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NURSES' KNOWLEDGE OF NEGATIVE PRESSURE WOUND THERAPY FOR DEEP STERNAL WOUND INFECTIONS IN A TERTIARY CARDIAC CARE HOSPITAL

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Abstract

Background: Negative pressure wound therapy (NPWT) is an evidence-based technique used in managing complex wounds, particularly deep sternal wound infection (DSWI) following cardiac surgery. Although NPWT improves healing outcomes, its effectiveness depends largely on nurses' knowledge and clinical competence. Limited evidence exists regarding nurses' knowledge of NPWT in Pakistan, highlighting the need for assessment in tertiary care settings.

Research Objectives: To assess nurses' NPWT knowledge for DSWI management and associated demographic factors in a tertiary cardiac care hospital in Karachi, Pakistan.

Material and Methods: A descriptive cross-sectional study was conducted among 100 nurses working in the Operating Theater (OT), Surgical Intensive Care Unit (SICU), Surgical High Dependency Unit (SHDU), and surgical wards. Data were collected using a validated structured questionnaire consisting of demographic items and a 10-item NPWT knowledge scale (Cronbach's alpha = 0.92). Data were analyzed using SPSS version 22, applying descriptive and inferential statistics.

Results: Among the participants, 42% demonstrated poor knowledge, 35% had average knowledge, and 23% showed good knowledge of NPWT. No significant association was observed between NPWT knowledge levels, gender, or educational qualification. However, significant associations were found with working department, clinical experience with NPWT, and self-perceived knowledge ($p < 0.05$). None of the participants had received formal NPWT training.

Conclusion: Nurses' knowledge regarding NPWT for DSWI management was suboptimal. The findings highlight the need for structured NPWT training programs, increased clinical exposure, and integration of NPWT competency development into continuous professional development initiatives to improve nursing preparedness and support safe wound management practices.

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INTRODUCTION

Background of the Study: Negative pressure wound therapy (NPWT) is globally recognized as an evidence-based, first-line, contemporary intervention for the management of complicated and chronic wounds, as well as surgical site infections (SSIs) following surgery, and is supported by strong international clinical consensus. Precisely, NPWT is a non-invasive modality that promotes wound healing through the application of controlled negative pressure to the wound bed, facilitating granulation tissue formation, reducing edema, enhancing tissue perfusion, and promoting the removal of exudates and microbial contaminants.[1] Despite the routine implementation of standard SSI prevention strategies, such as prophylactic antibiotic administration, total body bacterial decolonization, and strict maintenance of a sterile surgical field, post-operative wound complications remain a major challenge, particularly following cardiac surgery.[2] Median sternotomy, commonly performed during open-heart surgery, carries a substantial risk of deep sternal wound infection (DSWI). DSWI is a severe and potentially life-threatening complication, with superficial and deep infections occurring in approximately 78% and 22% of cases, respectively. This condition is associated with increased morbidity, prolonged hospitalization, delayed recovery, higher healthcare costs, and significant emotional and financial burdens for patients. [2] In this context, NPWT has emerged as a novel and effective approach for post-operative incision management, particularly in high-risk cardiac surgical patients. It assists in approximating incision edges, reducing lateral tension, and providing an extended protective barrier against external contamination, thereby reducing the risk of sternal wound dehiscence (SWD) and infection. [3]

Furthermore, patients undergoing cardiac surgery often present with multiple risk factors that predispose them to impaired wound healing and DSWI, including advanced age, obesity, diabetes mellitus, smoking, immunosuppression, prior radiation therapy, and repeated surgical interventions. NPWT mitigates these risks by improving local tissue perfusion, minimizing ischemic necrosis, preventing hematoma and seroma formation, and supporting accelerated primary wound healing.

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Consequently, NPWT contributes to improved short- and long-term clinical outcomes in patients with sternal wounds following cardiac surgery. [4]

The physiological mechanisms underlying NPWT are multifactorial and synergistic. Macro deformation induced by sub-atmospheric pressure reduces wound dimensions and stabilizes the wound environment, while micro deformation generates controlled mechanical stress at the cellular level, stimulating cell proliferation, migration, angiogenesis, and differentiation. Simultaneously, NPWT effectively removes excess exudate, maintains an optimal wound microenvironment, and enhances tissue oxygenation and nutrient delivery. [5] Collectively, these mechanisms promote granulation tissue formation, reduce bacterial burden, lower infection risk, and optimize wound healing. In addition, NPWT often reduces the frequency of dressing changes compared to conventional wound care, with dressings typically replaced every five to seven days, thereby improving patient comfort and clinical efficiency. [5-6] Given the complexity of NPWT application and its critical role in managing DSWI following cardiac surgery, the successful translation of this therapy into clinical practice relies heavily on competent nursing care. Currently, NPWT is increasingly applied in contemporary healthcare settings to both open wounds and high-risk closed surgical incisions susceptible to SSIs, including post-sternotomy wounds, to prevent dehiscence, control edema, and enhance tissue healing. [6] Accordingly, assessing nurses' knowledge related to NPWT is essential for improving the quality of patient care, minimizing post-operative complications, and reinforcing NPWT's role as an evidence-based cornerstone in advanced wound management within tertiary cardiac care settings. [7-8]

METHODOLOGY

Study Design: This research employed a descriptive cross-sectional study design to assess nurses' knowledge regarding NPWT for DSWI in a tertiary cardiac care hospital. The study was conducted over three months, from May 8, 2025, to November 7, 2025. A cross-sectional approach was selected to assess nurses' existing knowledge levels and their association with selected demographic variables

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at a specific point in time without requiring longitudinal follow-up. This design is appropriate for evaluating knowledge levels and identifying factors associated with clinical practice in healthcare settings.

Ethical Considerations: Ethical principles were strictly followed throughout the research process. The study protocol received ethical approval from the Institutional Review Board (IRB), Reference No. IRB-40/2025, before data collection. Permission to conduct the study and collect data was obtained from the relevant authorities of the tertiary cardiac care hospital in Karachi, Pakistan. Written informed consent was obtained from all participating nurses after providing detailed information regarding the study objectives, procedures, potential benefits, and voluntary nature of participation. Participants were informed of their right to refuse to participate or withdraw from the study at any stage without consequences. Confidentiality and anonymity were ensured by maintaining secure data handling procedures and removing any personally identifiable information from the collected data. All research activities were conducted in accordance with ethical standards for human participant research.

Study Setting: The study was conducted at a tertiary cardiac care hospital in Karachi, Pakistan, a specialized healthcare facility providing advanced cardiovascular surgical and critical care services. The hospital manages a high volume of cardiac surgery patients. It includes specialized units such as the Operating Theater (OT), Surgical Intensive Care Unit (SICU), Surgical High Dependency Unit (HDU), and surgical wards. These clinical areas were selected as they involve nurses directly engaged in postoperative cardiac care, wound management, and the application and monitoring of NPWT for patients with DSWI. The setting provided an appropriate environment for assessing nurses' knowledge and identifying educational needs related to NPWT practice.

Participants: The study population consisted of registered nurses working in the OT, SICU, SHDU, and surgical wards of a tertiary cardiac care hospital in Karachi, Pakistan. A consecutive sampling technique was employed, whereby all eligible nurses available during the data collection period were

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recruited until the required sample size was achieved. A total of 100 nurses who provided informed consent were included in the study.

Inclusion criteria comprised registered nurses with at least one year of clinical experience in the selected departments and willingness to participate. Nurses who were on leave, unavailable during the data collection period, or who declined participation were excluded. The selected participants were appropriate due to their direct involvement in postoperative cardiac care, wound management, and NPWT-related clinical practices.

Variables: The primary variable of interest was nurses' knowledge of NPWT for DSWI. Knowledge was assessed using a validated structured questionnaire consisting of 10 NPWT-related items, with knowledge levels categorized as poor, average, and good. Demographic variables included gender, educational qualification, working department, clinical experience, and self-perceived knowledge regarding NPWT. These variables were analyzed to determine their association with nurses' knowledge levels and identify factors influencing NPWT-related clinical competency. The study also assessed participants' previous exposure to formal NPWT training and its potential relationship with knowledge outcomes.

Data Collection and Instrument: Data were collected using a structured self-administered questionnaire consisting of two sections. The first section included seven items assessing participants' demographic characteristics, wound care training, clinical experience with NPWT, and self-rated knowledge. The second section comprised a 10-item NPWT knowledge questionnaire developed by Przybek-Mita et al.[9] assessing nurses' knowledge regarding NPWT principles and practices. The instrument demonstrated excellent internal consistency (Cronbach's alpha = 0.92). [9] Data were analyzed to determine nurses' knowledge levels and their association with selected demographic and professional characteristics.

NPWT Knowledge Scoring System: Knowledge of NPWT was assessed using a 10-item Knowledge Questionnaire. Each item was rated on a 5-point Likert scale:

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Response Category	Score
Definitely disagree	1
I rather disagree	2
I have no opinion	3
I tend to agree	4
Definitely agree	5

The total score was calculated by summing responses across all items and converted into percentage scores for standardized interpretation.

Score Range	Knowledge Level
≥70%	Good Knowledge
60–69%	Average Knowledge
<60%	Poor Knowledge

Potential Bias and Limitations: Several potential biases were considered in this study. The use of consecutive sampling may introduce selection bias; however, all eligible nurses available during the data collection period were approached to minimize this risk. Self-reporting bias was possible, as participants' responses regarding NPWT knowledge and clinical experience may have been influenced by recall or social desirability. This was minimized by using an anonymous, structured, and validated questionnaire with clear instructions. Additionally, the study was conducted in a single tertiary cardiac care hospital, which may limit the generalizability of findings to other healthcare settings.

Sample Size Determination: Based on the study by Przybek-Mita et al.[9], in which 18.5% of nurses demonstrated high readiness to undertake controlled NPWT for chronic wound management, the sample size was calculated using a 95% confidence level and a 5% margin of error, yielding an initial

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estimate of $n = 232$. Considering the finite population of 143 nurses working in the selected departments, the sample size was adjusted using the finite population correction formula, resulting in a minimum required sample of 89 nurses. To account for potential non-response, the target sample size was increased to 100 nurses. The final sample met this requirement and provided adequate precision for assessing nurses' knowledge of NPWT for DSWI.

Attrition Rate: The calculated sample size was 89 nurses; however, 100 nurses were recruited to account for possible non-response or attrition. No participant withdrew from the study, and all 100 completed questionnaires were included in the final analysis, resulting in an attrition rate of 0%.

Quantitative Variables: Quantitative variables included the total NPWT knowledge score derived from the 10-item knowledge questionnaire (score range: 10–50) and participants' age measured as a continuous variable. Knowledge scores were analyzed as continuous variables for comparison of mean scores and were also categorized into three levels (poor, average, and good knowledge) for descriptive analysis. Demographic characteristics, including gender, educational qualification, working department, clinical experience, previous NPWT training, and self-perceived knowledge, were classified as categorical variables.

Data Analysis: Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 22. Descriptive statistics, including means, standard deviations, frequencies, and percentages, were calculated to summarize participants' characteristics and NPWT knowledge levels. Data normality was assessed using the Shapiro–Wilk test. Associations between categorical variables and knowledge categories were evaluated using the Chi-square test. A p-value of <0.05 was considered statistically significant.

RESULTS

Table 1 summarizes the demographic and professional characteristics and self-reported knowledge levels of the participants. A total of 100 nurses were included in the study, with a higher proportion of females (56%) compared with males (44%). Most participants had a BSN qualification (76%),

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while 24% held a diploma in nursing. Regarding clinical working areas, more than half of the participants were from the surgical intensive care unit (SICU) (53%), followed by the surgical ward (19%), operation theatre (OT) (17%), and surgical high dependency unit (SHDU) (11%). None of the participants reported receiving any formal training or specialist courses in wound treatment.

Regarding clinical experience with negative pressure wound therapy (NPWT), only 1% of participants reported independently applying NPWT dressings. Most participants reported assisting with NPWT application (42%), while 33% had only observed the procedure. Additionally, 24% reported having no experience with NPWT application.

Self-rated knowledge of general wound care (rated on a scale of 0–10) showed that most participants perceived their knowledge level as moderate to high. The highest proportion of participants selected a score of 8 (36%), followed by scores of 7 (21%) and 5 (16%). In contrast, self-rated knowledge regarding NPWT was lower, with responses mainly concentrated between scores of 4 and 6. The most frequently reported scores were 4 (23%), 5 (21%), and 6 (15%). Only a small proportion of participants rated their NPWT knowledge as 7 (9%) or 8 (4%), and none reported scores of 9 or 10.

Table 1: Distribution of Demographic Variables

Gender	
Male	44 (44%)
Female	56 (56%)
level of education	
BSN	76 (76%)
Diploma in nursing	24 (24%)
Working department	
OT	17 (17%)
Surgical ward	19 (19%)
SICU	53 (53%)

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SHDU	11 (11%)
Any training or specialist courses in wound treatment?	0 (0%)
Taking into account your independence and your own professional experience, please comment on the following statements	
I apply a negative pressure dressing myself	1 (1%)
I assist in applying a negative pressure dressing	42 (42%)
I am observing the application of a negative pressure dressing	33 (33%)
I have no experience in this aspect	24 (24%)
How would you rate your current knowledge of wound care (0 - 10)	
0	0 (0%)
1	0 (0%)
2	1 (1%)
3	2 (2%)
4	2 (2%)
5	16 (16%)
6	6 (6%)
7	21 (21%)
8	36 (36%)
9	12 (12%)
10	4 (4%)
How would you rate your current knowledge of wound treatment using NPWT? (0 - 10)	
0	3 (3%)
1	2 (2%)
2	11 (11%)

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3	12 (12%)
4	23 (23%)
5	21 (21%)
6	15 (15%)
7	9 (9%)
8	4 (4%)
9	0 (0%)
10	0 (0%)

Association of NPWT Knowledge Levels with Demographic Characteristics

Among the 100 participants, 42% demonstrated poor knowledge of NPWT, 35% had average knowledge, and 23% showed good knowledge. Knowledge levels were not significantly associated with gender ($p = 0.797$), with similar distributions observed among males and females. No significant association was observed between level of education and NPWT knowledge categories ($p = 0.373$). However, diploma-qualified nurses had a higher proportion of poor knowledge compared with BSN-qualified nurses (54.2% vs. 38.2%).

A significant association was observed between working department and NPWT knowledge levels ($p < 0.001$). Participants working in the OT demonstrated the highest proportion of good knowledge (64.7%), whereas all participants from the surgical ward were categorized as having poor knowledge. Among SICU participants, the majority demonstrated average knowledge (54.7%), while most SHDU participants had poor knowledge (90.9%).

The association between formal wound treatment training and NPWT knowledge levels could not be assessed because none of the participants reported receiving formal training or specialist courses in wound treatment.

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Clinical experience with NPWT was significantly associated with knowledge levels (p = 0.001). Participants who independently applied NPWT dressings demonstrated good knowledge (100%), whereas participants with no experience predominantly demonstrated poor knowledge (75%).

Self-rated general wound care knowledge was significantly associated with NPWT knowledge levels (p = 0.007). Participants with higher self-rated wound care knowledge scores tended to have higher NPWT knowledge categories. Similarly, self-rated NPWT knowledge scores showed a significant association with categorized NPWT knowledge levels (p < 0.001), with higher self-assessment scores corresponding to better knowledge categories.

Overall, working department, practical experience with NPWT, and self-perceived knowledge were significantly associated with NPWT knowledge levels.

Table 2: Association of NPWT Knowledge Scores with Demographic Variables

(NPWT Knowledge Levels)					
	Total	Poor knowledge	Average knowledge	Good knowledge	P-value
Total (N)	100	42	35	23	
Gender					
Male	44	20 (45.5%)	14 (31.8%)	10 (22.7%)	0.797
Female	56	22 (39.3%)	21 (37.5%)	13 (23.2%)	
level of education					
BSN	76	29 (38.2%)	28 (36.8%)	19 (25%)	0.373
Diploma in nursing	24	13 (54.2%)	7 (29.2%)	4 (16.7%)	
Working department					
OT	17	1 (5.9%)	5 (29.4%)	11 (64.7%)	<0.001

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Surgical ward	19	19 (100%)	0 (0%)	0 (0%)	
SICU	53	12 (22.6%)	29 (54.7%)	12 (22.6%)	
SHDU	11	10 (90.9%)	1 (9.1%)	0 (0%)	
Any training or specialist courses in wound treatment?					
No	100	42 (42%)	35 (35%)	23 (23%)	-
Yes	0	0 (0%)	0 (0%)	0 (0%)	
Taking into account your independence and your own professional experience, please comment on the following statements.					
I apply a negative pressure dressing myself	1	0 (0%)	0 (0%)	1 (100%)	0.001
I assist in applying a negative pressure dressing	42	13 (31%)	14 (33.3%)	15 (35.7%)	
I am observing the application of a negative-pressure dressing	33	11 (33.3%)	16 (48.5%)	6 (18.2%)	
I have no experience in this aspect	24	18 (75%)	5 (20.8%)	1 (4.2%)	

How would you rate your current knowledge of wound care (0 - 10)					
0	0	0 (0%)	0 (0%)	0 (0%)	0.007
1	0	0 (0%)	0 (0%)	0 (0%)	
2	1	1 (100%)	0 (0%)	0 (0%)	
3	2	2 (100%)	0 (0%)	0 (0%)	
4	2	1 (50%)	1 (50%)	0 (0%)	
5	16	9 (56.3%)	7 (43.8%)	0 (0%)	

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6	6	6 (100%)	0 (0%)	0 (0%)	
7	21	10 (47.6%)	8 (38.1%)	3 (14.3%)	
8	36	12 (33.3%)	11 (30.6%)	13 (36.1%)	
9	12	1 (8.3%)	5 (41.7%)	6 (50%)	
10	4	0 (0%)	3 (75%)	1 (25%)	
How would you rate your current knowledge of wound treatment using NPWT? (0 - 10)					
0	3	2 (66.7%)	1 (33.3%)	0 (0%)	
1	2	2 (100%)	0 (0%)	0 (0%)	
2	11	10 (90.9%)	1 (9.1%)	0 (0%)	
3	12	9 (75%)	3 (25%)	0 (0%)	
4	23	11 (47.8%)	8 (34.8%)	4 (17.4%)	
5	21	6 (28.6%)	11 (52.4%)	4 (19%)	<0.001
6	15	2 (13.3%)	4 (26.7%)	9 (60%)	
7	9	0 (0%)	5 (55.6%)	4 (44.4%)	
8	4	0 (0%)	2 (50%)	2 (50%)	
9	0	0 (0%)	0 (0%)	0 (0%)	
10	0	0 (0%)	0 (0%)	0 (0%)	

DISCUSSION

Nurses' Knowledge Levels Regarding NPWT: This study assessed nurses' knowledge of negative pressure wound therapy (NPWT) in a tertiary cardiac care setting. The findings demonstrated that a considerable proportion of nurses had poor (42%) or average (35%) knowledge levels, while only 23% demonstrated good knowledge. These findings are consistent with previous studies that have reported inadequate knowledge of NPWT among nurses. Sheta [10] reported insufficient knowledge among nurses regarding NPWT, while Omara et al. [11] and Nagat et al. [12] also identified persistent gaps in NPWT-related knowledge and clinical practice. These findings highlight the need for

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structured educational programs and competency-based training to improve nurses' preparedness in NPWT management.

Association of NPWT Knowledge Levels with Demographic Characteristics: The present study found no significant association between NPWT knowledge levels and gender or educational level. This finding is consistent with Kardyś et al. [13], who reported that demographic characteristics have limited influence on nurses' readiness and perceptions regarding NPWT and suggested that knowledge levels may be influenced more by clinical exposure and educational opportunities than by basic demographic characteristics.

A significant association was observed between the working department and NPWT knowledge levels. Nurses working in the OT demonstrated higher knowledge levels, whereas participants from the surgical ward and SHDU showed comparatively lower knowledge levels. This finding is supported by previous research reporting that clinical environment and exposure influence nurses' wound care competence.[14] Similarly, hands-on clinical practice and ward-based learning may enhance knowledge and performance related to NPWT. [15] Clinical experience with NPWT was significantly associated with knowledge levels in this study. Nurses who had independently applied NPWT dressings demonstrated higher levels of knowledge, whereas those without prior experience predominantly exhibited poor knowledge. These findings are consistent with previous research highlighting the importance of practical experience and structured training programs in enhancing nurses' knowledge and clinical practice related to NPWT.[16] These results underscore the critical role of experiential learning in developing competency in NPWT management. Furthermore, self-perceived knowledge of wound care and NPWT was significantly associated with NPWT knowledge levels. Participants with higher self-rated knowledge scores demonstrated better knowledge levels. This finding aligns with previous research, which reported that nurses with greater confidence and readiness may demonstrate improved understanding and application of NPWT. [17] However, self-perceived knowledge may not fully reflect clinical competency and should be interpreted alongside objective assessments of knowledge and skills.

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The absence of formal training among all participants may have contributed to the lower overall NPWT knowledge levels observed in this study. Previous studies have demonstrated that educational interventions improve nurses' knowledge and clinical practice related to wound management.[18-19] These studies reported significant improvements in nurses' knowledge following structured training programs. Therefore, implementing regular NPWT-focused education and competency-based training may address an important gap in professional development.

Limitations: Several limitations should be considered when interpreting the findings. The use of a single-center study design limits the generalizability of results to other healthcare settings and institutions with different wound care practices. The cross-sectional design provides an assessment of nurses' knowledge at a single point in time and does not allow causal conclusions regarding factors influencing NPWT competency. Although consecutive sampling was used, selection bias cannot be completely excluded. Additionally, knowledge assessment was based on a structured questionnaire, which may not fully reflect actual clinical performance or hands-on competency in NPWT application. The absence of participants with formal NPWT training limited the ability to evaluate the impact of educational interventions.

Strengths of the Study: This study provides important insight into nurses' knowledge of NPWT for DSWI management in a tertiary cardiac care setting, an area with limited evidence from Pakistan. The use of a validated knowledge assessment tool with excellent internal consistency (Cronbach's alpha = 0.92) strengthens the reliability of the findings. Inclusion of nurses from multiple clinical areas involved in cardiac surgical care, including OT, SICU, SHDU, and surgical wards, allowed assessment of knowledge across different practice environments. Furthermore, the study explored associations between knowledge levels and professional characteristics, including clinical exposure and self-perceived knowledge, providing valuable information for identifying educational needs and targeted interventions.

Recommendations: Regular, structured NPWT education and competency-based training programs should be incorporated into nursing professional development, particularly in cardiac surgical

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settings. Training should include both theoretical concepts and supervised practical sessions to improve nurses' confidence and clinical skills in NPWT application and monitoring. Hospitals should consider developing standardized NPWT protocols, simulation-based learning, and ongoing competency assessments to maintain safe clinical practice. Future multicenter studies involving larger samples and objective evaluation of clinical skills are recommended to further explore factors influencing NPWT competency among nurses.

CONCLUSION

This study demonstrated that nurses' knowledge regarding NPWT for DSWI management was suboptimal, with 42% of participants categorized as having poor knowledge. While demographic factors such as gender and educational qualification were not significantly associated with knowledge levels, working department, clinical experience, and self-perceived knowledge showed significant associations with NPWT knowledge. The absence of formal NPWT training among participants highlights an important educational gap. Implementation of structured NPWT training programs, enhanced clinical exposure, and integration of NPWT competency development into continuous professional development initiatives may improve nurses' preparedness and contribute to safer wound management and improved outcomes among cardiac surgical patients.

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