Use of NPWT with instillation in complex chronic wounds — a Kuwaiti experience


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Negative pressure wound therapy combined with timed, cyclical instillation (NPWTi) of topical wound solutions has been presented as a new adjunctive modality for treating wounds with signs of infection. The authors present their experience of using NPWTi to treat complex and chronic wounds; the first such instance reported from Kuwait. This article presents six cases of NPWTi use in Kuwait.

Negative pressure wound therapy (NPWT), as distributed by V.A.C.® Therapy (KCI USA, Inc, San Antonio, TX), was introduced by Argenta and Morykwas (1997). Mechanisms of action for NPWT include drawing wound edges together, removing infectious materials, reducing oedema, promoting perfusion and creating tissue microdeformations, leading to cell stretching and subsequent cellular activity that are important for wound healing. The most visible clinical effect is wound reduction linked to subsequent granulation tissue formation (Morykwas et al, 1997).

At a later date, a technically improved NPWT system with instillation was designed — V.A.C. VeraFlo™ Therapy (KCI) — with volumetric distribution and removal of topical solutions that could be used as adjunctive treatment for infected wounds, wounds at high risk of infection and/or wounds that have not responded to conventional NPWT (Brinkert et al, 2013).

Since the introduction of Negative Pressure Wound Therapy with Instillation (NPWTi) in the first decade of the 21st century, many reports of its successful use in the management of different types of chronic and complex wounds have been described (Brinkert et al, 2013; Wolvos, 2013).

The first consensus panel of expert users recommended the use of NPWTi as an adjunctive therapy in acutely and chronically infected wounds, contaminated wounds, diabetic wounds, traumatic wounds, decubitus wounds, wounds with exposed bone, wounds with underlying osteomyelitis and as a bridge between staged/delayed amputations (Kim et al, 2013).

The plastic and reconstructive surgery unit at Adan hospital was the first centre in Kuwait to receive V.A.C. VERAFLO Therapy and use it. Since June 2014, hundreds of cases of various aetiologies and from different departments in Adan hospital have been managed successfully with the use of NPWTi.

The aim of this study was to describe the authors' experience using NPWTi for the management of complex and chronic wounds in one of the biggest hospitals in Kuwait. The authors have expanded the indication for its use based on their clinical experience. The benefits of the use of NPWTi is explained in this article with corresponding statistics. Detailed descriptions of the most remarkable cases managed by the plastic and reconstructive surgery unit using NPWTi in Adan hospital, together with a summarised outline of future plans, are presented in this article.

Patients and methods

During the 4-year period from June 2014 until June 2018, the authors were consulted to evaluate 638 adult cases of complex wounds. Of these, a total of 162 cases (25.4%) were managed by NPWTi. Indications to use NPWTi, as recommended by Kim et al (2015a), are:

- Wounds that require a revision ('second look') surgery
- Wounds that cannot easily be closed
- Severe traumatic wounds
- Wounds complicated by invasive infection or extensive biofilm
- Wounds in which healing progression has 'stalled' following traditional NPWT therapy
- Diabetic foot wound infections
- Exposed or infected bone (with or without

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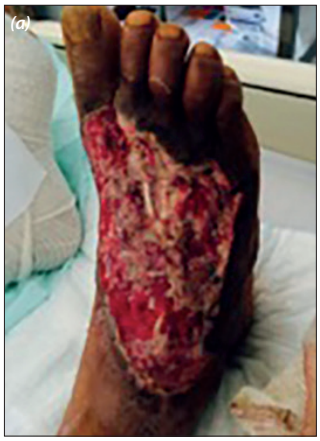

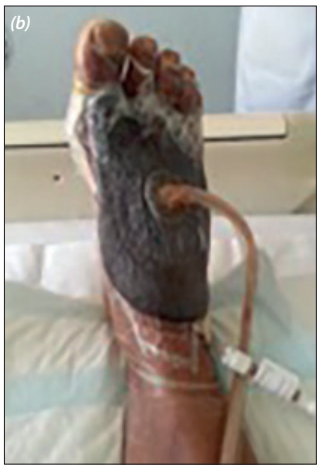

Figure 1. A case of traumatic de-gloving injury involving the dorsum of the right foot. Figure 1a. Unhealthy necrotic bed with exposed extensor tendons. Figure 1b. Dressing of NPWTi in situ. Figure 1c. Necrotic tissue was replaced with red and healthy granulation tissue and most of exposed tendons were covered.

traumatic defects)
- Ischaemic wound beds
- Necrotising fasciitis.

The instillation fluid of choice was Microsafe (Microcyn® Technology platform), which is available in Kuwait and the Arabian Gulf region (Sonoma Pharmaceuticals, 2019).

The decision to apply or discontinue NPWTi was made by agreement of the two authors. All patients and wounds were assessed at each dressing change and a decision was made to convert to conventional NPWT or proceed to wound closure. In cases of exposed hardware, tendons or bone, NPWTi was continued until sufficient granulation coverage was achieved. In some cases, additional debridement was performed and NPWTi was reapplied.

Results

A total of 162 cases were managed by NPWTi. *Table 1* summarises the number of cases of complex wounds consulted per year and the number of those wounds that saw NPWTi used on them. Wound closure was achieved in 153 of 162 wounds (93%). Closure was completed surgically via skin graft either directly or preceded by dermal substitutes application, flap or delayed primary closure. No wound recurrence or dehiscence was reported. Incomplete wound closure was observed in nine of 162 cases.

Variable cases of various aetiology were referred from nearly all departments within the hospital. Here, the authors present only the most remarkable cases that saw significant and outstanding results.

Case 1

A 46-year-old patient with known type 2 diabetes mellitus who was controlled on oral hypoglycaemic agents, presented with traumatic degloving injury involving the dorsum of the right foot. Although he underwent surgical debridement once, the wound bed was still unhealthy, necrotic and there were exposed extensor tendons *[Figure 1a]*. NPWTi was applied for 4 days, where 20 cc of Microsafe was installed that was soaked for 15 minutes every 6 hours of 125 mmHg negative pressure *[Figure 1b]*. Almost all the necrotic tissue was replaced with red and healthy granulation tissue, and most of exposed tendons were covered *[Figure 1c]*. Definite coverage of the wound was achieved by dermal substitute (Integra® Dermal Regeneration Template, Integra LifeSciences) followed by thin, split-thickness skin graft *[Figure 2]*. Long-term follow-up showed pliable and contoured coverage with normal function of extensors of the foot.

Case 2

A 31-year-old previously healthy married women, who was a mother of three, received a permanent filler injection to her hips and buttocks at her home, which was complicated by infection. She underwent incision and drainage in another centre. Her condition deteriorated and she required intensive care unit (ICU) admission with multi-organ failure (renal, shock, respiratory). On arrival, she was already intubated, on renal dialysis, and on high doses of inotropes. Wound examination revealed necrotising fasciitis *[Figure 3a]*. Urgent aggressive surgical debridement was carried out and resulted in a full-thickness defect to the deep muscles with remaining minimal necrotic tissue *[Figure 3b]*. The patient showed a dramatic improvement in her general status, where she was off inotropes, extubated in the first 48 hours following debridement. Five applications of NPWTi were initiated every 3 days. A total of 200 ml of Microsafe was installed with a dwell time of 10 minutes every 4 hours with target negative pressure of 100 mmHg. In 2 weeks, her wounds were ready for coverage *[Figure 3c]*. She was successfully covered with dermal substitute followed by split-thickness skin graft *[Figure 3d]*. The patient was discharged with acceptable functional coverage.

Case 3

A 73-year-old woman with long-standing complicated diabetes, hypertension, ischaemic heart disease and chronic renal impairment presented at the authors' hospital. She was admitted with an infected diabetic foot and an abscess on the ankle. She underwent multiple surgical debridement; the resulting wound affected the ¾ circumflect of the ankle posteriorly. The wound base did not show healthy granulation and there were areas of necrotic slough *[Figure 4a]*. After two applications of NPWTi, the wound bed was clean and covered with healthy red granulation within 1 week *[Figures 4b and c]*. The patient was discharged and travelled back to her country for further coverage.

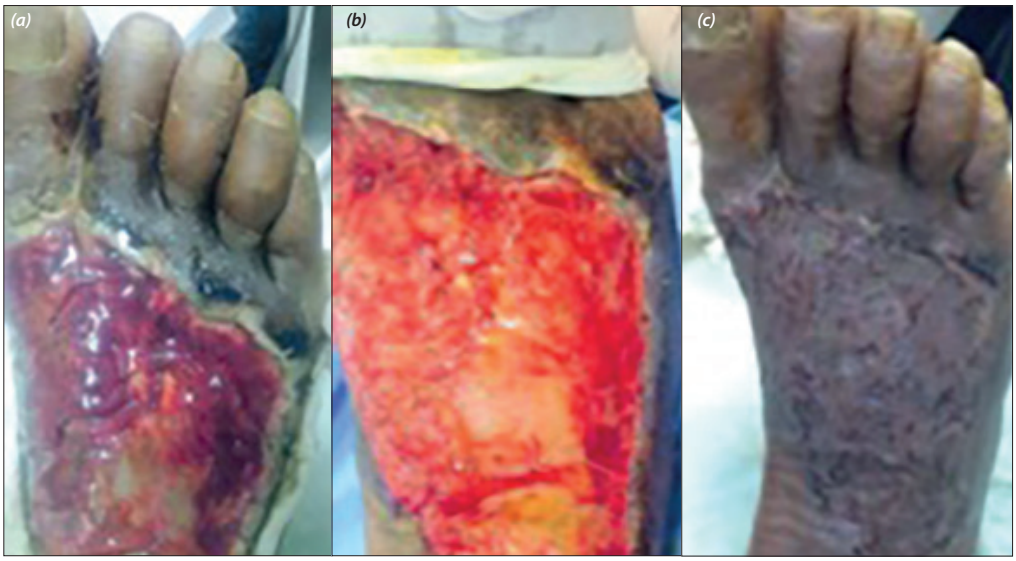

Figure 2a. Wound after 3 weeks of dermal substitute application. Figure 2b. After silicon layer removal and 100% take of Integra. Figure 2c. Coverage of the wound with thin split-thickness skin graft.

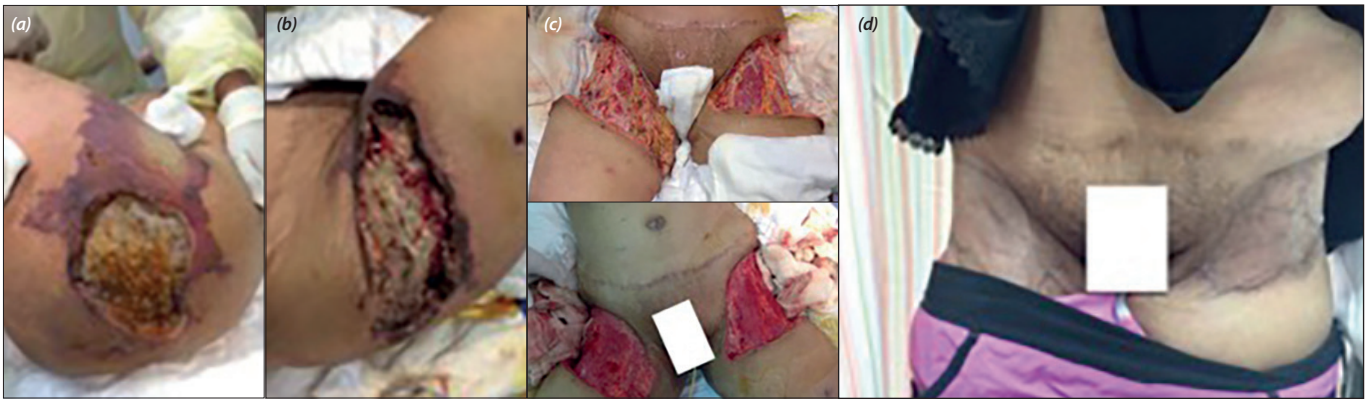

Figure 3a. Necrotising fasciitis on the bilateral groin and buttocks after infected permanent filler injection. Figure 3b. Status post first aggressive surgical debridement. Figure 2c. Wound after five cycles of NPWTi. Figure 2d. One year after coverage with Integra and skin graft.

Case 4,5 and 6

Cases 4,5 and 6 focus on patients presenting with Fournier gangrene, where all underwent aggressive surgical debridement of the scrotum, leaving both testes exposed. All cases involved only one application of NPWTi for 4 days, where it was found to help in covering the testes with healthy granulation tissue and reduced oedema, making the wound bed ready for definite coverage *[Figures 5, 6 and 7]*.

Discussion

NPWT main mechanism of action is to increase granulation tissue formation (Glass et al, 2014) and it was not indicated to be used over infected wounds. The advantages of NPWTi over the standard NPWT can be summarised in two aspects: firstly, reduction of bioburden and stimulation of wound healing, and reduction of bioburden in the form of mechanical debridement, reduction of biofilm and autolytic mechanisms (Gabriel et al, 2008; Bobkiewicz et al, 2016); secondly, it can be summarised as stimulation of wound healing in the form of thicker granulation (43%), greater reduction of wound volume and higher filling rate (Lessing et al, 2013; Kim et al, 2014).

The authors' 4-year study showed a steady increase in the percentage of cases managed successfully with NPWTi. It started with 13.9% in the first year and ended with 47% in the fourth year *[Table 1]*. The authors can explain the steady increased use of NPWTi due to gaining more experience over time, together with the expansion of the inclusion criteria.

A wide variety of cases referred from almost all hospital departments at Aden hospital were managed. These included, for example, diabetic foot, burst abdomen, wounds following incision and drainage, deep friction burn, degloving injury, necrotising fasciitis, Fournier gangrene, pressure sore, amputation stump necrosis, necrotic and infected flaps, sternal wound dehiscence with sternal osteomyelitis, rare autoimmune cases like pyoderma gangrenosum, and a rare fatal complication of chicken pox (varicella gangrenosa).

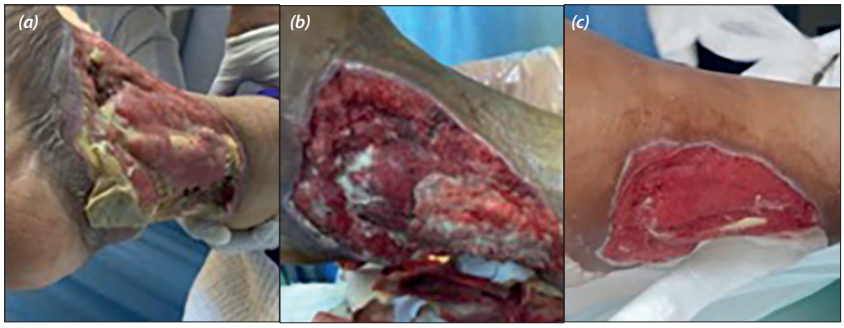

Figure 4a. Wound before application of NPWTi. Figure 4b. After one application. Figure 4c. After second application.

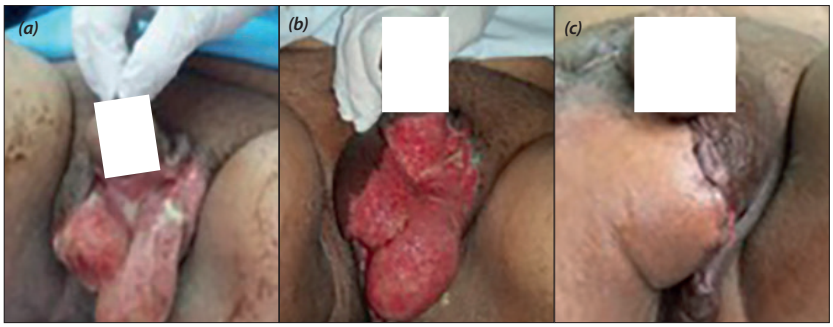

Figure 5a. After second application. unhealthy granulation tissue with necrotic slough 2 weeks after surgical debridement. Figure 5b. After one application of NPWTi using 10 ml microsafe with dwell time of 10 mins negative pressure of 75 mmHg every 6 hours. Figure 5c. Final wound after coverage with bilateral local flaps.

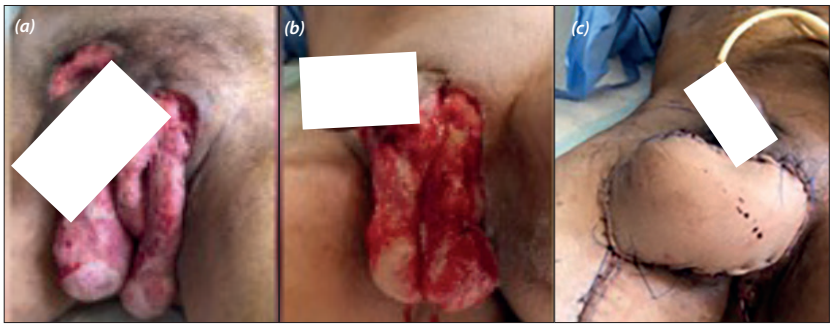

Figure 6a. Defect after 3 days surgical debridement Figure 6b. After one application of NPWTi using 20 ml microsafe with dwell time of 10 mins negative pressure of 100 mmHg every 4 hours. Figure 6c. Six months after coverage with right medial thigh flap.

The authors excel in the use of NPWTi in the paediatrics age group. There is another case series of patients younger than 10 years of age that were successfully managed by this technique. A separate paper is currently under submission with another journal dealing with that area.

The authors selected case 1 *[Figure 1]* as it was their first case managed by NPWTi. After the first surgical debridement, there was remaining unhealthy necrotic tissue with exposed extensor tendons. After one application of NPWTi, the wound bed showed a dramatic change with healthy red granulation tissue covering almost all the tendons. Wound bed preparation was achieved in 4 days and, hence, decreased time to wound closure with no extra operative visits.

The second case involved delayed necrotising fasciitis, after inadequate surgical drainage of infected permanent filler, as well as failures of three organs that carries a very high mortality rate (90%), yet the patient survived. With the help of NPWTi, her extensive and deep wounds were covered in 3 months' time. The patient and her family were very grateful, and she was very satisfied, recently giving birth to her fourth child.

The cases of Fournier gangrene required only one application of NPWTi. This is likely due to good blood supply in that region, together with the benefits of instillation added to the classic NPWT, as mentioned earlier. Although the perineum is a difficult anatomical area for adequate seal due to proximity to penis and anal verge, the authors were able to manage the seal perfectly with our own technique of applying thin hydrocolloid dressing around the wounds, penis and anal verge.

Wound closure was achieved in 153 of 162 wounds (93%). Closure was performed surgically via skin graft either directly or after dermal substitutes application, flap or delayed primary closure. There was no incidence of wound recurrence or dehiscence at the operated sites. Incomplete wound closure was observed in just nine of the 162 cases — six left for healing by secondary intension, according to patient preference. Three patients travelled abroad to continue their coverage in their respective countries.

There were no complications directly related to the application of NPWTi, because the decision of application was made personally by the two authors. However, there were a few technical errors in the form of kinking of the irrigation tube or blockage of the suction tube by debris, which were managed immediately by release of kink or the change of the suction tube, respectively.

In the prospective clinical study conducted by Brinkert et al (2013), 131 patients with 131 wounds were treated with NPWTi using saline between January 2012 and December 2012 in two orthopaedic centres and one surgical wound healing centre in France. Wound closure was achieved in 128 of 131 wounds (98%). Incomplete wound closure was observed in three of 131 cases (2.2%) — one due to limb ischaemia and two due to death unrelated to the therapy. The authors achieved similar wound closure rates (93%) with no mortality cases or major complications.

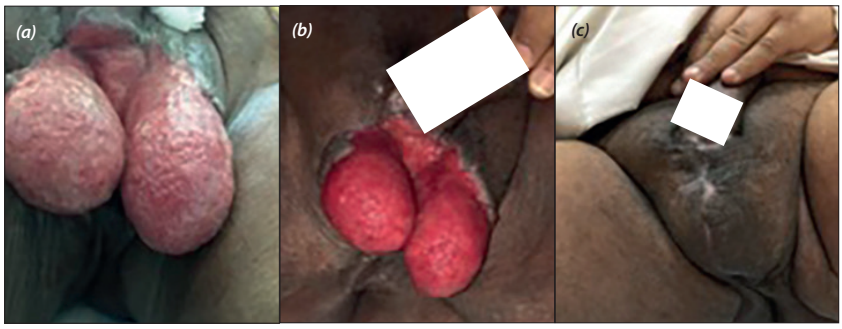

Figure 7a. One week after multiple surgical debridement. Figure 7b. After one application of NPWTi using 15 ml microsafe with dwell time of 10 mins negative pressure of 100 mmHg every 4 hours. Figure 7c. Six months after coverage with bilateral local flaps.

Table 1. The number of complex wounds consulted by year and number of cases that NPWTi was used.

Number/year	2015	2016	2017	2018	Total
Wounds	173	175	160	135	638
Use of NPWTi (%)	24 (13.9%)	31 (17.7%)	43 (26.9%)	64 (47%)	162(25.4%)

As previously mentioned, the instillation fluid of choice is Microsafe, Microcyn, although Kim et al (2015b) found no significant difference between the type of instillation fluid used in NPWTi whether normal saline, Dakin's solution, Microcyn, chlorhexidine or diluted betadine. However, the authors noticed significant clinical difference between Microsafe and other instillation fluids. The authors experienced faster granulation, better quality of granulation tissue (healthier and bright red) when the installation fluid was Microsafe. This article represents the authors' subjective observation only; a double-blinded controlled randomised study will be conducted to prove this observational finding at a later date.

Conclusion

The use of NPWTi for the management of complex and chronic wounds is a reliable tool that accelerates wound bed preparation and reduces operating room visits. The authors suggest the need for a well-designed, double-blinded, controlled randomised study before recommending the routine use of Microsafe as the instillation fluid, as they subjectively noticed faster and better quality of granulation compared with normal saline. WME

Conflict of interest

None.

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