# Closed incision management with VAC Prevena after lower-limb surgery: literature review and local experience






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Leg wound complications after open vascular surgery are fairly common and can have high morbidity. This makes optimal incision management critical for good patient outcomes. Closed incision management is a fairly new modality that aims to prevent wound complications through the use of topical negative pressure wound therapy. Here, we provide a brief overview of the literature on closed incision management for leg wounds due to vasculopathy and describe our local experience in a case series of patients treated prophylactically with vacuum-assisted closure after surgery for lower limb revascularisation.

Patients who undergo vascular surgical procedures are often elderly and have concomitant diabetes mellitus and ischaemic heart disease. In our population, a substantial proportion also have end-stage renal failure. All of these factors contribute to poor wound healing and a propensity for wound breakdown and surgical site infection (SSI) (Cheadle, 2006; Kalish et al, 2014; Turtiainen et al, 2014). Vascular surgical incisions are usually extremely long (e.g. long saphenous vein harvest for femoral–popliteal or popliteal–distal bypass) or sited in dirty areas (e.g. the groin) or on the distal aspects of the lower extremity where vascularity is most tenuous (e.g. the foot).

The reported incidence of SSI in the groin after vascular surgery ranges from 3% to 44% (Matatov et al, 2013; Pledger et al, 2018). Matatov and colleagues (2013) found a 30% postoperative infection rate in patients treated with conventional dressings, while Pledger et al (2018) reported a 17% local infection rate and wound healing complications in 45% of patients receiving conventional therapy following vascular surgery. The rate of leg wound complications after long saphenous vein harvest is somewhat less, ranging from 1% to 24% of cases (L'Ecuyer et al, 1996; Slaughter et al, 1993; Gaballah et al, 2013). One series, however, reported complications in 32.6% of patients (Fowler et al, 2005).

We report the results of a literature review assessing the efficacy of negative pressure wound therapy (NPWT) in closed incision management following surgery. The rates of SSI are compared to conventional therapies. We then provide details of five cases where we have used vacuum-assisted closure (VAC) with Prevena™ to prevent SSI.

## Results

### Methods

We performed Pubmed and Cochrane English language searches for all studies relating to "closed incision management" and "prophylactic negative pressure therapy". Search terms employed included "closed incision management", "prophylactic negative pressure" and "negative pressure primary intention". Titles were screened for relevance and all studies relating to closed incision management were collated. Animal studies and studies not relating to vascular surgery were excluded, with the exception of cardiothoracic surgery articles describing saphenous vein harvest wounds and meta-analyses covering diverse surgical disciplines.

### Results

The majority of the online literature describing closed incision management relates to cosmesis (plastic surgery), SSI in orthopaedic patients and SSI in cardiothoracic patients with mediastinal wounds (Colli and Camera, 2011; Grauhan et al, 2013). There is a relative paucity of articles specific to vascular surgical patients' leg wounds.

Hyldig et al (2016) performed a systematic review of ten randomised trials studying NPWT with closed surgical incisions in predominantly orthopaedic patients but also some patients post breast-reduction surgery. They reported a significant reduction in wound infections (4.7%

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versus 8.9%) and seroma formation with NPWT compared to standard wound care.

Strugala and Martin (2017) performed a meta-analysis comparing the PICO prophylactic topical NPWT device with non-NPWT dressings in a diverse variety of surgical disciplines including orthopaedics, breast surgery, obstetric surgery, colorectal and vascular surgery. They found significant reductions in the risk of SSI with PICO treatment (4.8% versus 9.7%) based on the results of ten randomised controlled trials. On the basis of findings from six observational studies, the risk of SSI was reduced from 22.5% to 7.4%. When pooled, the risk of SSI was reduced from 12.5% to 5.2%with PICO compared to standard treatment. A reduction in length of stay was noted with PICO compared to conventional treatment, but this reduction was only clinically significant for colorectal surgery and laparotomy.

De Vries et al (2016) systematically reviewed and performed meta-analysis of 19 articles describing 21 studies and reported significant reductions in SSIs for NPWT in both the randomized controlled trials and observational studies. This translated into SSI rates reducing from 140 to 83 per 1000 patients for RCTs and 106 to 34 per 1000 patients for observational studies. Results for vascular surgery were mixed with an RCT not showing a significant reduction SSIs while another observational study did.

Sandy-Hodgetts et al (2015) performed systematic review and meta-analysis of 8 studies and also found a statistically significant reduction in SSIs for NPWT compared to standard surgical dressings. Ingargiola et al (2013) also performed a systematic review of 10 studies and found a significant decrease in SSI with incisional NPWT.

Matatov et al (2013) retrospectively compared 52 patients with groin incisions after vascular surgery dressed with VAC (Prevena) and 63 incisions dressed with either skin adhesive or nonabsorbent dressing. There was a significantly lower rate of infection in the VAC therapy group (6%) versus the skin adhesive/ dressings group (30%). All of the VAC group infections were Szilagyi grade 1; whereas in the conventional treatment group, 52.6% were grade I, 36.8% were grade II and 10.5% were grade III infections.

Weir (2014) performed a prospective case-control study of patients with bilateral femoral incisions for vascular bypass who had Prevena placed on one groin and standard dressings on the contralateral groin. In total only 8 patients were presented. Notably in the Prevena group complications were minor and managed conservatively (1 small haematoma and 1 superficial wound necrosis) whereas in the standard dressing group 2 patients developed seromas requiring surgery and 1 developed a deep wound infection requiring surgery. The author concluded that there may e a potential advantage to using Prevena.

Pleger et al (2018) prospectively randomised patients with groin incisions after vascular surgery to receive NPWT with Prevena ($n$=58) or conventional dressing ($n$=71) and found a significant reduction in wound complications at 30 days in the Prevena group (8.6% versus 42.3%; $p$<0.0005).

Similarly Engelhardt et al (2018) performed a prospective randomised controlled study of 132 consecutive patients schedules for longtitudinal femoral cutdown, where 64 patients received closed incision negative pressure therapy (ciNPT) and 68 received conventional dressing. Early wound infection rates were 6% in ciNPT versus 15% in control, and overall infection rates were 14% versus 28%, however these differences were not statistically significant. The authors concluded that larger multicenter studies are required.

Pesonen et al (2017) performed a retrospective analysis between 2013 and 2016 that compared 7 patients with prophylactic groin VACs for high risk wounds to 13 patients who required groin wound VACs for established wound complications. The authors concluded that prophylactic groin wound VAC for enhanced risk vascular surgery patients may proactively decrease wound morbidity, decrease readmission secondary to groin wound complications and provide some cost benefit.

Sabat et al (2016) published preliminary results at the midpoint of a prospective randomized trial comparing 30 groin incisions for femoral access dressed with Prevena versus 33 groin incisions dressed with conventional dressings. The results did not reach statistical significant but wound infections were higher in the control group (21.2%) compared to the Prevena group (6.67%) with a trend towards statistical significance and a risk reduction of 74%.

Lee et al (2017) performed a single-blinded single-centre randomised controlled trial of patients following great saphenous vein harvest for coronary artery bypass graft surgery. They randomised 39 patients to NPWT and 29 to conventional dry gauze dressing. There were no statistically significant differences in the incidence of SSI at initial assessment, at

discharge 1 week post-surgery, or 6 weeks after surgery. The infection rates were low in both groups, with 4% infection in the conventional treatment group and no infections in the NPWT group at 1 week and no infections in either group at 6 weeks. The NPWT group had a shorter median hospital stay compared with the conventional treatment group (6 versus 10 days) and were significantly more mobile initial assessment and at 6 weeks.

Acosta et al (2017) performed a systematic literature search for papers published between 2007 and 2016 on closed incision management in patients who had undergone open abdominal aortic aneurysm repair and leg fasciotomy. This review did not confine itself to wound prophylaxis but also included the treatment of open wounds with NPWT. The authors concluded that prophylactic closed incision management appears promising.

## Case study series

Here, we describe five case studies in which Prevena were been used following surgery to aid wound closure and healing.

### Case study 1

A 68-year-old female patient with a past medical history of diabetes, hypertension, hyperlipidaemia, chronic renal impairment and atrial fibrillation underwent a diagnostic coronary angiogram via superficial femoral artery puncture to evaluate an abrupt fall in ejection fraction. Her surgery was complicated by a large pseudoaneurysm with haemorrhagic shock, which was controlled by resuscitation and the placement of an emergency covered stent over the arteriotomy.

The patient subsequently developed a large swelling in her groin, with tenting of the skin and discolouration and blistering. The ultrasound scan showed a 15 cm x 8 cm x 5 cm groin haematoma that was treated with antibiotics and compression bandaging for 2 days until it pointed and ruptured focally through the skin *[Figure 1a]*. Debridement of the unhealthy skin was offered but the patient declined.

We initially treated the wound with regular dressing changes, but these soaked through frequently and caused the patient discomfort. We then tried a stoma bag around the discharging point *[Figure 1b]* but it leaked and tended to fall off. We finally settled on VAC with Prevena due to the convenience of exudate management and to assist in wound closure. Thereafter, fluid no longer leaked out of the dressing and the patient was much happier. The swelling and discharge had resolved by the completion of two cycles of Prevena *[Figure 1c]*.

### Case study 2

A 72-year-old woman with diabetes, hypertension and hyperlipidaemia presented with left-sided short-distance intermittent claudication and underwent an elective left common femoral endarterectomy and Vascu-Guard patch repair with subintimal recanalisation of a long superficial femoral artery occlusion, angioplasty, drug-eluting balloon and Supera stenting. Her left groin wound was closed with subcuticular sutures and Dermabond skin adhesive, but unfortunately there was a slight gap superiorly through which a moderate amount of serous fluid was expressed on wound inspection at

*Case study 1*

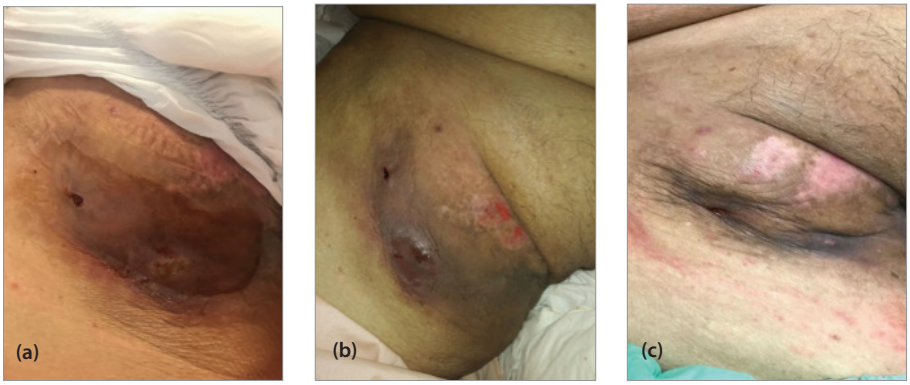


*Figure 1.* (a) Two days after the operation; (b) 3 days after the operation; and (c) after 14 days of Prevena therapy

*Case study 2*

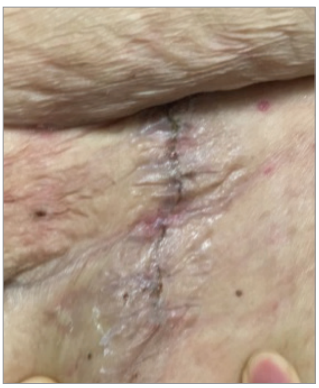

*Figure 2.* A single application of Prevena sealed the wound with no appreciable seroma

*Case study 3*

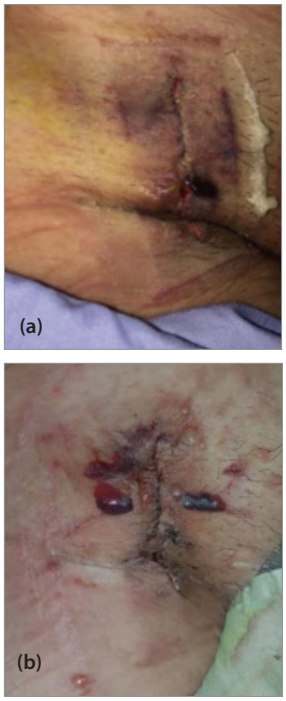


*Figure 3.* **(a) Postoperative day 1; (b) after 1 week of Prevena therapy**

postoperative day 2. This was treated with a single application of Prevena for 1 week, which resulted in resolution of fluid discharge and sealing of the wound. There was no appreciable seroma *[Figure 2]*.

**Case study 3**

This 69-year-old man had a history of diabetes, ischaemic heart disease with coronary artery bypass grafting in 1999, paroxysmal atrial fibrillation and known peripheral vascular disease with previous left femoral-tibial bypass. He underwent a right common femoral artery endarterectomy and patch and hybrid polytetrafluoroethylene-vein femoral-to-anterior tibial artery bypass for a non-healing ulcer on the right big toe. The groin wound was noted to be oozy with some ecchymosis on postoperative day 1 *[Figure 3a]*. Prevena was applied for a week with good skin union, although several small blisters formed adjacent to the wound *[Figure 3b]*. These subsequently resolved and the wound healed completely.

**Case study 4**

A 65-year-old man with ischaemic heart disease, diabetes, hypertension, hyperlipidaemia, end-stage renal failure and a previous cerebrovascular accident was admitted for a chronic right lateral malleolus wound. He underwent angioplasty with recanalisation of an superficial femoral artery chronic total occlusion and angioplasty to the popliteal artery, but unfortunately the peroneal artery was perforated during attempts to cross a tibioperioneal trunk occlusion.

As there was rapid calf swelling and pain, an emergency four-compartment fasciotomy was performed, with loose subcuticular Prolene running sutures and povidone gauze packing beneath. The patient's foot remained viable and the calf swelling improved, enabling the lateral wound to be gradually drawn closed on postoperative days 4 *[Figure 4a]* and 5 *[Figure 4b]*. The medial wound was closed by postoperative day 6. Prevena was applied to both wounds at this point *[Figure 4c]*, resulting in a marked reduction in the patient's pain. As a result, he began mobilising almost immediately. In total two cycles of Prevena were used, at which point the wounds were nearly completely closed *[Figure 4d]*. Epithelialisation was complete shortly after.

**Case study 5**

A 92-year-old man with a history of hypertension, hyperlipidaemia, previous cerebrovascular accident, dementia and previous subarachnoid haemorrhage presented with left acute lower limb ischemia secondary to thrombosed popliteal aneurysm as shown on duplex scan. We initially attempted to salvage his leg via an endovascular approach but were unable to cross the popliteal occlusion. The patient underwent an exclusion bypass with left-femoral popliteal reversed great saphenous vein bypass,and forefoot amputation due to multiple toe gangrene. Prevena was applied immediately postoperatively. The patient resumed ambulating shortly after and was discharged by

*Case study 4*

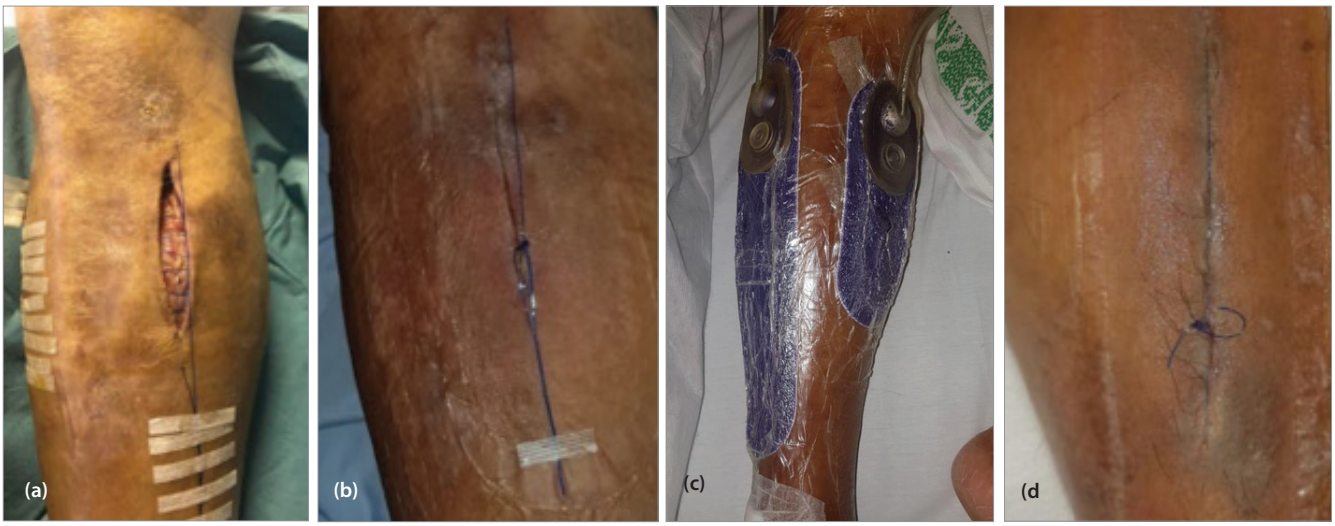


*Figure 4.* **(a) Postoperative day 4; (b) postoperative day 5; (c) application of Prevena after drawing the sutures taught; and (d) after two cycles of Prevena**

postoperative day 10. Notably, the wound had good skin union along its entire length after a single cycle of therapy.

## Discussion

A wealth of evidence is emerging that supports the efficacy of closed-incision management in preventing SSI and wound complications and its use looks promising for the management of lower limb wounds after surgical revascularisation. Adoption in practice remains patchy, however, because these therapies cost hundreds of times more than conventional gauze and tape dressings. It is difficult for physicians to justify the costs of closed-incision management, especially if they work in partially or non-reimbursed healthcare systems, as are no reliable tools to predict which patients will develop SSIs and are therefore most likely to benefit.

The sequelae and hidden costs of SSIs are substantial, however, and should be taken into account. SSIs increase hospital stay by an average of 9.7 days and increase costs by up to US$20,842 per admission (de Lissovoy et al, 2009). Prevena, in contrast, costs approximately US$288 for a weeks' therapy. Cost-effectiveness studies are needed to inform us whether the blanket use of such technologies will result in overall reductions in healthcare costs due to the prevention of SSIs. Otherwise, reliable predictive models need to be developed to enable physicians to identify particularly high-risk patients who should receive closed incision management. WAS

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