

Outcome of Negative Pressure Wound Therapy for Burst Abdomen

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ABSTRACT

Background: Negative pressure wound therapy (NPWT) promotes wound healing and enhances the prognosis of difficult wounds by draining the leaking fluids from the wound, assisting in boosting blood supply, enhancing the creation of granulation tissue, and improving the approximation of the wound margins. Numerous acute and chronic wounds, including those with infections, necrotizing fasciitis, and burst abdomens with or without intestinal fistula were managed with the NPWT system.

Objective: This study aimed to evaluate the effectiveness of negative pressure wound care in cases of ruptured abdomens, the length of time it took for the wound to fully heal, as well as the morbidity and death rates up until the wound was fully healed. **Methods:** This retrospective study examined seventeen individuals who had negative pressure wound therapy for burst abdomen. The gathered operative information included the indication of the primary surgery, intra-operative findings, the length of the operation, the surgical technique, the manner of wound closure, and any measurements of intra-abdominal pressure.

Results: The present study illustrated that the mean total days of vacuum assisted closure (VAC) application was 30.53 ± 4.47. It was found that 17.6% of them being transferred to ICU and another 17.6% experiencing a complication like fistula. The outcome was reported as good granulation tissue in 5.9% of patients, success with secondary sutures in 76.5% of patients, ileostomy in 5.9% of patients, and colostomy in 11.8% of patients.

Conclusion: In the treatment of ruptured abdomen, NPWT plays a significant role in the high rate of fascial closure and relatively low rate of complications.

Keywords: Negative pressure wound therapy, Burst abdomen, Large pfannenstiel, Paraumbilical hernia.

INTRODUCTION

The term "open abdomen" describes a weakness in the abdominal wall that allows the viscera to protrude. The most common justification for an open abdomen is damage control surgery related to trauma and abdominal compartment syndrome [1]. Laparostomy, a procedure in which the abdomen is purposefully left open while the visceroperitoneal contents are temporarily protected by a variety of technical ways, is a crucial part of the idea of "Damage control surgery." [2].

Early in the 1980s, Duff and Moffat introduced the open abdomen approach as an extreme remedy for acute abdominal sepsis, with a death rate of 39% regarded tolerable in comparison with the eventual primary closure of the abdominal wall [3]. When there is insufficient management of the primary source, there is severe intestinal oedema, or a second opinion is required, the open abdomen approach is still useful [4].

An open abdomen exposes the viscera and causes fluid and heat loss, which can be minimized by using graft coverage of the exposed viscera or temporary abdominal closure until the abdomen can be functionally or mainly closed [5].

Negative pressure wound therapy using the VAC is one of the most important methods of treatment in today's wound management. VAC has been used in numerous articles to treat a variety of wound types, including soft tissue injuries before surgical closure [6].

The VAC was developed to address a few problems with traditional techniques for creating negative pressure. The fundamental component of the system is

a microprocessor-controlled vacuum machine that can deliver sub-atmospheric pressure continuously or sporadically [7]. Although NPWT has been demonstrated to be a successful way in the treatment of injuries, procedures for temporary abdominal closure using negative pressure dressings are currently gaining popularity. However, the outcomes in the treatment of diffuse peritonitis are contradictory [8].

This study was conducted for evaluation of the effectiveness of NPW care in cases of ruptured abdomens, the length of time it took for the wound to fully heal, as well as the morbidity and death rates up until the wound was fully healed.

PATIENTS AND METHODS

This retrospective analysis was conducted in Mansoura University Hospital. Data from patients with burst abdomens treated with NPWT between August 2019 and August 2022 were obtained retrospectively.

Inclusion criteria: Patients who experienced a burst abdomen following any abdominal surgery during the study period.

Exclusion criteria: Patients whose wounds were treated with techniques other than negative pressure wound management.

Data collection: We collected data included demographic data in form of age, sex and BMI. Medical and surgical history were also documented. Operative data included indication of primary surgery, intra-operative finding, operative time, surgical technique,

method of wound closure and intra-abdominal pressure if measured. While, postoperative data included if there was any ICU admission, finding of intra-abdominal collection, the time burst abdomen occurred and laboratory investigation for inflammatory markers. We assessed the complications as presence of wound infection, bleeding, pulmonary problems, and/or organ failure. We also documented the time of VAC application, the time till complete healing and post-VAC outcome.

Ethical considerations: The Medical Research Ethics Committee, Faculty of Medicine, Mansoura University submitted the study protocol for approval. After ensuring confidentiality, each participant in the study gave an informed written consent. Helsinki Declaration was followed throughout the study's conduct.

Statistical analysis

There were no specialized grants awarded for the current investigation. Data were entered into the computer and analyzed using the IBM SPSS software package, version 25.0. To describe qualitative data, number and percentage were utilized, and Fisher's Exact test was applied to variables with low expected numbers. The Kolmogorov-Smirnov test was used to determine whether the distribution was normal. Quantitative data were described using the range (min and max), mean ± standard deviation, median, and interquartile range (IQR). The results significance was established at a level of 5%.

RESULTS

17 patients with burst abdomen treated with NPWT between August 2019 and August 2022 at Mansoura University Hospital were the subjects of this retrospective investigation. Figures (1-6) represented 3 cases before and after applying of NPWT. The demographics of seventeen people sample size for the study participants are shown in table (1). The patients had a mean age of 47.18 ± 8.87 years old with IQR of 46 to 55 years and the median age was 48 years, with eight (47.1%) men and nine (52.9%) women. In terms of comorbidities, 16 patients (94.1%) had DM and twelve patients (70.6%) had HTN.

Table (1): Demographics of the study patients

Variables		Patients (n = 17)	
Age			
Mean ± SD.		47.18 ± 8.87	
Median (IQR)		48.00 (46.00-55.00)	
		N	%
Sex	Male	eight	47.1%
	Female	nine	52.9%
Comorbidities	HTN	twelve	70.6%
	DM	sixteen	94.1%

Table (2) summarized the diagnosis of the studied patients, which provided critical information about the nature and severity of their medical conditions.

The results showed that the most common diagnosis among the study patients was large pfannenstiel and paraumbilical hernia, with a prevalence of 17.6% each. Intestinal obstruction and sigmoid volvulus were also prevalent, with a frequency of 17.6% each. Acute abdomen, large midline incision, necrosis of wound, and road traffic accident (RTA) were less common, with a prevalence of 11.8% and 5.9% respectively.

Table (2): Diagnosis patients in the study

Variables	Patients (n = 17)	
	N	%
Para umbilical hernia	3	17.6%
Acute abdomen	2	11.8%
Intestinal obstruction	3	17.6%
Large midline incision	2	11.8%
Large pfannenstiel	3	17.6%
Necrosis of wound	1	5.9%
Sigmoid volvulus	2	11.8%
RTA	1	5.9%

Table (3) showed the types of operations performed in the study patients.

A total of seventeen patients were included in the study, with most patients undergoing open hernia repair (47.1%) or exploration laparotomy (35.3%). One patient underwent hernia repair and abdominoplasty, while two patients had more complex procedures including exploration laparotomy with left side colostomy or amputation of the left leg above the knee.

Table (3): Types of operation in the study patients

Variables	Patients (n = 17)	
	N	%
Open hernia repair	8	47.1%
Exploration laparotomy	6	35.3%
Hernia repair and abdominoplasty	1	5.9%
Exploration laparotomy + left side colostomy	1	5.9%
Exploration laparotomy + above knee amputation of left side	1	5.9%

Table (4) showed that the study included 17 patients who underwent vacuum-assisted closure (VAC) application, and the mean total days of VAC application was 30.53 ± 4.47, with a median of 30.00 (interquartile range: 28.00-35.00).

Table (4): Total Days of Vac Application in the study patients.

Variables	Patients (n = 17)
Total Days of Vac Application	
Mean ± SD.	30.53 ±4.47
Median (IQR)	30.00 (28.00-35.00)

Table (5) showed that the study evaluated the complications and outcomes in 17 patients, with 17.6% of them being transferred by ICU and another 17.6% experiencing a complication like fistula.

The outcome was reported as good granulation tissue in 5.9% of patients, success with secondary sutures in 76.5%, ileostomy in 5.9% and colostomy in 11.8% of patients.

ILLUSTRATED CASES

Table (5): Complications and outcome in the study patients

Variables		Patients (n = 17)	
		N	%
Transferred By ICU		3	17.6%
Complication Like Fistula		3	17.6%
Outcome Success or Failure	Good granulation tissue	1	5.9%
	Success with secondary sutures	13	76.5%
	Ileostomy	1	5.9%
	Colostomy	2	11.8%

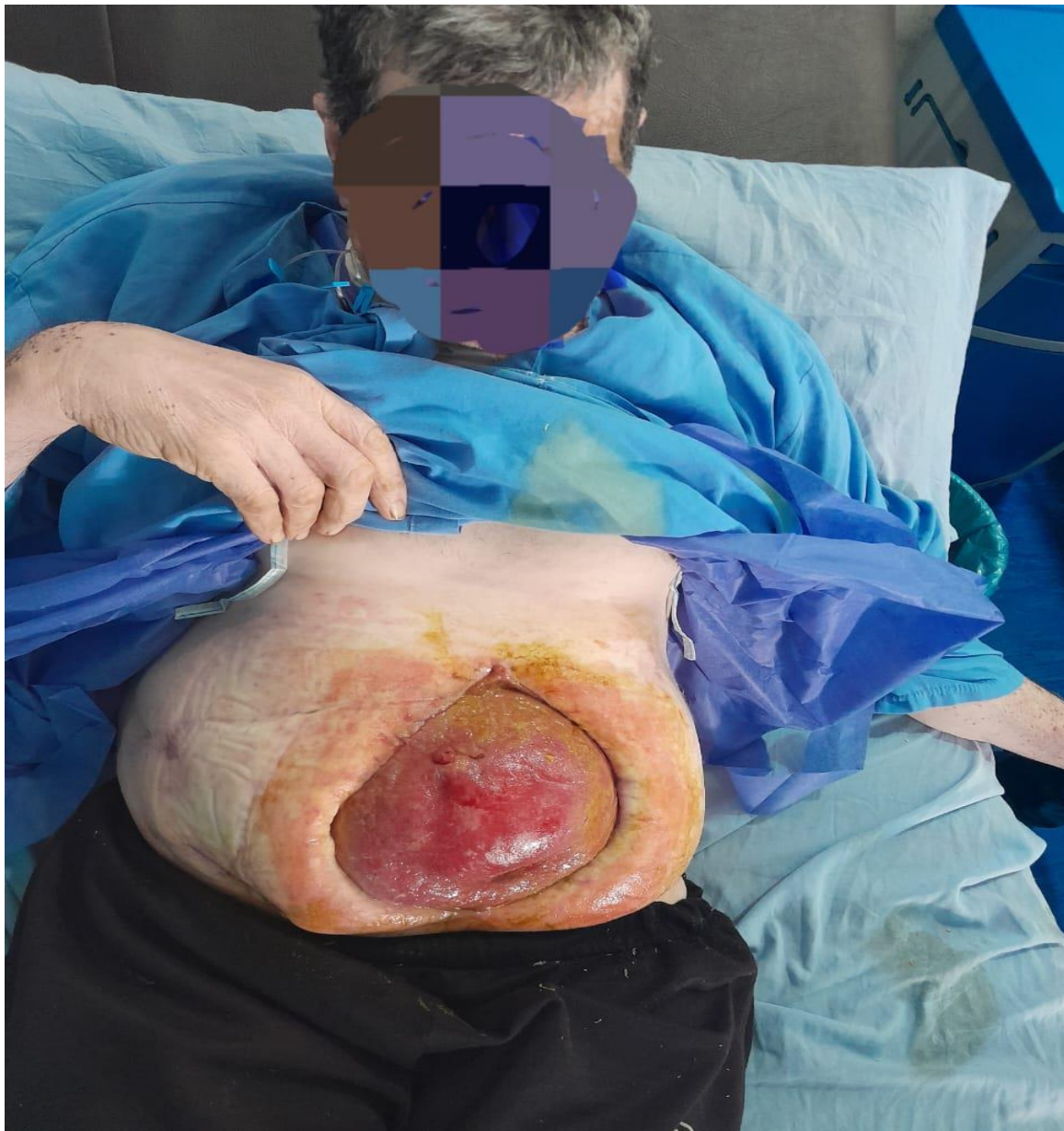


Figure (1): Before Applying of Vacuum Assisted Closure (VAC)



Figure (2): After Applying of Vacuum Assisted Closure (VAC)



Figure (3): Before Applying of Vacuum Assisted Closure (VAC)



Figure (4): After Applying of Vacuum Assisted Closure (VAC)



Figure (5): Before Applying of Vacuum Assisted Closure (VAC)



Figure (6): After Applying of Vacuum Assisted Closure (VAC)

DISCUSSION

A severe postoperative complication that worries many surgeons is burst abdomen. On average, the wound is disrupted between the sixth and ninth day. The greatest pathognomonic indicator of impending wound rupture is serosanguinous (pink) fluid coming from the wound. The most frequent risk factors include inadequate closure methods, deep wound infections, rising intra-abdominal pressure (IAP) in the early postoperative period, and poor patient metabolic status^[9].

With or without abdominal contents protruding, it is said that the abdominal wound's ability to totally close has been stopped. Separation of the face margins without evisceration and, infrequently, fibrin-coated intestinal loops are characteristics of partial wound dehiscence. Total separation of the fascia and skin, as well as the evisceration of the intestinal loops, are considered signs of wound dehiscence^[10].

For managing the open abdomen, a number of temporary abdominal closure techniques have been proposed, including the Wittmann patch (using two opposing sheets sutured to the lateral fascia to allow easy reoperation), sterilized zippers, and synthetic mesh^[11]. The Bogota bag is a sterilized intravenous fluid bag that is sutured to the fascia to allow the abdominal contents to expand. Primary fascial closure is the ultimate goal of each approach, and each has benefits and drawbacks^[12]. NPWT was launched in recent years as an alternative for the care of critically ill patients with an open abdomen^[13].

In NPWT, a suction dressing, also referred to as a vacuum dressing or a VAC® dressing (for "vacuum assisted closure"), is used to remove extra exudate and quicken the healing of acute or persistent wounds. The therapy comprises the controlled application of sub-atmospheric pressure to the local wound environment using a sealed wound dressing connected to a vacuum pump^[14]. The negative pressure causes a micro-deformation of the tissue, which has been shown to encourage cell migration and proliferation. Exudate from the wound is also removed, which speeds up the removal of matrix metalloproteinases and inhibitory mediators and encourages wound healing^[15].

According to the participants' demographic information, their average age was 47.18 ± 8.87 years with an interquartile range (IQR) of 46–55 years. 8 (47.1%) were males and 9 (52.9%) were females. The median age was 48 years. In terms of comorbidities, 16 patients (94.1%) had DM and 12 patients (70.6%) had HTN. In a similar vein, a hospital-based non-randomized comparative prospective interventional trial on 60 patients with AWD following laparotomy was conducted from July 2017 to November 2019. The 30 patients who received NPWT were among the 60 patients who had undergone laparotomies. The average affected age was 43.3 years. Males 46 cases (77%) had abdominal wound dehiscence more frequently than females (14 cases, 23%)^[14]. While, *Navsaria et al.*^[16]

conducted a prospective, open-label, non-comparative study between August 2010 and December 2011 in two centers in South Africa with 20 trauma patients receiving damage control laparotomy. ninety percent of the population was male, with a median age of 31.4 years (22-44). Additionally, 118 patients who underwent open abdomen treatment with negative pressure wound therapy between October 2006 and June 2014 at Trondheim University Hospital in Norway were retrospectively reviewed after being prospectively registered. This study identified 53 (44%) patients with abdominal compartment syndrome (ACS), 82 (69%) patients who were males, and a median age of 63 (20-88) years. 40 patients (34%) had HTN, and 6 patients (5%) had DM^[17].

Regarding the diagnoses of the study participants, the present investigation found that big pfnannenstiel and paraumbilical hernia, both with a prevalence of 17.6%, were the most frequent diagnoses. With a frequency of 17.6% each, sigmoid volvulus and intestinal obstruction were also frequent. With an incidence of 11.8% and lower, acute abdomen, large midline incision, wound necrosis, and RTA were less frequent. Aortic repair and bowel resections were the most frequent surgical procedures performed before or during the index operation for OAT, in contrast to *Seternes et al.*^[17] who found that abdominal aortic aneurysm was the most frequent diagnosis (38%). Additionally, *Tirpude et al.*^[14] discovered that out of 60 patients who were examined, 24 had perforation peritonitis, 9 had incisional hernias, 5 had malignancy, 4 had acute abdominal trauma, 1 had a psoas abscess, 3 had been delivered through lower segment caesarean section (LSCS), 7 had intestinal obstruction, 3 had SMA/SMV thrombosis, and the remaining 4 cases had various conditions.

In terms of the sorts of surgeries carried out on the study subjects, the majority of patients (47.1%) or patients who underwent exploration laparotomy (35.3%). One patient had an abdominoplasty and hernia repair, while two other patients underwent more involved surgeries including exploration laparotomies with left side colostomies or left leg above the knee amputations. *Seternes et al.*^[17] found that open aortic aneurysm repair, bowel resection, hemostatic surgery, and decompressive laparotomy were the most frequently performed surgical procedures prior to or at the index operation in an open abdomen.

The current study demonstrated that in terms of total days of VAC application, the mean total days was 30.53 ± 4.47 , with a median of 30.00 (interquartile range: 28.00-35.00). According to a comprehensive analysis by *Dumville et al.*^[18], the NPWT group reported median duration to healing was 57 days. In addition, the successful closure group time for NPWT application was 11.3 ± 6.9 days, whereas the failure closure group's duration was much longer at 18.9 ± 9.7 days.

Complications and results in the study's patients revealed that 17.6% of them were moved to the intensive care unit. According to **Seternes et al.**^[17], 113 patients required ICU care for a median of fifteen (1-89) days. 62 individuals required admission to HDU, which is often a step down from the ICU, for a median of six (1-36) days. In addition, fistula complications were experienced by 17.6% of patients. NPWT was formerly assumed to be connected to intestinal fistulation. An increased incidence of fistulation (6/29) was observed after NPWT treatment, according to a noncontrolled study^[19]. The findings of a nationwide study conducted in the United Kingdom of Great Britain and Northern Ireland, on the other hand, were exactly the reverse. NPWT for patients with open abdomens was not linked to an increase in fistulation, according to data from 578 individuals^[20].

Before drawing a definitive decision, NPWT should be applied more carefully. **Navsaria et al.**^[16] evaluated a variety of sequelae; one fistula (5%) was found in the course of the investigation in a single patient who had suffered penetrating trauma. The second dressing change revealed this low output fistula, but the next dressing change (48 hours later) revealed that it had healed.

The results of the current investigation showed that 5.9% of patients had good granulation tissue, 76.5% had success with secondary sutures, 5.9% had ileostomies, and 11.8% had colostomies. According to **Tirpude et al.**^[14], 36.66% of instances were resolved through secondary intention. In research by **Subramonia et al.**^[21], 27 out of 51 patients had secondary intention used to close their wounds. In the study by **Jang et al.**^[22], thirty-nine patients had their wounds treated (78%), 29 patients had their skin sutured, nine patients had granulation tissue form, and one patient had a prosthetic placed. Wound closure was unsuccessful in eleven patients (22%), while ten patients passed away from general deterioration. Thirty-one (61%) of the patients who had V.A.C. Therapy had effective wound healing, with healthy granulation tissue covering a flat confined lesion, according to **Subramonia et al.**^[21]. Of these, two patients had split skin grafting of the incision and secondary suturing of the fascial layers of the abdominal wall before being discharged.

Alternative TAC could not be as effective as NPWT at eliminating ascites that are proinflammatory cytokine-rich^[23]. NPWT may improve abdominal fascial closure by lowering visceral adhesion to the anterior abdominal wall while maintaining medial fascial traction and the abdominal domain. Furthermore, NPWT enlarges and deforms the abdominal wound, increasing its surface area and triggering angiogenesis and cell proliferation via a variety of techniques^[24].

LIMITATIONS

This study had several restrictions. First, a few of the patients were recognized backwards. Second, given the possibility of misclassification, data were retrospectively gathered for each patient from registries and patient records. Thirdly, although this cohort included individuals who experienced a burst abdomen at a specific time period, there were many cases, thus type II statistical error was probably going to occur.

CONCLUSION

We reached the conclusion that the majority of patients experienced burst abdomen following open hernia repair or exploration laparotomy, that the side effect of VAC was the development of fistulas and the use of a special sheet for covering the intestine prevented these complications, and that the majority of patients recovered successfully with secondary sutures. In the treatment of ruptured abdomen, NPWT played a significant role in the high rate of fascial closure and relatively low rate of complications.

- **Conflict of interest:** The investigators declared no conflict of interest.
- **Sources of funding:** There was no specialized grant from funding organizations for the current investigation.

REFERENCES

1. **Chabot E, Nirula R (2017):** Open abdomen critical care management principles: resuscitation, fluid balance, nutrition, and ventilator management. *Trauma Surgery & Acute Care Open*, 1 (2): e000063. doi: 10.1136/tsaco-2016-000063.
2. **Anastasiu M, Şurlin V, Beuran M (2021):** The Management of the Open Abdomen-A Literature Review. *Chirurgia*, 6 (116): 645-49.
3. **Duff J, Moffat J (1981):** Abdominal sepsis managed by leaving abdomen open. *Surgery*, 4 (90): 774-8.
4. **Coccolini F, Montori G, Ceresoli M et al. (2017):** The role of open abdomen in non-trauma patient: WSES Consensus Paper. *World J Emerg Surg.*, 12: 39-43.
5. **Coccolini F, Roberts D, Ansaloni L et al. (2018):** The open abdomen in trauma and non-trauma patients: WSES guidelines. *World Journal of Emergency Surgery*, 1 (13): 1-16.
6. **Mouës C, Heule F, Hovius S (2011):** A review of topical negative pressure therapy in wound healing: sufficient evidence? *The American Journal of Surgery*, 4 (201): 544-56.
7. **Yadav S, Rawal G, Baxi M (2017):** Vacuum assisted closure technique: a short review. *The Pan African Medical Journal*, 28: 246. doi: 10.11604/pamj.2017.28.246.9606
8. **Faust E, Opoku-Agyeman J, Behnam A (2021):** Use of negative-pressure wound therapy with instillation and dwell time: an overview. *Plastic and Reconstructive Surgery*, 1 (147): 16-26.
9. **Sultan A, Anwar H (2018):** Recent Therapeutic Alternative Methods for Burst Abdomen and its Relation to Development of Incisional Hernia. *The Egyptian Journal of Hospital Medicine*, 10 (73): 7632-37.

10. **Mahey R, Ghetla S, Rajpurohit J et al. (2017):** A prospective study of risk factors for abdominal wound dehiscence. *International Surgery Journal*, 1 (4): 24-28.
11. **Demetriades D, Salim A (2014):** Management of the open abdomen. *Surgical Clinics*, 1 (94): 131-53.
12. **Cristaudo A, Jennings S, Gunnarsson R et al. (2017):** Complications and mortality associated with temporary abdominal closure techniques: a systematic review and meta-analysis. *The American Surgeon*, 2 (83): 191-216.
13. **Sibaja P, Sanchez A, Villegas G et al. (2017):** Management of the open abdomen using negative pressure wound therapy with instillation in severe abdominal sepsis: A review of 48 cases in Hospital Mexico, Costa Rica. *International Journal of Surgery Case Reports*, 30: 26-30.
14. **Tirpude B, Borkar M, Lokhande N (2020):** Study of negative pressure wound therapy in management of abdominal wound dehiscence. *International Surgery Journal*, 7 (7): 2195-200.
15. **Baharestani M, Gabriel A (2011):** Use of negative pressure wound therapy in the management of infected abdominal wounds containing mesh: an analysis of outcomes. *International Wound Journal*, 2 (8): 118-25.
16. **Navsaria P, Nicol A, Hudson D et al. (2013):** Negative pressure wound therapy management of the "open abdomen" following trauma: a prospective study and systematic review. *World Journal of Emergency Surgery*, 1 (8): 1-8.
17. **Seternes A, Rekstad L, Mo S et al. (2017):** Open abdomen treated with negative pressure wound therapy: indications, management and survival. *World Journal of Surgery*, 41: 152-61.
18. **Dumville J, Hinchliffe R, Cullum N et al. (2013):** Negative pressure wound therapy for treating foot wounds in people with diabetes mellitus. *Cochrane Database of Systematic Reviews*, 10 (10): CD010318. doi: 10.1002/14651858.CD010318.
19. **Rao M, Burke D, Finan P et al. (2007):** The use of vacuum-assisted closure of abdominal wounds: a word of caution. *Colorectal Disease*, 3 (9): 266-68.
20. **Carlson G, Patrick H, Amin A et al. (2013):** Management of the open abdomen: a national study of clinical outcome and safety of negative pressure wound therapy. *Annals of Surgery*, 6 (257): 1154-59.
21. **Subramonia S, Pankhurst S, Rowlands B et al. (2009):** Vacuum-assisted closure of postoperative abdominal wounds: a prospective study. *World Journal of Surgery*, 33: 931-37.
22. **Jang J, Shim H, Lee Y et al. (2013):** Application of negative pressure wound therapy in patients with wound dehiscence after abdominal open surgery: a single center experience. *Journal of the Korean Surgical Society*, 4 (85): 180-84.
23. **Batacchi S, Matano S, Nella A et al. (2009):** Vacuum-assisted closure device enhances recovery of critically ill patients following emergency surgical procedures. *Critical Care*, 13: 1-8.
24. **Benninger E, Labler L, Seifert B et al. (2008):** In Vitro Comparison of Intra-Abdominal Hypertension Development After Different Temporary Abdominal Closure Techniques. *The Journal of Surgical Research*, 144: 102-6.