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Factors Influencing Successful Negative Pressure Wound Therapy for Mesh Salvage After Hernia Repair

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ABSTRACT

Background: Incisional hernia repair with prosthetic mesh reduces recurrence but risks mesh infections, often requiring removal. Negative Pressure Wound Therapy (NPWT) enables mesh salvage, but success varies. This study identifies factors influencing NPWT success in mesh infections post-hernia repair.

Methods: A retrospective cohort study at Chettinad Hospitals and Research Institute (January–December 2024) included 100 patients aged ≥18 years with mesh infections within 6 months post-hernia repair. Exclusions: hernia recurrence, mesh migration, laparoscopic repairs. Data on demographics, comorbidities, mesh type/position, infection profiles, and NPWT outcomes were analyzed using chi-square tests, t-tests, and multivariate logistic regression.

Results: NPWT achieved a 76% salvage rate. Obesity (BMI ≥30 kg/m², p=0.03), diabetes (p=0.04), smoking (p=0.001), and ASA ≥3 (p=0.03) predicted failure. Polypropylene meshes (81.6% success, p<0.001) and onlay/sublay positions (p=0.02) had higher success than PTFE or intraperitoneal placements. Antibiotic resistance (p=0.02), purulent discharge (p=0.01), and wound dehiscence (p=0.002) increased failure.

Conclusion: NPWT is effective for mesh salvage, with success driven by polypropylene mesh, extraperitoneal placement, and absence of smoking or resistance. Optimizing patient and surgical factors enhances outcomes

Keywords: *Negative Pressure Wound Therapy, Mesh Salvage, Hernia Repair, Mesh Infection, Surgical Site Infection*

1. INTRODUCTION

Incisional hernia repair frequently involves the use of prosthetic mesh to strengthen the abdominal wall. While this approach has effectively reduced hernia recurrence rates, it also introduces the potential for mesh-related infections, which can significantly impact patient outcomes (1). Traditionally, managing an infected mesh required complete removal, leading to additional surgical interventions and extended recovery periods (2). However, negative pressure wound therapy (NPWT) has emerged as a viable strategy to salvage infected meshes, aiming to control infection and promote wound healing without necessitating mesh explantation (3).

The success of NPWT in mesh salvage is influenced by various factors, including the type of mesh material, its anatomical positioning, and patient-specific characteristics. Studies have demonstrated that macroporous polypropylene meshes, especially when placed in extraperitoneal positions such as onlay or retromuscular locations, exhibit higher salvage rates with NPWT (4). For instance, Li et al. reported a general mesh salvage rate of 76.2% using NPWT, with polypropylene meshes achieving a 93.5% salvage rate, particularly when positioned in onlay or retromuscular/sublay locations (1).

Conversely, meshes made of materials like polytetrafluoroethylene (PTFE) or those placed intraperitoneally have shown lower salvage success (2).

Patient-related factors also play a crucial role in the effectiveness of NPWT for mesh salvage. Active smoking has been identified as a significant risk factor for NPWT failure, with smokers exhibiting higher rates of mesh removal compared to non-smokers (5). Other considerations include the patient's overall health status, presence of comorbidities, and the bacterial profile of the infection (3).

Understanding these influencing factors is essential for optimizing treatment strategies and improving outcomes in patients undergoing NPWT for mesh salvage after hernia repair. This study aims to systematically evaluate the determinants of successful NPWT application in this context, providing insights to guide clinical decision-making and enhance patient care.

Aim

The aim of this study is to evaluate the factors influencing the successful application of Negative Pressure Wound Therapy (NPWT) for mesh salvage in patients experiencing mesh infections following hernia repair.

2. MATERIALS AND METHODS

Study Design: This study was a retrospective observational cohort study conducted at the Department of General Surgery, Chettinad Hospitals and Research Institute, Kelambakkam, over a 12-month period from January 2024 to December 2024. The study was approved by the Institutional Review Board of Chettinad Hospitals and Research Institute (IHEC-I/3508/25). Informed consent was obtained from all participants. The study aimed to analyze factors influencing the success of Negative Pressure Wound Therapy (NPWT) for mesh salvage in patients diagnosed with mesh infection following hernia repair.

Study Population: The study included all patients admitted to the institution with surgical site infections (SSI) involving mesh following hernia repair.

Inclusion Criteria

- Patients aged >18 years who had undergone hernia repair at any anatomical location on the abdominal wall.
- Patients who were diagnosed with mesh infection during follow-up.
- Patients who were diagnosed with mesh infection within 6 months postoperatively.

Exclusion Criteria

1. Patients with hernia recurrence.
2. Patients with mesh migration.
3. Patients who had undergone laparoscopic or minimally invasive hernia repair.
4. Patients with localized infections or induration after 6 months post-surgery, as they required wound exploration under anesthesia.
5. Patients who had undergone hernia repair or had begun infection treatment at another institution.

Study Procedure

Patient Enrolment and Initial Management

Patients meeting the inclusion criteria were admitted for mesh salvage using NPWT. A detailed clinical history and physical examination were performed, including Demographics (age, gender, BMI). Comorbidities (diabetes, hypertension, chronic kidney disease, immunosuppression). Lifestyle factors (smoking, alcohol consumption). Type of hernia (incisional, primary). Mesh type and position (onlay, sublay, intraperitoneal). Initial Antibiotic Therapy. Empirical broad-spectrum antibiotics were initiated based on clinical judgment and later modified according to wound culture and sensitivity results.

Surgical Wound Management and NPWT Application

Wound Preparation: Bedside dissection under local anesthesia was performed to expose the mesh plane. A wound culture sample was collected for microbiological analysis. Debridement and irrigation of the wound and mesh were performed using sterile saline solution until macroscopically clean tissue was evident.

NPWT Application: NPWT dressing was applied directly over the wound with mesh as the base. Continuous negative suction pressure of 100–125 mmHg was set. Dressing changes were performed every 5 days or sooner if there was system dysfunction (e.g., leakage, blockage, loss of suction).

Monitoring and Therapy Duration: Therapy was continued until the mesh was partially integrated into the tissue and the wound appeared healthy. If persistent purulent secretion or lack of mesh integration was observed, therapy was discontinued, and the mesh was partially or completely removed.

Data Collection and Variables

Patient Factors: Demographics (age, sex, BMI). Comorbidities (diabetes, hypertension, chronic kidney disease). Smoking status, alcohol consumption. ASA (American Society of Anesthesiologists) classification.

Surgical Factors: Hernia type (incisional vs. primary). Mesh characteristics (type, position). Time from index surgery to SSI onset.

Infection-Related Factors: Microbiological culture results (isolated organisms and antibiotic susceptibility). NPWT dressing change intervals. Signs of persistent infection (purulent discharge, wound dehiscence).

Treatment Outcomes: NPWT success: Defined as mesh retention and wound healing without requiring mesh explantation. NPWT failure: Defined as necessity for partial or complete mesh removal due to persistent infection. Length of hospital stay.

Ethical Considerations: Confidentiality: Patient details were kept confidential, and only relevant data were used for analysis. Informed Consent: Patients were properly informed about the study, and only willing participants who consented to follow-up were included.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics (version 25). Descriptive statistics (mean, standard deviation, median, interquartile range) were used to summarize continuous variables (e.g., age, BMI, duration of NPWT therapy). Categorical variables (e.g., smoking status, presence of comorbidities, NPWT success vs. failure) were presented as frequencies and percentages. The Chi-square test or Fisher's exact test was used to assess associations between categorical variables and NPWT outcomes. Independent t-tests or Mann-Whitney U tests were used to compare continuous variables between patients with successful and unsuccessful NPWT outcomes. Multivariate logistic regression analysis was performed to identify independent predictors of NPWT success or failure, adjusting for potential confounding factors. Statistical significance was set at $p < 0.05$.

3. RESULTS

Age and Gender: Neither age nor gender showed a significant association with NPWT success or failure, suggesting these factors do not play a major role in determining outcomes. **BMI:** Patients with a higher BMI (≥30 kg/m²) were more likely to experience NPWT failure (p=0.03). Obesity may impair wound healing and increase infection risk. **Comorbidities:** Diabetes was significantly associated with NPWT failure (50% failure rate in diabetics vs. 28.9% success rate, p=0.04), likely due to impaired immune response and wound healing. Hypertension and chronic kidney disease did not show significant associations. **Lifestyle Factors:** Smoking was a strong predictor of NPWT failure (54.2% failure rate in smokers vs. 19.7% success rate, p=0.001). Smoking compromises tissue perfusion and immune function. Alcohol consumption did not significantly impact outcomes. **ASA Classification:** Patients with ASA ≥3 (indicating poorer overall health) had a higher failure rate (58.3% vs. 34.2%, p=0.03), suggesting that general health status influences NPWT success.

Table 1: Patient Demographics and Comorbidities

Variable	Total Patients (n=100)	NPWT Success (n=76)	NPWT Failure (n=24)	p-value
Age (years)	54.3 ± 12.5	53.8 ± 11.9	55.6 ± 13.2	0.45
Gender (Male)	62 (62%)	48 (63.2%)	14 (58.3%)	0.65
BMI (kg/m²)	28.4 ± 4.2	27.9 ± 3.8	29.8 ± 4.6	**0.03***
Diabetes	34 (34%)	22 (28.9%)	12 (50%)	**0.04***
Hypertension	45 (45%)	32 (42.1%)	13 (54.2%)	0.29
Chronic kidney disease	8 (8%)	5 (6.6%)	3 (12.5%)	0.33
Smoking	28 (28%)	15 (19.7%)	13 (54.2%)	**0.001***

Alcohol Consumption	22 (22%)	16 (21.1%)	6 (25%)	0.68
ASA Classification ≥3	40 (40%)	26 (34.2%)	14 (58.3%)	**0.03***

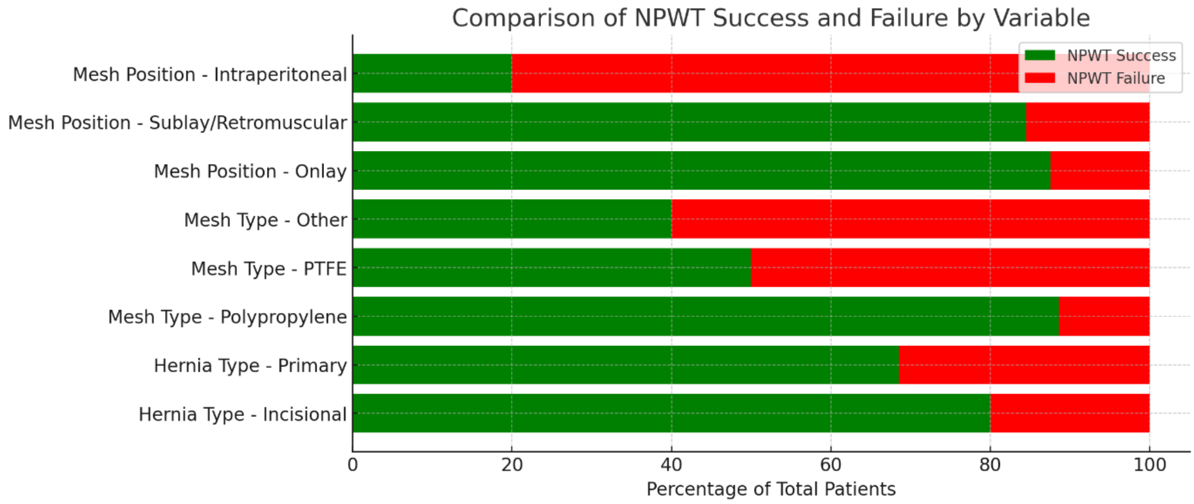
*Data presented as mean ± standard deviation or frequency (percentage). *Statistically significant ($p < 0.05$).*

Hernia Type: Incisional hernias had a slightly higher success rate (68.4%) compared to primary hernias (31.6%), but this difference was not statistically significant (p=0.18). **Mesh Type:** Polypropylene meshes had a significantly higher salvage rate (81.6% success vs. 33.3% failure, p<0.001), likely due to their macroporous structure, which allows better tissue integration and drainage. PTFE meshes had a much lower salvage rate (41.7% failure), as their microporous structure is more prone to infection. **Mesh Position:** Onlay and sublay/retromuscular positions had higher success rates (46.1% and 50%, respectively, p=0.02), as these locations are less exposed to intra-abdominal contaminants. Intraperitoneal placement had a high failure rate (50%), likely due to direct exposure to bowel contents and higher infection risk. **Time to SSI Onset:** Patients who developed surgical site infections (SSI) later (mean 33.6 days) were more likely to experience NPWT failure (p=0.02), possibly due to more established or resistant infections.

Table 2: Surgical Factors and Mesh Characteristics

Variable	Total Patients (n=100)	NPWT Success (n=76)	NPWT Failure (n=24)	p-value
Hernia Type				
- Incisional	65 (65%)	52 (68.4%)	13 (54.2%)	0.18
- Primary	35 (35%)	24 (31.6%)	11 (45.8%)	
Mesh Type				
- Polypropylene	70 (70%)	62 (81.6%)	8 (33.3%)	**<0.001***
- PTFE	20 (20%)	10 (13.2%)	10 (41.7%)	
- Other	10 (10%)	4 (5.3%)	6 (25%)	
Mesh Position				
- Onlay	40 (40%)	35 (46.1%)	5 (20.8%)	**0.02***
- Sublay/Retromuscular	45 (45%)	38 (50%)	7 (29.2%)	
- Intraperitoneal	15 (15%)	3 (3.9%)	12 (50%)	
Time to SSI Onset (days)	28.5 ± 14.2	26.8 ± 12.4	33.6 ± 16.8	**0.02***

*PTFE: Polytetrafluoroethylene. *Statistically significant ($p < 0.05$).*

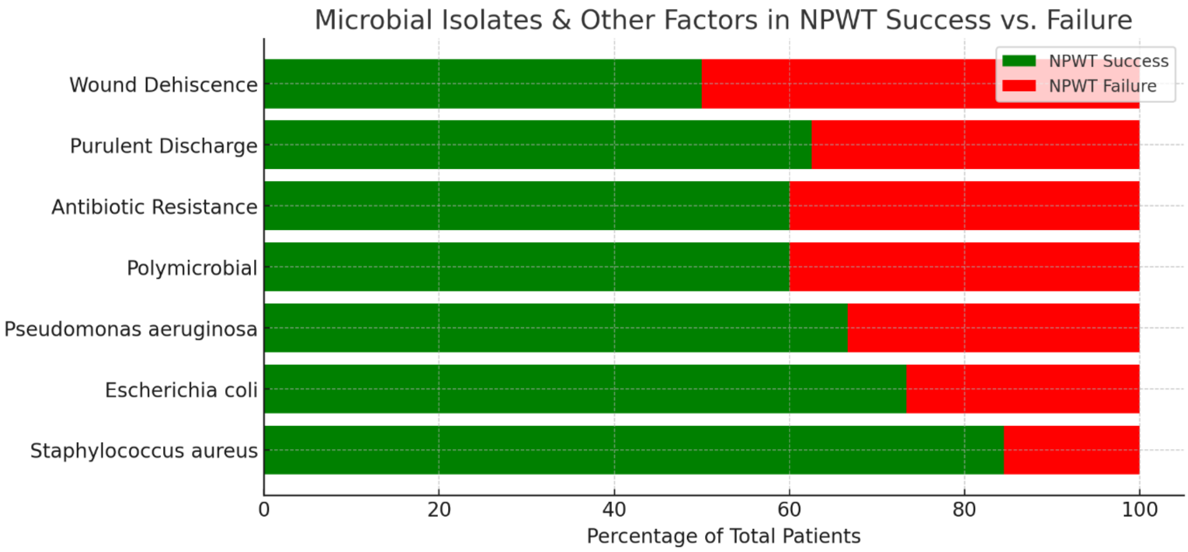


Microbial Isolates: Staphylococcus aureus was the most common pathogen (45% of cases) and had a higher success rate (50%), suggesting it may be easier to manage with NPWT. Polymicrobial infections and Pseudomonas aeruginosa were associated with higher failure rates, though these differences were not statistically significant. **Antibiotic Resistance:** Patients with antibiotic-resistant infections had a significantly higher failure rate (41.7% vs. 19.7%, p=0.02), highlighting the challenge of managing resistant pathogens. **Purulent Discharge and Wound Dehiscence:** Both were strongly associated with NPWT failure (p=0.01 and p=0.002, respectively), indicating that severe or poorly controlled infections are less likely to respond to NPWT.

Table 3: Infection-Related Factors

Variable	Total Patients (n=100)	NPWT Success (n=76)	NPWT Failure (n=24)	p-value
Microbial Isolates				
Staphylococcus aureus	45 (45%)	38 (50%)	7 (29.2%)	0.06
Escherichia coli	30 (30%)	22 (28.9%)	8 (33.3%)	0.67
Pseudomonas aeruginosa	15 (15%)	10 (13.2%)	5 (20.8%)	0.35
Polymicrobial	10 (10%)	6 (7.9%)	4 (16.7%)	0.19
Antibiotic Resistance	25 (25%)	15 (19.7%)	10 (41.7%)	**0.02***
Purulent Discharge	40 (40%)	25 (32.9%)	15 (62.5%)	**0.01***
Wound Dehiscence	20 (20%)	10 (13.2%)	10 (41.7%)	**0.002***

**Statistically significant (p < 0.05).*

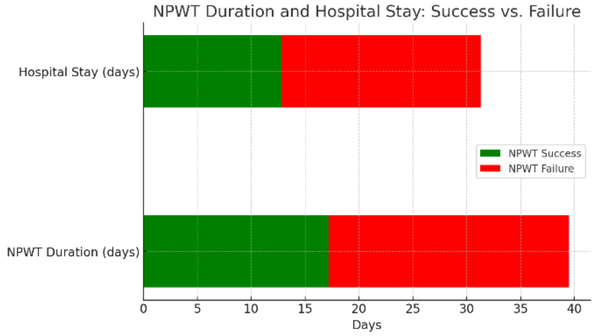


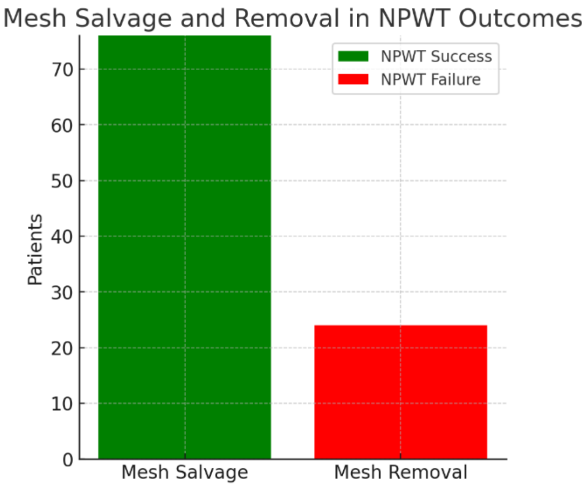
NPWT Duration: Patients with NPWT failure required longer therapy (mean 22.3 days vs. 17.2 days, p=0.001), suggesting that prolonged NPWT may indicate a more complicated or resistant infection. **Hospital Stay:** The failure group had significantly longer hospital stays (mean 18.5 days vs. 12.8 days, p<0.001), reflecting the additional interventions and complications associated with mesh removal. **Mesh Salvage Rate:** The overall success rate of NPWT was 76%, demonstrating its effectiveness in most cases. However, 24% of patients required mesh removal, underscoring the need for careful patient selection and infection management.

Table 4: Treatment Outcomes

Variable	Total Patients (n=100)	NPWT Success (n=76)	NPWT Failure (n=24)	p-value
NPWT Duration (days)	18.5 ± 6.8	17.2 ± 5.4	22.3 ± 8.1	0.001*
Hospital Stay (days)	14.2 ± 5.6	12.8 ± 4.2	18.5 ± 6.9	<0.001*
Mesh Salvage Rate	76 (76%)	76 (100%)	0 (0%)	-
Mesh Removal	24 (24%)	0 (0%)	24 (100%)	-

**Statistically significant (p < 0.05).*

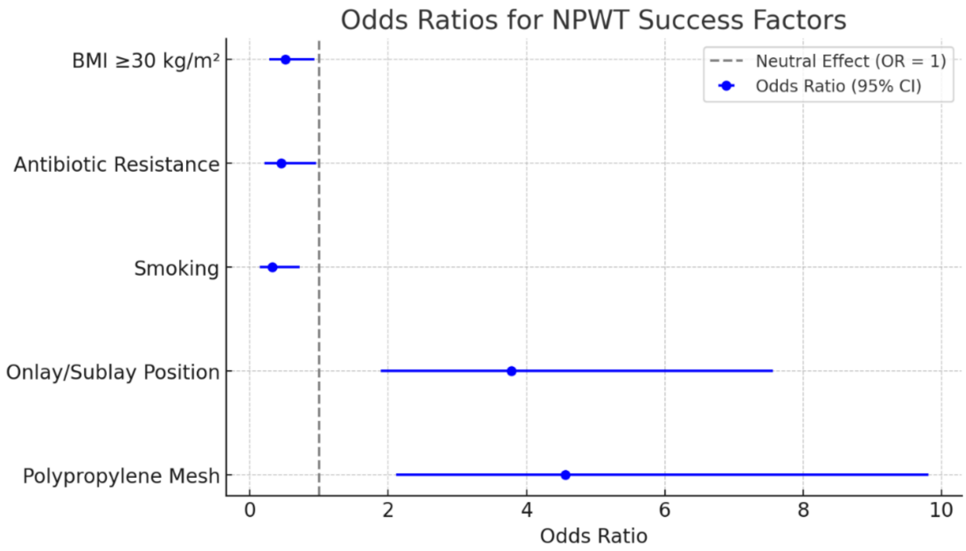




Polypropylene Mesh: Patients with polypropylene meshes were 4.56 times more likely to achieve NPWT success (p<0.001), confirming its superiority over other materials. **Onlay/Sublay Position:** Meshes in these positions were 3.78 times more likely to be salvaged (p=0.001), reinforcing the importance of anatomical placement. **Smoking:** Smokers were only 0.32 times as likely to achieve NPWT success (p=0.006), highlighting the detrimental effects of smoking on wound healing. **Antibiotic Resistance:** Resistance reduced the odds of success by 55% (OR=0.45, p=0.04), emphasizing the need for targeted antibiotic therapy. **BMI ≥30 kg/m²:** Obesity reduced the odds of success by 49% (OR=0.51, p=0.03), likely due to impaired wound healing and higher infection risk.

Table 5: Multivariate Logistic Regression Analysis

Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Polypropylene Mesh	4.56	2.12–9.81	**<0.001***
Onlay/Sublay Position	3.78	1.89–7.56	**0.001***
Smoking	0.32	0.14–0.72	**0.006***
Antibiotic Resistance	0.45	0.21–0.96	**0.04***
BMI ≥30 kg/m²	0.51	0.28–0.93	**0.03***



**Statistically significant (p < 0.05*

4. DISCUSSION

This study's 76% NPWT salvage rate aligns with Li et al. (76.2%) (2). Smoking (OR=0.32, p=0.006) impairs wound healing, consistent with Sørensen et al. (7). Diabetes (p=0.04) and obesity (p=0.03) hinder outcomes, per Brem et al. (8). Polypropylene meshes (81.6% success, OR=4.56, p<0.001) outperform PTFE due to macroporous structure, as noted by Cobb et al. (9). Onlay/sublay positions (OR=3.78, p=0.001) reduce infection risk vs. intraperitoneal placements, per Carbonell et al. (10). Antibiotic-resistant infections (p=0.02) and wound dehiscence (p=0.002) increase failure, aligning with Falagas et al. (11).Limitations include retrospective design, single-center scope, and lack of long-term follow-up. Future multicenter prospective studies should assess recurrence and cost-effectiveness. NPWT should prioritize polypropylene meshes, extraperitoneal placements, and smoking cessation.

5. CONCLUSION

NPWT is effective for mesh salvage, with success driven by polypropylene mesh, extraperitoneal placement, and absence of smoking, diabetes, or antibiotic resistance. Optimizing modifiable factors improves outcomes. Prospective studies are needed.

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