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ORIGINAL ARTICLE

A Prospective comparative study of Incidence of early Suture site infection following incisional negative pressure wound therapy and Povidone-iodine dressing in a post-operative emergency non-traumatic exploratory laparotomy

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Abstract

Aims and Objectives: The study aimed to assess the efficacy of incisional negative pressure wound therapy (iNPWT) in reducing the risk of suture site infections (SSI) in patients undergoing post-operative emergency non-traumatic laparotomy.

Materials and Methods: A cross-sectional observational prospective study was conducted in a tertiary care setup in a rural area between March 2018 and July 2018. Fifty emergency exploratory laparotomies performed for non-traumatic reasons were included. Patients were randomized into two groups: one receiving conventional povidone-iodine dressing and the other receiving iNPWT over the main wound. After 7 days, SSI was assessed using the center for disease control and prevention's criteria.

Results: iNPWT demonstrated a significant reduction in the risk of SSI development when compared to conventional povidone-iodine dressing ($p < 0.001$) within a 95% confidence interval. The odds of SSI development with conventional povidone-iodine dressing were found to be 8.48 times higher compared to iNPWT. The 95% confidence interval for the odds ratio was 2.21-32.45.

Conclusion: Incisional negative pressure wound therapy is superior to conventional povidone-iodine dressing in preventing the onset of SSI in patients undergoing emergency laparotomy for non-traumatic conditions.

Keywords: incisional negative pressure wound therapy, Suture site infection, povidone-iodine dressings

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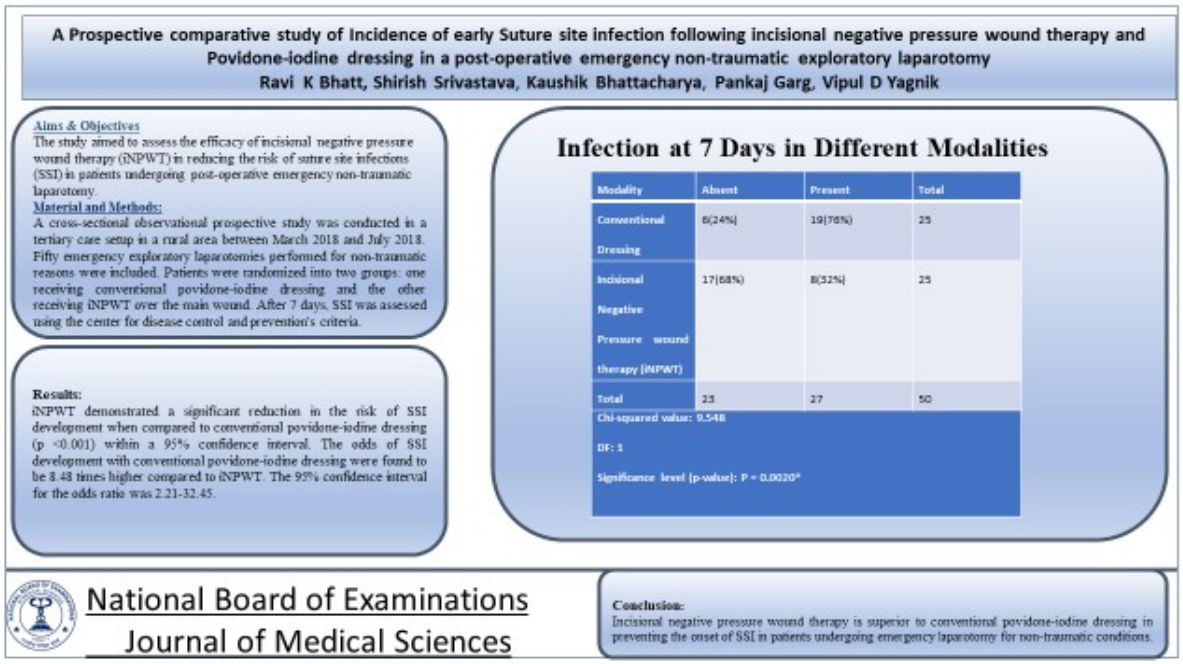
Graphical Abstract



Introduction

Suture site infection accounts for roughly 20% of hospital-acquired infections (HAIs), with reports ranging from 274,000 to 600,000 cases annually in the US [1]. High rates of SSI are reported for similar operations in the United States and other countries. The increasing complexity of SSI, especially those involving implanted materials or devices, often requires prolonged courses of antibiotics and additional surgery. Prolonged, frequent, and repetitive antibiotic use facilitates antibiotic resistance [2-4].Patients who undergo emergency laparotomies have a higher risk of SSI, wound dehiscence, pulmonary embolism, and renal failure. SSI significantly increases rates of ICU admission and readmission [5]. SSI carries a 29% risk of ICU admission. Readmission rates approach 41% in patients with SSI, compared to only 7.4% in non-infected patients. SSI also prolongs hospital stays, with average increases across specialties of 9.7 days [5], thereby increasing the cost to the patient.

In the past 15 years, there have been significant advances in complex acute and chronic wound management. One of the most significant discoveries was the improvement in wounds with negative pressure-assisted wound closure. With this technology, the surgeon now has additional options in addition to immediate closure of wounds (i.e., adjunctive therapy before or after surgery, or an alternative to surgery in the extremely ill). There have been reports of a decrease in hospital stays and cost with NPWT [6]. Clinical benefits of NPWT have been demonstrated in randomized controlled trials and case-control studies. These benefits include a decrease in wound volume or size, accelerated wound bed preparation, accelerated wound healing, an improved rate of graft take [7], decreased drainage time for acute wounds, reduction of complications, enhancement of the response to first-line treatment, increased patient survival, and decreased cost.

This study aims to study the effect of iNPWT in reducing the risk of the development of suture site infection in post-operative

emergency non-traumatic laparotomy cases. It compares the incidence of the development of SSI with conventional Povidone-iodine dressings and NPWT over the laparotomy incision. The study also assesses the wound for early signs of the development of SSI, which mainly include discharge, gape, erythema, and signs of local site infection at the end of 7 days.

Material and Methods

A cross-sectional observational prospective hospital-based study was conducted in the Department of Surgery at Shree Krishna Hospital of Pramukhswami Medical College, Karamsad. The study aimed to evaluate a new dressing modality for laparotomy wounds in emergency cases without traumatic causes and examine the early changes related to the development of SSIs. We collected data that includes age, sex, risk factors, operation types, post-operative wound status, and on which day the dressing was opened and discharged was present or absent. We also noticed the types of discharge.

During the study period from March 2018 to July 2018, a total of 50 emergency exploratory laparotomies were performed for non-traumatic causes. These cases were randomly allocated to receive either conventional beta-dine dressing (25 cases) or iNPWT (25 cases) on the main wound. We use custom-made Negative pressure wound dressing (Figure 1). In the group undergoing incisional negative pressure wound therapy (NPWT), the fascia is closed using 1-0 PolyDiaxanone Suture, followed by skin closure with 2-0 Nylon. For patients with stomas, the dressing is applied before the stoma matures. Routine preoperative antibiotic prophylaxis is given half an hour before surgery, and standard precautions are taken to avoid wound infection. The patients were able to move around the day after surgery. To facilitate their mobility, we removed the tube from the suction device and reconnected it when they returned to bed. After 7 days, the laparotomy wounds were assessed based on predefined criteria to identify early signs of suture site infection. The study recorded each case's risk factors and diagnosis to determine their impact on the development of SSIs in both treatment groups. The inclusion criteria for the study were as follows: Patients of all age groups who underwent emergency exploratory laparotomy for acute abdomen and cases of emergency non-traumatic laparotomy, regardless of the diagnosis. The following cases were excluded from the study: Exploratory laparotomy performed for blunt abdominal injuries to diagnose hemoperitoneum and manage solid organ injuries and elective exploratory laparotomy carried out for the definitive management of patients with intra-abdominal malignancies and those patients were wound kept open.

Ethical considerations were considered for the study. Ethical clearance was obtained from the Research Ethics Committee prior to conducting the research. Permission was also sought from the management of the hospital. Patients and their relatives or guardians were provided with information about the study's purpose. Since the study involved subjecting the patients to a new and unconventional dressing modality, separate consent was obtained from the guardians/relatives before the operation and from the patients themselves either preoperatively or postoperatively, once their general condition stabilized. The data collected during the study were entered into a data collection tool. The variables studied in the research included age, gender, risk factors, diagnosis, and evidence of surgical site infection in the laparotomy wound after 7 days of surgery. Data processing and analysis involved using descriptive analysis, correlation study, and regression analysis models to examine all the variables.

Results

Table 1. Infection at 7 Days in Different Modalities

Modality	Absent	Present	Total
Conventional Dressing	6(24%)	19(76%)	25
Incisional Negative Pressure wound therapy (iNPWT)	17(68%)	8(32%)	25
Total	**23**	**27**	**50**
Chi-squared value: 9.548 *DF: 1* *Significance level (p-value): P = 0.0020**			

Abbreviation: DF: Degree of freedom
P<0.05 (Significant value)

In the group of patients treated with conventional dressing, Wound infection was present in 76% of the patients, while in the group treated with incisional negative pressure wound therapy (iNPWT), wound infection was present in 32% of the patients. The difference between the two treatment modalities was statistically significant (P=0.0020) in favor of incisional negative pressure wound therapy (iNPWT).

Table 2. Table showing the diagnosis in each modality

Modality	Perforated Appendicitis	Ischemia	Obstruction	Peritonitis	
Conventional Dressing	2	2	7	14	*Chi-squared: 4.313* *DF: 4* *Significance level: P = 0.3652*
Incisional Negative Pressure Wound Therapy (iNPWT)	5	2	9	9	
Total	**7(14%)**	**4(8%)**	**16(32%)**	**23(46%)**	

DF: Degree of freedom
P<0.05(Significant value)

Table 2 shows the spectrum of the surgical conditions where most of them have a higher incidence of SSI. Neither of the groups had greater propensity to develop wound infection (p=0.3652).

Table 3. Risk factors Affecting Dressing Modalities

Modality	Absent	Present
Conventional Dressing	8	17
Incisional Negative Pressure	6	19

Wound Therapy (iNPWT)		
Total	14(28%)	36(72%)
Chi-squared: 0.389		
DF: 1		
*Significance level (P): 0.5329**		

DF:Degree of freedom
P<0.05(Significant value)

Table 3 depicts the Risk Factors of the patients in both the groups. The Risk Factors have contributed equally in both groups to the development of the wound infection (p=0.5329).

Thus, iNPWT decreases the incidence of SSI. The p Value is <0.001 which is statistically significant for 95% confidence interval, even by considering the effect of diagnosis and the risk factors affecting equally to both dressing modalities (Figure 1). During the 6-month follow-up, 4 patients in the conventional dressing group and 3 patients in the iNPWT group developed an Incisional hernia. However, the difference between the two groups was not statistically significant, with a p-value of 0.6318 (>0.05). Out of the total number of patients, 15 had a stoma. Among them, 8 patients in the conventional dressing group and 7 patients in the iNPWT group had a stoma.

The Odds Ratio of developing SSI is 8.48 higher with conventional povidone-iodine dressing as compared to iNPWT for 95% confidence interval (2.21-32.45).

Discussion

When negative pressure wound therapy is applied, it effectively creates a barrier between the wound and the hospital environment. This is particularly helpful in cases where there is a stoma, as previous research has shown that stomas are a risk factor for wound infections. Studies have also found that negative pressure wound therapy can improve tissue perfusion and vascularization underneath the dressing, which may increase oxygen delivery and immune cell transportation to the wound [8]. This can ultimately help reduce the incidence of infections. Additionally, negative pressure wound therapy can minimize shear forces that could disrupt the microscopic connections between wound edges during the healing process [9]. In addition to study done by Frazee R et al entitled Open vs Closed Negative Pressure Wound Therapy for Contaminated and Dirty Surgical Wounds found that Wound healing was significantly faster in contaminated and dirty wounds when managed with closed-NPWT [10].

Figure 1. Custom made negative suction wound dressing.

In this study, we conducted a comparative observational cross-sectional prospective trial with a sample size of 50 cases. of these, 25 subjects were randomly selected for conventional dressing postoperatively, and 25 were randomly allocated for iNPWT postoperatively. We found a statistically significant decrease in the incidence of suture site infection in cases who underwent iNPWT compared to those who underwent conventional povidone-iodine dressing (p-value < 0.001). Additionally, we observed that the odds ratio of developing surgical site infection (SSI) was 8.48 times higher with conventional povidone-iodine dressing compared to iNPWT, with a 95% confidence interval of 2.21 to 32.45.The results of the study indicated that the incidence of wound infection at 7 days was significantly lower in the iNPWT group (32%) compared to the conventional dressing group (76%) (p = 0.0020, Table 1). Furthermore, the analysis of the spectrum showed no significant difference between the two modalities in terms of the propensity to develop wound infection (p = 0.3652, Table 2). Regarding the risk factors affecting each modality, the study found that the risk factors contributed equally to the development of wound infection in both groups (p = 0.5329, Table 3). This suggests that dressing modality does not influence the impact of risk factors on SSI.

Considering the above findings, iNPWT emerges as a more practical option for reducing the incidence of SSI in emergency non-traumatic laparotomy procedures. The statistically significant difference in wound infection rates and the absence of significant differences in surgical diagnoses and risk factors support the preference for iNPWT over conventional povidone-iodine dressing. A single-center randomized controlled trial performed by Javed AA et al. also showed that SSI occurred in 9.7% of patients in the iNPWT group and 31.1% of patients in the standard closure group (relative risk = 0.31; 95% confidence interval, 0.13–0.73; P = 0.003) [11]. They found that iNPWT is associated with a significant reduction in surgical site infection. Another recent study by Piroski V et al. on general surgery patients also noted good results with prophylactic iNPWT [12].

A systematic review and meta-analysis on NPWT in open fractures revealed

that NPWT significantly reduces the risk of infection, wound coverage time, wound healing time, and hospital stay length compared to conventional wound dressings [13,14].

It's worth noting that there is only one Indian study about NPWT in non-traumatic emergency laparotomy wounds performed by Arun Garg et al. The study's results indicated that closed incision NPWT did not provide significant advantages over conventional dressing regarding postoperative complications and hospital stay. However, it significantly reduced the frequency of dressing changes, which reduced the mental stress of the patients and the burden of daily dressing changes [15]. This is the second Indian study about iNPWT in non-traumatic emergency laparotomy wounds, and the findings favors iNPWT compared to the first Indian study. Four patients from the conventional dressing group and three from the iNPWT group developed an Incisional hernia on a six-month follow-up. The difference was not statistically significant with a p-value of 0.6318 (>0.05). No patients developed wound dehiscence. The main strength of the study is: This study revealed that iNPWT exhibited a much better outcome compared to conventional povidone-iodine dressing in decreasing the incidence of surgical site infections (SSI) and despite the equal contribution of the risk factors and the diagnosis to both treatment modalities, the role of iNPWT in decreasing SSI is significant. The limitation of the study is on analysis (logistic regression), the impact of iNPWT is 18%; hence, there are definitely other factors influencing the outcome that have not been included in this study. However, in this study, their contribution was similar in both modalities.

Conclusion

iNPWT demonstrates clear advantages over conventional povidone-iodine dressing in emergency non-traumatic laparotomy. iNPWT significantly reduces the incidence of surgical site infections and offers potential benefits in terms of improved wound healing. Therefore, considering the observed benefits, iNPWT should be regarded as a preferred wound management modality in non-traumatic emergency laparotomy procedures. Further study in the form of randomized controlled trial may be helpful to identify patient populations who would have the greatest benefit from this technique.

Ethics approval, Consent to participate, Consent to publish, Availability of data and material, Code availability

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of the Pramukhswami medical college. Informed consent was taken from all the patients. Data will be available from corresponding author on demand.

Conflicts of interest: Nil

Financial disclosure: Nil

References

1. Blackham AU, Farrah JP, McCoy TP, Schmidt BS, Shen P. Prevention of surgical site infections in high-risk patients with laparotomy incisions using negative-pressure therapy. Am J Surg. 2013 Jun;205(6):647-54. doi: 10.1016/j.amjsurg.2012.06.007.
2. Evans HL, Sawyer RG. Preventing bacterial resistance in surgical patients. Surg Clin North Am. 2009 Apr;89(2):501-19, x. doi: 10.1016/j.suc.2008.09.011.
3. Falagas ME, Alexiou VG, Peppas G, Makris GC. Do changes in antimicrobial resistance necessitate reconsideration of surgical antimicrobial prophylaxis strate-

gies? Surg Infect (Larchmt). 2009 Dec;10(6):557-62. doi: 10.1089/sur.2008.105.

4. Fry, D.E., The continued challenge of Staphylococcus aureus in the surgical patient. Am Surg, 2013. 79(1): p. 1-10.
5. de Lissovoy G, Fraeman K, Hutchins V, Murphy D, Song D, Vaughn BB. Surgical site infection: incidence and impact on hospital utilization and treatment costs. Am J Infect Control. 2009 Jun;37(5):387-397. doi: 10.1016/j.ajic.2008.12.010.
6. Adjepong D, Malik BH. Clinical Applications and Benefits of Using Closed-incision Negative Pressure Therapy with Novel Dressing: A Review Article. Cureus. 2020 Feb 6;12(2):e6902. doi: 10.7759/cureus.6902.
7. Argenta LC, Morykwas MJ. Vacuum-assisted closure: a new method for wound control and treatment: clinical experience. Ann Plast Surg. 1997 Jun;38(6):563-76; discussion 577.
8. Wackenfors A, Gustafsson R, Sjögren J, Algotsson L, Ingemansson R, Malmsjö M. Blood flow responses in the peristernal thoracic wall during vacuum-assisted closure therapy. Ann Thorac Surg. 2005;79:1724–1730.
9. Bonds, Allison M. M.D.; Novick, Tessa K. B.A., L.M.S.W.; Dietert, Jessica B. B.S.; Araghizadeh, Farshid Y. M.D.; Olson, Craig H. M.D. Incisional Negative Pressure Wound Therapy Significantly Reduces Surgical Site Infection in Open Colorectal Surgery. Diseases of the Colon & Rectum 56(12):p 1403-1408, December 2013. DOI: 10.1097/DCR.0b013e3182a39959
10. Frazee R, Manning A, Abernathy S, Isbell C, Isbell T, Kurek S, Regner J, Smith R, Papaconstantinou H. Open vs Closed Negative Pressure Wound Therapy for Contaminated and Dirty Surgical Wounds: A Prospective Randomized Comparison. J Am Coll Surg. 2018 Apr;226(4):507-512. doi: 10.1016/j.jamcollsurg.2017.12.008.
11. Javed AA, Teinor J, Wright M, Ding D, Burkhart RA, Hundt J, Cameron JL, Makary MA, He J, Eckhauser FE, Wolfgang CL, Weiss MJ. Negative Pressure Wound Therapy for Surgical-site Infections: A Randomized Trial. Ann Surg. 2019 Jun;269(6):1034-1040. doi: 10.1097/SLA.0000000000003056.
12. Piroski V, Müller E, Herrmann E, Hanisch E, Buia A. Reducing Surgical Site Infection by Prophylactic Negative Pressure Wound Therapy in a Cohort of General Surgery Patients. Visc Med. 2022 Aug;38(4):272-281. doi: 10.1159/000520464.
13. Liu X, Zhang H, Cen S, Huang F. Negative pressure wound therapy versus conventional wound dressings in treatment of open fractures: A systematic review and meta-analysis. Int J Surg. 2018 May;53:72-79. doi: 10.1016/j.ijsu.2018.02.064.
14. Saunders C, Nherera LM, Horner A, Trueman P. Single-use negative-pressure wound therapy versus conventional dressings for closed surgical incisions: systematic literature review and meta-analysis. BJS Open. 2021 Jan 8;5(1):zraa003. doi: 10.1093/bjsopen/zraa003.
15. Garg A, Jayant S, Gupta AK, Bansal LK, Wani A, Chaudhary P. Comparison of closed incision negative pressure wound therapy with conventional dressing for reducing wound complications in emergency laparotomy. Pol Przegl Chir. 2021 Jun 25;93(5):1-5. doi: 10.5604/01.3001.0014.9759.