Effect of negative pressure wound therapy in exploratory laparotomies with coexisting ostomy

Avery C. Williams MD, Kripa Shrestha MBBS, MPH, MS, Alexis Cruz MD, Anastazia H. Gilman MD, MBA, Jonathan Huynh MD, Justin Vaughan MD, MS, Ariel P. Santos MD, MPH, FRCSC, FACS, FCCM

Abstract

Background: *Surgical site infection (SSI) is one of the most common healthcare-associated infections. The use of negative pressure wound therapy (NPWT) has decreased the overall rate of SSI, wound dehiscence, and length of hospital stay in surgical conditions. This study aims to determine the impact of NPWT applied to closed surgical incisions in patients with coexisting ostomies undergoing exploratory laparotomies.*

Methods: *A retrospective study of patients who underwent exploratory laparotomies between 2017 and 2019 was conducted. Negative pressure wound therapy was compared to standard post-operative surgical wound dressing. A sub-analysis of patients with ostomies was performed.*

Results: *A total of 286 patients who underwent exploratory laparotomies were identified; 51 patients received NPWT and 235 received standard dressing. The NPWT group had a higher percentage of patients with ostomies (37.3% vs. 20.4%, P = 0.016), of which 25.5% were colostomies (vs. 12.3%) and 11.8% were ileostomies (vs. 8.1%) with P = 0.002. No significant differences in the overall rate of SSI (7.8% vs. 5.5%, P = 0.517), wound dehiscence (7.8% vs. 2.1%, P = 0.57), and seroma formation (3.9% vs. 2.1%, P = 0.612) were observed. The mean length of ICU stays (3.5 vs. 7.0, P = 0.051) and the number of unplanned reoperation (5.9% vs. 16.6%, P = 0.051) were lower in the NPWT group compared to the control group. Sub-analysis of patients with stomas found no significant difference in SSI.*

Conclusions: *In our study, the use of NPWT on closed surgical incision wound was not associated with the reduction of SSI in patients with ostomies. Large studies are needed to determine significant benefits in these patients.*

Keywords: negative pressure wound therapy, surgical site infection, ostomy, exploratory laparotomy

Introduction

Surgical site infection (SSI) is one of the most common healthcare-associated infections and accounts for roughly $3.3 billion in attributable cost per year in acute care settings.[1] Patients who develop SSI will, on average, have 11 days added to their hospital stays.[1] These infections are associated with high morbidity along with a 30% postoperative mortality rate.[2] Surgical site infection is more common in colon and rectal surgery with increased rates of hospitalization and readmission.[3]

Prevention of SSI and its complications depends on patient factors, surgical factors, and environmental factors. A wide range of interventions with care bundles to limit SSI has been implemented. The United States Food and Drug Administration has cleared the

Corresponding author: Ariel P. Santos
Contact Information: Ariel.Santos@ttuhsc.edu
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use of prophylactic negative pressure wound therapy (NPWT) with closed portable, single-use battery power systems after wound closure at the time of surgery;[4] however, there is limited evidence that applying NPWT to a closed incision reduces SSI incidence. Negative pressure wound therapy is used to improve wound healing by acting as a barrier to contamination and removal of exudates from surgical wounds. Previous studies have shown that the use of NPWT decreases the rate of surgical site infections and hospital length of stay.[5–6] However, very limited studies have specifically observed these effects in patients with existing ostomies undergoing exploratory laparotomy. While the creation of an ostomy and its reversal have their own complications, including wound infections,[7] it is unknown if patients with ostomies are at greater risk for wound infections following exploratory laparotomy.

Our study will explore the effect of closed incision NPWT on the rate of surgical site infections and other clinical variables in patients with existing ostomies undergoing exploratory laparotomy.

Methods

A single-institution retrospective study was conducted under the approval of the Texas Tech University Health Sciences Center Institutional Review Board (IRB approval number: L20–180). All exploratory laparotomies were collected from March 2017 to March 2019. All patients received standard infection prevention measures like prophylactic antibiotics and standard skin aseptic techniques.

Data were collected by reviewing the medical records of patients. Patients with ages ≥18–89 years who underwent elective and emergency exploratory laparotomy between the aforementioned time frame were included. Patients under age 18 and above 90 years, prisoners, and pregnant women were excluded.

The patients with closed surgical incisions who received NPWT using Prevena™ (Kinetic Concepts, Inc, San Antonio, Texas) (Figure 1) were compared with patients receiving standard post-operative wound care (Gauze dressing). A sub-analysis of patients with ostomy undergoing exploratory laparotomy was performed. Demographic characteristics, comorbid conditions, American Society of Anesthesiologists (ASA) score, type of surgery (elective vs. emergency), type of wound, hospital stays, and outcome characteristics were analyzed.

All variables were analyzed using descriptive statistics (number, percentage, mean, and standard deviation). Data were analyzed by Chi-square tests if the number of observations was >5 or Fisher exact tests if the number of observations was ≤5 and by Wilcoxon Mann-Whitney U tests with significance set at $P < 0.05$. All analysis was performed using RStudio (Version 1.3.1073).

Results

A total of 388 patients who underwent exploratory laparotomy were identified; 102 patients were excluded when the wound was left open or when they received dressings other than NPWT and standard dressings (Appendix). Of the remaining 286 patients with closed surgical incision, 51 patients received

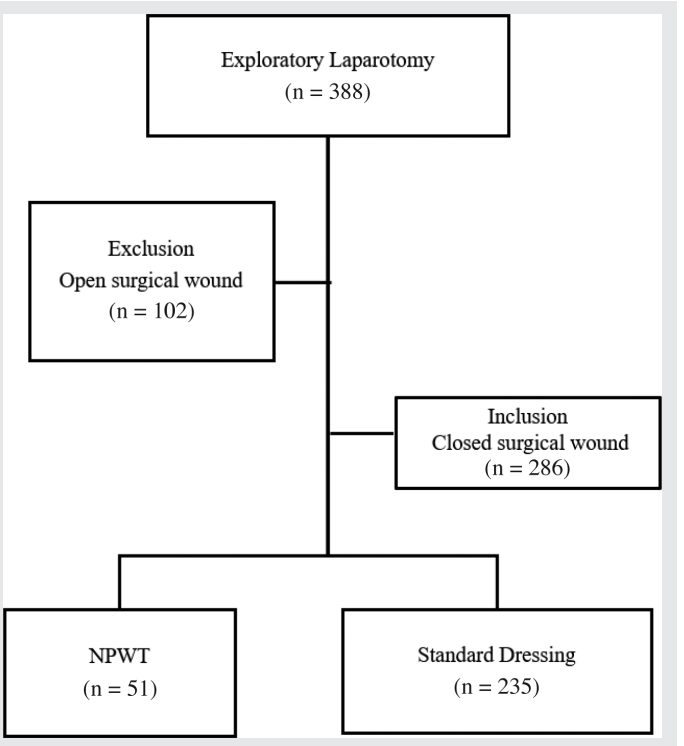

Figure 1. Flow chart: Illustration of study design.

Table 1. Demographic Characteristics and Comorbidities

Variable	NPWT (n = 51)	Standard (n = 235)	P-value
Age, Mean (SD)	64.84 (14.8)	64.2 (15.6)	0.907[a]
Sex, n (%)			0.765[b]
Male	18 (35.3)	91 (38.7)	
Female	33 (64.7)	144 (61.3)	
Race, n (%)			0.313[c]
White	41 (80.4)	195 (83.0)	
Black	2 (3.9)	18 (7.7)	
Others	8 (15.7)	22 (9.4)	
Ethnicity			0.018[b]
Non-Hispanic or Latino	34 (66.7)	194 (82.6)	
Hispanic or Latino	17 (33.3)	41 (17.4)	
BMI, n (%)			0.039[b]
Normal (<24.9)	8 (15.7)	79 (33.6)	
Overweight (>25–29.9)	16 (31.4)	62 (26.4)	
Obese (>30)	27 (52.9)	94 (40.0)	
Co-morbidities, n (%)			
HTN	39 (76.5)	153 (65.1)	0.161[b]
DM	17 (33.3)	56 (23.8)	0.217[b]
CKD	17 (33.3)	83 (35.3)	0.914[b]
ASA Score			0.436[b]
<3	31 (60.8)	159 (67.7)	
>3	20 (39.2)	76 (31.9)	
Type of surgery, n (%)			0.764[c]
General	47 (92.2)	219 (93.2)	
Colorectal	4 (7.8)	16 (6.8)	
Emergency surgery, n (%)	33 (64.7)	124 (52.8)	0.162[b]

[a]Mann-Whitney U test, [b]Chi-Square test, [c]Fisher Exact Test.
BMI, body mass index; HTN, hypertension; DM, diabetes mellitus; CKD, chronic kidney disease; ASA Score, American Society of Anesthesiology Score.

NPWT, and 235 received standard dressing. Patient ages ranged from 18 to 89 years with an average age of 64 years. Both groups had a female predominance. No significant difference was observed between groups in terms of age, sex, race, and comorbidities, in particular diabetes mellitus, hypertension, and chronic kidney disease. The NPWT group had significantly more obese patients with BMI >30 (52.9% vs 40.0%, P = 0.039). The ASA physical status classification system score was similar between the groups (Table 1).

A total of 157 patients underwent emergency surgery. No significant differences in wound type (P = 0.667), the overall rate of SSI (7.8% vs 5.5%, P = 0.517), wound dehiscence (7.8% vs 2.1%, P = 0.057), seroma formation (3.9% vs 2.1%, P = 0.612), and post-operative hematoma formation (2% vs 2.6%, P = 1.0) were observed (Table 2).

Table 2. Wound Types and Outcomes

Variable	NPWT (n = 51)	Standard (n = 235)	P-value
Wound class, n (%)			0.667[a]
Clean	10	35	
Clean-contaminated	22	120	
Contaminated	12	45	
Dirty/Infected	7	35	
Surgical site infection, n (%)	4 (7.8)	13 (5.5)	0.517[b]
Wound Dehiscence, n (%)	4 (7.8)	5 (2.1)	0.057[b]
Seroma formation, n (%)	2 (3.9)	5 (2.1)	0.612[b]
Postoperative hematoma, n (%)	1 (2.0)	6 (2.6)	1[b]

[a]Chi-Square test, [b]Fisher Exact Test.

Table 3. Hospital Outcome

Variable	NPWT (n = 51)	Standard (n = 235)	P-value
Length of stay (days), Mean (SD)	11.6 (8.7)	11.3 (9.5)	0.620[a]
ICU admissions, n (%)	22 (43.1)	112 (47.7)	0.665[b]
Length of ICU stay (days), Mean (SD)	3.5 (3.5)	7.0 (8.9)	**0.051[a]**
Readmission, n (%)	11 (21.6)	40 (17.0)	0.570[b]
Planned Reoperation, n (%)	0 (0)	4 (1.7)	1[c]
Unplanned Reoperation, n (%)	3 (5.9)	39 (16.6)	**0.051[c]**
Mortality, n (%)	2 (3.9)	32 (13.6)	**0.056[c]**

[a]Mann-Whitney U test, [b]Chi-square test, [c]Fisher Exact Test.
ICU, Intensive Care Unit.

No significant difference in mean length of hospital stays (11.6 days vs 11.3 days, P = 0.62) was observed. One hundred and thirty-four patients (46.8%) had ICU admission with the mean length of ICU stay (3.5 days vs. 7.0 days, P = 0.051). The planned reoperation was zero with NPWT, and the unplanned reoperation was lower in the NPWT group but not statistically significant (5.9% vs. 16.6%, P = 0.051) (Table 3).

A sub-analysis of patients with ostomies was done. Out of 286 cases of exploratory laparotomy, 67 patients had ostomies (42 colostomies and 25 ileostomies). The NPWT group had higher percentage of patients with ostomies (37.3% vs. 20.4%, P = 0.016), of whom 25.5% had colostomies (vs. 12.3%, P = 0.002) and 11.8% had ileostomies (vs. 8.1%, P = .002). Patients with colostomies were found to have high SSI rates in the NPWT group (15.3% vs. 3.4%, P = .222) whereas the patients with ileostomies were found to have higher SSI rates in standard dressing (0 vs 15.7, P = 0.553) (Table 4).

Discussion

Surgical site infection remains the most common complication following surgery. Exploratory laparotomy has a significantly high SSI rate along with those surgeries related to the colon and rectum. Patients with existing ostomies undergoing exploratory laparotomies have a high level of contamination, and thus the risk of developing SSI is even higher. Despite various practices preoperatively and intraoperatively to reduce SSI, the rate of SSI in these patient groups remains high.

Table 4. Stoma and SSI

Variable	NPWT (n = 51)	Standard (n = 235)	P-value
Stoma, n (%)	19 (37.3)	48 (20.4)	**0.016[a]**
Type of Stoma, n (%)			**0.002[a]**
Colostomy	13 (25.5)	29 (12.3)	
Ileostomy	6 (11.8)	19 (8.1)	
SSI			
Colostomy	2 (15.3)	1 (3.4)	0.222[b]
Ileostomy	0	3 (15.7)	0.553[b]
Mortality			
Colostomy	1	6	0.404[b]
Ileostomy	0	7	0.137[b]

[a]Chi-square test, [b]Fisher Exact Test.
SSI, Surgical Site Infection.

Negative pressure wound therapy has an important role in wound healing in different surgical scenarios. In cases of open surgical wounds, it provides cover and protection from external contamination and aids in reducing the size of wounds, promoting angiogenesis, and reducing edema, thereby promoting faster healing. In closed surgical wounds, in addition to providing cover to the incision area and protecting from external contamination, especially in presence of ostomies in which there is a higher chance of fecal spillage, NPWT dressing helps remove the exudate and promote granulation tissue formation, thus leading to early healing by primary intention.[8]

In this retrospective study, closed incision NPWT (Prevena^{TM}) was compared to our institution's standard surgical dressing (Gauze dressing). Prevena, compared to other NPWT, is composed of Granufoam and a non-adhering skin interface that provides continuous negative pressure of –125 mmHg for up to 7 days, helping to remove exudate and infectious debris.[4] The incidence of SSI was 6% (17 out of 286 patients) for the entire cohort of patients undergoing exploratory laparotomy, with no significant difference in rate of SSI between the two groups and no significant difference in wound dehiscence and seroma formation. A systematic review on NPWT to high-risk wounds showed no significant difference in rate of infection in abdominal wall reconstruction study, with inconsistent results on wound dehiscence and seroma formation.[9]

Subgroup analysis on patients with ostomies also showed no significant difference. Overall, SSI occurred in 10% (2 out of 19) of ostomy cases with NPWT dressing compared to 8.3% (4 out of 48) in standard dressing. Similar findings were observed in previous studies examining SSI outcomes comparing NPWT with a standard dressing. A study done by Webb and colleagues showed a significant increase in SSI in a patient undergoing colorectal surgery who received a colostomy and NPWT (iVAC) compared to standard dressing.[10] In one of the studies by Murphy and colleagues, no difference in SSI with NPWT compared to standard dressing in patients undergoing colorectal surgery with stool diversion was observed.[11] Hall et al. removed the ostomy wound from their analysis since those ostomy wounds are at the highest risk of SSI (5–40%).[13] A study performed in patients undergoing surgical reversal of double loop ileostomy observed a low infection rate, but this was not statistically significant,[13] as in our study in which no SSI was observed in patients with ileostomies. Moreover, there was no difference in mean length of hospital stay; Hall et al. found the mean length of stay between the groups was not significant. A study on colorectal cancer patients undergoing ileostomy reversal had a similar result in the length of stay.[14]

Our study demonstrated there was no difference in the rate of SSI in patients undergoing emergency or elective exploratory laparotomies with the application of NPWT to closed surgical incision compared to standard dressing, which is consistent with other studies.[3,11,15] Negative pressure wound therapy, if not preventative, adds extra cost to the overall care of surgical patients. The use of NPWT can potentially add $495 to the cost of the operation.[16] The presence of stoma is an independent risk for wound infection,[17] and our study demonstrated an increase in SSI rate in patients with colostomies on NPWT.

Our study is limited since it is a retrospective chart review study. Not all the variables could be assessed, such as indication to use NPWT, other risk factors for SSI, performance status at the time of surgery, and other important surgical details. Our study showed more NPWT was used in patients with ostomies, which was consistent with other studies.[3] There might have been bias in using the NPWT in patients with more potential to develop SSI. Also, the low number of patients with existing stomas in our study is another limiting factor in determining whether NPWT would be beneficial in these patients.

Therefore, it remains unclear whether application of NPWT to closed surgical incisions reduces the SSI in a high-risk patient with an existing ostomy undergoing exploratory laparotomy. The use of NPWT does not seem to be associated with the reduction of SSI in patients with exploratory laparotomy. No significant difference in SSI was observed in patients with existing ostomies; therefore, it is not possible to conclude that the use of NPWT even for closed surgical wounds in the presence of stomas is warranted. More studies with large numbers are needed to determine the significant benefit of NPWT in patients with ostomies.

Appendix. Application of negative pressure wound therapy (Prevena dressing) in a closed wound after exploratory laparotomy in a patient with ostomy.

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