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# Effect of negative pressure wound therapy on wound healing

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**Abstract: Background:** A wound may be defined as any disruption of the integrity of skin, mucous membrane or organ tissue. A distinction is made between simple wounds that are confined to the skin, and complicated wounds which are deeper and also involve injury to muscles, nerves, and vessels. Delay in wound healing poses the risk of additional wound complications like infection and disruption. It is a major contributor towards morbidity of surgical patients, adds to the cost of treatment and consumes a lot of hospital resources. The NPWT system (also known as microdeformational wound therapy MDWT or Vacuum assisted closure VAC) is a relatively new technology in wound management. **Objective:** This study is designed to evaluate NPWT methodology as a technique for management of difficult open wounds in paediatric surgery practice. Giving clinical examples of the usage of NPWT from our university, Ain shams university hospitals, department of pediatric surgery. **Methods:** This is a case series study was done at paediatric surgery department), Ain Shams University Hospitals study was conducted over a period of 6 months. **Results:** Advantages of NPWT to be discussed are better and faster wound healing, less discharge, short hospital stay and lower cost than the conventional dressing while it also has some disadvantages and challenges as sponge adherence to the surrounding tissues, possibility or contra-indication of usage with enteric fistula. **Conclusion:** NPWT showing great results but it needs more time to study and observe its usage to reach the optimum benefit out of it and to avoid its complications as much as possible.
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**Keywords:** Negative pressure wound; wound healing

## 1. Introduction

The NPWT system (also known as microdeformational wound therapy MDWT or Vacuum assisted closure VAC) is a relatively new technology in wound management. The general system is made up of 4 major components: (1) a filler material or sponge placed into the wound; (2) a semipermeable dressing to isolate the wound environment and allow the vacuum system to transmit subatmospheric pressures to the wound surface; (3) a connecting tube; (4) and a vacuum system. A fluid collection canister is also incorporated with the device. As a precautionary measure, an alarm sounds if the canister is full, alerting clinicians to potential bleeding problems [(1)].

The structure of the material packed into the wound may be important in the efficacy of NPWT. Although different materials may be used with various NPWT devices, reticulated, open-pore foam is the most common. This foam is made of many cells or bubbles that are highly interconnected. This structure, as the name suggests, resembles a 3-dimensional net, which is in the form of a lattice of open-faced polyhedra. Importantly, this attribute permits the vacuum to be distributed evenly throughout the foam and improves fluid drainage. When using NPWT devices in mobile areas such as the abdomen, significant shrinkage of the wound can be observed as the wound edges come together by a combination of foam shrinkage and drawing the edges of the wound together by foam contact [(2)].

At the wound interface, the foam creates microdeformations that stretch cells and activate molecular pathways for angiogenesis and cell division. For wounds with edema, these devices have the capacity to remove a large amount of fluid. For example, in large open abdominal or fasciotomy wounds, significant quantities of edematous fluid can be removed, resulting in decreased tissue swelling. In addition, because of the materials used to cover the wound, the dressing acts as an insulator to keep the wounds warm and moist. In our practice, we use these

devices after the wounds are debrided and are clean of visible necrotic material [3].

They can be used until the wound is closed or used in preparation for surgical closure such as a skin graft or flap. These devices also have the advantage in that they often only need to be changed every 2-3 days, reducing the number of dressing changes for patients [4].

The early clinical results of case reports and small series were impressive, prompting surgeons to apply this technology to a wide range of clinical problems. These devices have been commonly used to treat pressure sores, open abdomens, sterna wounds, traumatic wounds, diabetic foot infections, second-degree burns, and skin graft recipient sites. They are contraindicated in untreated fistulas, untreated osteomyelitis, or in a wound with malignant tumor present. Caution should be used when the porous foam is used around vascular structures such as the heart or large blood vessels because erosion may occur, resulting in massive blood loss. Caution must also be taken when placing the porous foam in contact with visceral organs because erosion can occur, leading to fistula [5].

**Aim of the Study**

This study is designed to evaluate NPWT methodology as a technique for management of difficult open wounds in paediatric surgery practice. Giving clinical examples of the usage of NPWT from our university, Ain shams university hospitals, department of pediatric surgery.

## 2. Patients and Methods

This is a case series study was done at paediatric surgery department), Ain Shams University Hospitals study was conducted over a period of 6 months.

All patients with highly infected wounds/Open burst wounds were recruited in the study**.**

Patients with clean closed wounds/Wounds with Fistulas to organs/Wounds with malignant or necrotic tissuewere excluded from the study.

Informed consent from patients care giver who are invited to participate in the research.

**All patients included in the study will be candidates for:**

**Clinical assessment**

Careful history taking as regard preoperative antibiotic coverage, immune deficiency, immune compromising drugs, General condition assessment.

**Preoperative Investigations:**

Routine preoperative investigations as CBC, kidney and liver functions, chest x ray, urine tests.

**Method of use:**

The NPWT involves a six step method. The following are the VAC steps, as detailed by Thomas in 2001: the foam dressing is cut to the approximate size of the wound with scissors and placed gently into position→ The perforated drain tube is then located on top of the foam and a second piece of foam placed over the top.

For shallower wounds, a single piece of foam may be used and the drainage tube is inserted inside it→ The foam, together with the first few inches of the drainage tube and the surrounding area of healthy skin, is then covered with the adhesive transparent membrane supplied.

At this stage it is important to ensure that the membrane forms a good seal both with the skin and the drainage tube →. The distal end of the drain is connected to the VAC unit, which is programmed to produce the required level of pressure→ Once the vacuum is switched on, the air is sucked out of the foam causing it to collapse inwards drawing the edges of the wound in with it→ Fluid within the wound is taken up by the foam and transported into the disposable container within the main vacuum unit Correct placement of the interface material is essential for successful NPWT.

We like to cut the foam so that it is slightly smaller than the wound and insert the interface material into all undermined areas or tracks. When possible, we use just 1 interface material that is carefully cut to fill any irregularities in the wound.

When more than 1 interface is used, it must to be carefully documented to assure that there are no retained foreign bodies. When granulation tissue is desired, the foam should be placed directly on the wound surface.

A no adherent contact layer should be used when granulation tissue is not desired or if the interface is over a luminal structure such as the bowel or large blood vessels. Having the suction port come out at a distance from the wound can help minimize the risk of additional pressure necrosis if weight is placed on the tube. A bridging technique where the foam continues from the wound to another location is frequently used for wounds located near the perineum or buttock or undermined wounds with a small skin opening.

We avoid placing the foam directly on top of intact skin and prefer to place this over a polyurethane drape or hydrocolloid dressing.

**Follow up:**

All the patients will be followed up postoperatively for length of hospital stay and surgical complications, Surgical wounds will be followed daily for a week to follow up the wound condition.

**Statistical Analysis:**

Descriptive statistics will be applied as appropriate.

## 3. Results

This study was applied at Ain shams university

hospitals, Pediatric surgery department.

*Only one patient where VAC was applied on open wound and the rest of the seven patients VAC was applied on closed wound.

*In this study VAC was applied on:

1. One patient with clean contaminated wound (12.5%)
2. Four patients with contaminated wounds (50 %)
3. Three patients with dirty wounds (37.5 %)

**Table (1): Descriptive analysis**

| Patient | Age of the patient | Type of wound | Serous Exudate | Purulent Exudate | Erythema | Granulation tissue formation | Pain | Improvement After VAC |
|---|---|---|---|---|---|---|---|---|
| 1.Zaman ibrahim | 3 months | Open contaminated wound | Still discharging because of open abdomen | stopped | improving | improving | decreasing | Better |
| 2.Kerolos magdy | 7 years | Closed contaminated wound | stopped | stopped | improving | Great improvement | decreasing | Better |
| 3.Hassan Mohamed | 1 year | Closed dirty wound | stopped | Was still discharging | improving | improving | Cant asses (Patient was sedated) | Better |
| 4.Mahmoud oda | 1 and half year | Closed contaminated wound | Stopped | Stopped | improving | improving | Decreasing | Better |
| 5.Islam Adel | 3 years | Closed dirty wound | Stopped | Stopped | improving | improving | Not much | better |
| 6.Mahmoud mostafa | 6 months | Closed dirty wound | Stopped | Stopped | improving | improving | decreasing | better |
| 7.Farida mostafa | 2 years | Closed potentially contaminated wound | Stopped | Still discharging | improving | improving | decreasing | better |
| 8.Hana mokhtar | 6 years | Closed clean contaminated wound | Stopped | Stopped | improving | Improving slowly | Decreasing | better |

## 4. Discussion

Papers referring to NPWT in PSC are scarce. Only retrospective case series and case reports are available, generally mixing many different clinical situations, so that the available evidence for the usage of the device is low, despite favorable results.

Along with the classic indications found in literature for adult cases (treatment of extensive deep tissue loss with and without infection, ACS, laparostomy and large complex postoperative wounds), new applications were developed in Pediatrics, including treatment of complicated abdominal wall malformations chemical/aseptic necrosis, vesico-cutaneous fistula and vascular malformations.

Method of use of customized VAC devices is as follows: first the adherent tape is applied to the skin then a piece of that tape to be cut so that the wound becomes exposed, then the sponge is modified according the size of the wound and applied over the wound after creating a tunnel for the nelaton 18 catheter to be inserted, after applying the sponge another layer of the transparent adherent tape is put allowing no air as much as possible between the sponge and the final layer of the adherent tape, The pump suction is turned on and observing the suction going on over the wound is the last step to ensure proper application of the dressing [(6)].

The proprietary systems consist of special porous polyurethane sponges to be cut in the shape of the wound in order to fill its cavity, a rounded aspiration device that must be positioned directly over the sponge in the center of the wound and a transparent adhesive film that isolates the system and enables the vacuum to be established over the entire surface. The catheter is connected to a pump that generates controlled negative pressure in a continuous or intermittent mode and collects the wound effluent in a canister, where it can be measured [(7)].

All the elements of the system are disposable, except for the vacuum generator machine. The sponges are available in three types: the traditional “black” sponge with large (400–600 μm) pores (GranuFoam), a silver-impregnated sponge designed for heavily infected wounds and a “white” polyvinyl no adherent alcohol sponge with smaller pore size (VersaFoam), to be used overexposed visceral or delicate surfaces (available in the abdominal-VAC system) [(8)].

Some believe that the “white” no adherent sponge allows less painful aspiration, while the “black” sponge is a better choice for wounds presenting copious amounts of drainage and more efficient to generate granulation tissue [(9)].

Sterile multi fenestrated plastic or no adhesive petrolatum impregnated gauze should be used to protect exposed viscera and may be customized from sterile “blood” bags (“Bogota bag”) like the one used with patient number 1 zaman Ibrahim a 3 months old male patient presented with Abdominal distension and AXR showing Air under the diaphragm Exploration revealed idiopathic sigmoid perforation followed by sigmoid colostomy, Abdominal wound was infected and burst abdomen occurred despite frequent dressing After closure of the abdomen by tension sutures [(10)].

The wound burst one more time, the patient was re operated again where a sterile blood bag was inserted intra-abdominally with multiple fenestrae

done to allow absorption of discharge followed by taking traction sliding sutures on the muscles and skin to help in the wound closure and the NPWT system was applied. Dressing was done daily on the wound with sliding the sutures tracking the muscles and skin until the patient had almost a closed wound week after and the patient had tension sutures to the skin and muscles under general anesthesia after removal of the sterile blood bag [(11)].

Customized NPWT devices has a greater benefit than the conventional NPWT regarding the cost effectiveness as the devices are generally cheaper (the proprietary device costs around 8000 thousands Egyptian pounds compared to only 2000 of the customized) plus easily trainable and can be used at home with daily nursing dressing that decrease the time of hospital stay. Comparison between modes of suction should be under the spot light. The continuous mode is possibly less painful. Some evidence suggests better efficacy towards generating granulation tissue while on the other side using intermittent suction may be slower regarding the healing results but can be used in cases of hemorrhage with NPWT usage or huge discharge [(12)].

The usage of NPWT with neonates is negligible as Neonates and small infants, not surprisingly, are the most frequent Pediatric Surgery patients treated with NPWT, owing to the relatively high frequency of abdominal catastrophes (especially necrotizing entero-colitis and bowel necrosis) and complicated abdominal wall malformations in this specific population. But, this age group is typically very difficult to manage due to bad general condition and critical care and service [(13)].

Advantages of NPWT to be discussed are better and faster wound healing, less discharge, short hospital stay and lower cost than the conventional dressing while it also has some disadvantages and challenges as sponge adherence to the surrounding tissues, possibility or contra-indication of usage with enteric fistula [(14)].

## Conclusion

NPWT showing great results but it needs more time to study and observe its usage to reach the optimum benefit out of it and to avoid its complications as much as possible.

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