to wound care measures. This questionnaire is scored based on the likert scale and each response to the items for signs and symptoms is categorized into 0 (no sign), 1 (a little), 2 (some), and 3 (a lot), and each response to the items for wound care measures is scored as zero (No) and one (Yes). The highest and lowest infection scores are 41 and zero, respectively. At a score below 6-8, no infection is detectable; however, infection will be present for higher scores. Thus, according to the BWHQ, the so-called cut-off infection score will be 6-8 (26). The validity of the English version of the Bluebell tool has been confirmed fully using methods such as face, content and consistency (26), but since the Persian version of the scale was not available in Iran, so translation and psychometric evaluation of the questionnaire were conducted before beginning the study by obtaining permission from its developers and after submitting the request to the respective department at Oxford university. The researcher performed the translation, back-translation, cognitive interview, and validity assessment of the scale according to the instructions and guidance provided by the questionnaire unit representative and after approval of its translated version. The Persian BWHQ was submitted to ten faculty members of the school of nursing and midwifery, Shahid Beheshti university of Medical Sciences, with expertise in neurology and then was given to ten nurses of the neurosurgery department and all the questions and answers of the questionnaire were checked and then confirmed in terms of simplicity and comprehensibility and composition of words. Finally, the tool was confirmed using qualitative and face validity. To measure the reliability of the Bluebell instrument, ten patients undergoing spine

surgery were selected and the image of the patients' wound, which was took with their mobile phones and sent virtually in the Rubika program, was checked by two researchers thirty days post-surgery. The Kappa coefficient was utilized for all questions to measure the consistency of observers in analyzing the images. The estimated kappa values ranged from 0.85 to 0.97, which were acceptable.

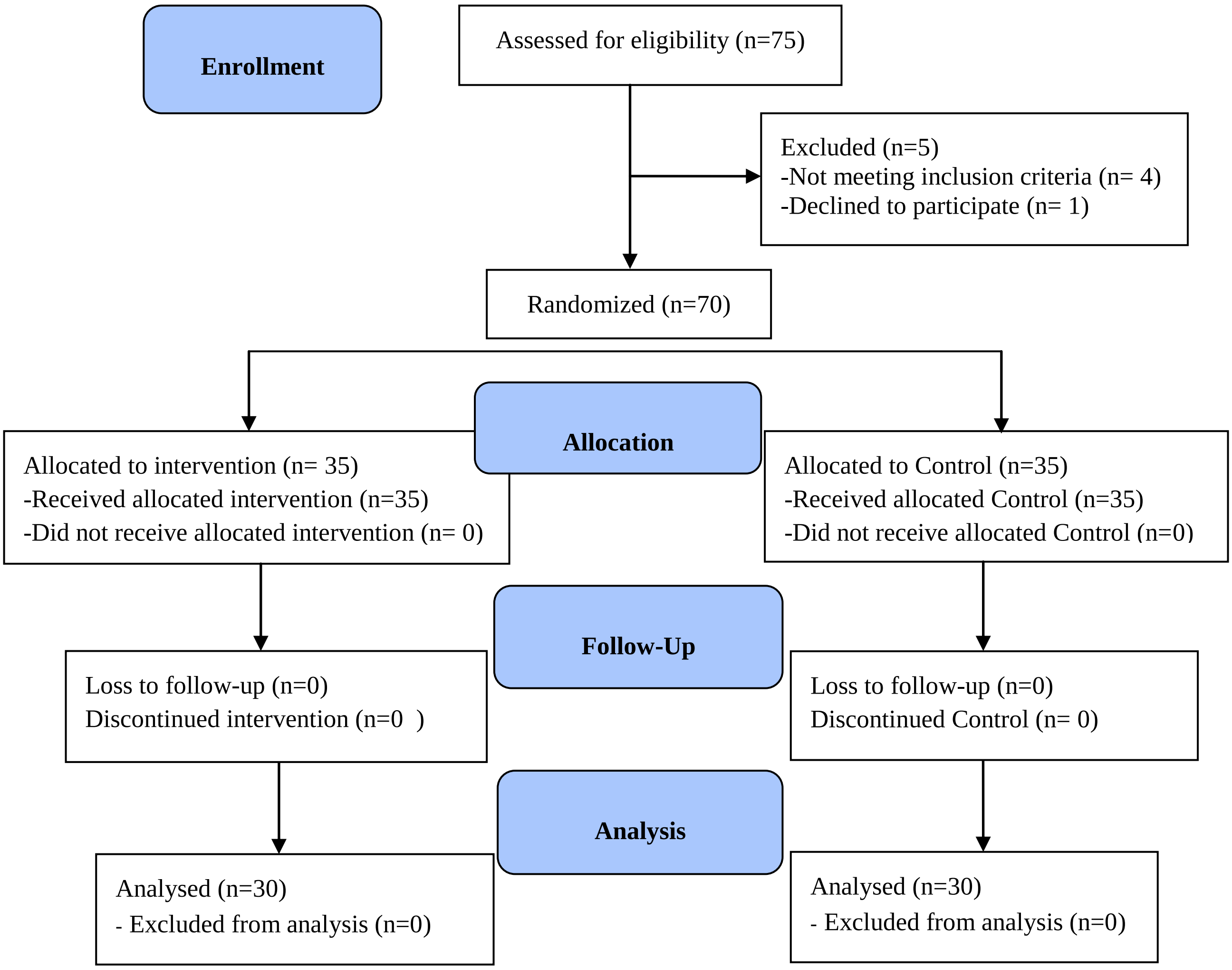

Figure 1. CONSORT flow diagram of the study

The effect of continuous care model on surgical site infection after spinal surgeries involved education of patients based on the continuous care model after spine surgery. The patients received constant follow-ups after discharge based on a four-stage model and the first stage, familiarization, was performed in the hospital for 30 minutes and aimed to introduce the care plan and obtain informed consent from patients. The second stage, sensitization, was implemented virtually via the Rubika messaging app. For this purpose, 5-7 member teaching channels were created, including the patients, their caregivers, and the research team, then, educational content with a focus on post-spine surgery care was uploaded to each channel in Rubika program and at the end of each session, patients were referred to the private page of the researchers in case of any possible ambiguity or question. This stage was implemented from admission time through three days post-surgery (over one week in total) and the educational content was provided via the teaching channel in five sessions over five days. The third or control stage started following the termination of the sensitization stage and continued for four weeks post-surgery, so that the patient training process was assessed weekly by virtually asking some questions of the questionnaire. In the final stage, which was evaluation stage, the mean of infection incidence in the intervention group was examined at the end of the fourth week based on the BWHQ using the images that the patients submitted from their wound sites with mobile phones. (with the informed consent of patients) (27,28).

The collected data were analyzed using SPSS software (version 19) and descriptive statistics such as mean and standard deviation. The analytical tests, including Chi-square, independent t-test, exact Fischer, and Mann-Whitney, were used to compare demographic and clinical information. The normality of data was checked using the Kolmogorov-Smirnov test. Mann-Whitney test was also applied to compare the infection mean between the control and intervention group. *P*<0.05 was considered statistically significant.

Table 1: Demographic and clinical characteristics of the participants in the two groups

Variables	Group: Intervention N (%)	Group: Control N (%)	*p*-value Test statistics
Gender			
Female	17(48.6)	17(48.6)	*>0.999****
Male	18(51.4)	18(51.4)	χ^2 =0
Marital Status			
Single	3(8.6)	1(2.9)	*0.303**
Married	32(91.4)	34(97.4)	F =1.061
Job status			
Employed	3(8.6)	4(11.40)	*0.858****
Free	16(45.7)	14(40.0)	χ^2 =1.061
Housewife	16(45.7)	17(48.6)	
Education Level			*0.099***
Lower than diploma	27 (77.14)	20(57.14)	M.W
Diploma or above	8(22.85)	15(42.85)	=497.5
BMI (kg/m^2)			
Weight Loss (<18.5)	0(0)	1(2.9)	*0.387***
Normal(18.5-24.9)	7(20.0)	10(28.6)	M.W
Overweight (25-29.9)	17(48.6)	18(51.4)	=491.5
Smoking			
No	34(97.4)	31(88.57)	*0.322**
Yes	1(2.9)	4(11.40)	F =1.938
Economic Status			
Low	4(11.40)	4(11.40)	*0.999****
Moderate to good	31(88.57)	31(88.57)	χ^2 =0
Other Diseases			
No Diseases	19(54.3)	23(65.7)	
Diabetes	3(8.6)	2(5.7)	
Hypertension	8(22.9)	2(5.7)	*0.410**
Hyperlipidemia	1(2.9)	1(2.9)	F =2.181
Irritable Bowel Disease	0(0)	1(2.9)	
Cancer	0(0)	1(2.9)	
Cancer + Diabetes	0(0)	1(2.9)	
Diabetes + Hypertension	4(11.4)	4(11.4)	
Type of Surgery			
Lombusacral canal stenosis	27(77.1)	31(88.6)	*0.351****
Cervical canal stenosis	7(20.0)	4(11.4)	χ^2 =2.094
Spinal fracture	1(2.9)	0(0)	
Age (Mean±SD)	50.31±12.65	48.20±11.31	*0.464***** T=0.737
Time of Surgery (Hour) Mean±SD	1.80±0.40	1.65±0.48	*0.184***** T=1.342

*Fisher's exact, **Mann-Whitney test, ***Chi-square test, ****independent t-test

Results

In the present study, the mean age of participants in the intervention and control groups were 50.31±12.65 and 48.20±11.31 years, respectively, and no significant difference between the two groups in this regard (p=0.464). The two groups were identical regarding gender, with 51.4% males and 48.6% females (p>0.999). Other demographic and clinical information about the participants is provided in Table 1. As this table shows, there was no statistically significant difference between the two groups in terms of demographic and clinical variables (p>0.05).

According to table 2, the mean the total infection score was 9.37±5.93 in the control group compared to 2.65±1.43 in the intervention group, indicating a statistically significant difference between the two groups (p<0.001). Considering the cut-off value of 6-8 for the Bluebelle questionnaire, the control group showed a higher infection rate than the intervention group. In addition, the means of dimensions related to symptoms and measures were higher in the control group than in the intervention group. For items related to symptoms, the mean was 7.02±05.00 in the control group and 0.6±1.24 in the intervention group, and the two groups were significantly different (p<0.001). Likewise, for items related to wound care measures, the mean was 2.34±1.05 in the control group compared to 2.05±0.33 in the intervention group, and the two groups were significantly different (p=0.030).

Table 2: Mean of infection score four weeks after surgery in the intervention and control groups

Variable	Group	Mean±SD	Median(Q1-Q3)**	*P*-value
Total score of infection (0-41)	Intervention	2.65±1.43	2(2-3)	0.001* M.W=39.00
	Control	9.37±5.93	8(6-11)	
Dimension of symptoms (0-33)	Intervention	0.6±1.24	0(0-1)	0.001* M.W=31.00
	Control	7.02±5.00	6(4-9)	
Dimension of measures (0-8)	Intervention	2.05±0.33	2(2-2)	0.030* M.W=510.00
	Control	2.34±1.05	2(2-2)	

*Mann-Whitney test, **quartiles

Discussion

This study aimed to evaluate the effect of the continuous care model on surgical site infection following spine surgery and the findings suggested the effectiveness of this model in reducing surgical site infection rate after the spine surgery procedure. The results of the present research corroborate previous studies that evaluated the effect of education on surgical site infection and those that investigated the impact of the continuous care model on the outcomes of different diseases. The study by Bagga et al. aimed to establish the impact of preventive care bundles on surgical site infections following spine surgery in India and the authors found that the considered care bundle reduced the infection in the intervention group compared to the control group (29). Regarding other surgeries, Zarei et al. performed a study in 2020 to assess the effect of a self-care training program on surgical incision wound healing in women undergoing cesarean section in a treatment center in Iran. Their results indicated the effective role of wound care training one day before receiving a C-section to enhance self-care and improve postpartum surgical incision wound healing in pregnant mothers (30). Also, the study by Hung et al. regarding the effect of evidence-based nursing on surgical incision infection in China in 2019 showed that evidence-based training before, during, and after surgery will reduce the rate of surgical site infection, treatment and hospitalization costs, and increase the quality of life in patients (31).

In addition to the fact that educational care bundles have had an effective result in adults, they have also had a positive effect on children. So that, a study by Kochert et al. (2020) in the United States aimed at determining the effect of the preventive protocol for surgical site infection on pediatric spinal deformity surgery showed that standard care bundles have had a significant effect in reducing surgical site infection in children (32). In addition to the studies investigating the effect of education on surgical site infection, there are studies which focused on the effect of the continuous care model on the outcomes of various diseases, which are consistent with the results of this study. In this context, a

study by Moradi et al. in 2022 in Iran showed that sleep health education based on the continuous care model has improved the quality of sleep in the elderly (33). Also, Salehipour et al. in 2021 investigated the impact of the continuous care model on the quality of life of patients with major thalassemia in an Iranian city and found that the quality of life of these patients was improved after implementing the continuous care model (34). Consistent with the results in Iran, a similar study in 2019 was conducted by Tang et al in China to evaluate the effect of the care model on the quality of life of patients with neurogenic bladder dysfunction suffering from spinal cord injuries. Based on their findings, the complication rate decreased in patients with neurogenic bladder after three months of follow-up and education, while their post-intervention quality of life enhanced significantly (23).
Concerning the mothers of pediatric patients, Okhovat et al. in 2017 studied the impact of the continuous care model on anxiety in mothers of children discharged from the pediatric surgery unit in Iran that the assessments at one week and one-month post-discharge showed that applying the continuous care model contributed to reducing anxiety in mothers after the discharge of their children from the pediatric surgery unit (35).
The literature review revealed that almost all studies have suggested the efficacy of education and the continuous care model in reducing surgical site infections. No study in the literature presented contrasting evidence for such an effect. This study supports those previous studies that reported the positive effects of the continuous care model on surgical site infections in spine surgery. The study has also some limitations that including the convenient nature of the sampling process and the fact that this study was only implemented in a single treatment center in the Iranian capital that may limit the generalizability of the research findings. The second limitation arises from the non-random sampling method. Thus, interpreting the results should be done with caution. Future studies are recommended to include randomized clinical trials in this field.

Implications for practice

The continuous care model can be effective as a targeted theory for the students patient education unit, for nurses to educate patients during discharge and remote follow-up at home and to improve the quality of nursing care, especially remote home care and the post-discharge follow-up of patients using the care model decrease postoperative complications, including surgical site infection. Thus, post-surgery follow-up of patients from admission through post-discharge at home is recommended to be implemented as a dynamic process using care models.

Acknowledgments

This study is derived from a master’s thesis in nursing conducted in the Shahid Beheshti School of nursing and pharmacy. The research was approved by the research ethics committee of the Shahid Beheshti School of nursing and pharmacy with the code IR.SBMU.PHARMACY.REC.1400.166. The researchers express their sincere gratitude to all the patients who participated in the study and the personnel of the Shohadaye Tajrish Hospital, Tehran, Iran, who contributed to completing this study.

Conflicts of interest

The authors declared no conflict of interest.

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