Effectiveness of Applying Nursing Care Protocol Regarding Negative Pressure Wound Dressing on Clinical Outcomes of Patients undergoing Cardiothoracic Surgeries

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Abstract

Background: Negative pressure wound therapy is a promising treatment post cardiothoracic surgery especially for patients with deep sternal wound infection. Appropriate wound care requires the integration of knowledge and skills to enhance the healing process and improve patient outcomes. **Aim:** To evaluate the effectiveness of applying nursing care protocol regarding negative pressure wound dressing on clinical outcomes of patients undergoing cardiothoracic surgeries. **Design**: A quasi-experimental design was utilized. **Setting**: Cardiothoracic Surgery Department and outpatient clinic at the Cardiothoracic and Vascular Surgery Center, Mansoura University Hospitals, Egypt. **Subject:** A Purposive sample composed of (64) patients and (21) nurses. **Tools**: The researchers used three tools to collect the data; Tool 1, a structured interview questionnaire, divided into three parts for assessing nurses' demographic and professional data in addition to assessing patients' demographic and medical data, and the nurses' knowledge questionnaire. Tool II: Observational checklist to assess nurses' practice regarding negative pressure wound dressing. Tool III: Bates-Jensen Wound Assessment tool. **Results:** There was a significant improvement in nurses' knowledge and practices after applying the nursing care protocol regarding negative pressure wound dressing**.** Also, there were significant differences between patients in the study and control groups regarding severity levels of the wound, as most of the patients in the study group had minimal wound severity with better wound condition compared to the control group. **Conclusion:** Applying nursing care protocol regarding negative pressure wound dressing has demonstrated significant effectiveness in improving clinical outcomes for patients undergoing cardiothoracic surgeries. **Recommendations:** Implementing a standardized nursing care protocol for negative pressure wound dressing across all cardiothoracic surgery units to ensure consistency in patient care and improve clinical outcomes.

Keywords: Cardiothoracic patients, Clinical outcomes, Nursing care protocol, Negative pressure wound dressing.

Introduction

Negative pressure wound therapy (NPWT) is a special and adaptable system that optimizes wound healing by applying sub-atmospheric pressure to minimize inflammatory exudate and promote granulation tissue. It can treat acute and chronic wounds, including closed surgical incisions, diabetic foot ulcers, and open fasciotomy wounds (**Zaver & Kankanalu, 2022).**

Since its first documented use in the modern era in the 19th century, negative pressure wound treatment (NPWT) has experienced substantial development. An electronically powered Yintermittent suction to a porous foam dressing in this kind of NPWT system **(Normandin et al., 2021).** By providing targeted negative pressure to the wound, a technique called negative pressure therapy (NPT), often referred to as vacuum-assisted closure therapy (VAC), aids in the non-invasive promotion of wound healing. Its airtight design creates a moist, enclosed space that eliminates extra fluid and speeds up the healing of wounds. Its goal is to promote the progression of the lesion from the inflammatory to the proliferative phase by achieving the epithelialization of the wound, which was not accomplished by the first intention (**Seidel et al., 2020).**

Additionally, the method of action makes it possible to lessen inflammation, cellular debris, exudate, edema, and excess liquid. In addition to promoting regional blood and lymphatic flow, this lowers the bacterial burden. Furthermore, it permits neovascularization, which boosts oxygenation and the flow of nutrients required by cells. The apparatus has the ability to alter the cytoskeleton of cells in response to intercellular signals that promote cell division. This promotes epithelial growth factor and forms granulation tissue, preparing the wound bed

(Astasio-Picado et al., 2022). Moreover, it is recommended to be used on wounds that, after a month of standard therapy, have not shrunk by around 50%. There are several applications for it, and the patient must be hemodynamically stable **(Normandin et al., 2021).**

Negative pressure wound therapy was originally developed to aid in the management of chronic open wounds. Recently, however, there has been an increasing focus on applying this technique to closed surgical incisions, particularly in patients deemed to be at high risk for serious surgical site infections and other complications. This approach utilizes a negative pressure device along with specialized dressings designed to maintain the alignment of incision edges, alleviate lateral tension, minimize swelling, enhance blood flow, and shield the surgical area from external sources of infection. **(Tao et al., 2023).** The application of preventive negative pressure has yielded highly favorable outcomes, facilitating remarkable wound healing even in patients classified as high-risk. This approach effectively mitigates the occurrence of seromas, hematomas, and alterations in skin integrity **(Zens et al., 2020).**

Cardiovascular diseases represent the foremost contributor to both morbidity and mortality on a global scale, resulting in approximately 18 million fatalities and 366 million years of life lost due to disability annually. A significant proportion, exceeding 80% of these occurrences, is concentrated in low- and middle-income nations. Among the various health challenges faced globally, cardiothoracic disorders stand out as particularly burdensome; notably, cardiac diseases are responsible for one-third of all deaths, establishing themselves as a predominant cause of mortality worldwide. **(World Health Organization, 2021).** The persistent disparities in global surgical care are underscored by the fact that 80% of fatalities resulting from cardiovascular disease (CVD) and associated conditions can be traced back to rheumatic heart disease and congenital heart disease, which account for a significant share of these deaths **(Lin et al., 2023).**

Patients who undergo cardiothoracic surgery face a significant risk of developing surgical site infections and experiencing delayed wound healing. This risk is further compounded by the potential for increased morbidity and elevated mortality rates **(De Martino et al., 2020& Oliveira et al., 2020).** Despite advancements in preventive measures and perioperative care for cardiac surgery patients, complications related to surgical wounds still manifest in approximately 1-3% of cases, contributing to high hospital mortality rates. Topical negative pressure therapy (TNP) has emerged as a promising intervention and is increasingly utilized for the management of surgical site defects **(Brega et al., 2021)**. Negative pressure wound therapy (NPWT) has advantages in enhancing sternal wound healing including the stabilization of the chest wall, promotion of tissue granulation, reduction of wound edema, and effective drainage of excessive or infected fluid in instances of persistent infection. Furthermore, NPWT facilitates patient mobilization while ensuring sternal stabilization **(Phoon & Hwang, 2020).**

Cardiothoracic nurses play an essential role in delivering wound care to patients post-cardiothoracic surgery, particularly in the assessment and management of wounds, including the use of NPWT dressings. Cardiothoracic nurses are responsible for assessing the wound's suitability for NPWT, ensuring that the therapy is appropriately initiated and maintained. They meticulously prepare the wound bed, apply NPWT dressings with an airtight seal, and monitor the system to ensure proper functioning. Regular assessments are performed to check for signs of infection, wound healing progress, and device-related complications such as leaks or skin breakdown **(Elhassan et al., 2024).**

Nurses also manage patient discomfort associated with NPWT and provide education on therapy objectives, device operation, and mobility precautions. Collaboration with the surgical team is crucial to ensure optimal outcomes, and any concerns, such as excessive drainage, bleeding, or delayed healing, are promptly communicated. Additionally, nurses document dressing changes, wound progress, and any deviations from expected outcomes to guide future care. Through their expertise in NPWT application, monitoring, and patient education, cardiothoracic nurses play a pivotal role in accelerating wound healing, reducing complications, and improving overall recovery

outcomes for post-cardiothoracic surgery patients **(Przybek-Mita et al., 2023).**

The implementation of negative pressure wound therapy (NPWT) dressings necessitates a comprehensive understanding of the underlying principles of the therapy, as well as specialized training in the operation of the associated devices. Personnel tasked with performing dressing changes must possess the requisite knowledge and skills to deliver optimal wound care effectively. Given that wound management falls within the purview of nursing responsibilities, nurses must acquire a specific level of expertise regarding the application of this therapeutic modality to guarantee the highest standards of wound care that can be achieved through the application of standardized tools as nursing care protocol **(Nawaz et al., 2023).**

Nursing care protocols empower qualified nursing professionals by granting them autonomy within their specialized domains, thereby enhancing safety, boosting staff satisfaction, and promoting efficiency in the delivery of care. Furthermore, these protocols contribute to the establishment of a healthy work environment and support high-quality, effective nursing practices, while also playing a crucial role in the prevention of complications **(Kelly et al., 2020).**

Significance of the study

Managing acute, chronic, and complex wounds is a significant medical challenge, consuming substantial healthcare resources globally and posing a notable burden in Egypt **(Sheta, 2020).** negative pressure wound therapy (NPWT) effectively promotes wound healing and reduces surgical site infections in cardiothoracic surgery patients. Successful NPWT application depends on nurses' knowledge and skills, which can be enhanced through a structured nursing care protocol. This protocol provides evidence-based guidelines for wound assessment, dressing application, infection prevention, and patient education, ensuring consistent and high-quality care while optimizing patient outcomes **(Tao et al., 2023).** However, limited empirical evidence supports the effectiveness of nursing care protocol specific to NPWT. Therefore, this study was designed to evaluate the effectiveness of applying nursing care protocol regarding negative pressure wound dressing on clinical outcomes of patients undergoing cardiothoracic surgeries.

Aim of the study

Evaluate the effectiveness of applying nursing care protocol regarding negative pressure wound dressing on clinical outcomes of patients undergoing cardiothoracic surgeries.

Research hypotheses:

H1: Nurses' knowledge scores regarding negative pressure wound dressing are expected to be improved post-application of nursing care protocol.

H2: Nurses' practice scores regarding negative pressure wound dressing are expected to be improved post-application of nursing care protocol.

H3: Application of the nursing care protocol is expected to be effective in improving clinical outcomes of patients with cardiothoracic surgeries treated with negative pressure wound dressing.

Operational definitions:

- **Nursing care protocol** is a standardized set of evidence-based guidelines and step-by-step procedures designed to assist nurses in effectively managing, applying, monitoring, and maintaining negative pressure wound dressing for cardiothoracic surgery patients.
- **Clinical outcomes** refer to measurable indicators of patients' levels of wound severity following cardiothoracic surgeries and after the application of negative pressure wound dressing. These outcomes are assessed through the Bates-Jensen Wound Assessment Tool, which provides a structured approach to evaluating wound healing and severity.

Subjects and Method

Research design:

A quasi-experimental design was utilized.

Setting:

This study was conducted at the Cardiothoracic Surgery Department and outpatient clinic at the Cardiothoracic and Vascular Surgery Center, Mansoura University Hospitals, Egypt's Delta region. The department delivers comprehensive

and specialized medical care, encompassing all aspects of operative management, perioperative evaluation, and postoperative care.

Subjects:

This study included two distinct groups of participants: **nurses** and **patients**

A) Nurses

A purposive sample of nurses working at the cardiothoracic surgery department at the Cardiothoracic and Vascular Surgery Center, at Mansoura University Hospitals.

Nurses' inclusion criteria:

- Both male and female nurses
- Nurses' qualifications (baccalaureate and postgraduate degrees).
- Nurses have more than one year of experience in the cardiothoracic surgery department.
- Nurses actively working at the cardiothoracic surgery department, with ultimate responsibility and accountability for patients treated with NPWT.
- Nurses voluntarily agreed to participate in the study.

B) Studied Patients:

A purposive sample of (64) patients undergoing cardiothoracic surgeries was included in the study, divided into two equal groups. The **study group** (n=32) and the **control group** (n=32).

Patients' inclusion criteria:

- Adult patients aged 21–60 years.
- Patients treated with NPWT.
- Patients agreed to participate voluntarily in the study.

Patients' exclusion criteria:

- Hemodynamically unstable patients.
- Patients with anemia and bleeding tendencies.
- Patients with uncontrolled diabetes mellitus.
- Patients with contaminated wounds requiring surgical debridement.

Sample size calculation:

The following formula was used to determine the sample size based on data from the literature **(Nawaz et al., 2023)**, taking into account the 5% threshold of significance and the 80% power of study:

$n = \frac{(Z\alpha/2 + Z\beta)^2 \times 2(SD)^2}{d^2}$ where SD is the standard deviation from the prior research; Zα/2 is 1.96 for 5%; Zβ is 0.84 for 80%; and d is the assumed difference. Consequently, $n = \frac{(1.96 + 0.84)^2 \times 2(2.55)^2}{(1.8)^2}$ =31.5. This calculation indicates that a sample size of 32 per group is needed.

Tools of data collection:

Three tools were used for data collection:

Tool I: A structured interview questionnaire:

This tool consisted of 3 parts. Parts 1 & 2 were developed by researchers after reviewing recent relevant literature and scientific references **(Sheta, 2020; Nawaz et al., 2023 & Przybek-Mita et al., 2023).**

Part (1): The studied nurses' demographic and professional data includes age, sex, qualification, years of experience, and previous participation in training programs on negative pressure wound therapy (NPWT).

Part (2): Demographic and medical data of the studied patients to collect the following data; age, gender, marital status, level of education, and type of surgery.

Part (3): Nurses' knowledge questionnaire:

It was adopted from **Mohamed et al. (2019)** to evaluate the theoretical and practical understanding of negative pressure wound therapy (NPWT) among the studied nurses. It consists of 36 questions (11 multiple choice questions and 25 true or false questions), including how it works, benefits, clinical indication, contraindications, precautions, frequency of dressing changes, urgent discontinuation of NPWT, complications of NPWT and the appropriate interventions, and device alarms and what it indicates.

Scoring system:

Each correct answer earned 1 point, while incorrect or unclear responses scored 0. The overall score was computed and translated to a percentage out of 36. The results were categorized accordingly as the following **(EL-Azab et al., 2023).**

Levels of knowledge	Scores (total scores=36)	Percentage
Poor	< 25	< 70%
Fair	25 -< 29	70 - < 80%
Good	≥ 29	≥80%

Tool II: Observational checklist to assess nurses' practice regarding applying negative pressure wound therapy:

It was adopted from **Taylor et al., (2015).** It consists of 26 steps of applying negative pressure wound dressing. The checklist is categorized into three items, need practice, satisfactory, and excellent practice. The goal of the checklist is to accomplish negative pressure wound dressing without contaminating the wound site, traumatizing the wound, or producing any discomfort for the patient.

Scoring system:

Responses were scored as follows: "Need practice" earned 1 point, "Satisfactory" earned 2 points, and "Excellent practice" earned 3 points. The total practice scores were then calculated and converted into a percentage as the following **(EL-Azab et al., 2023).**

Levels of Practice	Scores (total scores=78)	Percentage
Unsatisfactory	47 -< 59	60 -< 75%
Satisfactory	≥ 59	≥75%

Tool III: Bates-Jensen Wound Assessment Tool (BWAT).

It was originally developed and validated by **Harris et al. (2010)**, a reliable and evidence-based instrument designed to assist nurses in clinical decision-making, patient care planning, and evaluating wound healing progress. The current version of BWAT includes 13 assessment parameters that comprehensively evaluate wound characteristics, such as size, depth, edges, undermining, type and amount of necrotic tissue, type and amount of exudate, peripheral tissue edema, and induration, surrounding skin color, granulation tissue, and epithelialization.

The tool employs a five-point Likert scale, where 1 represents optimal wound conditions (non-harmful) and 5 denotes severe wound deterioration (extremely necrotic). The total score, derived from summing the individual scores of these parameters, ranges from 13 to 65 points, with higher scores indicating more severe wound conditions. Specific criteria, including size, depth, edges, and detachment, are assigned a score of zero when complete wound healing is achieved. Furthermore, the tool incorporates two additional descriptive parameters—wound location and shape—which, didn't contribute to the total score.

Scoring system:

Evaluating the wound severity depends on the overall BWAT score. It was classified as minimal severity, ranging from 13-20 indicating minor tissue damage with favorable healing potential. Scores ranging from 21-30 represent mild severity, suggesting mild tissue impairment that typically requires standard wound care interventions. A moderate severity level, with scores between 31 and 40, indicates more substantial tissue damage, often requiring specialized wound management strategies. Lastly, scores falling within the 41 to 65 range are categorized as extreme severity, reflecting extensive tissue damage.

Validity of the study tools:

Five experts specializing in medical-surgical nursing, cardiothoracic surgery, and medical biostatistics, all affiliated with Mansoura University, evaluated the content validity of the study tools. The experts thoroughly reviewed the tools to ensure their relevance, clarity, and appropriateness for the study objectives. Based on their feedback, necessary modifications and refinements were made to enhance the tools' validity and alignment with the study's requirements.

Reliability of the study tools:

The reliability of the study tools was evaluated using Cronbach's Alpha, a widely recognized statistical measure for assessing internal consistency. This coefficient ranges from 0 to 1.0, with 1.0 indicating perfect reliability and a minimum acceptable value of 0.65. Scores below this threshold suggest inadequate reliability of the instrument. In this study, the Cronbach's Alpha value for the nurses' knowledge assessment tool was 0.897, the nurses' practice checklist scored 0.895, and the Bates-Jensen Wound Assessment Tool achieved a value of 0.901. These values demonstrate high reliability across all tools, indicating their

consistency and suitability for accurately measuring the intended variables.

Pilot study:

A pilot study was conducted on 10% of the total sample, which included two nurses and six patients (out of the total 21 nurses and 64 patients). It aimed to evaluate the feasibility, clarity, and applicability of the developed tools and procedures. Feedback and observations from this pilot testing phase informed necessary modifications to enhance the tools' effectiveness and ensure they aligned with the study objectives. For this study, no major modifications were made therefore, participants in the pilot study were included in the main study sample.

Ethical consideration:

The Ethical Committee for Scientific Research at the Faculty of Nursing, Mansoura University, Egypt, granted ethical approval for the study (IRP Ref. no. P.0562). Before initiating the study, official permission was secured from the cardiothoracic surgery department administrator after a detailed explanation of the study's objectives and purpose. Informed consent was obtained from the participating patients and nurses, who voluntarily agreed to join the study after receiving clear information about its aim and procedures. Participants were assured of their right to withdraw at any time without repercussions on the quality of care they received. Additionally, privacy and data confidentiality were strictly maintained through data coding, and the researchers guaranteed that all collected information would be exclusively used for research purposes.

Fieldwork of data collection Procedure:

Nine months were dedicated to data collection, spanning from March 2024 to November 2024. The fieldwork was systematically structured into five consecutive phases, each meticulously carried out to ensure the achievement of the study's objectives.

Procedure phases

Phase I: Preparatory phase

- Written approval to conduct the study was obtained from the relevant authorities before initiating data collection. The study process was carefully coordinated with healthcare providers, including nursing staff, following a clear explanation of the study's objectives and procedures to ensure mutual understanding and cooperation.
- The researchers developed tool I, parts 1 & 2 after reviewing recent relevant literature and scientific references. Additionally, adopted tool I, part 3, tool II, and tool III and then assessed for their content validity by professional expertise.

Phase II: Assessment phase (Pre-test)

- **Nurses' assessment:** The researchers introduced themselves to nurses giving them a brief idea about the aim and nature of the study. Each nurse was interviewed according to his/her work schedule individually by the researchers to accomplish demographic and professional data for nurses using **Tool I, part I.**
- **Nurses' knowledge** about negative pressure wound dressing was evaluated using Tool I, Part 3. The participating nurses completed the questionnaire independently, with an average completion time of 20 to 25 minutes.
- **Nurses' practices** regarding negative pressure wound dressing were assessed using an observational checklist (**Tool II).**
- **Patients' assessment:** patients in both groups "control and study" were assessed for their demographic and medical data using **tools I, part 2**. Additionally, patients in the **control group** were assessed for their clinical outcomes using **Tool III** to assess levels of wound severity one month following NPWT device application regardless of whether they were in the cardiothoracic department or the outpatient clinic, as this is the expected duration of wound healing according to cardiothoracic surgeon expectations in the previously mentioned setting.

Phase III: Planning phase (Preparing the nursing care protocol)

- Based on initial data collection and after reviewing the literature **(Sheta, 2020; Lister et al., 2021; Nawaz et al., 2023& Przybek-Mita et al., 2023),** nursing care protocol was prepared and revised for applicability by 5 experts. All instructions and comments from the experts were

documented and considered in the formulation and modification of the nursing care protocol. Arabic colored booklet was developed by researchers after identifying the general and specific objectives of the nursing care protocol.

- **The general objective of the nursing care protocol** was to enhance nurses' knowledge and practices related to the application and management of negative pressure wound dressing.
- **The specific objectives** were as follows: Nurses will be able to:
  - Understand the principles of NPWT.
  - Explain the mechanism of action and benefits of NPWT.
  - Outline appropriate clinical scenarios for NPWT applications and recognize situations where NPWT should not be used.
  - Master application techniques.
  - Identify potential complications associated with NPWT and the appropriate interventions.
- The educational sessions were scheduled in alignment with the nurses' work schedules.
- The participating nurses were divided into four groups, with each group comprising almost five nurses, carefully organized to accommodate their timetables and ensure effective participation.

Phase IV: Implementation phase (Appling the nursing care protocol)

- The researchers provided sessions related to NPWT dressing. Educational sessions were conducted through three sessions, one theoretical and two practical sessions for each nurses' group. It was conducted over two weeks, accommodating both morning and evening shifts. The scheduling was flexible and aligned with the nurses' readiness and availability, ensuring optimal participation without disrupting their clinical responsibilities.
- The educational sessions covered theoretical knowledge and demonstrated the practice related to NPWT dressing.
- The content of the theoretical session covered the following items: definition and mechanism of action of NPWT, benefits, Indications, contraindications, precautions, complications, and the appropriate interventions.
- The content of practical sessions involved the demonstration of application technique, Tips for ensuring proper seal and avoiding complications, device alarms, monitoring, and managing complications, and when to escalate care or consult specialists.
- A variety of teaching and learning strategies were employed during the educational sessions to enhance engagement and comprehension. These methods included interactive lectures, group discussions, demonstrations, and re-demonstrations. Additionally, instructional media such as visual aids, diagrams, and printed handouts were provided in a well-organized, colored, and concise booklet designed to serve as a reference guide for future use. Nurses were actively encouraged to ask questions and seek clarification on any topic or concept presented during the sessions, fostering an interactive and supportive learning environment.
- A WhatsApp group was created, and all participating nurses were added to it. This group served as a communication platform, allowing nurses to ask questions, seek clarifications, and share concerns at any time. It also facilitated ongoing support, collaboration, and prompt responses throughout the study period.

Phase V: Evaluation phase (Post-test)

- **Nurses' evaluation: nurses' knowledge** was evaluated using tool I part 3 immediately after applying the nursing care protocol. Then **nurses' practices** were evaluated using Tool II when the patient exchanged negative pressure wound dressing for the first time.
- **Patients' evaluation: patients in the study group** were evaluated for their clinical outcomes using Tool III to evaluate levels of wound severity one month following NPWT device application.

Statistical analysis

The Statistical Package for the Social Sciences (SPSS, Inc., Chicago, Illinois, USA) version 20.0 was used to statistically analyze the data after gathering it. The quantitative data was presented using the mean, standard deviation (SD), and range (minimum and maximum), whereas the qualitative data was presented using numbers and percentages. The Kolmogorov-Smirnov and Shapiro-Wilk tests were used to determine whether the data was normally distributed before any computations were performed. To compare two groups with qualitative factors, the Chi-Square test was employed. The quantitative data for abnormally distributed variables between two groups were compared using the Mann-Whitney test (U-test). Pearson's coefficient (r) was used to assess the correlation between the research variables. The significance level for the results was set at 5% ($P \leq 0.05$).

Results

Table 1 illustrates that, 61.9% of the nurses were female, with 47.6% aged 30–<40 years and 42.9% aged 20–<30 years. In terms of education, 81% held a bachelor's degree, while 19% had postgraduate qualifications. Over half (52.4%) had 1–<5 years of experience. Notably, 76.2% had no prior training in negative pressure wound therapy (NPWT) and 57.2% reported frequently handling NPWT patients, indicating active involvement despite limited formal training.

Table (2) demonstrates a statistically significant improvement in nurses' knowledge following the application of the nursing care protocol, with mean scores rising from 21.05±7.41 before to 34.81±2.34 after application. Initially, 52.4% of nurses had poor knowledge levels, but post-application, the majority (90.5%) achieved good knowledge levels, underscoring the protocol's effectiveness in enhancing understanding of NPWT.

Table (3) shows a statistically significant improvement in nurses' practices regarding negative pressure wound dressing following the application of the nursing care protocol. The mean practice scores increased from 50.57±3.40 before application to 64.95±4.69 after. Initially, 90.5% of nurses had unsatisfactory practice levels, but this improved significantly, with 81% achieving satisfactory practice after protocol application.

Table (4) demonstrates a strong positive correlation between nurses' knowledge and practice regarding applying negative pressure wound dressing before and after the application of the nursing care protocol. This suggests that as nurses' knowledge increased, their practical performance also improved, emphasizing the critical role of knowledge enhancement in advancing clinical skills.

Table (5) indicates no statistically significant differences between the control and study groups concerning demographic characteristics. The majority of patients (81.3%) of the control group and over two-thirds (68.7%) of the study group were aged 50 to 60 years. Moreover, 48.4% of the control group and 78.1% of the study group were males. In both groups, most of the patients were married, and over two-thirds had basic literacy skills (could read and write).

Figure (1) illustrates the distribution of patients according to type of surgery. In the control group, 62.5% of patients underwent valve replacement surgeries, while 37.5% underwent coronary artery bypass graft (CABG). In the study group, 56.3% had valve replacement surgeries, and 43.7% underwent CABG.

Figure (2) highlights a statistically significant difference between the control and study groups concerning wound severity levels. Most of the patients (93.7%) in the study group experienced minimal wound severity, compared to only 34.4% in the control group. This suggests that improvements in nurses' knowledge and performance following the application of the nursing care protocol positively impacted patients' wound conditions, resulting in better clinical outcomes in the study group.

Table (1): Distribution of the studied nurses according to their demographic and professional data (n =21).

Demographic &Professional data	No.	%
Age		
20 - < 30 years	9	42.9
30 - <40 years	10	47.6
40 - <50 years	2	9.5
Gender		
Male	8	38.1
Female	13	61.9
Qualifications		
Bachelor's degree	17	81.0
Postgraduate	4	19.0
Years of experience		
1 - < 5 years	11	52.4
5 - 10 years	10	47.6
Previous training participation in NPWT		
Yes	5	23.8
No	16	76.2
If yes, the last time attending sessions (n = 5)		
6 - < 12 months	3	60.0
> 12 months	2	40.0
How frequently do you handle patients with NPWT?		
Always	4	19.0
Frequently	12	57.2
Occasionally	5	23.8

Table (2): Comparison of the studied nurses' knowledge regarding negative pressure wound dressing before and after the application of the nursing care protocol (n =21).

Scores	Before		After		Test of significance	
	No	%	No	%	Test	P-value
Poor (< 70%)	11	52.4	0	0.0	X^2 =36.00	P = <0.001*
Fair (70%- < 80%)	6	28.6	2	9.5		
Good (≥ 80%)	4	19.0	19	90.5		
Overall Mean Knowledge						
Min. – Max.	14.0-30.0		28.0-36.0		U=14.00	P = <0.001*
Mean ± SD	21.05±7.41		34.81±2.34			

SD: *Standard deviation* ***X^2:*** *Chi-Square* ***U:*** *Mann-Whitney test* *******Significant at P ≤ 0.05*

Table (3): Comparison of the studied nurses' practices regarding applying negative pressure wound dressing before and after the application of the nursing care protocol (n =21)

Score	Before		After		Test of significance	
	No	%	No	%	Test	P-value
Unsatisfactory (60 - < 75%)	19	90.5	4	19.0	X^2 =21.62	P = <0.001*
Satisfactory (≥ 75)	2	9.5	17	81.0		
Overall Mean practice						

Min. – Max.	48.0-59.0	58.0-69.0	U=9.00	P = <0.001*
Mean ± SD	50.57±3.40	64.95±4.69		

SD: *Standard deviation* ***X^2:*** *Chi-Square* ***U:*** *Mann-Whitney test* *******Significant at P ≤ 0.05*

Table (4): Correlation between the studied nurses' knowledge and practice regarding the application of negative pressure wound dressing (n =21)

Variables	Before	R P	After	R P
	Mean ± SD		Mean ± SD	
Nurses' knowledge	21.05 ± 7.41	0.807	34.81 ± 2.34	0.662
Nurses' practice	50.57 ± 3.40	<0.001**	64.95 ± 4.69	0.001**

********Correlation is significant at the 0.01 level (2-tailed).* ***r****: Pearson coefficient*

Table (5): Comparison between control and study groups according to their demographic data (n =64).

Demographic data	Control Group (N=32)		Study Group (N=32)		Test of Significance	P-Value
	N	%	N	%		
Age						
40-<50	6	18.7	10	31.3	X^2= 1.333	0.248
50-60	26	81.3	22	68.7		
Gender						
Male	27	84.4	25	78.1	X^2= 0.410	0.522
Female	5	15.6	7	21.9		
Marital status						
Married	30	93.7	29	90.6	X^2= 0.217	0.641
Widow	2	6.3	3	9.4		
Educational level						
Read & write	22	68.8	22	68.7		
Primary education	7	21.8	8	25.0	X^2= 0.267	0.875
Secondary education	3	9.4	2	6.3		

X^2: *Chi-Square* *******Significant at P ≤ 0.05*

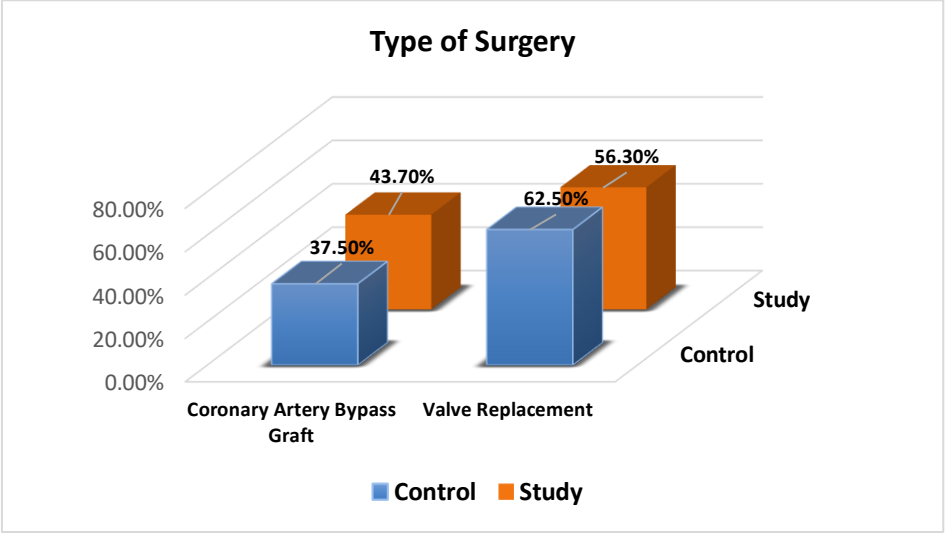

Figure (1): Comparison between control and study groups according to their types of surgery

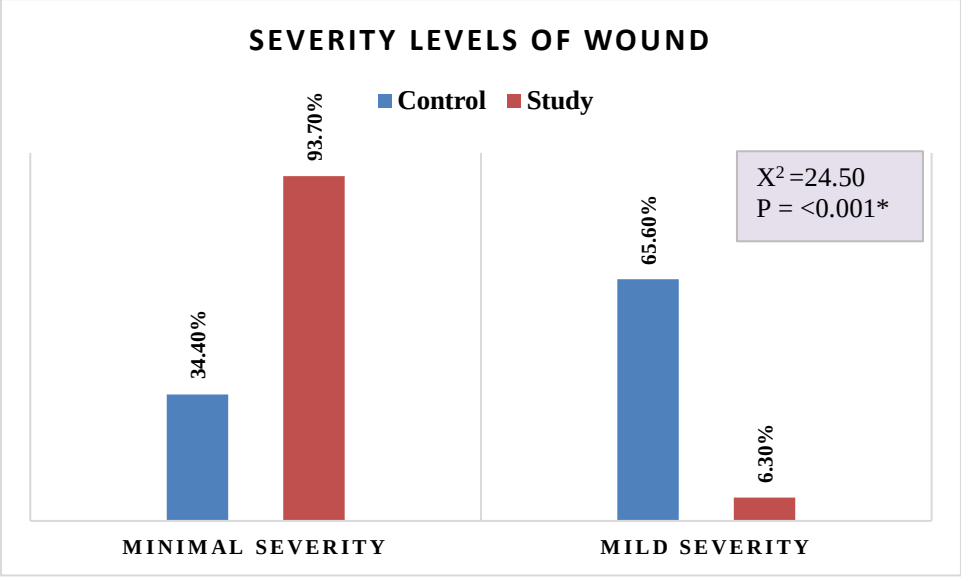

Figure (2): Comparison between control and study groups according to severity levels of wound

Discussion

Negative pressure wound therapy (NPWT) has become widely recognized as an effective intervention for managing soft tissue infections and chronic refractory wounds **(Kramer et al., 2022).** Recently, there has been a growing interest in applying NPWT to closed surgical incisions, particularly in high-risk patients, as a preventive measure against severe surgical site infections and other wound-related complications. This approach aims to enhance postoperative healing outcomes and improve the overall prognosis of patients following cardiac surgery by minimizing complications and promoting optimal wound management **(Tao et al., 2023).**

Nurses are central to patient care, especially in wound management where their expertise is vital, continuous training keeps them updated, particularly in the cardiothoracic department, ensuring adherence to protocols and safety standards. This leads to accurate, secure care, and improves treatment efficiency and outcomes. Appropriate use of advanced wound

therapies such as NPWT requires integrating knowledge and skills to enhance the healing process and improve patient outcomes **(Brownhill et al., 2020).** Therefore, this study demonstrated the effectiveness of applying nursing care protocol regarding negative pressure wound dressing on clinical outcomes of patients undergoing cardiothoracic surgeries.

With reference to the main demographic characteristics of the participant nurses, the findings revealed that most of the participants were aged between twenty to forty years, representing a relatively young workforce. This age group aligns with global trends where early to mid-career nurses dominate critical care and surgical settings. Younger nurses are generally more adaptable to evidence-based practices, including advanced wound care protocols, which are essential for optimal patient outcomes **(Almarwani & Alzahrani, 2023).** The study also explored that the majority of studied nurses hold a bachelor's degree. This distribution reflects global trends, where most nursing professionals possess undergraduate degrees, and fewer pursue advanced postgraduate education **(Alqahtani et al., 2020).**

Additionally, the findings showed that over three-quarters of studied nurses didn't participate in previous training programs about negative pressure wound therapy (NPWT) highlighting a significant gap in professional education and skill development within the nursing workforce. This lack of formal training can directly affect the quality of wound care provided, as NPWT is a specialized intervention requiring specific knowledge, technical skills, and ongoing practice to ensure safe and effective application **(Norman et al, 2022).** From the researcher's perspective, this gap can be attributed to several factors, including insufficient time to participate in educational sessions due to heavy workloads and a lack of motivation to pursue opportunities for acquiring new knowledge and skills.

Concerning nurses' knowledge regarding negative pressure wound therapy (NPWT), the current study explored that the nursing care protocol demonstrated a statistically significant improvement in nurses' knowledge, as over half of the studied nurses had poor knowledge levels before the protocol's application, which improved to be good for most of them after the protocol's application. This outcome emphasizes the effectiveness of nursing care protocol in bridging knowledge gaps and enhancing clinical competency. These results come in agree with **Catton et al., (2020)** who found that the nurses had inadequate knowledge before implementing the educational program about NPWT. Moreover, **Sheta (2020)** found highly significant differences between pre- and post-program implementation in the total mean score of nurses' knowledge regarding negative pressure wound therapy, as nurses' knowledge was improved significantly post-program implementation.

As regards nurses' practice related to negative pressure wound therapy (NPWT) dressing, the present study showed a statistically significant improvement in the studied nurses' practices following the application of the nursing care protocol compared to the fact that most of them had unsatisfactory levels before the nursing care protocol was applied. This could be attributed to the recent introduction of NPWT in the department, the increased workload faced by nurses, and the fact that NPWT dressing requires more specialized skills and knowledge compared to conventional wound dressing methods. This is confirmed by **Mohamed et al. (2019)** whose study results illustrated that there was an enhancement of nurses' practices about NPWT dressing after providing an educational program.

Furthermore, these findings are supported by **Mlambo et al. (2021)** who concluded that a continuous in-service training program for nurses is considered a very important concern that helps the professional nurse to know the new in the nursing science which enhances nursing practice. In addition, **Anh et al. (2024)** revealed that ongoing training not only reduces costs and enhances care quality for patients but also empowers nurses, boosting their competence and confidence in delivering effective care. This emphasizes the importance of continuous education and ongoing training programs to equip nurses with updated knowledge and skills for efficient and safe patient care.

Moreover, **Basuony et al. (2023)** identified a notable deficiency in nurses' knowledge and

practices related to surgical wound management before the implementation of a training program. However, their findings demonstrated a significant improvement in both knowledge and practice levels post-intervention. From the researchers' perspective, this gap can be attributed to the fact that negative pressure wound therapy (NPWT) remains a relatively new modality in wound care, and many nurses may have had limited exposure or formal training on its application during their initial education or professional practice. This highlights the need for structured training programs to ensure nurses are equipped with the necessary skills and knowledge to effectively implement NPWT in clinical settings that reflect on improving patients' clinical outcomes.

Regarding the main demographic data of the studied patients, the current study revealed that the majority of patients in the control and study groups were males aged fifty to sixty years. This agrees with **Sela et al. (2024)** who mentioned that the mean age of patients was fifty-six years, and the majority of the enrolled population were males. While **Abd El-gafour et al. (2021)** showed that less than half of the studied patients ranged between 50-60 years with a mean age of fifty-two years. This is commonly due to the increasing life expectancy and the higher incidence of cardiovascular diseases (CVDs) with advancing age. As individuals grow older, they face a significantly increased risk of developing CVDs, which often require surgical intervention.

Concerning the evaluation of levels of wound severity, there was a significant improvement in wound healing with minimal wound severity in the study group rather than the control group. This agrees with **Ibrahim & Allawy (2023)** who revealed that there was a statistically significant improvement in total wound status score in the post- and follow-up interventions compared with pre-intervention. Similarly, **Burhan et al. (2022)** emphasized that nursing care is crucial in the application of advanced treatments such as NPWT and proper implementation of NPWT dressing has demonstrated potential in improving microcirculation and accelerating the healing process. Professional nurses not only carry out the procedure processes but also provide thorough patient care. They provide a dual function, guiding patients regarding device care and troubleshooting, while simultaneously assessing the effectiveness of the treatment. Their expertise and meticulousness greatly enhance the effectiveness of NPWT, guaranteeing that patients receive optimal care and assistance during the healing process.

The study findings were also confirmed by **Ibrahim & Allawy (2023)** who demonstrated that the nurse intervention guidelines significantly improve the efficacy of NPWT by skillfully adjusting and modifying the vacuum settings to meet the specific needs of both the wound and the patient and the nurses play a vital role in proficiently managing NPWT equipment, ensuring its proper functioning, and regularly evaluating the wound site to maintain an optimal therapeutic environment. From the researchers' point of view, continuous integration of nursing proficiency in the application of NPWT dressing is essential for minimizing complications, optimizing therapeutic outcomes, and ensuring patient safety and comfort throughout the treatment process. In summary, the study highlights the importance of applying nursing care protocol regarding NPWT dressing to enhance nurses' knowledge and practice and improve clinical outcomes of cardiothoracic patients in terms of wound healing and reducing surgical site infection.

Conclusion

The present study concluded that applying nursing care protocol regarding negative pressure wound dressing demonstrated significant effectiveness in enhancing nurses' knowledge and practices. This improvement had a direct positive impact on the clinical outcomes of cardiothoracic surgery patients, particularly in reducing wound severity levels.

Recommendations

The current study recommended:

- Implementing standardized nursing care protocol for negative pressure wound dressing across all cardiothoracic surgery units to ensure consistency in patient care and improve clinical outcomes.
- Developing and maintaining continuous education and training programs for

nursing staff on NPWT techniques and wound assessment.

- Establishing a robust system for monitoring clinical outcomes related to NPWT, including infection rates, wound healing, and patient satisfaction.
- Encouraging further research to explore the long-term effects of NPWT on clinical outcomes in diverse patient populations and various types of wounds.

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