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Preventing surgical site infection using operating room bundle of care in patients undergoing elective exploratory laparotomy cholecystectomy surgery

Original Article

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Abstract: **Objective:** Surgical procedures manifest immense risks to patients. One of the adverse events that healthcare professionals see as a threat to the patient's health is the development of complications known as surgical site infection (SSI). Although several efforts are being undertaken to determine the proper means to reduce such complications, there is still a high incidence of SSI worldwide. Surgery requires knowledge in infection control and high precision in maintaining a clean surgical site. This study tested the effectiveness of an operating room (OR) bundle of care in preventing SSI in patients undergoing elective exploratory laparotomy cholecystectomy surgery.
Methods: A quasi-experimental pretest and posttest design was utilized to determine its effectiveness. The study was composed of 60 participants divided into two groups: 30 subjects were selected to receive the OR bundle of care, while the other 30 subjects received the usual care. The groupings were determined through a systematic random sampling technique. The OR bundle of care had three interventions, namely: (1) maintaining perioperative normothermia, (2) no pre-operative surgical site hair removal, and (3) changing gloves before abdominal wall closure. These patients were evaluated using the standard instrument, Bates–Jensen Wound Assessment Tool (BWAT) in the post-intervention phases of the wound healing process, which are as follows: hemostasis, inflammatory, and proliferative phases. To describe the difference in the patients' wound status after implementation of the OR bundle of care in each post-intervention phase, Friedman's test was used. To describe the difference in the patients' wound status in both groups after implementation of the OR bundle of care, the Mann–Whitney U test was used.
Results: The patient's wound status was lower, indicating a more healing process. Differences between the wound status of the control and the experimental group were observed on the third postoperative day. This indicates that the experimental group's wound status healed much faster and more effectively than the control group based on the BWAT scoring severity scoring. A significant difference in the patient's wound status from the hemostasis phase compared with the proliferative phase was observed.
Conclusions: The OR bundle of care has been shown to be effective in preventing SSI in patients who had undergone exploratory laparotomy cholecystectomy surgery in the selected hospital, if there is uniform and consistent implementation of the said intervention.

Keywords: *bundle of care • exploratory laparotomy • operating room bundle of care • preventing surgical site infection • surgery*

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1. Introduction

Surgical procedures are far more complex aspects of health services that display significant risks to a patient's safety. Unsafe surgical practices can cause not only harm, but also adverse outcomes. One of the adverse

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events is the threat to the patient's health when complications arise known as surgical site infection (SSI). SSI remains a significant clinical problem in the healthcare system and is associated with increased morbidity, longer duration of hospital stays, re-admission, and excess unnecessary utilization of healthcare resources.[1] Although several efforts have been undertaken to determine the proper means to reduce such complications, there is still a high incidence of SSI worldwide.

Surgery requires doctors and nurses to have a vast knowledge of infection control and a high precision skill level for maintaining a clean surgical site to prevent infection. These healthcare professionals have been trained to always ensure a sterile environment inside the operating room (OR). Once this practice is broken, several risks can occur, such as the development of SSI.

The Institute for Healthcare Improvement (IHI) introduced the use of Care Bundles. A bundle of care displays a variety of interventions that when used together can improve patient outcomes. It is a structured way of improving the process of care through an evidence-based approach, which can help guide the healthcare professionals and surgical team to raise their standard of care.[2] Several studies have supported the concept of bundle of care as it has shown positive changes compared with the usual practice. Each study varies in the intervention incorporated in their respective bundles, however, the outcome revealed promising results as they significantly promote patient outcomes. The OR bundle of care was used in this study to prevent the occurrence of SSI. The interventions included in the OR bundle of care are: (1) maintaining perioperative normothermia, (2) no preoperative surgical site hair removal, and (3) changing gloves before abdominal wall closure.

This study aimed to test the effectiveness of OR bundle in the prevention of SSI in patients undergoing exploratory laparotomy cholecystectomy surgery. The OR bundle aims to guide healthcare professionals and patients in the proper management of their condition by promoting a safe and quality surgical practice. If proven effective, the condition of patients will improve by decreasing the incidence of morbidity and mortality rates. This study can contribute to the medical field by providing innovative and practical interventions to prevent the occurrence of SSIs.

1.1. Review of literature

Several efforts have been made regarding infection control practices, including an improvement in OR ventilation, sterilization methods, surgical techniques, and availability of antibiotic prophylaxis. However, SSI remains a substantial cause of morbidity, prolonged hospitalization, and even death. According to the Centers for Disease Control and Prevention,[3] SSI is the costliest hospital-acquired infection (HAI) with an estimated annual cost of US$3.3 billion to US$10 billion, and is associated with a mortality rate of 3% and 75% of SSI-associated deaths that directly attribute to this complication. According to the World Health Organization,[4] 1 in 10 develop SSI in the low- and middle-income countries and the rate ranges from 1.2% to 23.6% per 100 surgical procedures. Also, 11% of patients who had undergone surgery and became infected in the process came from low- and middle-income countries. This is the reality of third-world countries where resources in hospitals, especially in government institutions, are limited. However, SSIs are not just an issue in third-world countries. In the United States, this contributes to patients spending more than 400,000 extra days in the hospital at the cost of an additional US$10 billion per year. The overall incidence of SSI remains a substantial burden of disease. This is a serious postoperative complication that represents a significant impact on morbidity and mortality.

One of the most performed general surgical procedures around the world is elective cholecystectomy. Approximately 20 million people in the United States have gallstones. Of these people, there are approximately 300,000 cholecystectomies performed annually.[5] In the Philippines, more than 8,000 patients undergo elective cholecystectomy in different accredited surgical hospitals in a year.[6] Elective cholecystectomy is also one of the most common surgeries in our institution. There are still incidences of SSI in the said hospital, despite carrying out all the necessary infection controls and protocols. Knowing this, the researcher wanted to address this issue to develop a better plan of care in the management of this condition.

SSI is still one of the leading HAIs worldwide, despite the advancement in the surgical healthcare system.[4] Several efforts have been made to prevent the existence of this complication, however, there is still a high incidence globally. Figure 1 illustrates the conceptual framework of this study showing the relationship among each variable.

The interventions included in the bundle are (1) maintaining perioperative normothermia, (2) no preoperative surgical site hair removal, and (3) changing gloves before abdominal wall closure. The implementation of OR bundle of care intervention together with the usual care, such as administration of prescribed antibiotics, maintaining a sterile technique inside the OR, appropriate skin preparation technique using scrub and antiseptic solution, and proper regular wound care, can help prevent the occurrence of SSI. The first OR

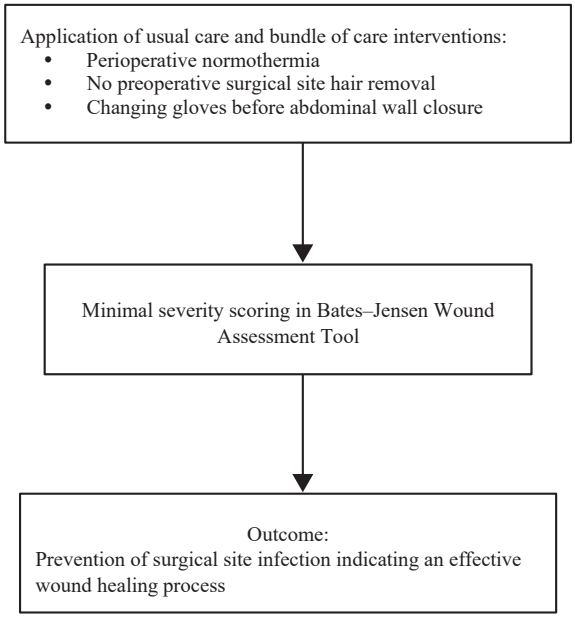


Figure 1. The conceptual framework of operating room bundle of care in the prevention of surgical site infection.

bundle of care discussed is the maintenance of perioperative normothermia. When the subject patient is inside the OR, the nurse and the healthcare providers are tasked with maintaining the patient's temperature within the normal range during the whole duration of the procedure. Duff et al.[7] believe that keeping patients normothermic perioperatively prevents adverse surgical outcomes. Hypothermia leads to serious complications, including increased risk of surgical bleeding, SSIs, and morbid cardiac events. Another intervention mentioned in the bundle is the no preoperative surgical site hair. The removal of body hair must only be done with the use of clippers, if needed. Shaving causes disruption of the skin barrier's defense against microorganisms, causing SSI.[3] At the end of the procedure, with the closure of the abdominal wall, the scrub team was asked to change into a new set of sterile gloves, as this can minimize contamination of the wound.[4] When performed collectively and reliably, the said interventions helped promote the wellbeing and optimal health in patients by having a minimal severity score in the Bates–Jensen Wound Assessment Tool. This indicates that the patients' wound healing process is taking place effectively and continuously, thus preventing the incidence of SSI.

2. Research design

The quasi-experimental pretest and posttest designs were employed to test the effectiveness of the OR bundle of care in preventing SSI. The data were collected and analyzed thoroughly in the perioperative phase. The patient's wound status was evaluated in the post-intervention phases to generalize the results. The dependent variable, which is the SSI, was measured after the implementation of the OR bundle of care in each post-intervention phase, specifically in the homeostasis, inflammatory, and proliferative phases of the wound healing process. A total of 60 participants were included in this study; 30 of them received the OR bundle of care interventions together with the usual care, while the remaining 30 received the usual care only. With the given inclusion and exclusion criteria, a systematic random sampling technique was used (Figure 2).

2.1. The setting of the study

The study took place in a 150-bed capacity government hospital in Parañaque City, specifically inside its OR department. The data were gathered perioperatively, while the patient's wound status was evaluated in the postoperative phase specifically in the homeostasis, inflammatory, and proliferative phases of the wound healing process to determine the effectiveness of the OR bundle.

2.2. Sampling technique

The researcher utilized a probability sampling technique, specifically the Systematic Random Sampling technique. The selected patients were randomly assigned to be included in the control group wherein the usual care for postoperative patients was given. On the other hand, the experimental group was treated with the usual care together with the application of the OR Bundle of Care.

The 60 subjects were divided into two main groups: 30 under the control group while the other 30 were placed under the experimental group to determine the interval in the selection of patient's assignment. The results revealed a value of 2, which means that every second patient that met the inclusion criteria was assigned to be in the experimental group. The researcher gathered subjects that share similar characteristics based on the inclusion criteria.

2.3. Ethical considerations

The study was approved by the Institutional Ethics and Review Committee (CEU IERB Approval No. 2018-19/452) of Centro Escolar University for implementation of the research to patients. The approval of the head of the hospital was secured prior to the implementation of the study. The researcher was guided using the ethical principles of autonomy, non-maleficence, beneficence, and justice for the protection of the subjects. The subject

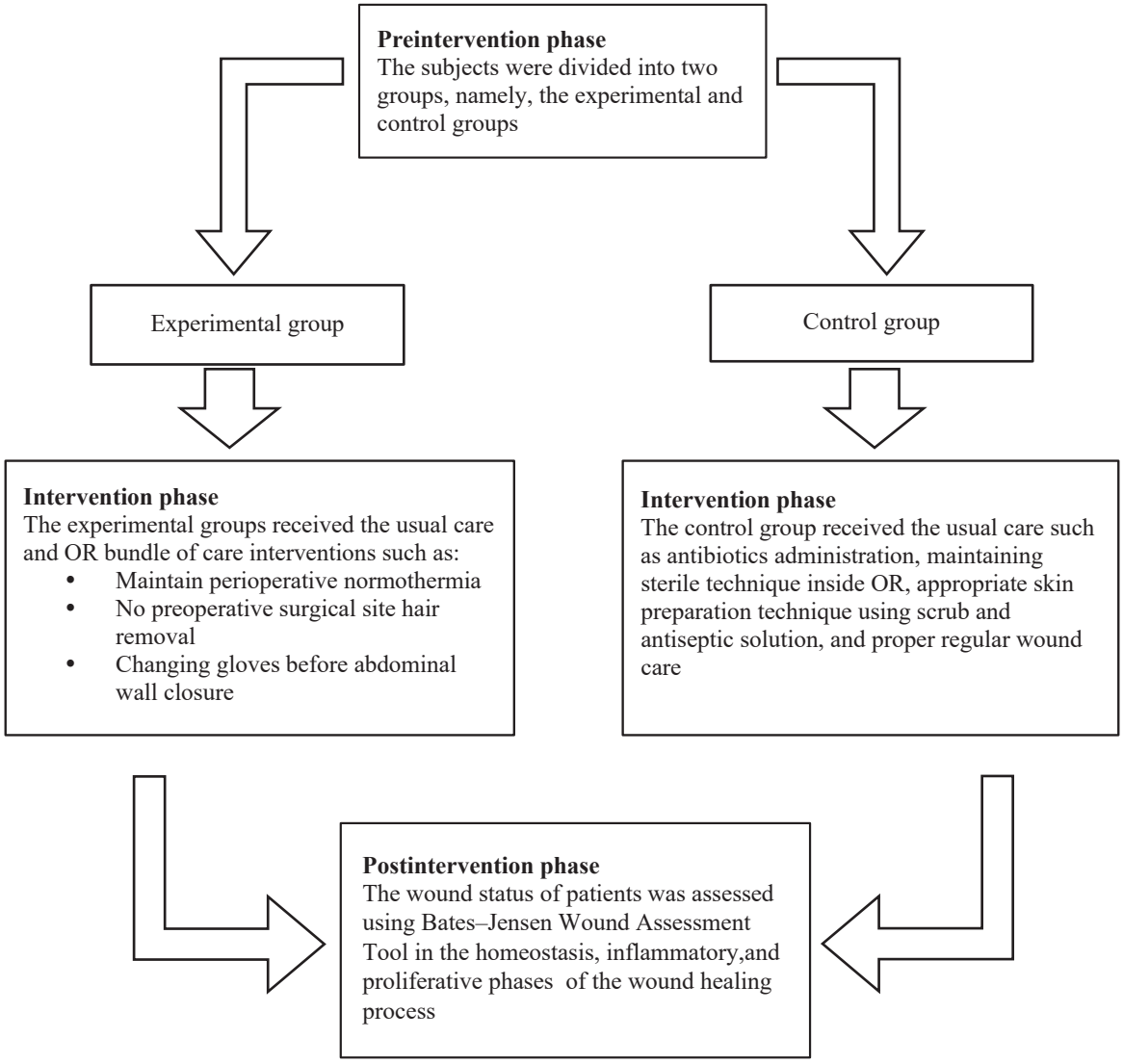


Figure 2. Research framework.

patients had the right to exercise their autonomy for the duration of the research. The right to refuse at any given time was respected. The subjects were respected by securing proper informed consent for both control and experimental groups. The research protocol was explained thoroughly to them. The consent form was given to them containing information and explanation about the essence of the study. It discussed the procedure to be done, how this would be done, how long the procedure would take place, and the freedom to withdraw from the study at any time. The risks and benefits of the study were also explained. Beneficence and nonmaleficence were also practiced in which the researcher maximized any benefit for the subjects and minimized any risks. The researcher focused on improving the status of the patients while reducing any potential hazards. In general, the researcher respected the decisions made by the patients. The researcher assured the subjects that confidentiality, anonymity, and data privacy would be always maintained.

2.4. Research instruments

The following instruments were used while conducting the research:

2.4.1. Checklist

The compliance of healthcare providers in the OR bundle of care interventions was monitored using a

checklist. The researcher provided this tool to the nurse and physician counterpart to evaluate the compliance of OR medical staff to the Bundle of Care. The three elements in the OR bundle of care were evaluated individually using a checklist with two options namely: done and not done.

2.4.2. The Bates–Jensen wound assessment tool

The BWAT is a valid and reliable tool developed by Bates–Jensen (2010) to assess and monitor the healing of all types of wounds. This uses a method of scoring several factors to determine the state of a wound. This tool has 15-wound components with location and shape which are excluded from the scoring, while the remaining 13 are independently ranked from 1 to 5. A score of 1 indicates that the specific factor being measured is non-harmful or the healthiest, while a score of 5 indicates the most unhealthy attribute for each characteristic. The other wound components in this tool are size, depth, edges, undermining, necrotic tissue type, necrotic tissue amount, exudate type, exudate amount, skin color surrounding the wound, peripheral tissue edema, peripheral tissue induration, granulation tissue, and epithelialization. This tool was used to grade the wound initially and at regular intervals, to track and evaluate the effectiveness of the OR bundle of care interventions. Each may have a score from 1 to 5 to provide an assessment. After assessing and scoring each item, the sum of the 13 scored items revealed the overall severity of the wound. The total BWAT scores were divided into four severity categories: 13–20 means minimal severity, 21–30 means mild severity, 31–40 means moderate severity, and 41–65 means extreme severity. In using the BWAT, the researcher was able to determine the effectiveness of the OR bundle of care interventions by identifying the presence or absence of SSIs.

2.5. Data collection process

This study was divided into three phases, namely: preintervention, intervention, and postintervention phase. The recruitment of subjects was done after the patients were advised to undergo elective exploratory laparotomy cholecystectomy surgery. The patients were assessed and selected based on the set inclusion criteria by the researcher. The procedure and selection processes were explained clearly. Informed consent was given and then signed by the subject patients prior to the conductance of the study. In the preintervention phase, the subjects were divided randomly by the researcher into two groups, namely, the experimental and control groups through a systematic random sampling technique. The experimental group received the OR bundle of care interventions together with the usual care, while the control group received the usual care only.

2.5.1. Preintervention phase

In the preintervention phase, the nurse and physician counterparts were oriented on the OR bundle of care and the tool used in the study, which is the BWAT. The nurse and the physician counterparts conducted the interrater reliability test prior to the conductance of the study. A total of 15 patients were assessed to determine the agreement between the two raters. The Cohen K was run to determine if there was an agreement between the two raters' judgment on whether the BWAT was effective in assessing the wound status of postoperative patients. The results indicated that there was a substantial/good agreement between the two-raters' judgment (k = 0.74; P < 0.005).

2.5.2. Intervention phase

The interventions included in the OR bundle of care were as follows: (1) maintaining perioperative normothermia, (2) no preoperative surgical site hair removal, and (3) changing gloves before abdominal wall closure. The researcher counterpart performed the OR bundle of care intervention together with the usual care. This was routinely monitored by the researcher for compliance in the perioperative phase.

2.5.3. OR bundle of care

2.5.3.1. Perioperative normothermia

Perioperative normothermia is a condition of having a normal body temperature of 36.5–37.5. This indicates an environmental temperature that does not cause an increase or decrease in activity of body cells. This intervention in the OR bundle of care was implemented by the researcher counterpart. Once the subject was inside the OR, the nurse and the healthcare providers maintained the patient's temperature within the normal range during the whole duration of the procedure through regular monitoring of the patient, use of warm blankets perioperatively, use of warmed IV fluids and warmed irrigation fluids for the abdomen, and through engineering controls adjustment so that the OR is not excessively cold.

2.5.3.2. No preoperative surgical site hair removal

No preoperative surgical site hair removal means that shaving of the surgical site preoperatively was strictly prohibited. Removal of body hair was done only with

the use of clippers as close to the time of surgery as possible.

2.5.3.3. Changing gloves before abdominal wall closure

The scrub team used the double gloving technique throughout the procedure. At the point of nearly closing the abdominal wall, the scrub team removed their outer gloves before wound closure.

For the control group, the usual management was given wherein monitoring of the patient's condition as well as compliance with the standing order for the administration of antibiotics, maintaining sterile technique inside OR, appropriate skin preparation technique using scrub and antiseptic solution, and proper wound care were observed. The type of antibiotic used, and nutritional support given for each patient were not controlled in this study, because this factor is beyond the control of the researcher. However, it was still strictly monitored through chart validation and review. All patients still received antibiotics prescribed by the physician. Their diet was also based on the physician's order. Strict compliance to the prescribed diet and medications were observed.

2.6.1. Post intervention phase

After implementation of the OR bundle of care together with the usual care, the patient's wound status was assessed by the researcher and the physician counterpart using BWAT. The average scores from the two results were used to find out the patient's mean score and determine the effectiveness of the OR bundle of care.

2.6.1.1. Phase 1

The hemostasis phase is the first phase of wound healing. It begins at the onset of injury or on postoperative day 1 of the study. Upon completion of the exploratory laparotomy cholecystectomy surgery, the wound status of the patient was assessed by the researcher and physician counterpart within 24 hr or 1 day of using BWAT.

2.6.1.2. Phase 2

The inflammatory phase is the next phase in the wound healing process or postoperative day 2 of the study. During this phase, neutrophils enter the wound to eradicate bacteria and remove debris. These bacteria reach their peak at 24–48 hr after injury. After reaching the peak of 24–48 hr, the neutrophil count greatly reduced within 3 days. This phase is often associated with edema, erythema, heat, and pain. Using BWAT, the wound status of the patient was reassessed on day 2 postoperatively by the researcher and physician counterpart.

2.6.1.3. Phase 3

Once the wound is cleaned out, the wound enters another phase, namely, the proliferative phase or postoperative day 3 of the study. The focus in this phase is to fill and cover the wound. The researcher and physician counterpart then reassessed the wound status of the patient on day 3 postoperatively using BWAT.

The patient's surgical wound was monitored consistently using the BWAT for assessing the severity of the wound postoperatively. The researcher and the physician counterparts both assessed and recorded the patient's wound status from Phase 1 to Phase 3 of the wound healing process. This was performed daily to determine the effectiveness of the OR bundle of care for the prevention of SSI.

2.7. Internal validation

For the study to be fully reliable and free from bias, internal validation was done as follows: interrater reliability test was conducted by the researcher and the physician counterpart using BWAT severity scoring. The average scores of the two were used to know the patient's mean scores. Monitoring for patients' adherence to the OR bundle of care was done using a checklist and validation of patients' records. Patients were monitored by the nurse and the physician counterparts during the intervention phase and were validated by the researcher to ensure compliance to the OR bundle of care. Patients' wound status was assessed by the researcher and the physician counterparts using BWAT severity scoring in the control and experimental groups during the post-intervention phases, namely, the hemostasis, inflammatory, and proliferative phases of the wound healing process.

2.8. Data analysis

To describe the patients' wound status in the control and experimental groups during the post-intervention phases, the frequency, percentage distribution, mean, and standard deviation were used. To describe the difference in the patients' wound status after implementation of the OR bundle of care in each post-intervention phase, Friedman's test was used. Finally, to describe the difference in the patients' wound status in the control and experimental groups after implementation of the OR bundle of care, the Mann–Whitney *U* test was used. A *P*-value of <0.05 was used to determine the statistical significance.

3. Results

3.1. Patients wound status

On postoperative day 1 after the implementation of usual care, BWAT scores of 30 (mild severity) and 28 (mild severity) got the highest frequency of 8 with a percentage of 26.7 each. Only 6% or 20% of the total population had a BWAT score of 26 (mild severity). BWAT score 29 (mild severity) and 27 (mild severity) had the lowest frequency of 4 with 13.3%. The mean score for this day was 28.13 with a standard deviation of 1.48 (Table 1).

The changes in the patients' wound status on postoperative day 2 of evaluation were evident. During the inflammatory phase, most of the patients incurred a BWAT score of 24 (mild severity), which was 7 or 23.3% of the total population. This was followed by a BWAT of 25 (mild severity) with a frequency of 6 or 20% and a BWAT score of 23 (mild severity) with a frequency of 5 or 16.7%. On the other hand, the BWAT score of 22 (mild severity) had a frequency of 4 or 13.3%, while the BWAT score of 23.5 (mild severity) and 26 (mild severity) both had a frequency of 2 and a percentage of 6.7 each. Only 1 or 3.3% of the total population had a BWAT score of 21, 21.5, 22.5, and 27.0, which were all under mild severity scoring. The mean score of day 2 was 23.73 (mild severity) with a standard deviation of 1.44.

BWAT score	Day 1 Hemostasis phase		Day 2 Inflammatory phase		Day 3 Proliferative phase	
	F	%	*F*	%	*F*	%
18.0					1	3.3
19.0					9	30.0
20.0					14	46.7
21.0			1	3.3	6	20.0
21.5			1	3.3		
22.0			4	13.3		
22.5			1	3.3		
23.0			5	16.7		
23.5			2	6.7		
24.0			7	23.3		
25.0			6	20.0		
26.0	6	20.0	2	6.7		
27.0	4	13.3	1	3.3		
28.0	8	26.7				
29.0	4	13.3				
30.0	8	26.7				
Total	30	100.0	30	100.0	30	100.0
Mean	28.13		23.73		19.83	
SD	1.48		1.44		0.79	
V.I.	Mild severity		Mild severity		Minimal severity	

Table 1. Patients wound status based on BWAT in the control group.

On day 3 of the postoperative day of evaluation of the patients' wound status, the results indicated significant changes as the majority of the patients had a BWAT score of 20 (minimal severity), which is 14 or 46.7% of the total population. It was followed by a BWAT score of 19 (minimal severity) with a frequency of 9 or 30%. The BWAT score of 21 (mild severity) came in next with a frequency of 6 or 20%. The BWAT score of 18 (minimal severity) obtained the lowest frequency of 1 or 3.3% in the control group. The mean score during the proliferative phase is 19.83 (minimal severity) with a standard deviation of 0.79.

Most of the patients under the control group had shown a positive result regarding wound healing after the surgical operation. Despite having the usual care alone as an intervention, all the subject patients did not develop any postoperative complications particularly, SSI. The application of the bundle of care for preventing SSI was implemented in the experimental group.

In the inflammatory phase of the wound healing process, the BWAT score of 22 (mild severity) gained the highest frequency of 11 or 36.7% followed by the BWAT score of 19 (minimal severity) with a frequency of 5 or 16.7%. The BWAT score of 23 (mild severity) and 20 (minimal severity) both earned a similar frequency of 4 or 13.3%, while the BWAT score of 21 (mild severity) attained a frequency of 2 or 6.7%. Ranked last were the BWAT scores 24.5, 24, 22.5, and 21.5 (mild severity scoring) which garnered a frequency of 1 or 3.3% of the total population. The mean score in the inflammatory phase is 21.45 (mild severity) with a standard deviation of 1.54. The results showed that the mean score for the experimental group is lower compared to that of the control group. This indicates that the majority of the patients' wound status in the experimental group healed faster. The proliferative phase of the wound healing process in the experimental group showed the most significant improvements based on the BWAT. Most of the subject patients in the experimental group acquired a BWAT score of 16 (minimal severity), which is 13 or 43.4% of the total population. On the other hand, 11 or 36% of the total population in the experimental group obtained the BWAT score of 15 (minimal severity). The BWAT score of 17 (minimal severity) accumulated the lowest frequency of 6 or 20%. The mean score of the proliferative phase in the experimental group was 15.83 (minimal severity) with a standard deviation of 0.75 (Table 2).

In the hemostasis phase, the mean score is 28.13 with a standard deviation of 1.48. The inflammatory phase has a mean of 23.73 with a standard deviation of 1.44 and the proliferative phase has a mean of

BWAT score	Day 1 Hemostasis phase		Day 2 Inflammatory phase		Day 3 Proliferative phase	
	F	%	*F*	%	*F*	%
15.0					11	36.7
16.0					13	43.3
17.0					6	20.0
18.0						
19.0			5	16.7		
20.0			4	13.3		
21.0			2	6.7		
21.5			1	3.3		
22.0			11	36.7		
22.5			1	3.3		
23.0			4	13.3		
23.5						
24			1	3.3		
24.5			1	3.3		
25.0						
26.0						
27.0	2	6.7				
28.0	16	53.3				
29.0	7	23.3				
30.0	5	16.7				
Total	30	100.0	30	100.0	30	100.0
Mean	28.50		21.45		15.83	
S.D.	0.86		1.54		0.75	
VI	Mild severity		Mild severity		Minimal severity	

Table 2. Patients' wound status based on BWAT in the experimental group.

19.83 with a standard deviation of 0.79. Friedman Test was used to determine the significant difference in the patients' wound status using the *P*-value <0.05. During the first day of the postoperative phase, also known as the hemostasis phase of the wound healing process, the subject patients obtained a mean score of 28.13 (mild severity) with a standard deviation of 1.47. This shows a higher result compared with the other phases of the wound healing process, which was expected because of this marked baseline data for the study. In the inflammatory phase of the study, the subject patients garnered a mean score of 23.73 (mild severity) with a standard deviation of 1.44. This indicates that there was an improvement in the severity of the wound status of patients compared with the postoperative of day 1. On the third day (proliferative phase) postoperatively, the patients' mean score under the control group was 19.83 (minimal severity) with a standard deviation of 0.79 (Table 3). This implies a much lesser mean compared with day 1 and day 2. Friedman Test was used to determine the significant difference in the patients' wound status under the control group. The resulting value of $P = 0.000<0.05$ denotes a significant difference in the patients' wound status in the control group within each

Phases of wound healing process	Mean	SD	Chi-square	*P*-value
Control group			60	$P = 0.000<0.05$*
Hemostasis	28.13	1.48		
Inflammatory	23.73	1.44		
Proliferative	19.83	0.79		
Experimental group			60	$P = 0.000<0.05$*
Hemostasis	28.5	0.86		
Inflammatory	21.45	1.54		
Proliferative	15.83	0.75		

Note: *$P<0.05$ is the level of significance.

Table 3. The day-to-day comparison of patients' wound status after the application of usual care and operating room bundle of care.

phase of the wound healing process after implementation of the usual care to prevent SSI.

Table 3 presents the statistical result of the experimental group where the application of usual care and the OR bundle of care was implemented. The evaluation of the wound status was done following the exploratory laparotomy cholecystectomy surgery of each subject patient and using the BWAT as a tool to assess the healing progress of their wound. The mean score during the first day postoperative was 28.50 (mild severity) with a standard deviation of 0.86 that was used as the baseline data for the experimental group. This was slightly higher compared with day 1 in the control group, where the mean difference was 0.37. However, there was a noticeable decrease in the mean score among the patients during the inflammatory phase of the wound healing process. During the second postoperative day, the mean score became 21.45 (mild severity) with a standard deviation of 1.54. The result showed that the subject patients under the experimental group displayed a significant improvement in their wound healing process as compared with day 1. In a study conducted by Bruce et al.[8] and abdominal closure bundle was implemented, and the SSI rates were assessed overall and within subgroups. After the implementation of the said bundle, the researchers found a reduction in the SSI rate in the post bundle group compared with the pre-intervention phase. On the third postoperative day, the mean score was 15.83 (minimal severity) with a standard deviation of 0.75. The results revealed that during the proliferative phase of the wound healing process, most of the patients showed an effective wound healing process, hence preventing the chance of developing SSI.

In evaluating the significant difference in the patients' wound status in the experimental group, a *P*-value of 0.05 was used to assess the level of significance. The researcher used the Friedman test again to determine if

Day of evaluation	Mean	SD	Mann–Whitney	*P*-value	Interpretation
Day 1 Hemostasis phase			390	$P = 0.355 > 0.05$	Not significant
Control	28.13	1.48			
Experimental	28.5	0.86			
Day 2 Inflammatory phase			129.5	$P = 0.000 < 0.05$	Significant
Control	23.73	1.44			
Experimental	21.45	1.54			
Day 3 Proliferative phase			0	$P = 0.000 < 0.05$	Significant
Control	19.83	0.79			
Experimental	15.83	0.75			

Note: $^{*}P < 0.05$ is the level of significance.

Table 4. Differences in patients' wound status between control and experimental groups after application of the operating room bundle of care and usual care per day of evaluation.

the intervention implemented was effective in preventing SSI. The result of $P = 0.000<0.05$ showed a significant difference in the patients' wound status in the experimental group after implementation of the usual care and the OR bundle of care, hence the acceptance of the alternative hypothesis. Furthermore, it indicated that the usual care together with the application of the OR bundle of care is effective in preventing SSI, following an exploratory laparotomy cholecystectomy surgery.

Mann–Whitney Test was used to compare the significant difference on both groups using a *P*-value of 0.05. This nonparametric type of test was used to compare two independent groups, because the data presented had no assumption of normality, the dependent variable was measured at the ordinal level, and there was independence of observation in both the groups. In the hemostasis phase, the result revealed a $P = 0.355>0.05$. This can be interpreted as "no significant difference" found in the patients' wound status in both the control and experimental groups. This result is justifiable as this phase occurs 24 hours following the closure of the major surgery. The patients' wound status from both the groups fell under the mild severity scoring of BWAT. Both the control and experimental groups were on the same wound status severity scoring based on the computed mean (Table 4).

During the second day of the study (inflammatory phase), there was a more noticeable difference between the control and experimental groups. The mean score of the control group was 23.73 (mild severity) with a standard deviation of 1.44, which was found to be greater than the mean of the experimental group which was 21.45 (mild severity) with a standard deviation of 1.54. This means that the experimental group's wounds healed more efficiently than the control group. This was based on the BWAT severity scoring with the Mann–Whitney test as the method of statistical analysis to determine their significant difference, which was $P = 0.000>0.05$.

The significant differences were more evident in the proliferative phase of the wound healing process. The control group's mean score of 19.83 (minimal severity) with a standard deviation of 0.79 was higher compared with that of the experimental group, which was 15.83 (minimal severity) with a standard deviation of 0.75. In comparing the significant differences between the control and experimental groups using a *P*-value of 0.05 to the Mann–Whitney Test resulted in a value of $P = 0.000<0.05$. The statistical analysis revealed that there is a "significant difference" between the patients' wound status in the control and experimental groups after application of the usual care and the OR bundle of care.

4. Discussion

Both the control and experimental groups were classified under "mild severity" in the BWAT scoring at the start of the study. During the inflammatory phase, the patients' wound status mean in the control group was higher compared with that in the experimental group; however, the same status falls under mild severity. A significant difference was noticeably seen during the proliferative phase. The mean score of the patients' wound status in the control group was higher compared with the experimental group. The mean scores of both groups were lower, indicating a more effective wound healing process.

A striking difference between the control and experimental groups on the third postoperative day was also visibly manifested in this phase. This indicates that the experimental group's wound status healed much faster and more effectively than the control group based on the BWAT severity scoring. In a study conducted by Weiser et al.[9], they determined that by implementing a

multidisciplinary care bundle at a hospital-wide level, a meaningful reduction in SSI can be achieved. It can be further interpreted that there is a significant difference in the patients' wound status between the control and experimental groups during the inflammatory phase. In a study conducted by Vij et al.[10] a simple OR bundle was implemented. After implementation of a simple fast, low-cost, and easily reproducible bundle in the OR, there were reduced SSI rates.

When comparing the control group alone, the patients' wound status initially had a mean score of 28.13 (mild severity) during day 1, which decreased by day 3 to 19.83 (minimal severity). Both were under mild severity in the BWAT scoring during the hemostasis phase and eventually improved to mild severity scoring during the proliferative phase. This indicates that the patients somewhat experienced wound healing since the application of usual care. In the experimental group, the results showed a significant difference in the patients' wound status from the hemostasis phase compared with the proliferative phase. The average mean of the patients' wound status in the experimental group during postoperative day 1 was 28.50 (mild severity). In comparison to postoperative day 3, the mean of the patients' wound status in the experimental group was 15.83 (minimal severity), which was lower compared with the results shown in the control group. This falls under the minimal severity scoring in the BWAT. This further indicates that there was an improvement in the results when comparing both groups. The application of the OR bundle of care has been an effective tool in preventing the occurrence of SSI. Tufts et al.[11] believe that the implementation of a multidisciplinary care bundle was associated with a 61% reduction in SSIs with the greatest impact on superficial/deep SSI. Furthermore, implementing these evidence-based interventions can greatly reduce SSI.[1]

The study is limited only to the 60 subjects and generalization of conclusions cannot be attained. Thus, the results of the study may apply to the study subjects and further study may be recommended to determine further the effectiveness of the OR bundle.

5. Conclusions

Based on the above, the results showed that there was a significant difference in the wound status of patients in the homeostasis, inflammatory, and proliferative phases of the wound healing process after application of the OR bundle of care and usual care in the experimental group. There is also a significant difference in the wound status of patients between the control and experimental groups. Therefore, the OR bundle of care has shown to be effective in preventing SSI to patients who had undergone exploratory laparotomy cholecystectomy surgery in the selected hospital if there is uniform and consistent implementation of the said intervention.

Ethical approval

The study was approved by the Institutional Ethics and Review Committee (CEU IERB Approval No. 2018-19/452) of Centro Escolar University for the implementation of the research to patients.

Conflicts of interest

All contributing authors declare no conflicts of interest.

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